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In-Depth Comparison of Spatial Configuration, Nurse's Walking Distance, and Patient Visibility in Selected Intensive Care Units of District Hospitals in Khyber Pakhtunkhwa, Pakistan

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Abstract

Intensive Care Units (ICU) fall in the category of most needed departments of a healthcare center irrespective of its size, catchment area and frequency of use. Patients are very closely monitored and cared for in these units, and the availability of trained nursing staff is never compromised whatsoever the circumstances be. Placement of nursing station therefore becomes critical as the staff has to keep eye on each individual patient from their nursing counter, ensuring their access to the patient if and when needed without any delay. Primary objective of this study was to examine a number of key aspects in each selected ICU including circulation space, staff area, grossing factor, gross area, bed area allotment per patient, patient visibility, and the nurses' walking distance. The methodology adopted for this study was to draft the existing ICUs plans of the sample District Hospitals of Khyber Pakhtunkhwa and compare the different aspects of spatial configuration. For visibility "Targeted Visibility Method" was used to find visibility of patient in beds. Nurse walking distance, patient visibility, gross area, grossing factor, services, patient area, circulation area, staff area and DGSF (Departmental Gross Square Feet) of Intensive Care Unit (ICU) were calculated using AutoCAD and MS excel. In second step the concluded results from selected District Hospitals were compared with each other to find out design appropriateness. The analysis led to the fact that a strong correlation existed between Nurse Walking Distance and Visibility. This fact became more evident through comparison with other selected hospitals. From the selected sample hospitals, Karak and Batkhela District Hospitals' ICU wards demonstrated relatively higher Patient Area per bed and circulation area percentage in comparison to other District Hospitals. It was found that a strong correlation existed between Patient Area per bed and circulation area. Maximum Nurse walking to patient bed was found to be 75'-0" in Hangu District Hospital followed by Kohat District Hospital with 62'-4",

Batkhela with 31'-9", Mansehra with 30'-6" and Karak with 22'-9".

Keywords: Intensive Care Unit (ICU), Nurse Walking Distance, Patient Visibility, Area per Patient Bed.

Introduction:

Intensive Care Units (ICU) are Hospital specialized units, these units provide care to persons, suffering from critical injuries or illnesses. The hospital's intensive care unit (ICU) is a highly advanced and specifically designed, appropriately staffed, situated, and equipped units(Butt & Khan, 2018). The design and layout of ICUs are critical for the safety and wellbeing of patients and healthcare workers. In recent past years, there has been an increase interest in researching the impacts of ICU design on patient outcomes, nurse performance, and overall efficiency of hospitals. It was observed that nurses in hospitals spent more time walking than providing care due to hospital's layouts (Zimring, Joseph, & Choudhary, 2004). According to one study, walking took up 28.9% of a nurses' time (Burgio, Engel, Hawkins, McCormick, & Scheve, 1990). Hospital layout prevents approximately 67% of workers from doing their tasks effectively (Jia, Nourian, Luscuere, & Wagenaar, 2023), which lead to unsatisfied patient care and higher healthcare expenses. It was also discovered that the additional cost of $220,000 annually resulting from wayfinding difficulties was in the USA in 1990. The reasons was that staff members were interrupted trying giving directions to patients (Peponis, Zimring, & Choi, 1990). The distribution of space for different purposes, including as patient care, staff work areas, and equipment storage, is an important factor in ICUs spatial design (D. K. Hamilton & Shepley, 2010). It emphasizes how essential it is to plan ICUs with flexibility in mind so that it can adapt to changing patient needs and changing healthcare practices. According to a study, patient satisfaction and the general standard of care can be raised through patient-centered design, which emphasizes patient privacy and access to Natural light (Seda & Parrish, 2019). It has been discovered that when it comes to improved patient safety and privacy, single rooms are superior to multi-bed rooms (Teltsch et al., 2011). Building codes, architectural standards, and evidence-based best practice guidelines are necessary for the best possible ICU design (D. Hamilton & Thompson, 2005). Improving healthcare design is essential to reducing the risk of accidents and patient deaths as well as increasing staff and patient satisfaction. Several research on the topic of space syntax examined how various spatial factors impact staff or patient outcomes as well as nurse behavior (Pachilova & Sailer, 2019). Air quality, noise control, thermal comfort, privacy, lighting, and views of nature have all been the subject of extensive research over the past years. In contrast, comparatively little research has been done on other aspects of Intensive Care Units, such as nurse walking distance, patient visibility, and the impact of unit design on patient outcomes, nurse performance, and overall efficiency. This research had evaluate patient visibility, nurse walking distance, spatial configuration through In-depth analysis of each sample ICU unit. The Methodology for this research includes Data Collection From selected District Hospitals, drafting the existing layout of sampled district ICUs of Khyber Pakhtunkhwa in AutoCAD and area calculation of existing layout plans in Excel software, while comparing the wards. The analysis found out a strong correlation exist between Nurse walking distance and visibility and it is evident through comparison with other selected hospitals. Karak and Batkhela ICU wards higher demonstrated Patient area per bed and circulation area percentage as compare to other district hospitals. Suggesting a strong correlation exists between Patient area per bed and circulation area. Maximum Nurse walking to patient had been found out to be 75'-0" in Hangu district hospital followed by Kohat district hospital with 62'-4", Batkhela with 31'-9", Mansehra with 30'-6" and Karak with 22'-9".

Statement of the Problem

Over the past years extensive research has been done on hospital's air quality, noise control, thermal comfort, privacy, lighting and patient's visual connection to nature. However, comparatively little research has been done on important aspects of Intensive Care Unit. These neglected aspects such as Nurse's Walking Distance, patient visibility, gross area, grossing factor, services, patient area, circulation area, staff area and DGSF (Departmental Gross Square Feet) of Intensive Care Unit (ICU), are seldomly placed on priority in research and design at local context (i.e. Khyber Pakhtunkhwa, Pakistan).

Research Objectives

Primary objective of this research was to compare the sample ICUs in Hospitals of Khyber Pakhtunkhwa by finding out the nurse walking distance (NWD), patient visibility, gross area, grossing factor, services, patient area, circulation area, staff area and DGSF. Other significant objective was to provide guidelines in the light of research recommendations for wards' layout design in context of Patient visibility, NWD and spatial configuration.

Scope and Significance of the Study

Batkhela, Karak, Kohat, Mansehra and Hangu were the five selected District Headquarter Hospitals (DHQ) in Khyber Pakhtunkhwa. On the plans of these sample hospitals, this study was conducted. The selection criteria for these five hospitals included the availability of fully functional ICU's with adequate bed capacity. The sample hospitals' ICUs offered variation in bed capacity ranging from 8-21, offering an insight into the scale of factors affecting the efficiency of these ICUs, that were compared in this study allowing to reach reliable conclusions. Another selection criteria was the representation of different ICU typologies. Kohat featured Pod type ICU layout, while the rest of hospitals had single corridor type ICU layout. Inclusion of both typologies enabled examination of how spatial geometry influences Nurse Visibility and Nurse Walking Distance. Finally, the selection was designed to attain the geographic representation of different regions of Khyber Pakhtunkhwa including Kohat, Karak and Hangu from southern region, from the central region i.e. Malakand Division, Batkhela, and from Hazara Division, Mansehra. The ICUs which were either inaccessible or of which floor plans were not provided, were excluded.

This research focused on the evaluation of only Nurses' walking distance, patient visibility, grossing factor, DGSF, circulation area, staff area, patient area, gross area and services area. Comparison was done after evaluating each ICU individually and recommendations for future ICU designs in the province were prepared. This research will improve quality of health care, overall performance of staff and wellbeing of patients. Recommendations of the research will have positive economic impact on designing ICUs in light of design guidelines.

