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Enhancing Spatial Relationships in Healthcare Facilities through BIM-Driven Pragmatic Design

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Abstract

The spatial relationships within healthcare facilities need to be optimized as it is crucial to increase the efficiency of operation, patient security, and quality of care. This paper explores the ways in which Building Information Modeling (BIM) with the input of the pragmatist approach to design can benefits the spatial configurations of the hospital environment. The question posed by the research is: How would BIM-driven pragmatic design be used to dynamically optimize on proximity and visual accessibility between important functional spaces of the healthcare facility? By covering eight hospitals in the Kurdistan region, the research takes a multi-stage approach that constitutes the following elements: institutional data collection, site measurement, 3D modeling with Archicad, and spatial analysis with Solibri Office based on rules. Results indicate that government hospitals adhered completely to the set spatial standards, whereas, a considerable gap exists in the case of the privately operated hospitals, especially in cases involving spatial distances beyond 30 meters or those without direct access. The findings underscore that BIM-enabled, pragmatic design approaches offer a robust framework for achieving spatial efficiency and patient-centered care in hospital environments.

Keywords: *Spatial Relationships; BIM; Pragmatic Design, Operational Efficiency*.

Introduction

The core nature of healthcare buildings is a complex system that is capable of continuously responding to the changes occurring in their operations, regulatory codes and varied user needs [1, 2]. The current approaches to design are largely unable to keep pace, resulting in the inefficialities and missed opportunities to pursue genuinely patient-centered care [3, 4]. In hospitals, efficient spatial relationships are not solely regarding the workflow, they constitute the core of daily operations, safety, and the quality of care [5-7].

Building Information Modeling (BIM) has turned into the driver of change within the Architecture, Engineering, and Construction (AEC) industry, delivering innovations in spatial planning, design accuracy, and team-based work [8, 9]. Nevertheless, with the increased distribution of BIM across the globe, there are still a large number of architects who work in strict theoretical frameworks that do not allow them to adjust themselves very well to the complex and real-world healthcare requirements [4-7]. At the philosophical level, pragmatism that focuses on experimentation, context, and outcomes that can be measured provides a route toward more pragmatic and responsive design [10-14].

The recent trends indicate that BIM is not only technical tool but it can also be utilized to design honestly patient- and staff-friendly settings. It is of particular importance in emerging environments such as Kurdistan, where BIM is to be integrated through constant learning and collaboration [8]. BIM does not only avoid costly errors and optimize designing because it facilitates visualization of the project in real-time, safety control, and adaptation to changes [1,5], not to mention the problem of design streamlining [9]. The application of BIM with technologies like virtual reality or automatic verification of compliance permits the designers to optimize the space in a hospital even before it is constructed [3-7], and test the layout not only under regular conditions but in the case of an emergency [6]. In spite of such improvements, a really applied, user-experience-based design methodology, using feedback

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instead of regulations, is yet to be accomplished. This paper fills this gap by discussing BIM as a flexible and convenient method of making hospital environments compliant, but rather supportive and resilient.

By focusing on real hospital projects in Duhok, this study is among the first to empirically apply BIM-driven pragmatic design in the context of Kurdistan's healthcare facilities, providing practical evidence and new perspectives for regional and international hospital design. Specifically, this research examines how BIM-driven pragmatic design can be used to dynamically optimize proximity and visual accessibility between essential spaces in healthcare settings. In doing so, this work seeks to bridge the gap between architectural theory and operational realities, ultimately aiming to foster better patient outcomes, staff efficiency, and more future-proof hospital design.

Proximity focuses on how close key units—like nurse stations and patient rooms—are to each other, with shorter distances leading to quicker responses and better communication [1-5]. BIM tools make it possible to carefully measure and improve these distances to meet operational needs [3-6]. Research shows that rooms within 11–21 meters of the nurse station lead to greater patient satisfaction [20,21], and distances beyond 30 meters may require additional nurse stations for optimal care [22].

Visual accessibility means nurses should have a clear line of sight to patient rooms and key areas to ensure rapid and effective care. Central nurse stations with open views are essential for both safety and operational efficiency [1,2]. Guidelines recommend that at least half of all patient rooms (50%) should be directly visible from nurse stations, making visual oversight a foundation of patient-centered, responsive hospital design [23,24].

