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Comparative Analysis of Inpatient Department (IPD) for Spatial Configuration, Nurse Walking Distance, and Patient Visibility in Selected Hospitals for Efficient Design

Muhammad Shakil[1], Ubaid Ullah[2], Shahid Mansoor Khan[3]

[1]Master Student, Department of Architecture, University of Engineering & Technology Peshawar, Abbottabad Campus, Khyber Pakhtunkhwa, Pakistan.
[2]Lecturer, Department of Architecture, University of Engineering & Technology Peshawar, Hayatabad Campus, Khyber Pakhtunkhwa, Pakistan.
[3]Assistant Professor, Department of Architecture, University of Engineering & Technology Peshawar, Abbottabad Campus, Khyber Pakhtunkhwa, Pakistan.

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Corresponding Author:
Muhammad Shakil,
Master Student, Department of Architecture, University of Engineering & Technology Peshawar, Abbottabad Campus, Khyber Pakhtunkhwa, Pakistan.

ABSTRACT

This study proposes guidelines for designing efficient inpatient wards with a focus on patient visibility, nurse walking distance, and spatial configuration. These guidelines prioritize clear lines of sight between caregivers and patients, enabling nurses to respond promptly to patient needs while minimizing unnecessary movement. Thoughtful spatial design can also enhance communication among staff and foster a more calming and supportive environment for patients. Ultimately, these improvements aim to promote healing, well-being, and patient satisfaction.

Seven selected Inpatient Departments (I.P.D.s) from District Headquarters (D.H.Q.) hospitals in K. were analyzed to evaluate plan configurations that accommodate diverse healthcare requirements and improve staff performance and patient care. The plans were obtained from NESCOM and the respective hospital authorities. Nurse walking distance (N.W.D.), patient visibility, and spatial configuration were analyzed for each ward type using AutoCAD software. The results were then tabulated and compared.

D.H.Q. Charsadda demonstrated the smallest average nurse walking distance at 23’2” per unit, while D.H.Q. Hangu recorded the highest patient visibility at 88.88%, followed by D.H.Q. Abbottabad at 63.10%. Increased fenestration in appropriate locations was found to enhance visual permeability. The spatial placement of the nurse station plays a crucial role in the functional efficiency of inpatient departments and should be positioned to ensure full visibility of all wards.

INTRODUCTION

Staff areas, patient areas, circulation, and service zones are arranged differently within each layout type according to departmental needs and design requirements. To organize these spaces efficiently, various ward configurations have been proposed and implemented in healthcare facilities. These include circular, square, rectangular, triangular, and cross-shaped forms, as well as single- and double-loaded corridor layouts (Z. Tuğçe Kazanasmaz, 2006). Each of these designs aims to achieve the following goals:

a) Providing the highest possible level of patient care.
b) Accommodating and satisfying patient privacy and comfort needs (Z. Tuğçe Kazanasmaz, 2006; Zehra Tuğçe Kazanasmaz, 2005).

Different factors can influence the overall form of inpatient ward layouts, including spatial economy, cultural considerations, access to natural lighting, and the quality of patient care (Catrambone, Johnson, Mion, & Minnick, 2009). The spatial composition typically comprises single or multiple patient rooms, vertical circulation cores, circulation patterns, and the placement of nurse stations, staff areas, and service zones (Rafeeq & Mustafa, 2021). Enhancing these spatial aspects is critical for reducing accidents and mortality rates while increasing both patient and staff satisfaction, thereby improving overall health outcomes (Graban, 2018).

Numerous studies on spatial configuration have examined how different spatial variables affect staff and patient outcomes, as well as nurse behavior (Pachilova & Sailer, 2019). Research has investigated how the physical layout of nursing units and ward designs influence nurse–patient and staff–staff interactions, and how these relationships affect nurses' perceptions of social support—a key factor in reducing stress and enhancing job satisfaction (Pachilova & Sailer, 2019, 2020). The selection of visibility and accessibility as key spatial measures stems from the argument that higher visibility enhances opportunities for social support and communication, while accessibility—determined by travel routes and the placement of support areas—facilitates collaboration among nursing staff (Cai & Zimring, 2012).

