International Journal of Sustainable Development and Planning
Vol. 20, No. 10, October, 2025, pp. 4215-4226
Journal homepage: http://iieta.org/journals/ijsdp

# Monitoring System in Nursing Units of Hospital Architecture - Evaluation of the Visual System for Axial Pattern (T-Shape)

Ghada M. Younis*, Sinan Mohammed Talee

Department of Architecture, College of Engineering, University of Mosul, Mosul 41002, Iraq

Corresponding Author Email: ghadayounis@uomosul.edu.iq



https://doi.org/10.18280/ijsdp.201013

**Received:** 10 September 2025
**Revised:** 14 October 2025
**Accepted:** 27 October 2025
**Available online:** 31 October 2025

***Keywords:***
*nursing units, nursing monitoring, spatial organization, T-Shape ward, hospital*

**ABSTRACT**

Many entities designing healthcare institutions in most countries of the world seek to achieve and accomplish the goal of maximizing the quality of the medical and nursing monitoring system for nursing units, as one of the most important factors supporting the development and improvement of the level of nursing health services provided by hospitals in all their medical specialties. The research adopted the study of evaluating the quality of the monitoring system in the nursing station for nursing unit designs based on the impact of spatial distribution and the characteristics of space that support and achieve performance and effective connectivity (visual and axial) between the patients' beds and the nursing station as an integrated entity spatially and temporally and enhances the efficiency of functional performance and the quality of nursing monitoring. The study aimed to define the monitoring system tools in the nursing units of hospital architecture and the most important factors affecting the quality of performance by evaluating the structure of the visual and movement system of nursing stations. The research methodology was represented in building a theoretical framework for the design dimensions supporting the nursing monitoring system according to two axes: first, analyzing and studying the tasks assigned to the nursing staff, second, the spatial structure and connection between the nursing staff and patients. The theoretical framework was applied in a comparative study of one of the most important design patterns of the axial model (T-Shape). The study reached, through its focus on the sensory dimension supporting the monitoring system, the importance of the visual characteristics that enhance the factors of interaction and privacy for both the nursing staff and the patient, represented by: visual area, maximum visual radial, occlusivity, visual control, and visual controllability. The research concluded the importance and role of the design characteristics of the visual system in the functional performance of the nursing monitoring system and the importance of taking this role into account in future studies.

## 1. INTRODUCTION

The process of monitoring is the regular and continuous collection and analysis of information about the progress of the phased intervention (Cambridge Academic Content Dictionary). Among the classifications of monitoring is what is known as nursing monitoring, which means the need for the nurse to remain vigilant to follow up on patients and monitor all types of complications of the disease, in addition to what technical developments provide for nurses to monitor patients more effectively [1]. Currently, many competitive market trends in healthcare services have emerged that emphasize the importance of designing ideal nursing units with supportive and functional nursing stations, and the actual working environment in the hospital and nursing station designs in particular remain a largely unexplored possibility to meet the future requirements of healthcare services [2, 3]. The stages of progress in health monitoring systems have also been accompanied by major changes in the treatment of immediate disorders that threaten the patient's life, as the periodic quantitative assessment of measured physiological and biochemical variables has become essential in the decision-making process, as physicians perform immediate therapeutic interventions based on them [4]. Bayraktar Sari and Jabi [5] have highlighted significant advancements in hospital spatial layout design, emphasizing the integration of computational methods, facility layout planning, and machine learning (ML) techniques. The study dealt with defining the aspects related to the characteristics and elements of nursing monitoring systems, and the most important factors that enhance and support the efficiency of the functional and professional performance of nursing staff within the treatment halls system, to reach a comprehensive theoretical framework for the most important formal and structural characteristics and features. The research problem was represented by the knowledge gap of the factors affecting the enhancement of the quality of performance of the nursing monitoring system in terms of the efficiency of effective interconnection (axial and visual) between patients' beds and nursing stations. As for the objectives of the research, they were represented by answering the following questions:

- What is the nature of the nursing tasks assigned to the

nursing staff and their most important spatial and functional requirements?
- What is the nature of the mutual relationship between the patient and the nursing staff within the nursing monitoring system?
- What are the physical characteristics that support effective interconnection between members of the nursing staff to achieve optimal performance?

## 2. HEALTH SUPERVISION (MONITORING SYSTEM): PATIENT MONITORING

The definition of "Monitoring" in the Collins Dictionary and within the health field is what is required information about the disease, medications, health monitoring, through specific devices, etc. [6]. Health supervision or patient monitoring can be defined accurately as repeated or continuous observations or measurements of the patient and his physical physiological functions, as well as the functions of the life support equipment associated with him, to guide the required health care decisions such as performing therapeutic interventions and assessing the current condition of the patient. These interventions may not only alert caregivers to events that may threaten their lives, but many of them may also provide physiological input data used to control directly connected life support devices [6]. Patient monitoring can be performed for diagnostic purposes in the emergency room or for therapeutic purposes in the operating room. Monitoring techniques were used only in the intensive care unit years ago, but now they are routinely used in general hospital units [7]. Continuous measurement of patient symptoms is essential in both time and space, whether for the care of normal patients or those with serious conditions, such as heart rate, pulse, respiratory rate, blood pressure, blood oxygen level, and other symptoms, where accurate and immediate decision-making is crucial for effective and rapid patient care [8]. Electronic monitoring devices are used to collect and display physiological and organic data on the patient. This data is usually collected using sensors in hospital medical-surgical units, maternity wards, nursing homes, or private homes, to detect unexpected life-threatening conditions or to record routine and required data at a high level of efficiency [9]. There are two types of communication within the work of the nursing staff, the first is called (case talk) and the second (comfort talk), as they are related to the profession, gender, and physical layout of the hospital. Nurses use comfortable speech when interacting with patients and their families and providing support to patients through encouraging and informative messages, each form of communication is linked to a set of factors, including spatial configuration, communication styles, and professional identity [8]. Table 1 shows the most important nursing activities within the nursing monitoring system.

It is clear from the above that nursing monitoring is a continuous measurement of the symptoms appearing in patients by the nursing staff, and what this requires in terms of providing special spaces and places equipped with the latest equipment and sensing and control devices. The term monitoring or health supervision is synonymous with the processes of verification, observation, tracking, interaction and control. From the technical definitions of monitoring and health supervision, it appears that it has two axes, the first is within the work of a specific entity such as observation, monitoring, verification, and control, while the second works within more than one entity such as communication and supervision in addition to interaction (see Figure 1).