This study adopted 30 m and ≥50% as operational thresholds to support and structure the practical evaluation. The 30 m cap speeds staff response and reduces walking; the ≥50% visibility rule keeps at least half of ward entrances in direct view to support awareness and quick escalation. Together, they balance reach and oversight.

Table 1. Literature-based thresholds for nurse-station–ward distance and visual by the authors.

Source		Distance/visual	Context
Distance	MacAllister et al. (2018), Cai et al. (2021). [20-21]	11-21 meters	Patient satisfaction
	Deng et al. (2023).[22]	30 meters	More than 30m require additional nurse stations

Methodology

This research adopts a pragmatic multi-stage method to investigate how BIM-based processes can attain optimum spatial relationships see Figure 1, i.e., distance between nurse stations and wards—in sampled hospitals located within Kurdistan region. The method adopts the following successive stages:

Figure 1. Research methodology by the authors.

Selection of case study hospitals

The initial move was a purposive selection of eight hospitals located in the Kurdistan region at different cities. Namely five government hospitals, three private hospitals. These locations were selected in order to embrace diversity in terms of ownership, size and the operating models, so that to get results that portray a wide range of healthcare settings within the area. Each hospital information about bed capacity and functional profile was recorded in a fine detail in order to offer a necessary background to further analysis.

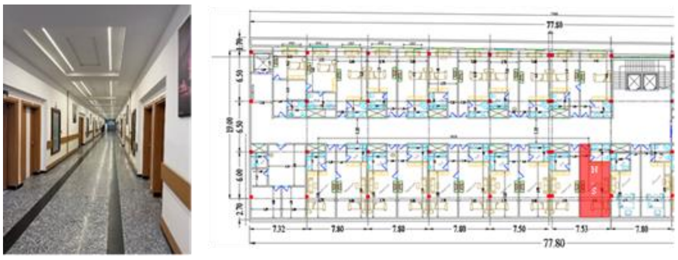

Figure 2. .Corridor in Medi Hospital inpatient department, with verifying nurse station placement by the authors.

Data collection from institutional sources

During stage two, primary information is collected from consultations with Duhok, Hawler, and Sulaymaniyah Directorate of Health. This includes conducting semi-structured interviews among architects and facility managers with a purpose to garner details regarding work patterns and functioning, spatial considerations, and design intents. Building drawings and corresponding paperwork for each hospital are also obtained from its own Directorate for purposes related to access to recent and original records.

Site observation and plan verification

Site visits were conducted at each hospital to validate the accuracy of architectural plans attained from the Directorate of Health. Via laser distance meters and manual measurements, the researcher verified main dimensions and spatial relationships, mainly between nurse stations and wards. Any discrepancies identified were documented, and as-built plans were updated accordingly. Photographs, such as Figure 2 from Medi Hospital, were taken to support the verification process and ensure the digital models reflect real-world conditions.

BIM Modeling using ArchiCAD

The second step was the development of the detailed digital models on Archicad after ensuring that the plans of the hospital were correct. Archicad is a high-tech BIM software developed by Graphisoft that guarantees the architects and engineers to create precise 2D and 3D models, design areas within the building, and coordinate the whole design process in a collaborative ecosystem [15-17]. One of the most important aspects of Archicad is the opportunity to develop and control the zones, which are different spatial segments (nurse stations, wards, etc.), and organize and analyze them precisely [17]. To have a clear picture of each area (see Figure3)

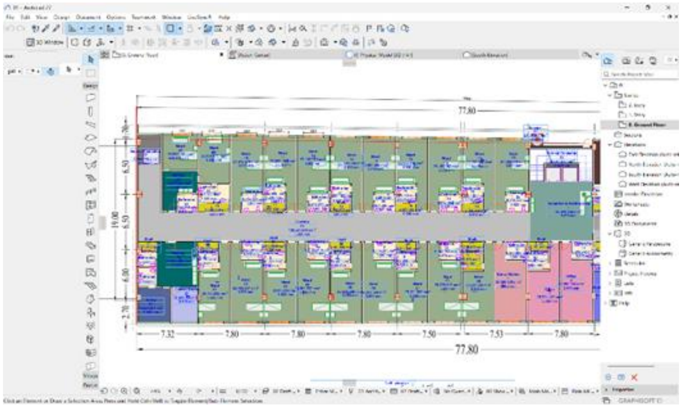

Figure 3. Medi Hospital inpatient department by the authors.