Pachilova and Sailer (2019) concluded that nurses' movement patterns, including the frequency of visits to patient rooms and nurse stations, were influenced by the spatial characteristics of their work environment. Conversely, inadequate use of research and lack of data-driven insights can create significant inefficiencies in hospital ward design, negatively affecting staff productivity, patient care, and overall operational performance.

This study, therefore, examines several critical factors across selected D.H.Q. hospitals in K.P., including circulation space, staff area, grossing factor, gross area, DGSF (departmental gross square feet per bed), patient visibility, and nurse walking distance, to develop guidelines for the efficient design of inpatient wards.

LITERATURE REVIEW

The main functional spaces within inpatient departments—such as staff areas, nursing stations, patient rooms, circulation zones, and service areas—are arranged differently depending on the design intent and operational requirements of each department. To optimize these areas, various ward configurations have been proposed and implemented in healthcare facilities (Z. Tuğçe Kazanasmaz, 2006).

In the pursuit of hospital efficiency, several building forms have been suggested, including circular, square, rectangular, triangular, and cross-shaped layouts, as well as single- and double-loaded corridor designs (Cai & Zimring, 2012; Z. Tuğçe Kazanasmaz, 2006). The nursing unit is the key element that determines the architectural form and spatial characteristics of hospital buildings. The selection of a specific plan configuration is

primarily influenced by the efficiency of the nurse station and its spatial relationship with patient rooms (Gurascio-Howard & Malloch, 2007).

To minimize nurse travel distances, the placement of patient rooms must allow for efficient access from the nurse station and between patient rooms located near the ward's center (A. Hendrich & Chow, 2008; Pachilova & Sailer, 2019). Wards accommodating 40–50 beds with a single nurse station may be cost-effective in terms of construction but are less efficient for patient care. Researchers recommend limiting wards to 20–30 beds per unit, each with its own nurse station (Pachilova & Sailer, 2020).

Among the major typologies—single-corridor, double-corridor, circular, and square wards—the double-corridor layout has been identified as more efficient due to its operational effectiveness, improved observability, and flexibility in subdividing wards. It also enables shorter travel distances between destinations and better thermal performance (Zehra Tuğçe Kazanasmaz, 2005). The only notable drawback of this layout is its relatively higher construction cost.

Conversely, circular wards are highly effective in terms of patient visibility, allowing nurses to maintain visual contact with a greater number of patients (Pachilova & Sailer, 2020). However, nurse walking distances in circular wards tend to be greater than in double-loaded corridor configurations. Studies conclude that circular units are more efficient for patient observation and enable nurses to spend more time with each patient (Shakil, Ali, & Ullah, 2022). The architectural shape and configuration of the nursing unit thus have a significant impact on nurse walking distance; historically, compact circular layouts from the 1950s have proven most efficient, while the compact triangular layouts introduced in the 1970s resulted in the highest average walking distances (Nazarian, 2014; Shakil et al., 2022).

Direct patient care is the primary responsibility of nurses, who represent one of the most valuable human resources in the healthcare sector. Achieving high standards of patient care and improving clinical outcomes rely heavily on the dedication and efficiency of nursing staff (Nursing, 2011). However, the demanding nature of nursing work has led many professionals to leave the field, resulting in a significant shortage of qualified nurses. Nursing work is physically and emotionally demanding (Zimring, Joseph, & Choudhary, 2004), and fatigue and stress among nurses often arise from multiple factors, including long walking distances, continuous work shifts, extended working hours, and insufficient rest periods (A. Hendrich & Chow, 2008).

Researchers have sought to determine the extent to which reducing walking distances can save time that could instead be devoted to patient care (Gurascio-Howard & Malloch, 2007). The spatial configuration of wards, particularly the arrangement of patient rooms, plays a critical role in influencing nurse walking distance (Ullah& Park, 2016a, Ullah & Park, 2016b). Studies of various ward layouts reveal that the compact circular layout of the 1950s was the most efficient, with the smallest average walking distance of 18 feet 9 inches per bed. In contrast, the compact triangular layout of the 1970s resulted in the greatest average walking distance, measuring 28 feet 5 inches per bed (Shakil et al., 2022).