Theoretical and Conceptual Base of Research

Background

According to the Institute of Medicine (2011), nurses' roles and responsibilities are important for fulfillment of rising demands for patients to receive high-quality care. The intensive care unit design must reduce Nurse walking distance, increase patient visibility and nurses' well-being and ensure time for patient care. According to an observation-based study, nurses' walked between the nurse station and patient rooms for 34.5% of their 12-hour shift (Acar & Butt, 2016). One study found that nurses spent 28.9% of their duty time walking. The amount of time nurses spend caring for patients directly correlates with their travel time (Burgio et al., 1990). Shorter nurse walking distances and higher patient visibility have been linked to decreased falls, infections, and the duration of hospital stay (Rapin et al., 2018).

Nurse Walking Distance

Over the course of a day shift, a nurse walks between two and three miles (Shepley & Davies, 2003). Furthermore, this distance may extend up to six miles. Prior studies of ICU design have found that the architectural design of an ICU affects patient outcomes, such as nosocomial infections (Teltsch

et al., 2011). ICU architecture design should be patient-centered, since it has impact on both ICU staff and visiting family members, being patient-centered ICU design must consider their needs into account. More single-patient rooms and fewer patient beds per room are becoming common features of hospital ward design trends, which are motivated by concerns about infection risk reduction, confidentiality, and other difficulties (de Matos, Fumis, Nassar Junior, Lacerda, & Caruso, 2020). Studies had found that Single rooms are preferred to multi-bed rooms in terms of improved patient safety and privacy(Butt & Khan, 2018). In order to optimize the proximity between direct patient care areas and support spaces. The efficient use of nursing time, operational procedures and physical facilities. However, in a research study it was concluded that Nurse Walking Distance in Compact Square design layout was less compared to others (Shakil, Ali, & Ullah, 2022). Intensive care units are always designed with these objectives in mind. It has been concluded from literature, nurses spend less time bedsides of patients when they spend more time walking.



Figure 1: A view of nurse attending patients. Source: Author (AI generated image)

Patient Visibility

The ability of healthcare providers to keep an eye on and assess patients from a distance is known as "patient visibility". In 19th century, a basic rectangular room or unit, which was providing care up to 36 patient, beds with an open floor plan in a single nursing unit. Florence Nightingale emphasized in her 1863 description of the design element of visibility as crucial to nursing efficacy, by emphasized the significance of placing a nursing station in the unit such that it had a view of the entire space both during the day and at nighttime. The confined and congested ward design in the early ICUs prevented patient visibility (Nightingale, 1863). However, patient visibility has been improved since the introduction of modern ICU designs. Research suggests that open floor plans and centralized nursing stations enhance patient visibility, lower the chance of adverse incidents, as well as improve patient outcomes in intensive care units (Ulrich et al., 2008). Open floor plans, centralized nurse stations, and better lighting have all been included into modern ICU designs to increase patient visibility Pattison (Pattison & Robertson, 1996). According to literature, increased visibility has at least three significant advantages. First, improved visibility for caregivers able them quicker response to patient and better observation (Lu & Zimring, 2012). As a result, mortality and patient falls can be greatly decreased. Increased visibility and better patient assistance have allegedly resulted in a 67% reduction in patient falls in a new, 56-bed comprehensive cardiac ICU at Methodist Hospital in Indianapolis,

Indiana (Lu & Zimring, 2012). In (1960) Sturdavant found that nurses' walking distance and travel time were decreased when there was greater visibility from their nursing stations (Catrambone, Johnson, Mion, & Minnick, 2009). Improved staff-patient visibility may improve communication and contact, which will raise patient satisfaction (Trites, Galbraith, Sturdavant, & Leckwart, 1970).

Spatial configuration

Spatial configuration can be defined as a progressive process which connects the built environment and the human's spatial experience and behavior (Hasgül, 2015). The majority of intensive care units featured a linear or corridor layout in the 1950s and 60s, with patient rooms arranged along a central corridor. The Corridor ward is an advanced version of the Nightingale ward, an earlier form of hospital wards. This particular type of hospital ward named as the Nightingale ward, or Long-nave ward (as designated by HBN 04, 1997), had a single, big room with no partitions for patient occupancy. Poor patients' privacy and dignity, reducing cross infections and ventilation, and were few drawbacks (Pattison & Robertson, 1996). The authors found that patient outcomes, including length of stay and mortality rates, were significantly impacted by spatial design, particularly by the placement of nurse stations and patient visibility (Chiu, Chang, Hsieh, Chao, & Lai, 2018)

There should be visual access to the outdoor space from each patient care unit. The patient care unit should have a window of the proper size for this reason. The study concluded that ICU stays for patients in window rooms were shorter than for those in non-window rooms (4.8 days vs. 5.8 days, p 0.045). Although there is no impact on morality rate of patient in ICU (Chiu et al., 2018). In Accordance with literature that because of inappropriate layout design, approximately 67% of workers are unable to do their duties effectively (Chraibi, Kharraja, Osman, & Elbeqqali, 2013). Furthermore, because of problems in hospital layouts, it was found that nurses in hospitals spent more time walking than providing care (Zimring et al., 2004).

Research Methodology

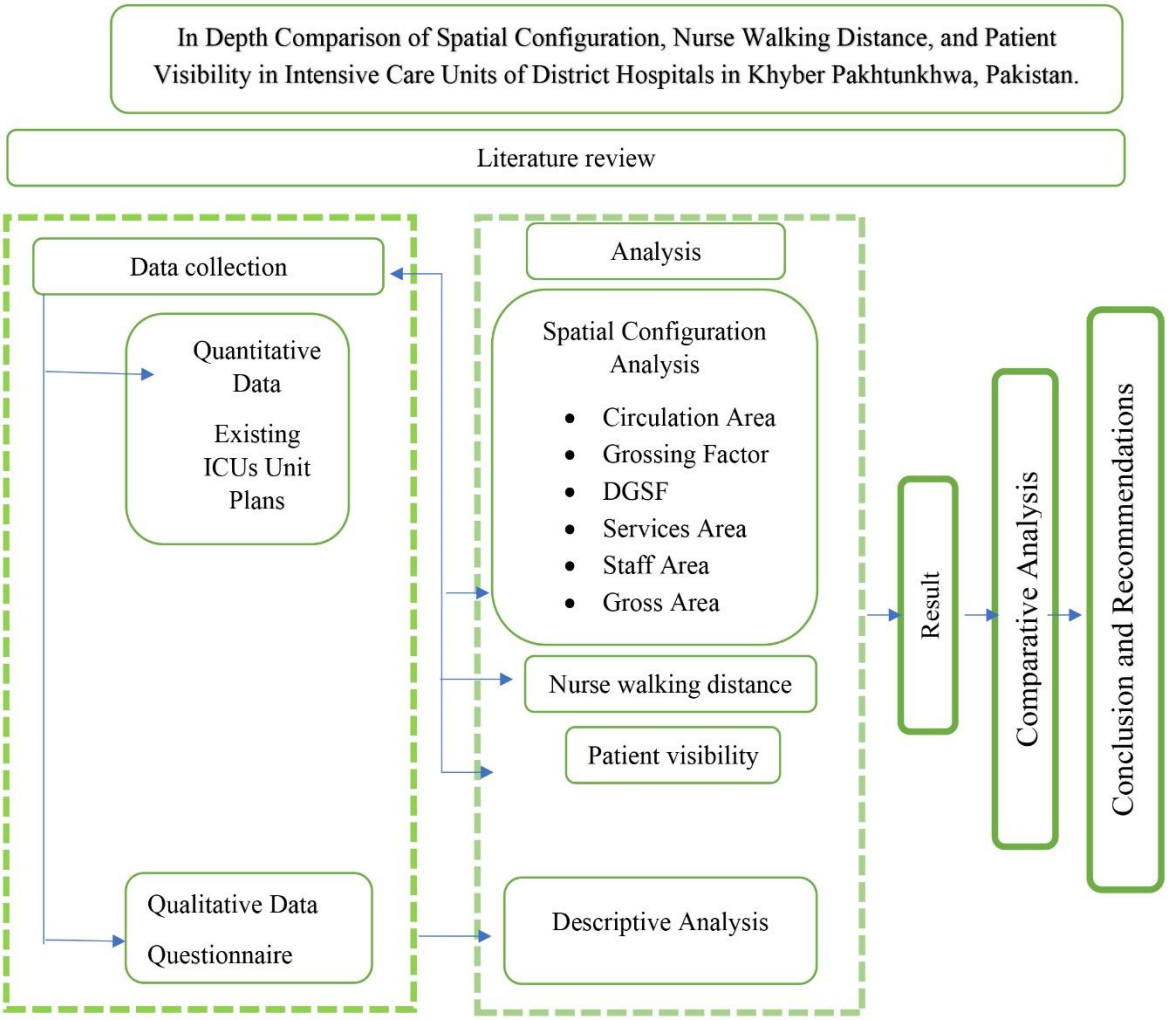


Figure 2: Flow Chart Summarizing Research Methodology. Source: Author

Method Of Analysis

The Analysis of existing ICU's was divided into four (4) steps. Detail of each step is given hereunder.