The researcher created zones of all the critical spaces and further created a complex 3D model to visualize the layouts, spatial adjacencies, and circulation (see Figure 4). Lastly, export of each BIM model was performed in IFC file, hence they were completely compatible with sophisticated spatial analysis and compliance checking in Solibri Model Checker. This systematic approach of BIM modeling served as a trustful interoperable source of spatial assessment within all the four hospitals.

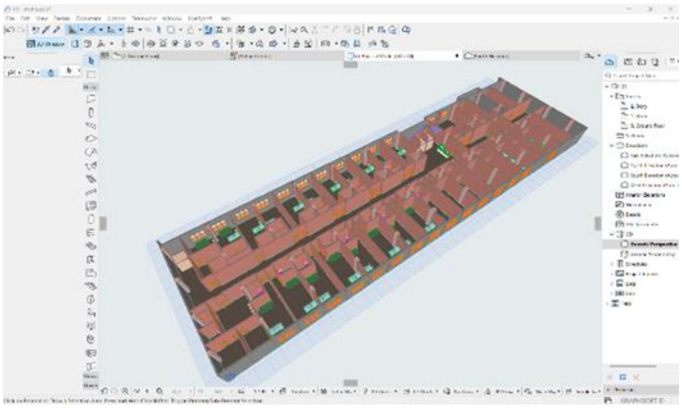

Figure 4. Three-Dimensional BIM (ArchiCAD) model by the authors.

Spatial analysis using Solibri Office

The IFC models generated using ArchiCAD were imported into Solibri Office for comprehensive spatial analysis and rule-based compliance checking. Solibri Office (Solibri Model Checker) is a standard-specific BIM validation tool for automating rule-based compliance checking and improving the quality and integrity of digital building models through enhanced clash detection, deficiency detection, and information verification [16, 17]. It enforces customizable rulesets suitable for specific standards for regulation and enables detailed and selective scrutiny of spatial relationships and compliance [17, 18]. Through its automatic checking tool, actual distances and visual relationships are systematically quantitated and non-complying or suboptimally ordered layouts objectively identified on the basis of proscribed spatial criteria [16]. Figure 5 shows an indicative compliance-checking process within Solibri Office and identifies how spatial inconsistencies are highlighted and flagged visually through rule-based inspection.

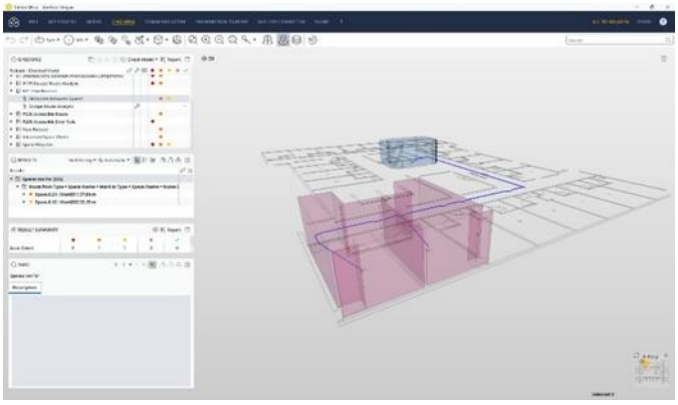

Figure 5. Example of spatial compliance checking using Solibri Office by the authors.

Also, Solibri Office offers the Ruleset Manager—a dedicated workspace from which model validation rulesets can be constructed, edited, and managed. With this interface, rules can be tailored according to project-specific or nationally-based laws and multiple subsets of rules can be compiled and configured together into ordered checking [19]. Figure 6 shows the Ruleset Manager workspace with a sample "distance between spaces" rule being edited. Figure 7 illustrates how Solibri Office allows customization of rule parameters: by right-clicking a rule and selecting Rule Parameters, the user can define start and destination spaces (e.g., wards and nurse stations), set maximum/minimum distances, toggle linear measurement, and enforce or ignore direct access. Group selection of spaces and routing methods further streamline the process. After adjusting parameters, clicking Check model runs the analysis and displays results in the results box.