Visibility is a crucial factor in inpatient ward design, as it supports effective oversight, observation, patient–nurse interaction, and communication. The degree of visibility within a ward is largely influenced by its physical layout (Johanes & Atmodiwirjo, 2015; Pachilova & Sailer, 2019). Typically, an inpatient ward comprises a nurse station, several support spaces (such as supply, equipment, relaxation, pantry, and consultation rooms), and patient rooms. Among these, the level of visibility is a key design component that directly impacts patient care and staff performance (Johanes & Atmodiwirjo, 2015).

It is essential that the ward design allows nurses to maintain visual proximity with patients, enabling observation and monitoring—even during nighttime—without disrupting patient rest (Cai & Zimring, 2012). Research indicates that greater patient visibility and ease

of observation enhance nursing performance, as increased visibility reduces nurse walking distances and allows more time for direct patient care (Ann Hendrich, Chow, Skierczynski, & Lu, 2008).

RESEARCH METHODOLOGY

This study adopts a systematic methodological approach to analyze the spatial efficiency of inpatient wards in selected District Headquarters (D.H.Q.) Hospitals across Khyber Pakhtunkhwa (K.P.). The research process consists of four main steps: data collection, data analysis, comparative evaluation, and the formulation of conclusions and recommendations. The methodology integrates both primary and secondary data sources and utilizes digital analysis tools to assess spatial parameters such as configuration, visibility, and nurse walking distance. The following steps outline the research methodology adopted for this study:

Step 1: Data Collection

Primary Data: Floor plans of seven selected District Headquarters (D.H.Q.) Hospitals in Khyber Pakhtunkhwa (K.P.).
Secondary Data: Relevant published articles and literature on hospital design, spatial configuration, and nursing efficiency.

Step 2: Data Analysis

Spatial Configuration: Calculated using AutoCAD software.
Patient Visibility: Assessed through visibility analysis conducted in AutoCAD.
Nurse Walking Distance: Measured and analyzed using AutoCAD.

Step 3: Comparative Analysis

Comparative evaluation of the selected Inpatient Departments (I.P.D.s) based on spatial configuration, patient visibility, and nurse walking distance.

Step 4: Conclusions and Recommendations

Drawing conclusions from the comparative analysis and providing design recommendations for enhancing the efficiency of inpatient wards.

DATA AND ANALYSIS

This paper examines the inpatient wards of seven hospitals by analyzing their existing floor plans as part of the research methodology. Various spatial parameters—including nurse walking distance, patient visibility, patient area, circulation area, staff area, gross area, net area, and grossing factor—were analyzed for each type of ward using AutoCAD software. The results were subsequently tabulated and compared to evaluate the spatial efficiency and functional performance of the selected inpatient departments (I.P.D.s).

D.H.Q. Abbottabad comprises four Inpatient Departments, each subdivided into male, female, and isolation wards. Every ward has its own nurse station strategically positioned to maintain visual supervision over the patients. In the isolation rooms, patient beds are separated by partition walls to ensure privacy and infection control.

Figure 1: Case-I (D.H.Q Abbottabad), orthopaedics ward

K.T.H. Peshawar is a multi-storey building, with the Inpatient Department (I.P.D.) distributed across different floors to facilitate patient care. The nurse station is centrally located within each ward, with two wards on either side, allowing staff easy access to patient beds and maintaining visual supervision. K.T.H. Peshawar has a total of 58 beds; for this study, 50 beds on the ground floor were analyzed.