Space Programming

In this step floor plans of ICU's were measured to find out the DGSF, grossing factor, number of beds in ward. AutoDesk AutoCAD and MS Excel were used for this purpose.

Area Distribution

In the second step, floor plans were further broken down by calculating the patient area percentage, circulation area, staff area, and services area, which were also calculated by using AutoCAD and MS Excel.

Nurse Walking Distance

In this step, nurse walking distances were calculated from nurse station to patient bed. In these calculations, the minimum and maximum distances a nurse covers from and to a patient's bed for all patient beds were found. The average distance to each bed of ward was also found out while calculating the average length per patient.

Visibility

Targeted visibility method is used in visibility toward those targets which are already been selected. In this step, the patient bed is divided into three equal parts. Then selected the upper part of the bed.

The reason behind selecting the upper part was that if a nurse can observe the upper part of patient body. Nurses can have a clear and easy idea of patient condition and in emergence, nurses can have prompt response. The selected upper part of the bed is then divide into 30 equal part or tiles. After that, imaginary lines have been drawn from the tile towards the nurse station. To find the visibility of each tile while also finding the average visibility of each patient bed and average visibility of a ward in each selected case.

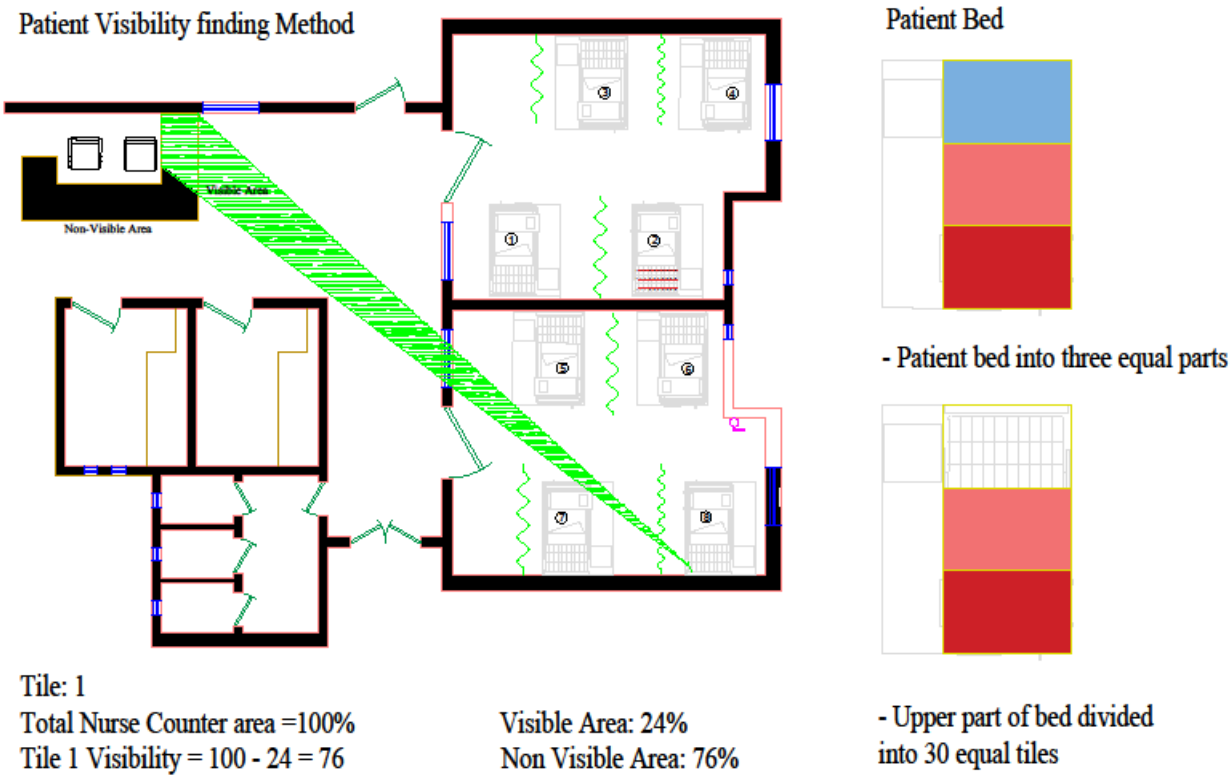


Figure 3: Patient Visibility

Overview of Selected Cases (ICUs)

For analysis, five different District Hospitals were selected from Khyber Pakhtunkhwa on basis of data availability. From each hospital, only one ICU ward was selected for in depth analysis and comparison.

Case 1: Kohat District Hospital (POD Type Ward)

KDA hospital's ICU ward is a POD type ward. In this type of ward design, beds are arranged around nurse for ease of access to individual patient beds. KDA hospital has a total strength of 449 beds, whereas 410 beds are fully functional. The number of ICU patient beds are 20, almost 5% of the total bed capacity of the hospital. The area per bed is 277 sqft and the Grossing factor is 1.14.



Figure 4: Kohat District Hospital (1st Floor)

Case 2: Karak District Hospital (Single Corridor Type)

District Headquarter Hospital Karak has a single corridor type ICU ward. In single corridor ward design, patient beds are arranged on both sides of the corridor. Karak District Hospital has a strength of 200 patient beds. The number of ICU patient beds are 10, which is almost 5% of the total capacity. The area per patient bed is 566 sqft and grossing factor is 1.15.



Figure 5: Karak District Hospital (Ground Floor)

Case 3: Hangu District Hospital (Single Corridor Type)

District Hospital Hangu has a single corridor type ICU ward. Hangu District Hospital has a total strength of 110 patient beds. The number of ICU patient beds is 10, which is 11% and the area per patient bed is 511 sqft. The grossing factor is 1.15.