**Table 1.** Nursing activities (researchers)

| Vocabulary of Monitoring | Monitoring Indicators |
|---|---|
| Watching | Visual observation<br>Assessment of the patient's current condition |
| Monitoring | Provision of life support equipment (respiratory and cardiac)<br>Guiding medical care decisions<br>Public-private gateway |
| Tracking | Periodic examinations<br>Continuous examinations of vital signs<br>Timing of therapeutic interventions |
| Verification | Entering current patient data<br>Receiving and distributing therapeutic supplies<br>Transferring data between nursing stations |
| Communication and supervision | Visual communication<br>Walking distance and rapid access<br>Frequency of trips between staff and nursing unit |
| Interaction | Social interaction<br>Patient Privacy<br>Patient autonomy and identity<br>Visual exposure |
| Control and command | Proximity to requirements for a sense of control<br>Flexibility in space and furniture<br>Adaptability |

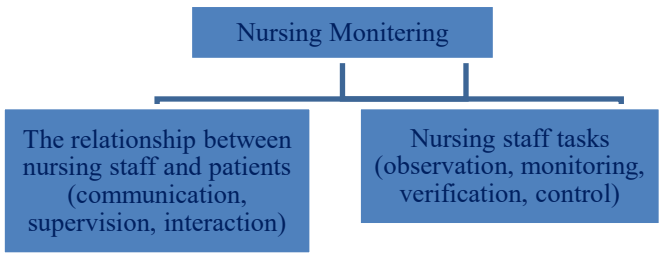



**Figure 1.** The relationship between nursing monitoring of patients and nursing staff (prepared by researchers)

## 3. THE NURSING UNIT

The term (nursing unit) refers to the space areas in the hospital building dedicated to providing healthcare of all types from simple to severe, where patients with similar needs are gathered to facilitate the provision of healthcare to them by medically trained specialists, and these units are usually managed by the nursing manager responsible for them [6]. There are different types of nursing units represented by inpatient and outpatient units, intensive care units, and other specialized care units. Managing work in nursing units is a complex matter at all its technical and procedural levels, as hospital administrations must take into account the formation of the work team, healthcare delivery patterns, community culture and the physical environment where services are provided [9]. There are three basic procedures for designing a nursing unit necessary to achieve effective nursing care [10]:

- Spatial grouping of service requirements, health care, and support services (including nursing stations) to minimize access time and walking distance for nurses.
- Minimizing unnecessary communication and design tools that hinder maximum contact between the nurse and the patient.
- Effectively incorporating these principles and procedures into the design of the nursing unit.

## 4. NURSING STATION

A nursing station is defined as a room or area used by nurses or other healthcare personnel from patient care staff who supervise or manage healthcare services [6]. It is the primary workstation that is usually assigned to a lobby suite and includes the reception area, admission and records desks, and a work area layout. It is also known as decentralized when there is more than one station within the same nursing unit [11]. The first signs of the emergence of the nursing station were in the design of nursing units that were built decades ago with one central nursing station, which resulted in some challenges related to privacy, social needs, noise levels, communication methods, and technology. While the decentralized nursing station was planned to keep the nursing staff closer to the patients, which resulted in nurses and doctors meeting and consulting in the corridors and within a close auditory distance from the patients [12]. Currently, the trend has been to use decentralized hybrid substations as nurses have become more mobile, represented by mobile or portable nursing stations that enable nurses to move their substations from one room to another [13]. Salman and Kadhim [14] recommend large intensive care units divided into smaller groups of units can be used to enhance privacy, and hybrid nursing station systems are used. Moving from central nursing stations to decentralized nursing units distributed in the form of cavities near patient rooms to increase monitoring, increase the security and safety factor, and integrate spaces to increase the access factor and response speed to provide patient comfort, and achieve a healing environment in the unite [14]. It is clear from this that the nursing station is the space for supervising healthcare services, as the design of the nursing station has evolved according to taking into account the privacy of patients and saving the effort of the nursing staff from single central stations to decentralized stations closer to patients to more flexible mobile stations.

## 5. DESIGN DIMENSIONS ACHIEVED FOR ACTIVITIES OF NURSING STATION

When studying the structural characteristics of the nursing unit space and its spatial and visual relationship with the nursing station resulting from studying the movement of the nursing staff, the nurse's movement requires determining the spatial locations according to the design of the nursing unit and is captured through traditional structural analysis, in addition to the motivational requirements associated with it, such as monitoring patients from the nursing station and placing it in areas that provide the best monitoring of patients' rooms and what is the minimum and maximum number of beds that can be seen at one time [15]. To achieve the optimal performance of the monitoring system and the main activities and tasks of the nursing station, the units must be designed according to the following design dimensions.

### 5.1 The functional dimension of nursing station

Evidence-based knowledge about the effects of nursing station design on nursing staff is essential and must be developed to improve their working conditions, which constitutes the indispensable basis for providing effective healthcare. Therefore, the function of the nursing station depends on the nature of its design [1]. The open design provides a clear view of the floor as a whole, which is believed to improve the condition of patients, In other words, a less open design leads to inhibiting interaction between the patient and the nurse [2]. The increasing prevalence of nursing care provision in nursing units requires more flexible and interconnected decentralized nursing stations, where factors such as (walking distances - accessibility - visibility - ease of supervision) are critical issues for design [3]. However, nursing staff in decentralized stations have increased their sense of isolation from their colleagues and lost the sense of connection with the team as a whole [13]. Therefore, proximity is one of the requirements for the sense of control for staff, as the patient must be close to the nursing station, i.e., by reducing the distance between the nursing station and the patient rooms. Among the factors that work to increase the sense of control and dominance are flexibility and adaptability, meaning easily adjustable furniture, as well as the presence of a personal workspace to increase the sense of control [16]. The presence of isolated spaces within the nursing station as private professional spaces for staff to preserve patients' secrets, in addition to the availability of places to supply services, equipment, and materials near the nursing station and sufficient storage spaces, and what is required in designing short corridors to reduce effort and reduce time [16]. The contribution of Elkhamisy et al. [17] is a method that bridges spatial analytics with experiential validation, supporting evidence-based, user-centered design in constrained healthcare renovations. The study addresses several key limitations:

- Expanding the diversity of participant groups is essential; including patients, administrative staff, and additional healthcare professionals beyond doctors will provide a more comprehensive understanding of how different user types of experience and interact with ED environments.
- Extracted motion data from VR simulations should be further analyzed using motion dynamics and kinematic profiling techniques to gain deeper insights into behavioral patterns, navigational efficiency, and cognitive load under high-stress scenarios.
- Additional design attributes—such as lighting quality, furniture layout, and acoustic performance—must be integrated into future evaluations [17].

### 5.2 Social dimension of nursing station (communication and interaction)

The social dimension is an important aspect of the nursing station that needs further analysis. It includes the interaction of nursing staff in the workplace, job satisfaction, reducing staff turnover and burnout, as well as social communication

between staff and patients [18]. From a communication perspective, the hospital is viewed as a social and physical context where designs that support social communication can improve health conditions [8]. Wakefield [19] identified a number of its practical social functions as a dedicated area for the provision of care and separate from the nursing unit, as a symbolic barrier separating the public and private space of the nursing unit, as a mechanism of social control, and as a reference point where individuals request formal permission to enter the unit before proceeding to their patients' rooms. Furthermore, the nursing station plays a professional surveillance role as a "gatekeeper" allowing staff to expedite the daily flow of work by assessing, filtering, and classifying individuals and their reasons for entry. On the other hand, face-to-face consultations are an important part of the medical and therapeutic profession within central meeting areas, and this activity may be carried out in the corridors of nursing units [20]. The International Organization for Migration (IOM) (2001, 2011) has identified communication as a critical factor in clinical quality, safety, collaboration, and teamwork, as the most significant underlying cause of sentinel events (monitoring) [8]. The concept of an open, patient-centered nursing station provides a more welcoming environment in which patients or family members feel more comfortable communicating with nurses [19]. It also provides a clear view of the floor, which is believed to improve patient safety. This serves as a model for designing nursing stations that support patient-nurse interaction [2], while decentralized stations typically improve visibility but increase feelings of isolation from coworkers and a loss of a sense of teamwork [13]. Nurses in centralized stations share more patient-related information with other nurses, receive more support, communicate more with other providers, and have a greater sense of formal and informal teamwork than in decentralized units [21].