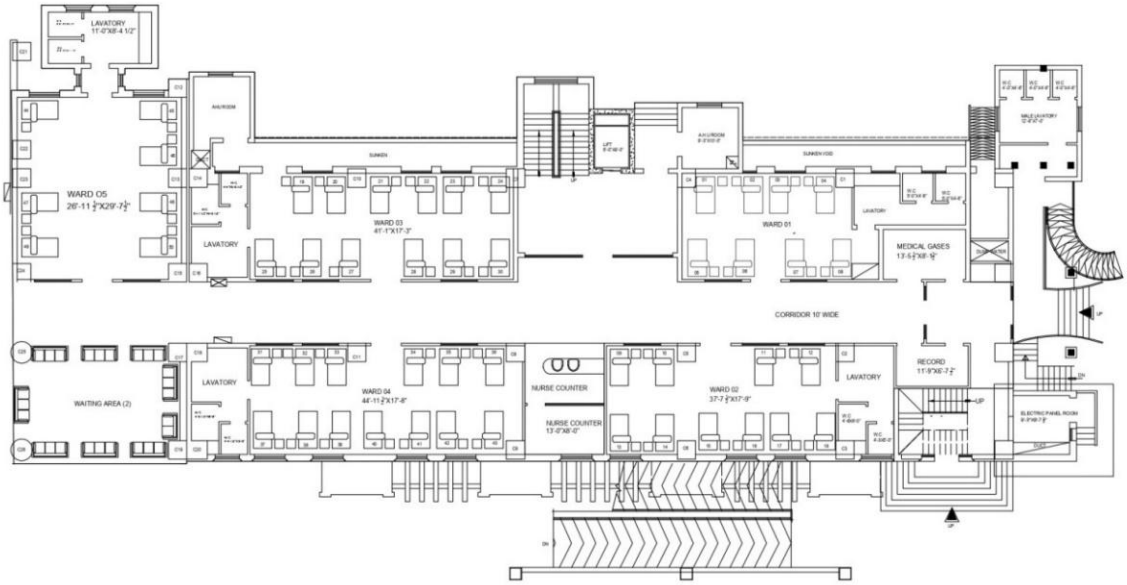

Figure 2: Case-II (K.T.H Peshawar), K.T.H Peshawar, I.P.D

D.H.Q. Charsadda is a two-storey building, with the Inpatient Department (I.P.D.) designed on both floors to facilitate patient care. The nurse counter is located within the patient wards, providing 100% visibility of the patients. However, a limitation of this department is that the nurse counter is not provided for every ward. The combined bed capacity of the ground and first floors is 153 beds.

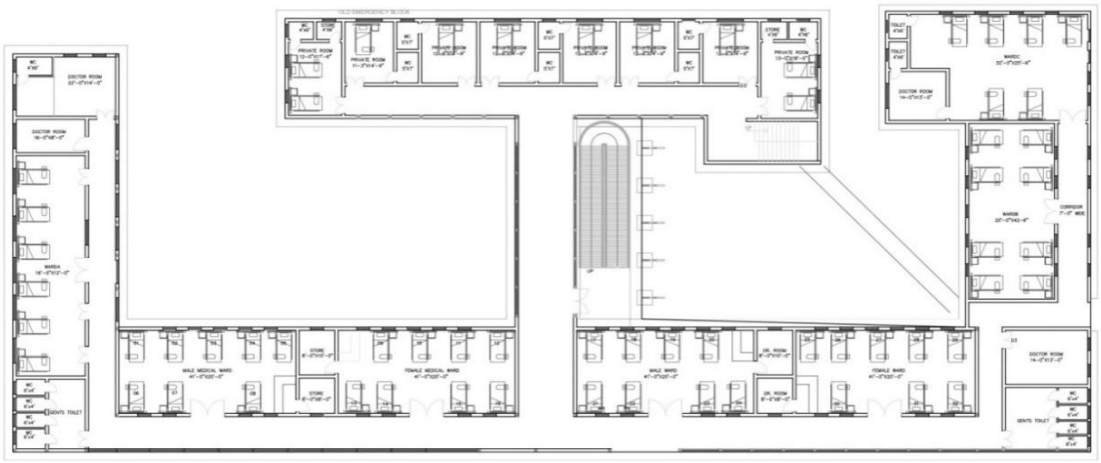

Figure 3: Case-III (D.H.Q Charsadda), Wards Section

D.H.Q. Mansehra comprises multiple wards; for this study, one ward containing 22 beds was analyzed. The nurse station is centrally located, providing easy accessibility to patient beds. However, solid walls without windows limit visibility, with door fenestration being the only source of visual access. The location of staff offices facilitates effective staff-to-staff and staff-to-patient communication.