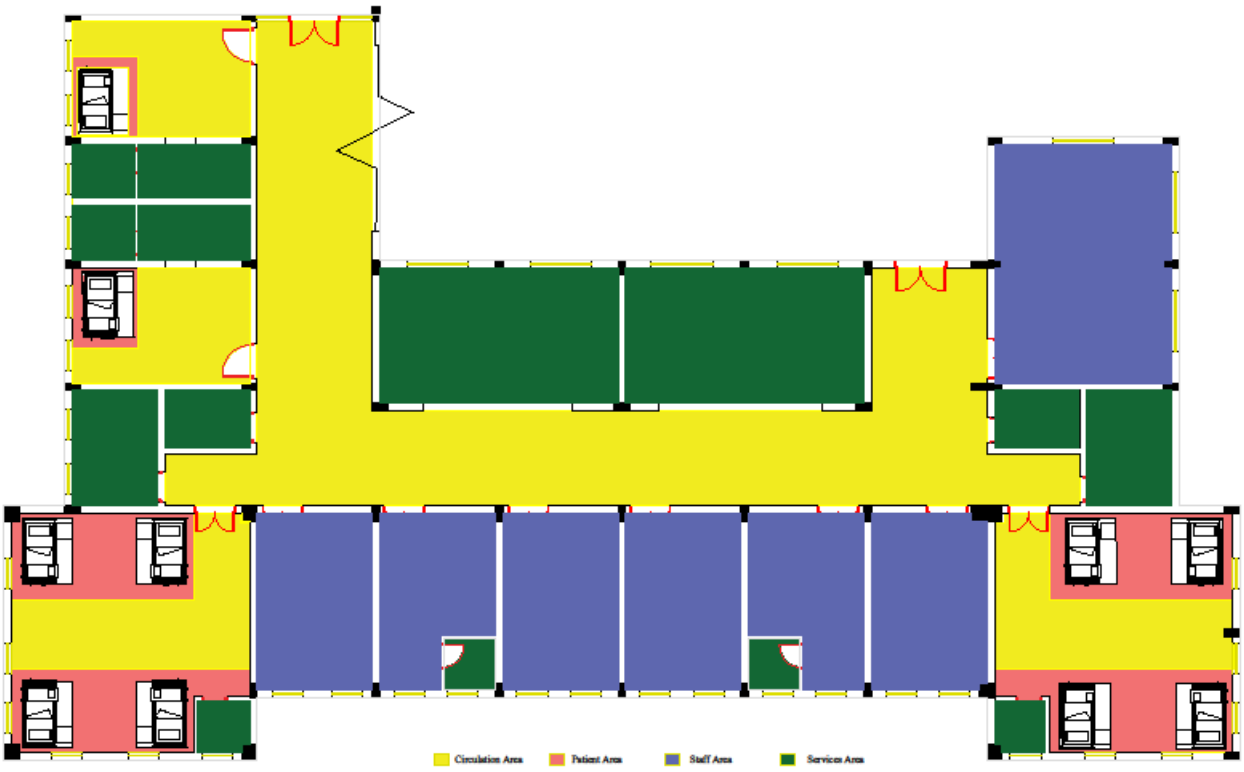


Figure 6: Hangu District Hospital (1st Floor)

Case 4: Batkhela District Hospital (Single Corridor Type)
Batkhela District Hospital also has a single corridor type ICU ward. Batkhela District Hospital has a strength of 200+ patient beds. The number of ICU patient beds in this hospital is 21, which is almost 12% of the total capacity. The area per patient bed is 663 sqft and the grossing factor is 1.22.



Figure 7: Batkhela District Hospital (2nd Floor)

Case 5: Mansehra District Hospital (Single Corridor Type)
District Hospital Mansehra also has a single corridor type ICU ward. Mansehra District Hospital has a strength of 325 patient beds. The number of ICU patient beds in this hospital is 8, which is almost 2.5%. The area per patient bed is 410 sqft and the grossing factor is 1.13.

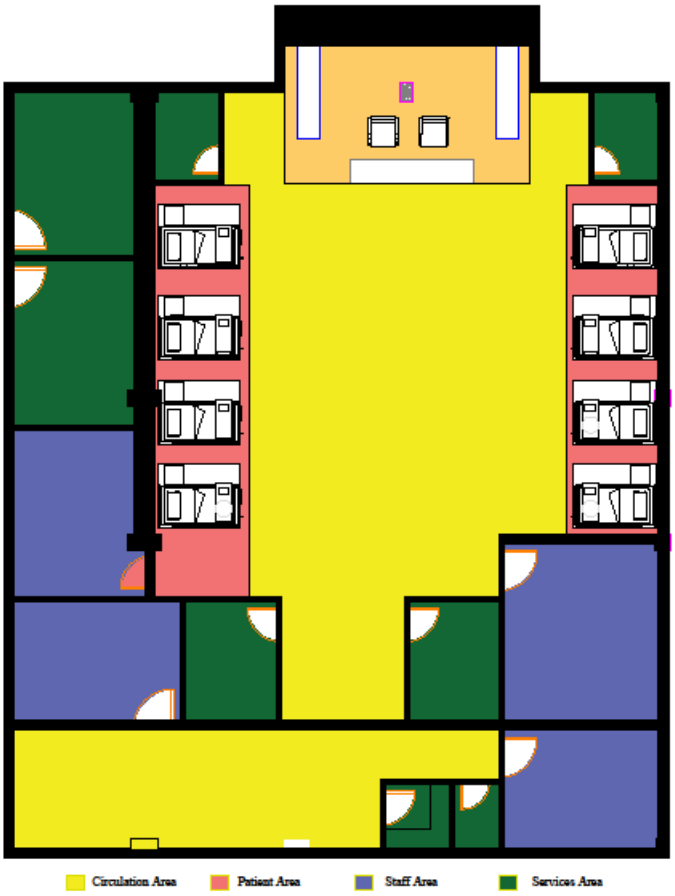


Figure 8: Mansehra District Hospital (Ground Floor)

Results

Visibility

By comparing the visibility personage of Kohat, Mansehra, Hangu, Karak and Batkhela. It was concluded that Mansehra and Batkhela ranked highest, each achieving patient visibility of 100%. In contrast, Hangu district hospital is at lowest in patient visibility with visibility of 0%.

Based on the visibility index, Batkhela and Mansehra ranked highest with 100% patient visibility, followed by Karak with 54%, Kohat with 31.10%, and Hangu with the lowest visibility at 0%.

Nurse Walking Distance (NWD)

Hospital Name	Distance from Nurse Station			Total length covered by Nurse (feet)
	Minimum	Average	Maximum	
Karak District Hospital	18'-7"	13'-8"	22'-9"	1863'-0"
Batkhela District Hospital	9'-2"	21'-9"	31'-9"	1856'-0"
Mansehra District Hospital	16'-10"	23'-0"	30'-6"	1998'-4"
Kohat District Hospital	35'-2"	50'-0"	62'-4"	4321'-3"
Hangu District Hospital	46'-1"	120'-0"	75'-0"	3120'-6"

[Table 1] Nurse walking distance

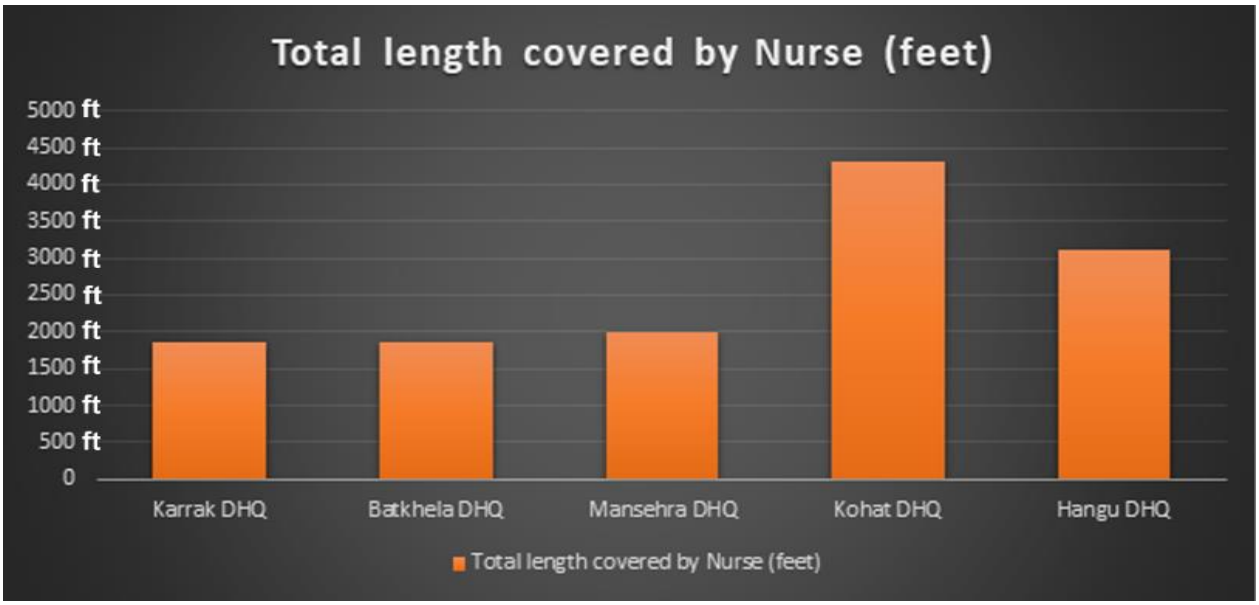


Figure 9: Total length covered by nurse (in feet)