### 5.3 Time dimension (time investment): Time usage

Walking distances and frequencies between patients and nursing staff are among the most important and common studies in nursing unit designs [22]. The travel distance for each nurse is the result of the total distance traveled between the different parts mentioned above and the number of trips made for each task, and this is related to the location of the station for the patient, as service rooms have a great impact on nurses' walking distances [23]. Therefore, the location the design of the nursing station affects the efficiency of care delivery, travel time, walking distance, patient monitoring, and staff satisfaction [3]. During nursing service, nurses spend a lot of time walking, as up to 28 percent of staff time can be spent walking [22]. The type of nursing station and unit design naturally affect the walking rate, and some research studies have revealed the effect of unit design on nurses' walking distances [24]. The circular nursing unit design with a central nursing station reduces walking distance because the nursing station is surrounded by patient rooms, and has direct access to all patient rooms and better monitoring [23]. The radial unit design also requires less walking per shift by nurses compared to the corridor unit and cluster unit design [24]. Decentralized nursing stations also allow nurses to interact more closely with patients, reducing staff's ability to walk and increasing patient care time, especially when supply spaces are also decentralized and located near the nursing station, bringing staff closer to the logistical supplies physically and visually from patients helps reduce the time spent walking [25].

### 5.4 The sensory dimension includes

5.4.1 The psychological dimension (patient-nursing staff & patients' privacy)

It is known that respecting patients' privacy within the nursing unit space is important for physical, mental, emotional, and spiritual recovery [26]. Most studies in the field of patient privacy examine physical privacy with a focus only on the hospital environment, while it has been shown that the loss of physical privacy leads to a feeling of stress, which is linked to the inability to process information in the surrounding environment and failure to understand doctors' instructions or recommendations [1, 27]. Developing targeted, interdisciplinary approaches that balance technological innovation with human judgment will be essential for creating hospital environments that are both functional and conducive to healing [5]. Privacy is always linked to the concept of control and this is reflected in the different definitions of privacy [27]. In theories of control in environmental psychology, which focus on the extent of people's control over environmental stimuli, people who have a lot of control over the quantity and quality of stimuli in the environment feel better than those who have little control, and the lack of control may cause a psychological reaction through which people try to maintain the freedom they have lost [28]. In healthcare settings, respect for patients' autonomy by nursing staff, which provides more control for patients, is seen as enhancing a sense of security and reducing anxiety among patients, which in turn may help in the healing process, or the lack of control is a major problem in hospitals, which can lead to aggravation of stress and negatively affect patients' health, as the lack of privacy was considered a major factor contributing to the loss of the sense of control in the hospital [29]. There are eight axes that form and shape the concept of patient identity (privacy, safety, autonomy, trust, space, social communication, guidance, freedom of choice), as these factors interact with each other to form the concept of patient identity [30].

5.4.2 Visual dimension (visibility factor)

Visual monitoring in nursing stations varies depending on whether they are centralized or decentralized. It was found that decentralized nursing stations usually improve visibility, but in contrast, it was found that nurses felt more isolated from their colleagues and lost a sense of connection with the team [13]. It is generally believed that open single-room units allow nurses to have a clear view of all patients at once, while gulf units limit the view from a centrally located nursing station [12]. It appears that the visual connection between the nurse and the patient is important in the satisfaction of both the nurse and the patient with the design of the unit [15]. Although decentralized nursing stations typically improve visibility, nurses reported feeling more isolated from their colleagues and losing a sense of connection with the nursing team [15]. With this inspired idea, Peponis in 2009 created effective visual contact, a measure that represents the number of unique targets that can be seen from a single point. Nurses may intuitively place themselves in locations that provide more opportunities for observation of the patients they care for [8]. The structural characteristics of the nursing unit that affect the movement of the nursing staff according: axial integration, visual contact, path distance, visual step depth, and number of turns [10]. Archea hypothesized that in physically defined environments, visual contact or visual exposure regulates the flow of privacy-related information, which in turn is governed

by the physical position (i.e., spatial location and orientation) and/or the visual properties (e.g., reflectivity or transparency) of elements of the physical environment such as corners, walls, and doors [23]. Visual exposure is the amount of visual surveillance that others in the spatial environment exercise on an individual's behavior as a result of the individual's location within the physical environment, and people may seek low-exposure locations when they need a higher level of privacy because these locations are likely to hide information from nearby individuals [26]. Excess visibility is a major problem for privacy regulation. Excess exposure means communicating more information than one is willing to convey to others, while less visibility than one is willing to convey can also cause difficulties because it leads to one's behavior not being recognized by others [30].

5.4.3 Acoustic dimension (noise level factor)

Nursing stations can be noisy due to the high activity and often crowded space where nurses consult with doctors, specialists, and nursing colleagues [26]. Other sources of sound include alarms, pagers, telephones, and other technical equipment. The World Health Organization (WHO) recommendation for hospital sound levels (continuous background noise) during daytime hours is 45 dB(A) and the nighttime maximum is 35 dB. Prolonged exposure to 85 dB will result in significant hearing loss in the workplace. Noise control has been identified as an important way to improve hospital environments for both staff and patients. Bedside noise levels in the vicinity of a nursing station can reach 113 dB [3]. These noise levels will interfere with any conversation and pose a significant risk to patient health. High noise levels in corridors due to talking may be due to long distances from the patient room to the nursing station or between nursing stations where staff may tend to consult in the corridors rather than using the nursing station for this purpose [28]. High sound levels have also been associated with increased stress and discomfort among nursing staff, and more importantly, noise stress in nurses is associated with emotional exhaustion or stress. Blomkvist examined the effects of changing acoustic conditions in a coronary intensive care unit (using sound-absorbing ceiling tiles versus sound-reflecting ceiling tiles) on the same group of nurses over months [31].