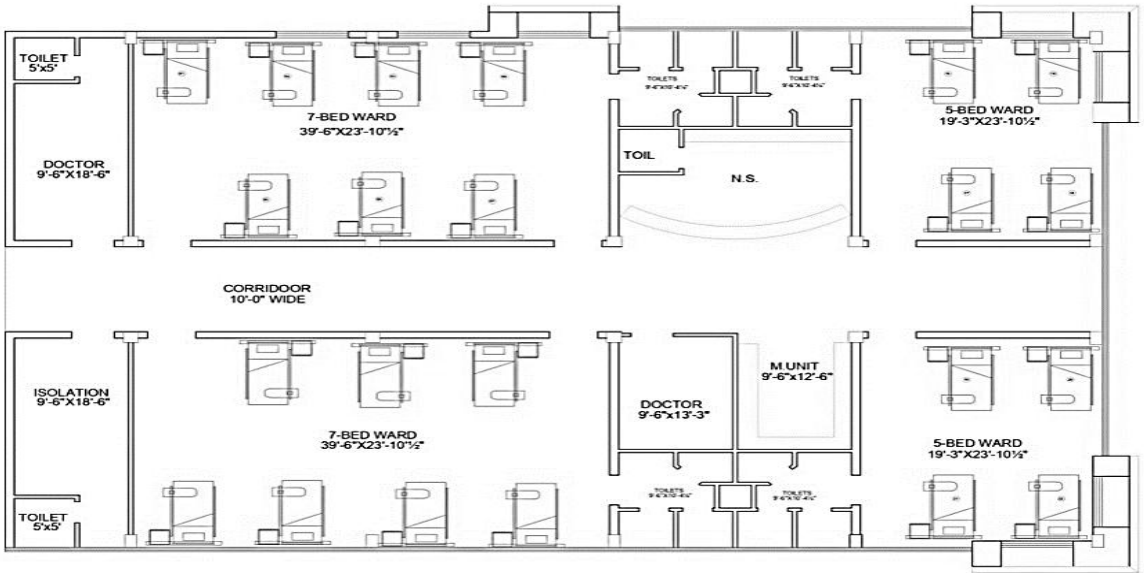

Figure 4: Case-IV (D.H.Q Mansehra), Ward

D.H.Q. Karak comprises multiple wards; for this study, one ward containing 24 beds was analyzed. The nurse station is centrally located, allowing easy access to patient beds. However, similar to D.H.Q. Mansehra, solid walls without windows limit visibility, with door fenestration serving as the only visual access. The placement of staff offices supports effective staff-to-staff and staff-to-patient communication.

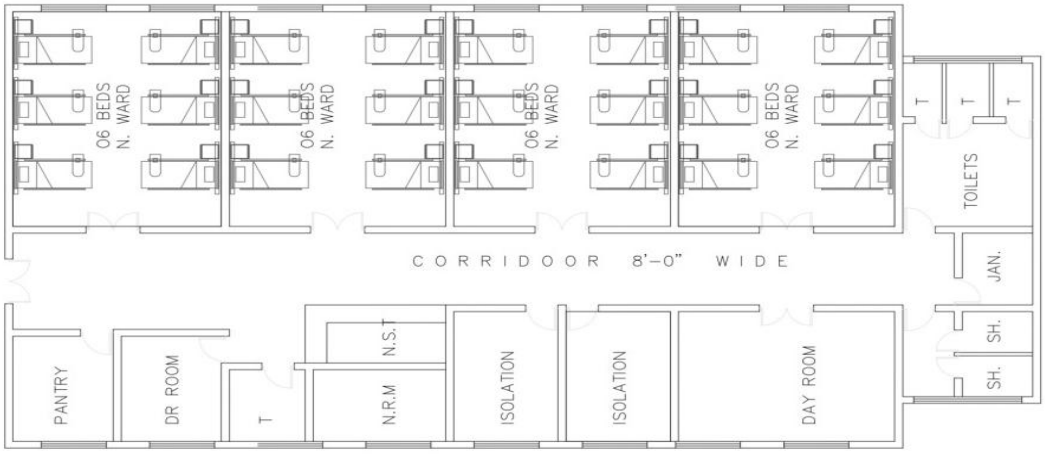

Figure 5: Case-V (D.H.Q Karak), Ward

The wards of D.H.Q. Hangu are arranged along the outer perimeter, with nurse stations located within each ward. While this design requires more staff and effort, it is highly effective in terms of both physical and visual access. D.H.Q. Hangu has a total of 54 beds, with the right and left sections arranged as mirror images.