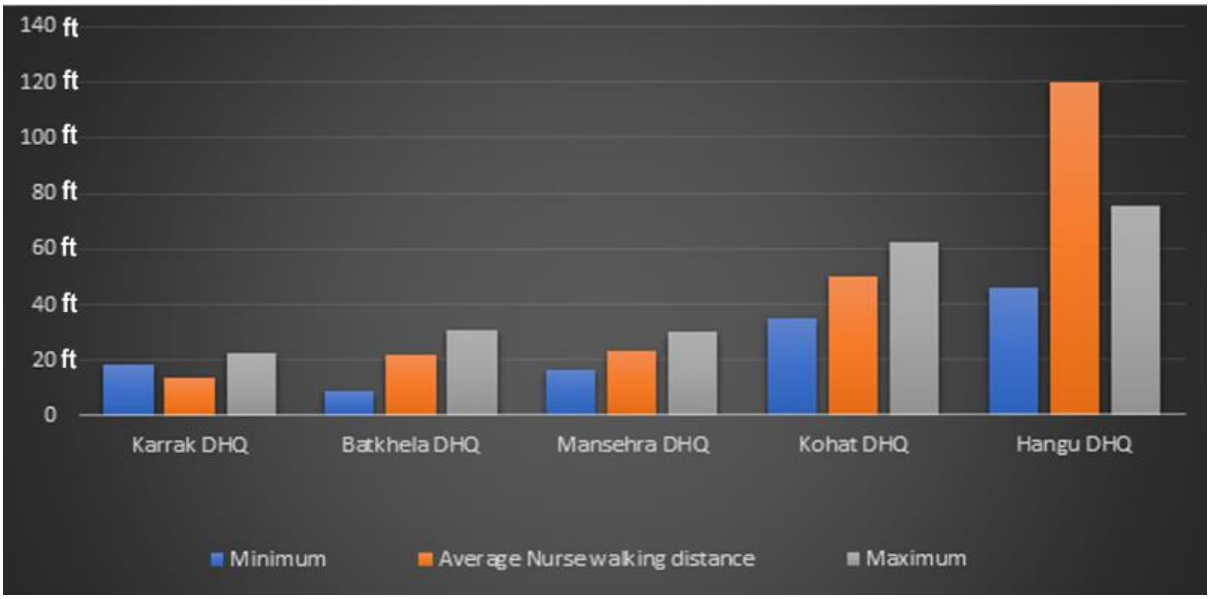


Figure 10: Minimum, Maximum and Average walking distance of nurse (in feet)

In terms of Nurse Walking Distance (NWD), Karak is on top of analysis list with the average distance of 13'-8" per bed, whereas Hangu district hospital ranked lowest with the average NWD of 120'-0" per bed.

According to the Nurse Walking Distance (NWD) index, Karak district hospital recorded the shortest average Nurse walking distance to Patient bed of 13'-8" followed by Batkhela with 21'-9", Mansehra with 23'-0", Kohat district hospital with 50'-0" and at the bottom of the list is with the longest average distance 120'-0". Moreover, Total NWD recorded in ICU ward was 1856'-0" in Batkhela, 1856'-0" in Karak, 1998'-4" in Manshera, 3120'-6" in Hangu, 4321'-3" in Kohat.

Hospital Name	Patient Area (%)	Staff Area (%)	Services Area (%)
Batkhela District Hospital	11	9.74	14.81
Mansehra District Hospital	22	13.2	11.75
Kohat District Hospital	42	4.62	12.81
Karak District Hospital	18	9.77	13.2
Hangu District Hospital	19	21.41	20.41

[Table 2] Patient area, Staff area (%), Services Area (%)

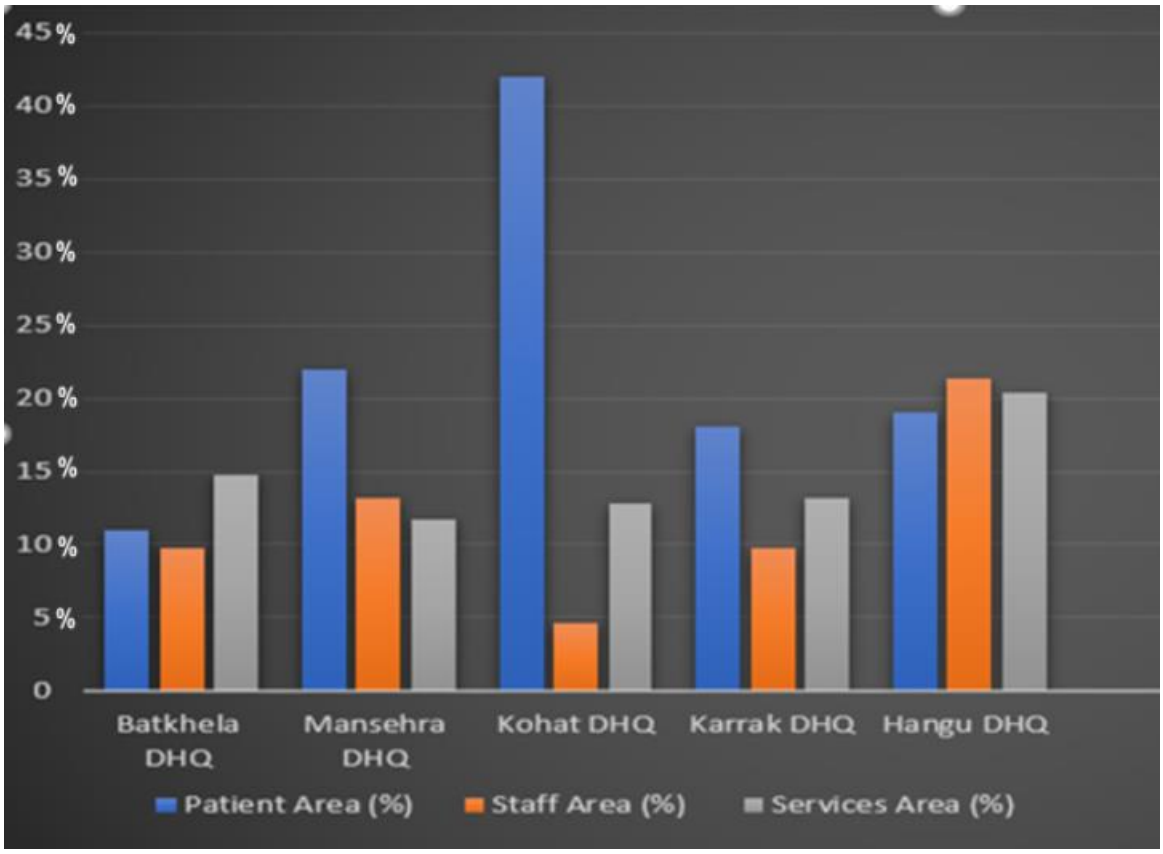


Figure 11: Patient Area, Staff Area and Service Area

Staff Area

In terms of staff area, Hangu District Hospital ranks highest with a total staff area of 1,341 sqft, accounting for 21.41% of the total ICU unit area. On the other hand, Kohat District Hospital has the smallest staff area in percentage terms, despite a staff area of 259 sqft—which is smaller than those of Karak (383 sqft), Batkhela (454 sqft), and Mansehra (535 sqft). However, when assessed as a percentage of the total ICU area, Kohat had the lowest staff area coverage of 4.62%, indicating limited space allocation for staff activities within the unit.