## 6. THEORETICAL FRAMEWORK OF NURSING STATION MONITORING SYSTEM

Based on the above literature to define the monitoring system, the characteristics of nursing units, the tasks of nursing stations, and the most important design dimensions that achieve the efficiency of monitoring systems, the following theoretical framework terms were reached:

- The functional design achieved for the monitoring system in the nursing station requires full knowledge of the nature of the nursing station design, providing flexibility and sufficient space within the space and interior design, as well as organizing the functional specializations in their various forms within the station, and the presence of spaces for control and control with modern technologies.
- Enhanced communication and social interaction for the monitoring system in the nursing station, which is through the nursing station's design that supports communication, which requires allocating social spaces with the presence of a spatial gradation that facilitates the flow of work.
- Reducing the period for monitoring activities and tasks in the nursing station, by determining the distances that the nursing staff walks, which is linked to the location and design of the nursing station, as well as the ease of access to it.
- Sensory dimensions that support control and Health supervision in the nursing station, sensory dimension includes several dimensions that support health supervision, such as the psychological dimension of the privacy of patients and nursing staff, and the visual dimension from the station to the entire nursing unit, in addition to the audio dimension and its control. Table 2 shows the most important main terms of the monitoring system with the secondary terms.

**Table 2.** The important main & second components of monitoring system (researchers)

| Main | Second | |
|---|---|---|
| Functional Design of Monitoring System | Nature of design | Open Design |
| | | Central Nursing Station |
| | | Interconnection in Decentralized Nursing Stations |
| | Flexibility in design | Architectural elements |
| | | Furniture |
| | Adequate and enough space for work | Design dimensions of spaces |
| | | Furniture dimensions within the space |
| | | Suitable furniture: For patients; For nursing staff |
| | Electronic control and management | Sufficient designated places |
| | | Sufficient monitoring devices |
| | Functional allocation | Having separate workspaces |
| | | Taking into account the details that avoid risks |
| | | Providing service spaces |
| | | Providing reception desks |
| Enhanced communication and Social Interaction of Monitoring System | Customization of social spaces | Social spaces for the patient and family |
| | | Spaces for nursing staff integration |
| | | Central social spaces |
| | Spatial gradation | |
| | Ease of daily workflow | |
| | Open nurse station | |

| | | | | |
|---|---|---|---|---|
| Reducing the period for Monitoring Activities in Nursing Stations | Nature of enhanced design for communication | Central nurse station | Nursing staff communication | |
| | | | Teamwork | |
| | | Nursing staff communicate with patients at the decentralized station | | |
| | Determining walking distances for nursing staff | Study of reducing movement corridors | | |
| | | Adequacy of movement dimensions | | |
| | | The shape of movement corridors | | |
| | Location of nursing station | Proximity to service supply points | | |
| | | Proximity to patient rooms | | |
| | Design of nursing station | Circular | | |
| | | Central | | |
| | | Radial | | |
| | Ease of access | Clarity of movement pattern | | |
| | | Finding movement paths | Directional signs | |
| | | | Continuity in design | |
| | | Motor and spatial restriction | | |
| Sensory Dimensions Supporting Control and Health Supervision in Nursing Stations | Psychological dimension | Patient Privacy | Controlling the environment | Architectural element |
| | | | | Furniture |
| | | | Preserving the identity of patients | Spatiality |
| | | | | Independence |
| | | | | Communication |
| | | Privacy of nursing staff with patients | Private, closed, isolated communication spaces | |
| | | | Decentralized nursing stations | |
| | Visual dimension | Visual connection and effective exposure level | Physical features | Reflection |
| | | | | Transparency |
| | | | | Visual clarity |
| | Audio dimension and its control | Controlling the sound of medical monitoring devices | | |
| | | Long distance study | | |
| | | Reducing distractions for nursing staff | | |
| | | Creating a quiet environment for patients | | |

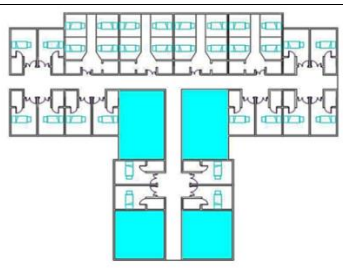
## 7. PRACTICAL STUDY

The practical study adopted the comparative approach in evaluating the design characteristics of one of the common patterns of nursing units (T-Shape) in hospital buildings, by analyzing several possible design solutions for this pattern proposed by the study (NHS Estates) [32], to reach the characteristics that support the efficiency of the health monitoring and supervision system of the nursing station about the structural shape of the nursing unit as a whole. Since the nursing unit is an entity that is primarily based on the interaction of two categories of users, namely patients on the one hand, and the nursing and medical staff on the other hand, it is necessary to evaluate the common spaces that determine the aspects of efficient performance of nursing supervision. The study was based on evaluating one of the effective aspects of the designs of the halls, which is the visual system formed from the design characteristics, and concluding which of them are important in supporting the nursing monitoring and supervision system. The practical study was conducted according to the following steps:

1) Selecting the patterns designed for axial type (T-Shape) proposed by the (NHS Estates) study, which include patterns (A, B, C, D, E, F, G, H, I, J, K) with the same spatial dimensions, a difference in the number of single and quadruple beds (Table 3).
2) Adopting the Depth Map software in analyzing possible spatial arrangement and visual characteristics of the different patterns according to the Isovist analysis indicators (Isovist Area, Isovist Max Radial, Occlusivity, Visual Control, Visual Controllability).
3) Conducting a visual analysis of the selected wards to measure the visual characteristics of users within the user's movement position, and then conducting a focal analysis of the nursing station within the user's state position.
4) Adopting two main methods in the spatial and visual analysis of ward types, the first is for the different patterns in the number of movement axes and situation of the nursing station, and the second is for the different patterns in the situation of the bathroom to the outside or to the inside.

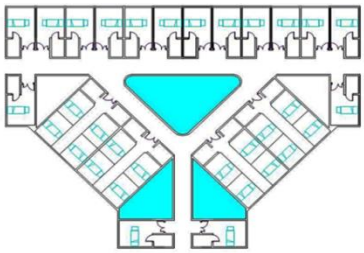
Concluding the design characteristics that support and enhance the efficiency of the nursing monitoring and supervision system in terms of effective visual indicators that are important in their impact.

**Table 3.** Types of ward (T-Shape)

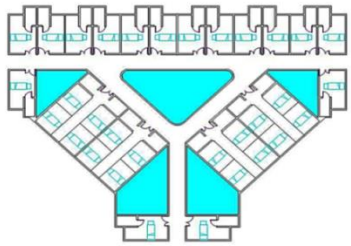
| | Internal Bathroom | External Bathroom |
|---|---|---|
| 50% Single bed – 50% 4 bed |  | |