The Inpatient Department (I.P.D.) is configured with wards on the left and right sides, while staff areas and service spaces are located centrally. This spatial arrangement enhances operational efficiency. The ward design also benefits from door fenestration; however, windows are limited. Additional windows along the corridor could further improve communication, visibility, and overall workability.

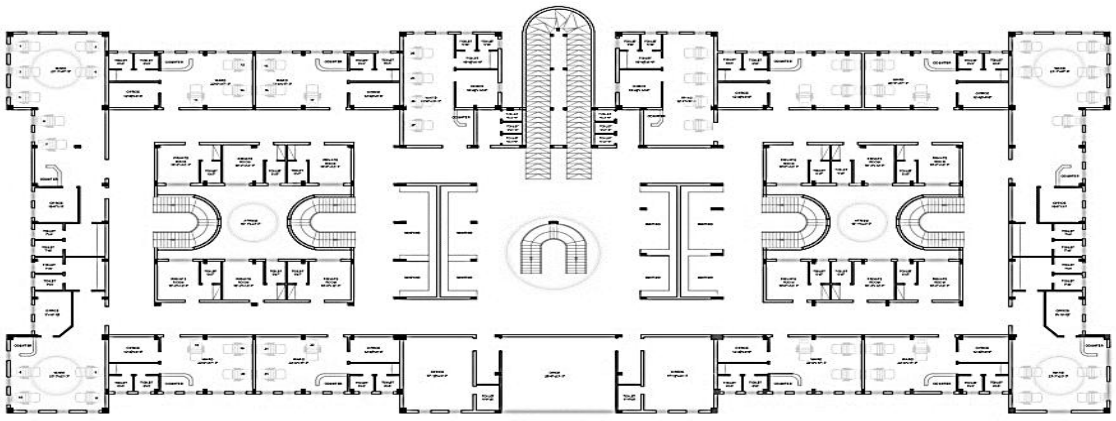

Figure 6: Case-VI (D.H.Q Hangu)

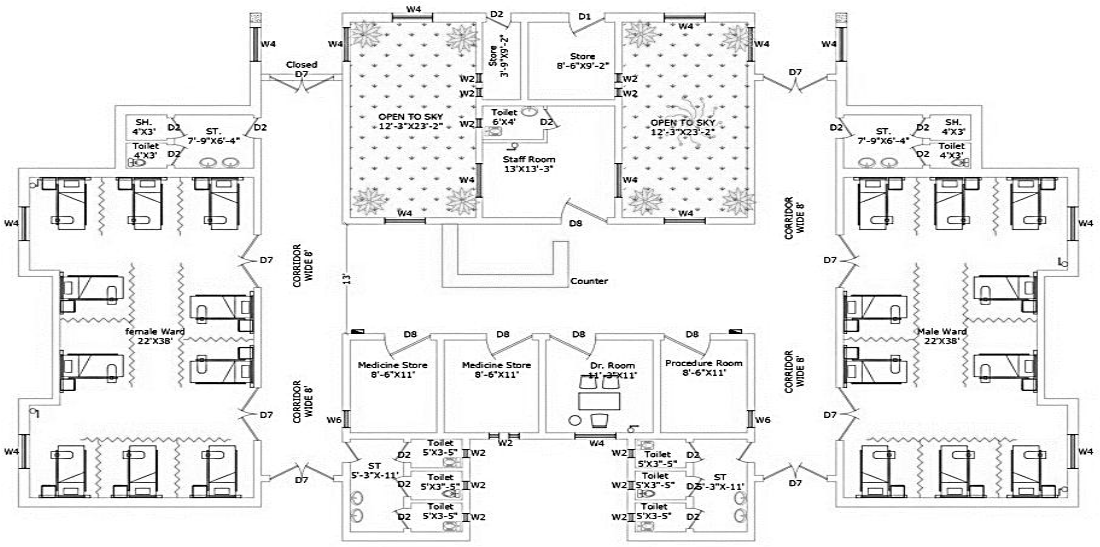

Figure 7: Case-VII (K.D.A Kohat), I.P.D

Table 1 presents an analysis of the selected hospitals in terms of gross area, net area, departmental gross square feet (D.G.S.F.), grossing factor area, and grossing factor. Among the hospitals analyzed, K.T.H. Peshawar exhibited the lowest departmental gross square feet at 180 sqft/bed, whereas D.H.Q. Hangu had the highest value at 512 sqft/bed.