In staff area personage from top to bottom in list Hangu ranked top with 21.41%, followed by Mansehra, Karak, Batkhela and Kohat district hospital with respective values of 16.29%, 13.2%, 9.77% and 9.74%.

Service Area

It is area or space used for clinical or operational functions and are not used for staff or patient care.

Hangu district hospital is with 1234 sqft with a personage of 20.1% while at lowest side the Kohat district hospital is with a value of 710 sqft-covered area and with 12.81% in whole ICU unit.
Hangu District Hospital recorded the highest service area among the selected ICUs, with 1234 sqft comprising 20.1% of the total unit. This was followed by Batkhela with 688 sqft (14.81%), Karak with 383 sqft (13.20%), Kohat with 386 sqft (12.81%), and Mansehra with 710 sqft, accounting for 11.75% of the total ICU area. These findings highlight variations in service space allocation, which can influence operational efficiency within the ICU units.

Hospital Name	Grossing Factor	DGSF	Circulation Area (%)
Batkhela District Hospital	1.12	663 sqft/bed	46
Mansehra District Hospital	1.13	410 sqft/bed	37.67
Kohat District Hospital	1.14	227 sqft/bed	27.50
Karak District Hospital	1.15	556 sqft/bed	50
Hangu District Hospital	1.15	511 sqft/bed	28.2

[Table 3] Grossing Factor, Area per bed, Circulation Area (%)

Grossing factor

Grossing factor means gross area divided by net area (net area means area of a building without walls). It is calculated as below:
Grossing factor = Gross area/ Net area.
In DGSF (Departmental Gross Square per bed) analysis, Hangu and Karak District Hospitals ranked highest with a DGSF ratio of 1.15. They were followed closely by Kohat (1.14), Mansehra (1.13), and Batkhela, which recorded the lowest value of 1.12.

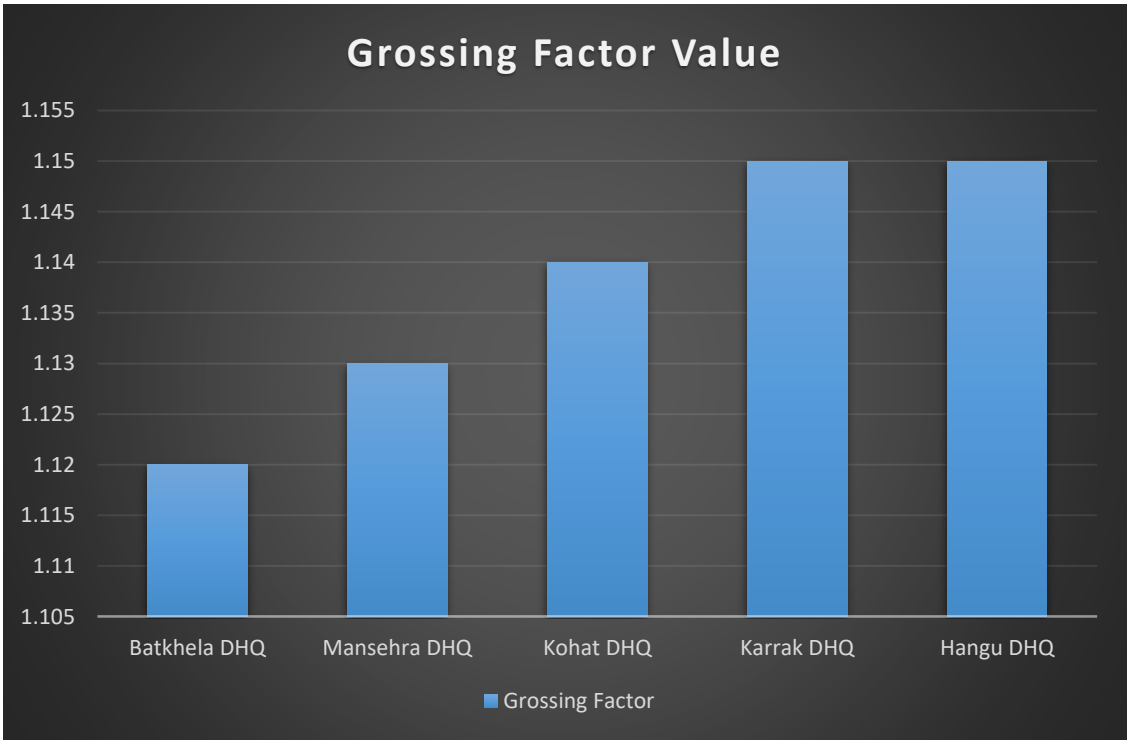


Figure 12: Grossing Factor Value

Departmental Gross Square Feet

DGSF means the area per patient bed in a ward. It is calculated as:

DGSF = total area/ no. Of beds

Batkhela district hospital ranked on top of the list with a grossing factor of 663 sqft per patient bed, Karak with 556 sqft, Hangu with 511 sqft, Mansehra with 410 sqft, Kohat with 227 sqft area per patient bed.

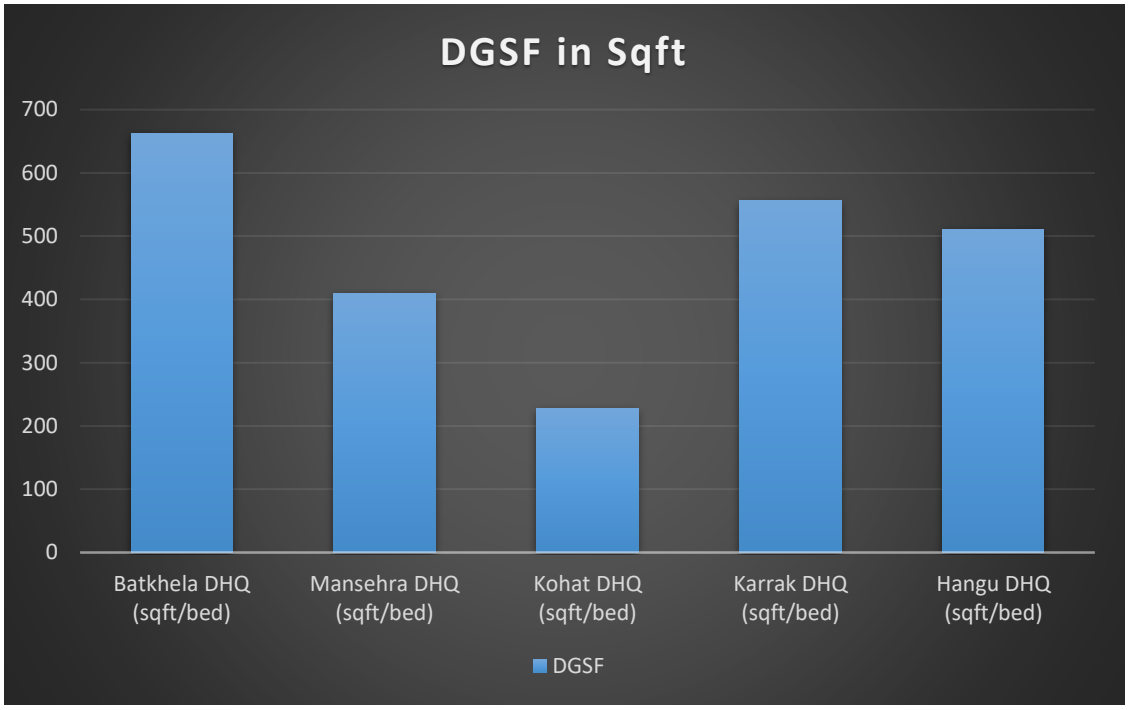


Figure 13: Departmental Gross Square Feet (DGSF) in SFTs

Gross Square Feet Area

Gross area means total Area of the unit or ward. Hangu district had the highest value of 6137 sqft, followed by Kohat with 5552 sqft area, Batkhela with 4644 sqft, Karak with 3337 sqft and at the bottom of the list is Mansehra with 3283 sqft.