100% single bed

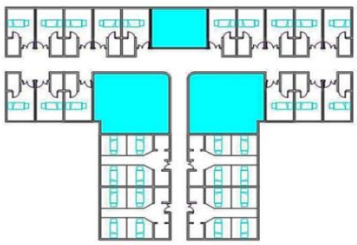
WARD TYPE: A



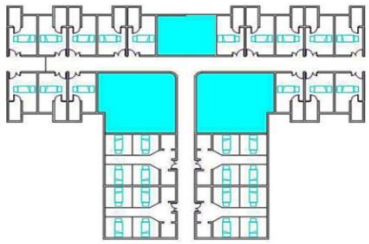
WARD TYPE: B



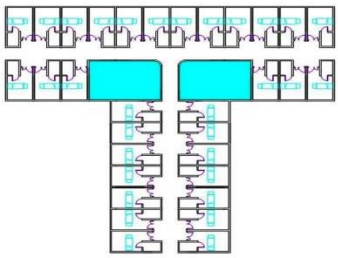
WARD TYPE: C



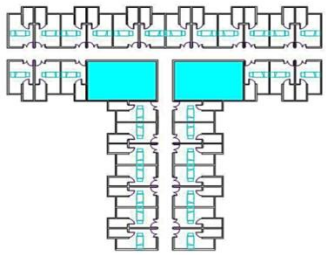
WARD TYPE: D



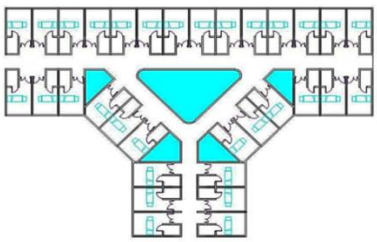
WARD TYPE: E



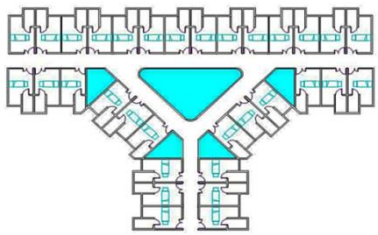
WARD TYPE: I



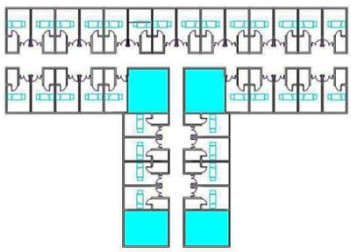
WARD TYPE: G



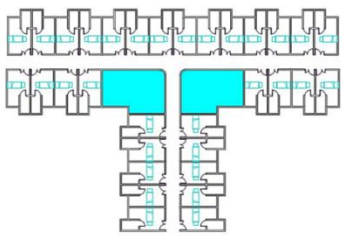
WARD TYPE: F



WARD TYPE: J



WARD TYPE: H



WARD TYPE: K

## 8. DEFINITION OF MEASURED CONCEPTS

Occlusivity: The morphological side of occluded space and occlusivity is derived from this occluding radial surface of an Isovist, it is defined as the length of the open (occluding radial) edges of an Isovist [Depthmap/handbook, 2010]. It accounts for the potential area that can be revealed through occluded radials within one visual step [33]. The occlusivity value and the occluding surface are independent of the physical boundaries of the space, its value depends on the observer's vantage point and spatial partitions. The compactness and occlusivity values have an inverse proportion because compactness has a low probability of open edges and undefined edges, and occlusivity has a negative correlation with environmental performance. Thus, occlusivity refers to a disconnectivity regarding a visual information flow. Theoretically, a space with a high occlusivity value can be expressed as a space where the user's awareness increases [depthmap/handbook, 2010].

Control, and Controllability**:** The local measures calculated by Depth Map, How the visual information is changing within systems, dictating, perhaps, the way a journey is perceived and where the decision points come within it [34]. While controllability is a measure proposed in, the differences between two items are, control picks out visually dominant areas, whereas controllability picks out areas that may be

easily visually dominated. For control, each location is first assigned an index of how much it can see, the reciprocal of its connectivity [32]. Then, for each point, these indices are summed for all the locations it can see. As should be obvious, if a location has a large visual field will pick up a lot of points to sum, so initially, it might seem controlling. However, if the locations it can see also have large visual fields, they will contribute very little to the value of control. So, to be controlling, a point must see a large number of spaces, but these spaces should each see relatively little. Controllability is much easier to describe: for a location, it is simply the ratio of the total number of nodes up to the radius of the connectivity [34].

## 9. DISCUSSION OF PRACTICAL STUDY

### 9.1 Results of spatial and visual analysis within the user's movement position

The results of the practical study indicated a significant variation in the visual characteristics formed by the design characteristics of the wards with aspects that may support or inhibit the features of the visual interaction required for the nursing monitoring and supervision system. Table 4 indicates the results of the visual analysis of ward patterns according to the variation in the characteristics of the movement system axes (perpendicular dual movement axes and a corner nursing station [D, E, G, I, H, K], and triple axes and a central nursing station [B, F, C, J]), which are as follows:

1) The results of the spatial analysis of the ratio of movement spaces to the ward area for the patterns (D, E, G, I, H, K) indicated values at a rate of (30.58%), which is lower compared to the patterns (B, F, C, J) at a rate of (35.00%), which indicates the impact of the design characteristics For the axes of the movement system on the sizes of the spaces of encounter or interaction between the categories of users.
2) The results of the values of the ratios of the visual area to the area of the movement system for the patterns (D, E, G, I, H, K) indicated values at a rate of (39.5%), which is low compared to the patterns (B, F, C, J) at a rate of (44.9%), which indicates that the three-axis ward with a central station achieves a larger visual area.
3) The results of the values of visual occlusivity for the patterns (D, E, G, I, H, K) indicated values at a rate of (49.012), which is significantly low compared to the values of the patterns (B, F, C, J) at a rate of (71.085), which indicates that the three-axis ward with a central station achieves high visual closure.
4) The results of the visual control values for patterns (D, E, G, I, H, K) at an average of (2.379), which is close to the values of patterns (B, F, C, J) at an average of (2.333), indicating that the design characteristics do not affect this factor.
5) The results of the visual controllability values for patterns (D, E, G, I, H, K) at an average of (0.231), which is higher compared to patterns (B, F, D, J) at an average of (0.190), indicating that the dual-axis ward with a corner station achieves greater control potential. Table 5 shows the comparison between patterns (K, J).
6) The results of the visual analysis of the ward patterns according to the variation of the bathroom rooms' locations, inside [A, B, D, F, H, I], outside [C, E, G, J, K]), are as follows:
7) The results of the spatial analysis of the ratio of movement spaces to the ward area for the patterns (A, B, D, F, H, I) indicated values at a rate of (35.21%), which is higher compared to the patterns (C, E, G, J, K) at a rate of (28.51%), which indicates the effect of the design characteristics of the bathroom rooms' location on the areas of movement spaces and the surfaces of the interface.
8) The results of the values of the ratios of the visual area to the area of the movement system for patterns (A, B, D, F, H, I) indicated values at a rate of (39.59%), which is low compared to patterns (C, E, G, J, K) at a rate of (49.99%), indicating that the situation of the bathroom to the outside achieves a higher percentage of visual area.
9) The results of the values of visual occlusivity for patterns (A, B, D, F, H, and I at a rate of (53.49), which is low compared to the values of patterns (C, E, G, J, K) at a rate of (59.73), indicating that the situation of the bathroom to the outside enhances visual closure.
10) The results of the visual control values for patterns (A, B, D, F, H, I) at an average of (2.083), which are low compared to the values of patterns (C, E, G, J, K) at an average of (2.635), which indicates that the situation of the bathroom to the outside enhances the visual control, but to a limited extent.
11) The results of the visual controllability values for patterns (A, B, D, F, H, I) at an average of (0.2342), which are higher compared to patterns (C, E, G, J, K) at an average of (0.2064), which indicates that the situation of the bathroom to the inside enhances the possibility of visual control. Table 6 shows the comparison between patterns (I, G).