In terms of the grossing factor, K.T.H. Peshawar recorded the highest value of 1.11, indicating a higher ratio of gross to net area, while D.H.Q. Charsadda (first floor) and D.H.Q. Hangu demonstrated the most efficient layouts with a minimum grossing factor of 1.07. These results suggest that while K.T.H. Peshawar is compact in terms of space per bed, D.H.Q. Hangu provides more spacious wards, and both Charsadda and Hangu achieve efficient utilization of built-up space relative to their net functional areas.

Table 1: Gross Area, Net Area, D.G.S.F., Grossing Factor Area, and Grossing Factor

S.No	Hospital	Gross Area, Sqft	Net Area, Sqft	No. of Beds	D.G.S.F/bed	Grossing Factor Area, Sqft	Grossing Factor
1	D.H.Q Abbottabad	11127	10276	36	309	851	1.09
2	K.T.H Peshawar	9018	8108	50	180	910	1.11
3	D.H.Q Charsadda	19897	18364	62	320	1533	1.08
4	D.H.Q Mansehra	5718	5217.5	22	260	500.5	1.09
5	D.H.Q Karak	4603	4096	24	192	507	1.12
6	D.H.Q Hangu	29841	27656	54	512	2185	1.07
7	K.D.A Kohat	5248	4521	20	262	707	1.16

According to the study's findings, the maximum patient area was observed in D.H.Q. Abbottabad at 61.66%, followed by D.H.Q. Mansehra at 50%, while the minimum patient

area was found in K.D.A. Kohat at 33.58%, followed by D.H.Q. Charsadda with 34% on the ground floor and 41.84% on the first floor.

In terms of staff areas, D.H.Q. Mansehra and D.H.Q. Charsadda were determined to be more suitable for staff facilitation, with values of 15.49% and 10.55%, respectively. The maximum services area was observed in K.T.H. Peshawar at 18.14%, while the minimum was recorded in D.H.Q. Abbottabad at 5.5%.

For circulation areas, D.H.Q. Charsadda had the highest values, with 27.25% on the ground, whereas D.H.Q. Abbottabad had the lowest circulation area at 12.83%.

Table 2 Patient Area, Staff area, Services area and Circulation Area

S.No	Hospital	Patient Area, %	Staff Area, %	Services Area, %	Circulation Area, %
1	D.H.Q Abbottabad	61.66	7	5.5	12.83
2	K.T.H Peshawar	38.64	3.44	18.14	23
3	D.H.Q Charsadda	34	8.93	8.52	27.25
4	D.H.Q Mansehra	50	15.49	7.88	15.87
5	D.H.Q Karak	54	6.35	10.25	17.30
6	D.H.Q Hangu	27.97	9.47	12.30	27
7	K.D.A Kohat	33.58	6.71	9.52	22.54

Nurse walking distances were determined by drawing lines from the nurse station to each bed, from the first to the last, as presented in Table 3. The average nurse walking distances were as follows: D.H.Q. Abbottabad – 39’1’’, K.T.H. Peshawar – 55’0’’, D.H.Q. Charsadda – 23’2’’, D.H.Q. Mansehra – 43’3’’, D.H.Q. Karak – 40’0’’, D.H.Q. Hangu – 29’0’’, and K.D.A. Kohat – 62’11’’.

Among the seven inpatient departments, D.H.Q. Charsadda was the most efficient in terms of nurse walking distance, with an average of 23’2’’ per bed. Conversely, K.D.A. Kohat exhibited the longest average walking distance, measuring 62’11’’ per bed. These findings highlight the significant impact of ward layout on nurse mobility and operational efficiency.