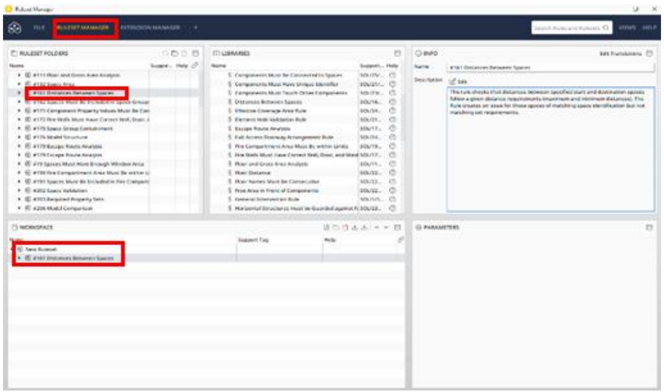

Figure 6. Solibri Ruleset Manager interface by the authors.

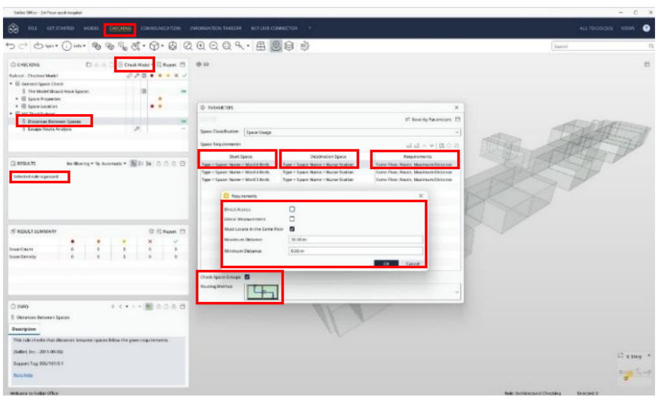

Figure 7. Solibri Office compliance checking interface for the "Distances Between Spaces" by the authors.

Case Study

In connection with an empirical research work on optimizing relationships between spaces within health-care facilities, eight health-care facilities situated within Kurdistan region were selected as case studies. These health-care facilities were selected with the objectives of obtaining a balanced representation between governmental and private health-care facilities with varied ``photo documentation for each health-care facility can be found in Figure 8.

Case Studies		Photos	Case Studies		Photos
Azadi hospital	Duhok Government 400 beds		Shiryan hospital	Duhok Private 71 Beds	
Bedare hospital	Duhok Government 200 Beds		Medi hospital	Duhok Private 50 Beds	
Rizgary hospital	Erbil Government 400 Beds		Barzan hospital	Erbil Government 60 Beds	
Shar hospital	Sulaymaniyah Government 400 Beds		Faruk Hospital	Sulaymaniy ah Private 400 beds	

Figure 8. Selected hospitals for case study by the authors.

A. Azadi hospital

It's a very large governmental medical complex situated in Duhok city and can accommodate 400 beds. Moreover, there are 14 patient rooms on a regular floor. It's one of the region's largest medical institutions and serves as a principal health care provider and comprehensive support and clinical services. Because of its scope and complexity, its utilization through spatial analysis and BIM techniques can be suitable.

B. Zakho general hospital (Bedare)

It is a government functioned facility in Duhok, offering 200 beds and a standard floor contains 23 patient rooms. It provides general healthcare services to the population of Zakho and the surrounding areas. The hospital's medium scale lets for the duty of spatial relationships in a typical regional healthcare setting.

C. Shiryan Hospital

Shiryan Hospital is a private hospital in Duhok, with a capacity of 71 beds and the second floor contains 25 wards. It provides to both inpatient and outpatient needs, reflecting the operational characteristics of private healthcare provision in the city. Its presence in the study provides insight into spatial organization and efficiency in the private sector.

D. Medi Hospital

Another private hospital is Medi Hospital, situated in Duhok and with a capacity of 50 beds and Level 2 comprises 25 wards. Noted for its modern infrastructure and patient-based services, Medi Hospital is an epitome of recent trends for private administration and provision of healthcare.

E. Rizgary Hospital

Government (400 beds). One of the biggest public hospitals in Erbil, playing a key role in the region's health system. A typical level comprises 14 wards. Its many inpatient wards and elongated corridors are critical for circulation and egress checks.

F. Barzan Hospital

This government hospital in Barzan has a capacity of 60 beds. A smaller government facility in Barzan that serves the local community; its inpatient unit contains 12 patient rooms.