**Table 4.** Physical & visual characteristics (Isovist analysis)

| Ward Type | Physical Characteristics | | | | Visual Characteristics (Isovist Analysis) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Gross Area $m^2$ | Circulation Area % | Support Area % | Bathroom Type | Visual Area | Max Radial | Visual Occlusivity | Visual Control | Visual Controllability |
| A | 1174 | 30.44 | 21 | Internal | 110.3 | 46.800 | 41.157 | 1.964 | 0.2576 |
| B | 1176 | 34.25 | 19 | Internal | 136.47 | 46.789 | 72.221 | 2.148 | 0.2012 |
| C | 1155 | 30.60 | 20 | External | 145.20 | 46.461 | 66.990 | 2.500 | 0.1907 |
| D | 1149 | 30.27 | 20 | Internal | 148.08 | 46.94 | 52.198 | 1.880 | 0.2943 |
| E | 1093 | 24.20 | 20 | External | 143.92 | 46.928 | 39.644 | 2.738 | 0.2765 |
| F | 1283 | 42.24 | 12 | Internal | 132.65 | 54.504 | 67.097 | 2.104 | 0.2134 |
| G | 1144 | 27.68 | 13 | External | 104.86 | 46.789 | 60.449 | 2.659 | 0.1939 |
| H | 1231 | 36.78 | 12 | Internal | 101.12 | 55.101 | 41.451 | 2.139 | 0.2180 |
| 1 | 1230 | 37.28 | 12 | Internal | 103.77 | 47.004 | 46.821 | 2.270 | 0.2220 |
| J | 1199 | 32.93 | 13 | External | 136.36 | 54.399 | 78.048 | 2.582 | 0.1838 |
| K | 1148 | 27.27 | 13 | external | 101.77 | 54.437 | 53.540 | 2.700 | 0.1879 |
| | Source: NHS Estates | | | | Source: Depth map Application | | | | |

**Table 5.** Analogy of visual characteristics between two deferent type wards (K-J)

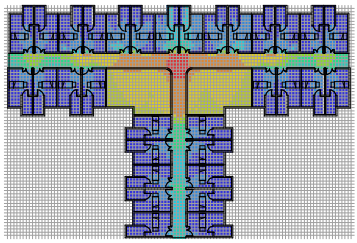
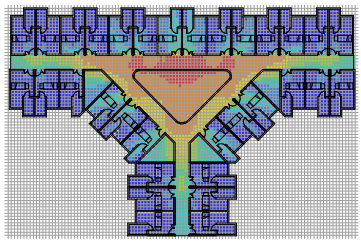
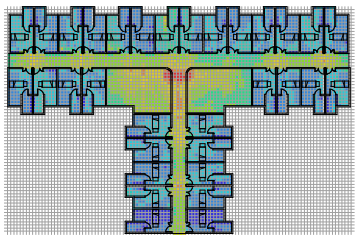
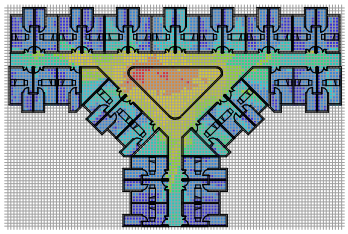
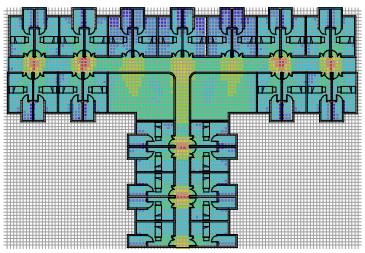
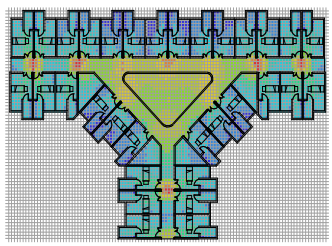
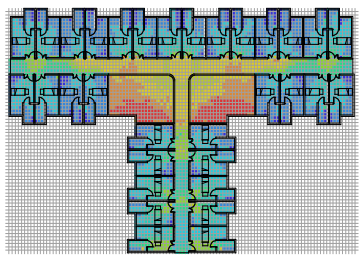
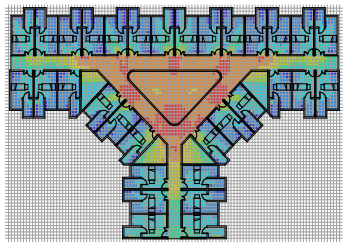
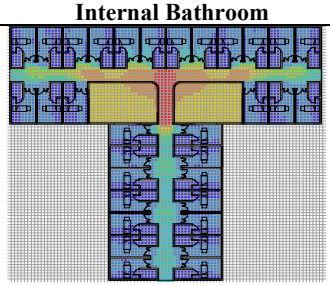
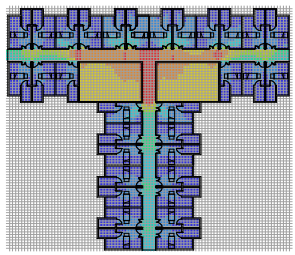
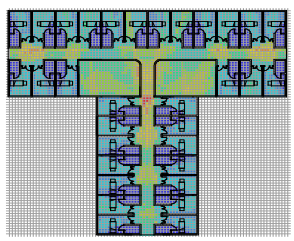
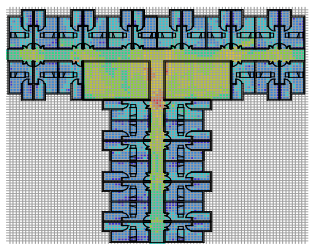
| | Corner Nurse Station | Central Nurse Station |
|---|---|---|
| ISOVIST AREA |  |  |
| | Ward (K) = 40.7% | Ward (J) = 45.92% |
| VISUAL OCCLUSIVITY |  |  |
| | Ward (K) = 53.54 | Ward (J) = 78.04 |
| VISUAL CONTROL |  |  |
| | Ward (K) = 2.701 | Ward (J) = 2.582 |
| VISUAL CONTROLLABILITY |  |  |
| | Ward (K) = 0.1879 | Ward (J) = 0.1838 |

**Table 6.** The analogy of visual characteristics between two types of bathroom situation

| | Internal Bathroom | External Bathroom |
|---|---|---|
| ISOVIST AREA |  |  |
| | Ward (I) = 31.06% | Ward (G) = 42.28% |
| VISUAL OCCLUSIVITY |  |  |
| | Ward (I) = 46.82 | Ward (G) = 60.44 |