Patient visibility analysis revealed that D.H.Q. Hangu had the highest visibility at 88.88%, followed by D.H.Q. Abbottabad at 63.10%. In contrast, D.H.Q. Mansehra exhibited the lowest patient visibility, followed closely by K.T.H. Peshawar, with percentages of 5.73% and 5.83%, respectively.

RESULTS AND DISCUSSION

This study used existing floor plans as the primary research methodology, focusing on the inpatient wards of seven hospitals. For each ward type, AutoCAD software was employed to analyze key spatial parameters, including nurse walking distance, patient visibility, patient area, circulation area, staff area, gross area, net area, grossing factor area, and grossing factor. The results were subsequently tabulated and compared to evaluate the efficiency and functional performance of the selected inpatient departments (I.P.D.s).

Among the hospitals analyzed, K.T.H. Peshawar had the lowest departmental gross square feet per bed at 180 sqft/bed, while D.H.Q. Hangu had the highest value at 512 sqft/bed. In terms of grossing factor, K.T.H. Peshawar recorded the highest value of 1.11, indicating a

higher ratio of gross to net area. Conversely, D.H.Q. Charsadda (first floor) and D.H.Q. Hangu were the most efficient, with a minimum grossing factor of 1.07.

A low D.G.S.F./bed indicates that a larger portion of space is allocated to patient areas, allowing more beds per ward, whereas a high D.G.S.F./bed reflects a greater proportion of space dedicated to staff, circulation, and services. Similarly, grossing factor varies with the grossing factor area: a lower grossing factor area indicates more economical use of hospital space, and vice versa.

D.H.Q. Abbottabad exhibited the highest patient area at 61.66%, followed by D.H.Q. Mansehra at 50%. D.H.Q. Mansehra and D.H.Q. Charsadda were determined to be more suitable for staff facilitation, with staff area percentages of 15.49% and 10.55%, respectively. D.H.Q. Charsadda also had the highest circulation area, with 27.25% on the ground floor and 29% on the first floor.

K.T.H. Peshawar and D.H.Q. Abbottabad showed a strong focus on patient care compared to other I.P.D.s. In D.H.Q. Abbottabad, the nurse station is located within the wards, resulting in lower nurse fatigue and higher workability. In contrast, at K.T.H. Peshawar, staff and service areas are positioned opposite the nurse station, which limits staff-to-staff communication and coordination.

Among the seven I.P.D.s, D.H.Q. Charsadda was identified as the most efficient ward based on nurse walking distance, with an average of 23’2’’ per bed, while K.D.A. Kohat had the longest distance at 62’11’’ per bed. Wards with nurse stations located inside the wards, like D.H.Q. Charsadda, resulted in lower fatigue, higher workability, and improved proximity to patient care areas.

Maximum patient visibility was observed in D.H.Q. Hangu at 88.88%, followed by D.H.Q. Abbottabad at 63.10%. Wards with nurse stations outside the wards, such as D.H.Q. Mansehra, had the lowest patient visibility due to solid walls along corridors and limited door fenestration, with no supplementary monitoring such as CCTV cameras. Higher visual permeability not only reduces nurse fatigue but also supports patient healing by enhancing observation, air circulation, and staff efficiency.

DISCUSSION:

The results collectively emphasize that spatial configuration plays a decisive role in healthcare efficiency, nurse performance, and patient well-being. Wards that prioritize central nurse stations, balanced spatial allocation, and sufficient visual connectivity outperform those designed with segregated or opaque layouts.

Efficient designs, such as that of D.H.Q. Charsadda, demonstrate that even modest hospitals can achieve high functional performance through well-thought-out layouts rather than increased floor area or cost. Moreover, visibility and accessibility do not only impact operational efficiency but also influence emotional and psychological comfort. Wards with greater transparency and proximity between nurses and patients foster trust and interaction, aligning with evidence-based design principles that link spatial openness to better patient satisfaction and recovery rates.

Finally, the study underlines that hospital design efficiency should not merely focus on spatial economy but also on functional harmony between staff needs, patient comfort, and operational sustainability. The integration of data-driven spatial analysis tools can guide future hospital projects toward creating environments that enhance healthcare delivery while maintaining cost efficiency and human well-being.

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