G. Shar Hospital

Government (400 beds). A major Sulaymaniyah hospital providing wide-ranging services. Typical floors have 40 patient rooms. The inpatient department consists of two triangular corridor loops with near-identical layouts; accordingly, one side was selected for the practical study.

H. Faruk Hospital

A 400-bed private hospital in Sulaymaniyah, combines high capacity with advanced services. It contains 46 patient rooms; this study selected one side of the normal-class inpatient unit (26 rooms), excluding the suite class.

The selection of these eight hospitals ensures diversity in ownership, size, and service delivery models, allowing for a comprehensive analysis of spatial relationships and BIM-based design optimization across different healthcare contexts in Duhok.

Result and Discussion

Visual Illustration of Compliance Assessment

To define an objective and transparent process for evaluating nurse station and ward spatial relationships, a series of illustrative figure (9-16) are employed. These figures represent pragmatic cases with a “pass” or “not pass” outcome determined by adopted spatial criteria employed by this study. The “pass” diagrams show optimal nurse-station closeness for wards and are typically within the range of distances set (e.g., less than 30 meters) and direct access or unobstructed visual connection. These configurations enable convenient observation and immediate attending by staff and enhance operational efficiency and patient safety. The visual plans also show nurse stations and patient rooms centrally located and arranged for direct visual connection and minimal unobstructed distances. The "not pass" figures are instances when wards are more than permissible distance from nurse stations or have no direct access. For example, a ward more than 30 meters from a nurse station and separated by multiple corridors or out of view from a nurse station is non-compliant. These diagrams depict undesirable configurations that delay agile people movement and put patient safety at risk because reaction takes a little longer. The visual comparison between these figures provides an immediate method for stakeholders and readers to discern successes and improvement opportunities spatially. The visual approach provides an introduction to the quantitative ranking scale (0–5) adopted from the assessment for compliance and provides a basis for interpreting results from tables and charts thereafter.

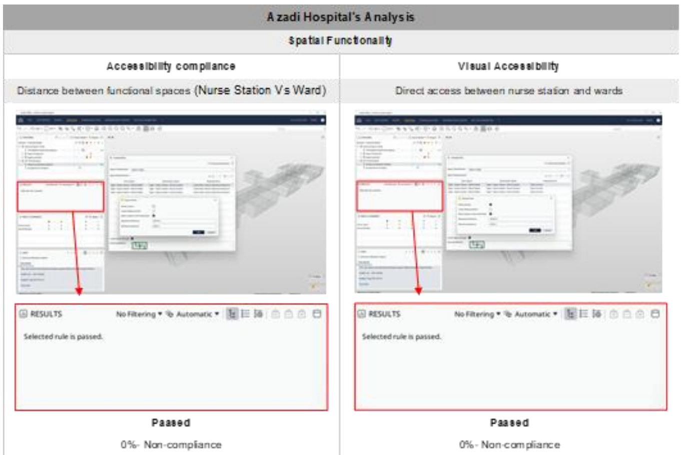

Figure 9. Checking a spatial functionality for Azadi hospital by the authors.

Figure 9 shows a ward in the Azadi hospital located within 30 meters of the nurse station with an unobstructed, direct path. Visual lines between the nurse station and patient rooms are clear, allowing for easy monitoring and rapid response. Such spatial organization meets all the criteria for compliance and is classified as "passed."

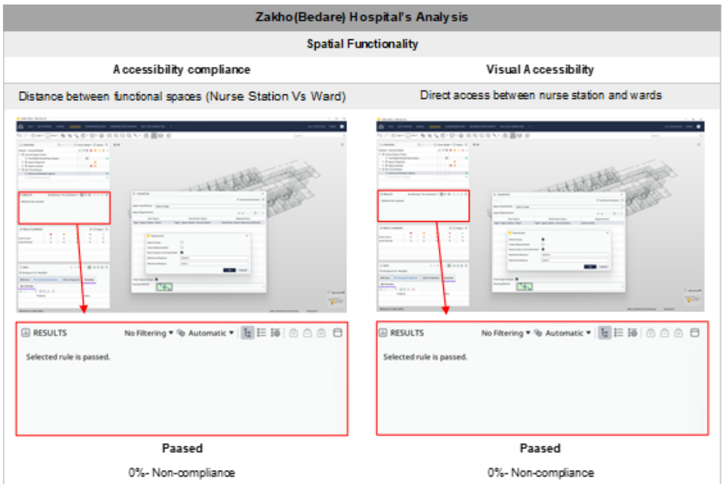

Figure 10. Checking a spatial functionality for Zakho general hospital by the authors.