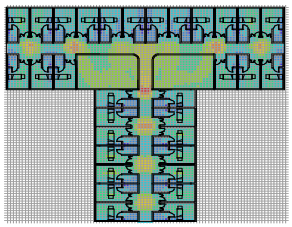
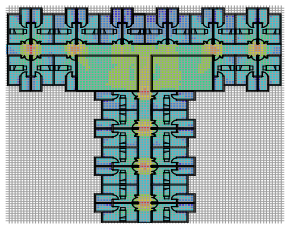
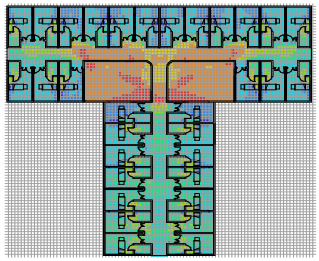
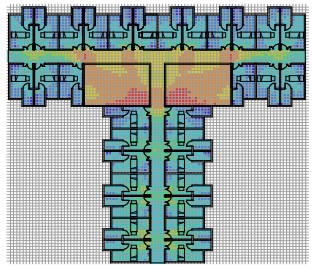
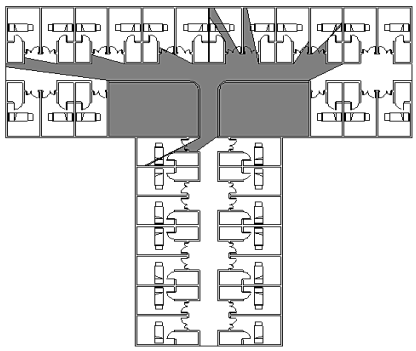
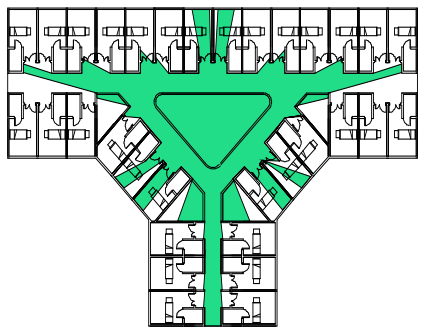
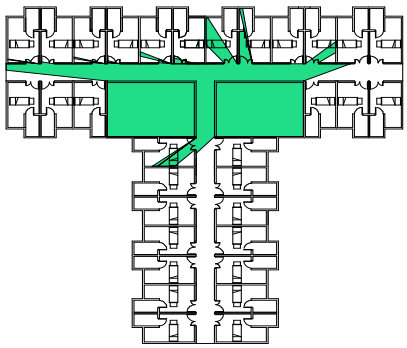
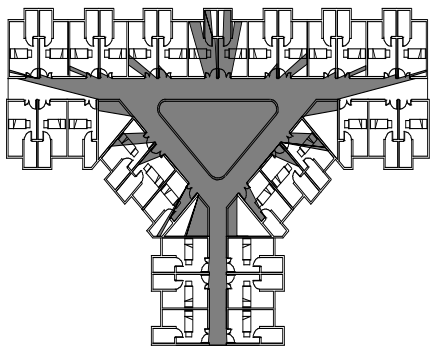
| | | |
|---|---|---|
| VISUAL CONTROL |  Ward (I) = 2.27 |  Ward (G) = 2.65 |
| VISUAL CONTROLLABILITY |  Ward (I) = 0.222 |  Ward (G) = 0.193 |

**Table 7.** Results of Visual analysis with user state position of the nurse station

| | Visual Characteristics (Isovist Analysis) | | | Physical Characteristics |
|---|---|---|---|---|
| | Visual Area | Max Radial | Visual Occlusivity | |
| A | 236.792 | 19.894 | 66.156 | Corner station/internal bath |
| B | 367.753 | 23.551 | 183.19 | Central station/internal bath |
| C | 369.078 | 24.145 | 156.31 | Central station/external bath |
| D | 353.836 | 29.875 | 59.50 | Corner station/internal bath |
| E | 342.812 | 29.971 | 67.357 | Corner station/external bath |
| F | 409.54 | 26.871 | 156.969 | Central station/internal bath |
| G | 277.607 | 30.144 | 123.736 | Corner station/external bath |
| H | 266.071 | 65.580 | 120.068 | Corner station/internal bath |
| I | 274.617 | 30.679 | 84.258 | Corner station/internal bath |
| J | 382.453 | 28.062 | 213.544 | Central station/external bath |
| K | 266.472 | 32.972 | 106.488 | Corner station/external bath |

**Table 8.** Visual analysis with user state position of nurse station (I, F) & (G, J)

| | Corner Station | Central Station |
|---|---|---|
| Internal Bathroom Position |  WARD (I) |  WARD (F) |
| External Bathroom Position |  WARD (G) |  WARD (J) |

### 9.2 Results of the focal visual analysis of the state position of the nursing station

The visual analysis was conducted by adopting a focal point centred in the nursing station and with a 360-degree viewing angle to reach the maximum surfaces of the visual relationship between the nursing staff in the fixed position in the nursing station with the locations of the patients' beds for the patterns designed, and the results were as follows (Table 7):

- The results of values of the visual area of wards with three axes and a central nursing station (B, C, F, J) indicated significantly higher values compared to the patterns with perpendicular axes and a corner station (D, E, G, H, I, K).
- The results of visual occlusivity values for the three-axis patterns with a central station (B, C, F, J) indicated higher values compared to the two-axis patterns with a corner station (D, E, G, H, I, K), which indicates that the extension of the visual space enhances the closure of vision (Table 8).

## 10. CONCLUSIONS

Within its theoretical framework of the most important tools of monitoring and supervision systems for the nursing unit, the study concluded that the quality of the systems is linked to the efficient performance of the nursing tasks assigned to the nursing staff and their spatial, functional, and visual requirements. It also highlights the importance of the mutual visual relationship between the patient and the nursing staff, which is enhanced by design features that support effective communication between the nursing staff themselves to achieve optimal performance. The tasks of the monitoring system included the following activities: observation, monitoring, tracking, verification, communication and supervision, interaction, control, and domination. These tasks can be efficiently implemented through the design features of the nursing unit, which take into account the efficient functional design of the monitoring system in the nursing station, enhance communication, support social interaction in the nursing station, and reduce the duration of monitoring activities in the nursing station to support patient privacy. As for the summary of the practical study in testing the effect of the spatial structure of the nursing unit for one of the important patterns in unit design (T-Shape) in formulating the visual characteristics that support the performance of monitoring and supervision systems, I indicated that the designs of the horizontal movement axes between the halls and the location of the nursing station in relation to those axes and the designs of the halls in terms of the location of the bathroom system to the inside or outside, all of these factors affect the formulation of the patterns of visual characteristics that may be enhancing or inhibiting the monitoring system for nursing units, in addition to the possibility of using software as a tool to evaluate the designs of nursing units before their implementation to achieve an effective visual system for monitoring systems, which requires more future research related to the application of those software.

## REFERENCES


[1] Hawai'i Pacific University Course. (2023). Transcultural nursing in remote areas. https://online.hpu.edu/blog/transcultural-nursing.