Circulation Area

The space used for movement within a unit/ward. Analysis of the circulation area across the selected ICUs revealed that Karak District Hospital ranked highest, with 1447 sqft dedicated to circulation space, accounting for 50% of the total unit. This was followed by Batkhela with 2129 sqft (46%), Mansehra with 1,237 sqft (37.67%), Hangu with 1735 sqft (28.2%), and Kohat with 1527 sqft (27.50%).

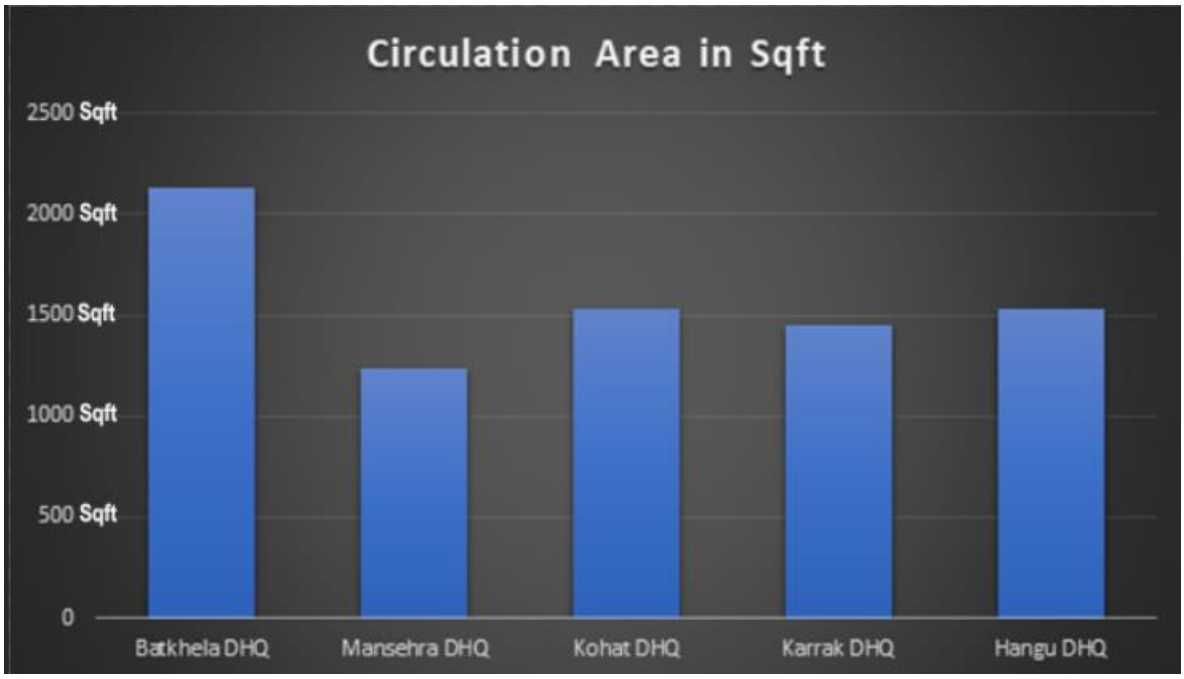


Figure 14: Circulation Area in SFTs

Comparison

Comparison of Patient area per bed and Circulation area

The analysis revealed that Karak and Batkhela district hospitals has highest values for both Patient area per bed and circulation area percentage. This indicates a strong positive correlation exist between them Patient area and circulation area, suggesting as patient area increases, circulation space is also expanded proportionally.

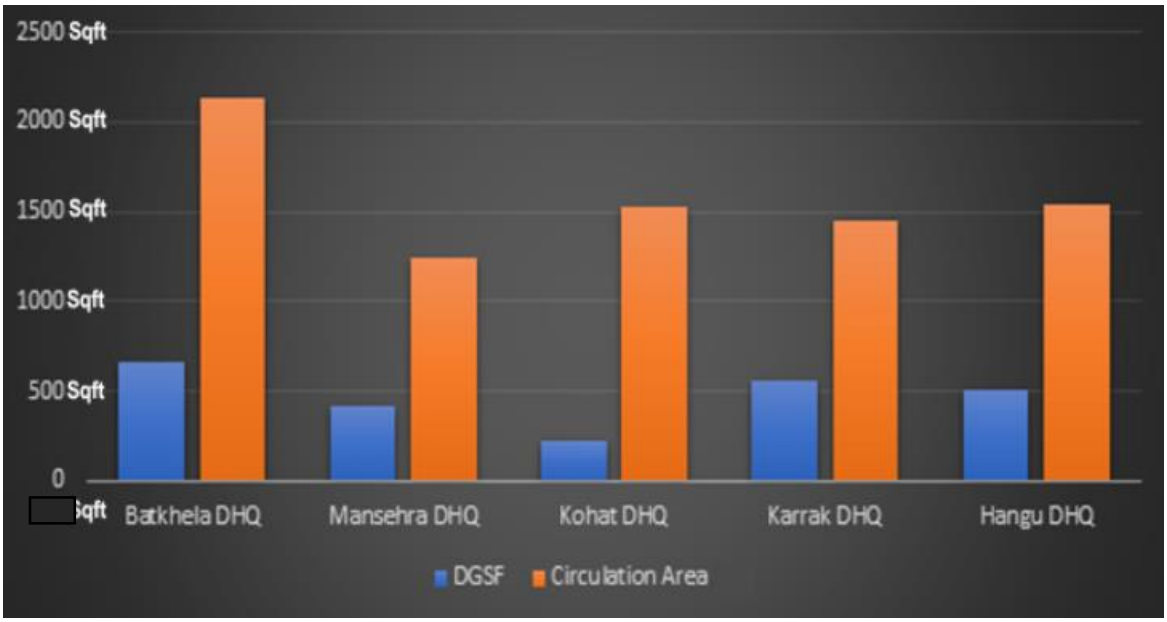


Figure 15: Comparison of Patient Area per Bed and Circulation Area

Correlation between Nurse walking distance and Visibility

The analysis concluded that Hangu district hospital recorded the highest average NWD value of 1200'-0" amongst all district hospitals, accompanied by the lowest patient visibility of 0%. Kohat followed with a visibility of 31.10% and the second highest Nurse walking distance. These findings highlight a strong inverse correlation between nurse walking distance and patient visibility—indicating that as NWD increase, visibility tends to decrease.

Correlation of Nurse Station and Visibility

The Study found a strong correlation between the placement of Nurse Station and overall patient visibility within the wards. Strategically designing and locating nurse stations can significantly enhance visibility within wards, as observed in existing cases such like Mansehra, Batkhela and Karak nurse station were found to be positioned within wards, offering a greater visibility personage of patients. In contrast, Kohat had an average patient visibility of 31.10% and Hangu reported 0% visibility, both of the hospitals correlate with less optimal nurse station placement.

Correlation of DGSF and Average Nurse Walking Distance to Patient Bed

Batkhela and Karak were found to be having higher DGSF of 633 sqft and 556 sqft respectively. Karak also recorded the lowest average Nurse Walking Distance (NWD) of 13'-8", followed by Batkhela with the second-lowest NWD of 23'-0". The research findings indicate a strong negative correlation between DGSF and Average Nurse walking distance while in case of Hangu and Kohat DHQ this correlation finds to be untrue with high average NWD and Patient area per bed respectively, suggesting that well-design patient space contributes to more efficient nurse movement within the ward.