[2] Adams, A. (2000). Review: Healthcare architecture in an era of radical transformation by Stephen Verderber, David J. Fine. Journal of the Society of Architectural Historians, 59(4): 556-557. https://doi.org/10.2307/991638

[3] Becker, F. (2007). Nursing unit design and communication patterns: What is "real" work? HERD: Health Environments Research & Design Journal, 1(1): 58-62. https://doi.org/10.1177/193758670700100115

[4] Glaeser, D.H., Thomas Jr, L.J. (1975). Computer monitoring in patient care. Annual Review of Biophysics and Bioengineering, 4(1): 449-476. https://doi.org/10.1146/annurev.bb.04.060175.002313

[5] Bayraktar Sari, A.O., Jabi, W. (2024). Architectural spatial layout design for hospitals: A review. Journal of Building Engineering, 97: 110835. https://doi.org/10.1016/j.jobe.2024.110835

[6] Collins. Definition of 'monitoring'. https://www.collinsdictionary.com/dictionary/english/monitoring, accessed on Aug. 4, 2025.

[7] Shabot, M.M., Gardner, R.M. (1994). Decision support systems in critical care. Springer New York. https://doi.org/10.1007/978-1-4612-2698-7

[8] Real, K., Santiago, J., Fay, L., Isaacs, K., Carll-White, A. (2018). The social logic of nursing communication and team processes in centralized and decentralized work spaces. Health Communication, 34(14): 1751-1763. https://doi.org/10.1080/10410236.2018.1536940

[9] Hamilton, K.D. (1993). Unit 2000: Patient Beds for the Future -- A Nursing Unit Design Symposium. Walkins Carter Hamilton Publications.

[10] Hendrich, A.L., Fay, J., Sorrells, A.K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. American Journal of Critical Care, 13(1): 35-45. https://doi.org/10.4037/ajcc2004.13.1.35

[11] Departmental Space Inventory Survey - Room Type Codes and Definitions. (2006). Office of Space Analysis, University of Michigan. https://procurement.umich.edu/u-m-employees/property-management/space-analysis/.

[12] Gurascio-Howard, L., Malloch, K. (2007). Centralized and decentralized nurse station design: An examination of caregiver communication, work activities, and technology. HERD: Health Environments Research & Design Journal, 1(1): 44-57. https://doi.org/10.1177/193758670700100114

[13] Tyson, G.A., Lambert, G., Beattie, L. (2002). The impact of ward design on the behaviour, occupational satisfaction and wellbeing of psychiatric nurses. International Journal of Mental Health Nursing, 11(2): 94-102. https://doi.org/10.1046/j.1440-0979.2002.00232.x

[14] Salman, N.A.H., Kadhim, M.K. (2025). The role of the spatial configuration of the system designed for intensive care units in creating healing environment - Iraqi hospitals as a case study. International Journal of Sustainable Development and Planning, 20(2): 453-467. https://doi.org/10.18280/ijsdp.200201

[15] Haq, S., Luo, Y. (2012). Space syntax in healthcare facilities research: A review. HERD: Health Environments Research & Design Journal, 5(4): 98-117. https://doi.org/10.1177/193758671200500409

[16] Morelli, A.D. (2007). Implications of nursing station design on nurses' psychosocial health and work behavior. Master's Thesis, Environmental Psychology D, Center for Built Environment. https://www.academia.edu/78709357.
[17] Elkhamisy, I.M.F., Mansour, Y., Kamel, S. (2025). An integrated design evaluation method for critical hospital units: Combining space syntax and virtual reality for operational efficiency. Ain Shams Engineering Journal, 16(9): 103503. https://doi.org/10.1016/j.asej.2025.103503
[18] Devlin, A.S. (1992). Psychiatric ward renovation. Environment and Behavior, 24(1): 66-84. https://doi.org/10.1177/0013916592241003
[19] Wakefield, A. (2002). The changing 'shape' of the nursing station. Contemporary Nurse, 13(2-3): 148-157. https://doi.org/10.5172/conu.13.2-3.148
[20] Flynn, L. (2005). Nursing stations for the 21st century, building design & construction. Building Design & Construction, 24: 2-5.
[21] Pati, D., Harvey, T.E., Jr., Redden, P., Summers, B., Pati, S. (2015). An empirical examination of the impacts of decentralized nursing unit design. HERD: Health Environments Research & Design Journal, 8(2): 56-70. https://doi.org/10.1177/1937586715568986
[22] Burgio, L.D., Engel, B.T., Hawkins, A., McCormick, K., Scheve, A. (1990). A descriptive analysis of nursing staff behaviors in a teaching nursing home: Differences among NAs, LPNs, and RNs. The Gerontologist, 30(1): 107-112. https://doi.org/10.1093/geront/30.1.107
[23] Ibrahim, E., Sherif, A., Serag Eldin, H. (2022). Improving the efficiency of hospital nursing unit design: An analytical study. IOP Conference Series: Earth and Environmental Science, 1056(1): 012013. https://doi.org/10.1088/1755-1315/1056/1/012013
[24] Shepley, M.M. (2002). Predesign and postoccupancy analysis of staff behavior in a neonatal intensive care unit. Children's Health Care, 31(3): 237-253. https://doi.org/10.1207/s15326888chc3103_5
[25] Zimring, C., Ulrich, R. (2006). The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. http://www.healthdesign.org/research/reports.
[26] Woogara, J. (2001). Human rights and patients' privacy in UK hospitals. Nursing Ethics, 8(3): 234-246. https://doi.org/10.1177/096973300100800308
[27] Leino-Kilpi, H., Välimäki, M., Dassen, T., Gasull, M., Lemonidou, C., Scott, A., Arndt, M. (2001). Privacy: A review of the literature. International Journal of Nursing Studies, 38(6): 663-671. https://doi.org/10.1016/s0020-7489(00)00111-5
[28] Maciorowski, L.F. (1991). The enduring concerns of privacy and confidentiality. Holistic Nursing Practice, 5(3): 51-56. https://doi.org/10.1097/00004650-199104000-00010
[29] Chaudhury, H., Mahmood, A., Valente, M. (2005). The use of single patient rooms versus multiple occupancy rooms in acute care environments. Facility Guidelines Institute. https://www.healthdesign.org/sites/default/files/use_of_single_patient_rooms_v_multiple_occ._rooms-acute_care.pdf.
[30] Alaiouch, C.R. (2009). Hospital ward design: Implications for space and privacy. Doctoral Dissertation, Heriot-Watt University, School of the Built Environment. https://files.core.ac.uk/download/pdf/29824619.pdf.
[31] Blomkvist, V., Eriksen, C.A., Theorell, T., Ulrich, R., Rasmanis, G. (2005). Acoustics and psychosocial environment in intensive coronary care. Occupational and Environmental Medicine, 62(3): e1. https://doi.org/10.1136/oem.2004.017632
[32] Norton, S. (2017). Ward layouts with single rooms and space for flexibility status in Wales. NHS Estates. https://silo.tips/download/ward-layouts-with-single-rooms-and-space-for-flexibility-status-in-wales-informa.
[33] Turner, A. (2004). Depthmap 4 | A researcher's handbook. In Bartlett School of Graduate Studies. UCL.
[34] Ayram, C., Emin, M. (2022). Examining the occluded space in a museum gallery through user's cognition and space morphology. In Proceedings of the 13th Space Syntax Symposium. https://www.hvl.no/globalassets/hvl-internett/arrangement.