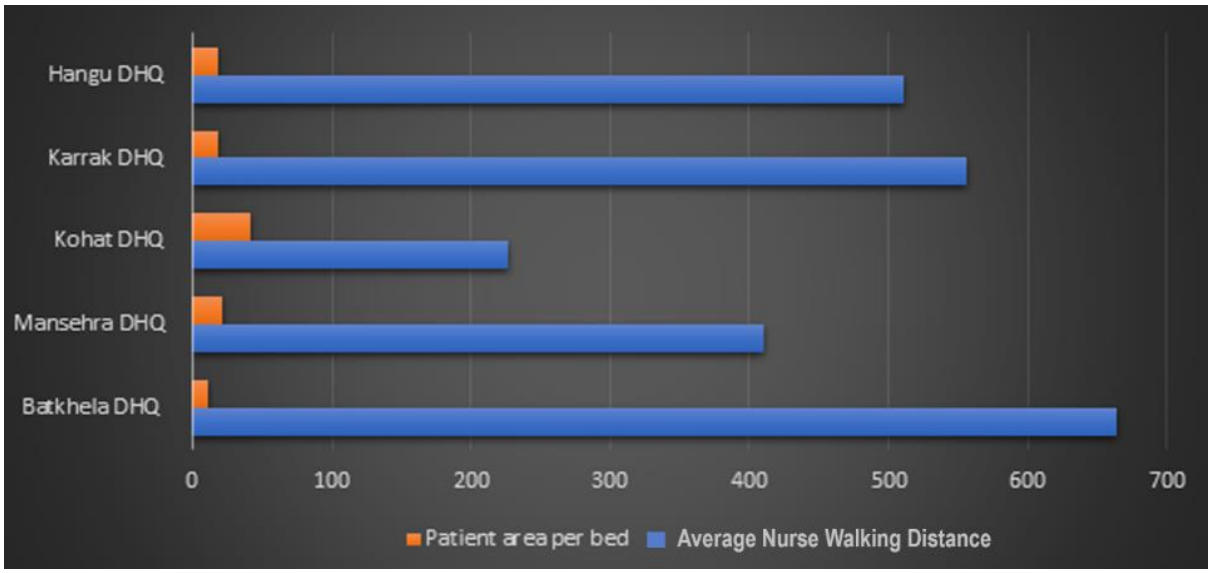


Figure 16: Correlation of DGSF and Average Nurse Walking Distance to Patient Bed

Correlation of NWD and Patient Area

It research found out that NWD had stronger correlation with Patient area in most existing ICU cases For instance, Batkhela and Kohat demonstrated a positive relationship, where lower patient areas corresponded with shorter Nurse walking distance. However, in case of Hangu District Hospital, this correlation appeared to be negative—despite having a lower patient area then other ICU wards, Hangu exhibited a significantly higher Nurse Walking Distance.

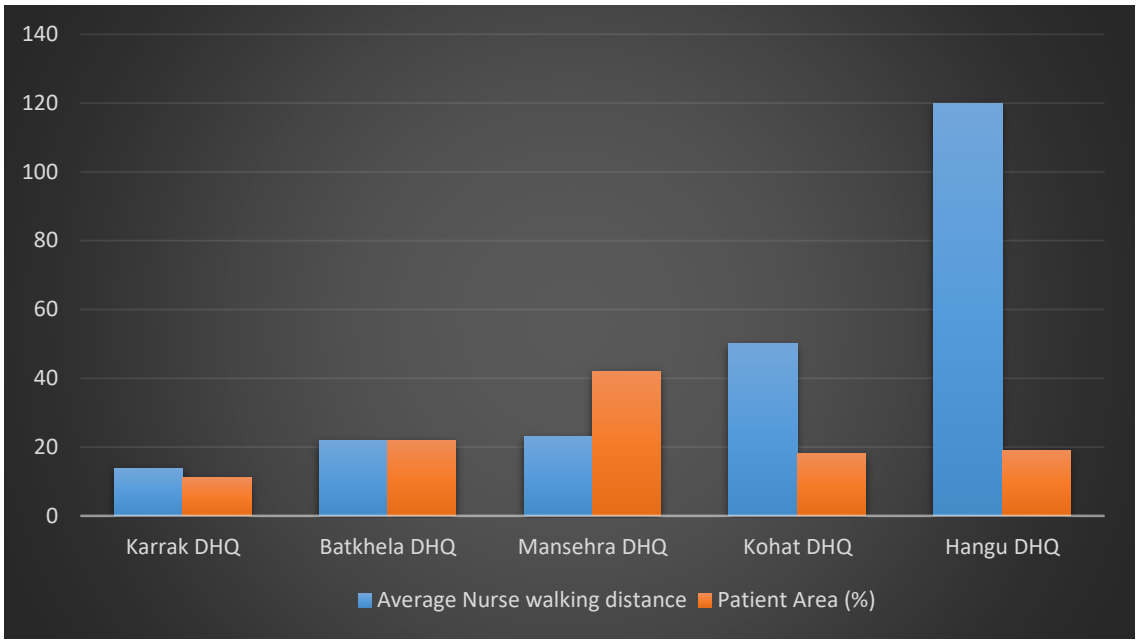


Figure 17: Correlation of NWD and Patient Area

Conclusion

1. Among the Selected ICU's Wards, Batkhela and Mansehra exhibited the highest patient visibility, achieving 100%, whereas Hangu recorded the lowest visibility, with a patient visibility percentage of 0%.
2. The analysis found out a strong correlation exist between Nurse walking distance and visibility and it is evident through comparison with other selected hospitals.
3. Karak and Batkhela ICU wards higher demonstrated Patient area per bed and circulation area percentage as compare to other district hospitals. Suggesting a strong correlation exists between Patient area per bed and circulation area.
4. The analysis finding revealed that Karak district hospital has shortest Nurse Walking Distance (NWD) of 82'-2", with average NWD of 13'-8", making it more suitable for patient care. In contrast, Hangu district hospital are found be having an average NWD of 120'-0" twice the average NWD as compare to other selected district hospitals ICU's.
5. The maximum Nurse Walking Distance (NWD) to reach a patient bed were at 75'-0" in Hangu district hospital followed by 62'-4" in Kohat district hospital, 31'-9" in Batkhela, 30'-6" in Mansehra and with the shortest distance of 22'-9" in Karak district hospital.
6. In selected ICU wards, a strong negative correlation was observed between Patient area and Nurse walking distance in case of Kohat and Mansehra, but in contrast Hangu ICU ward this relation found to be untrue.
7. The study revealed a strong correlation among the location of Nurse Station and overall visibility of Patient visibility. Carefully designing and placement of Nurse Station can significantly enhance the overall visibility of a patients/ward.

Recommendation

1. Reduce Nurse Walking Distance (NWD) can improve the quality of patients care significantly, as researcher had find out a direct relationship between NWD and enhanced patient care (Rapin et al., 2018). The Hangu district hospital ICU unit should be at consideration for visibility and NWD. As analysis, find it with higher average NWD and lowest visibility.

2 The analysis revealed that, unlike other district ICU's, Hangu district hospital lacks a designated nurse station in ward or central nurse station in unit like Kohat district hospital. Currently, the nurse room is design, positioned adjacent to the ICU ward, and can be feasibly converted into a proper nurse station. This design modification could significantly improve patient visibility from the current 0% to approximately 60–70%.

3 Most of the ICU's are located on first or upper floors, resulting in a lack of connection to nature. Researchers had find out that exposure to nature/natural elements can reduce patient recovery time, which in return may lower healthcare costs on patients and ease the burden on government hospitals by having ICU's beds available for patients in need.

Future Research

1 Documentation is another critical aspect, which need to be addressed at technological field. Research had find out that nurses spend nearly one-third of their time on documentation, which can reduce the time available for direct patient care especially in ICUs, where patients require constant and intensive monitoring. Therefore, specialized studies should be conducted within existing ICU ward/unit to assess documentation practices and explore technological solutions that can streamline this process and enhance nurse efficiency.

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