In Figure 10, nurse's office and patient room positions are centralized such that good wayfinding and on-the-spot visual coverage are achieved. The distance between each ward and nurse's office does not exceed the set cut-off. The layout strictly meets spatial standards and can be termed as a "passed" account.

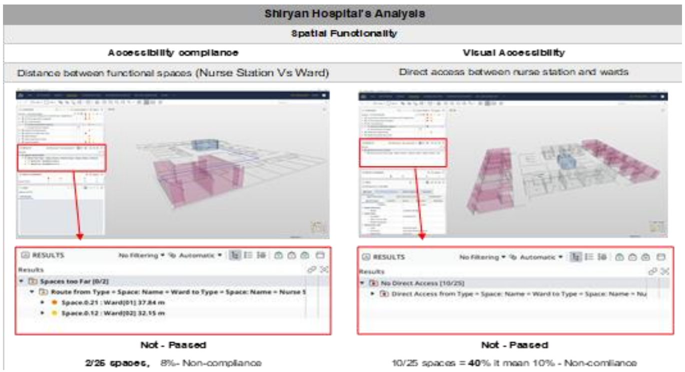

Figure 11. Checking a spatial functionality for Shiryan hospital by the authors.

Figure 11 Shiryan hospital, The location of the ward is more than 30 meters from the nurse station and constitutes a significant barrier to convenient care. The pathway is roundabout and lines of view are interrupted, thereby minimizing visibility and response time among personnel. This layout does not meet compliance requirements and scores as not passed.

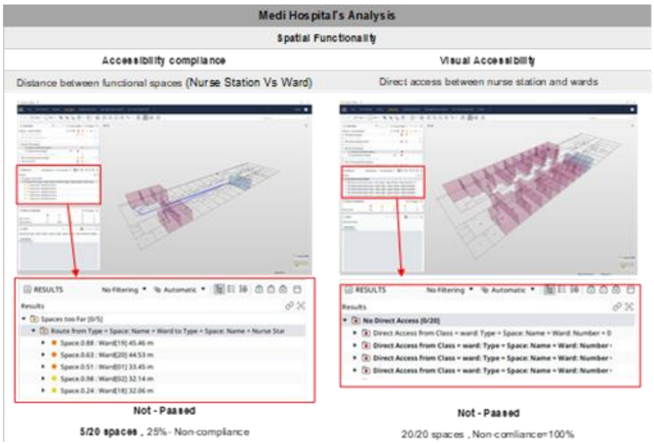

Figure 12. Checking a spatial functionality for Medi hospital by the authors.

Figure 12 will serve as the illustration that not all wards are accessible to the nurse in the station which are separated by corridors or space. This inappropriate distance and poor visibility reduce the effectiveness of operations and safety of patients. This arrangement passed so as a "not passed" rate is as a result of such considerations.

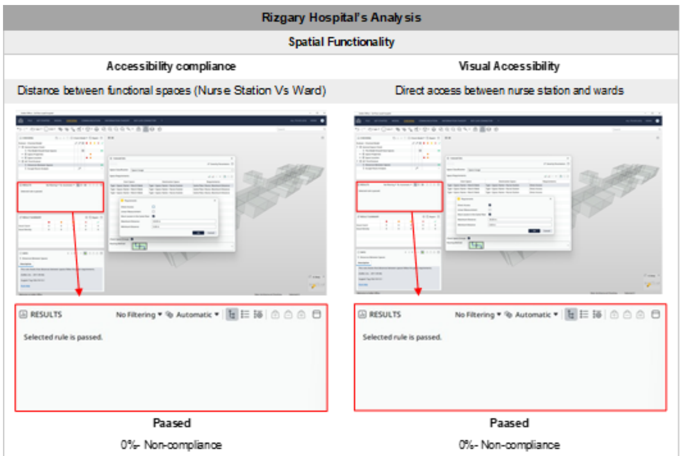

Figure 13. Checking a spatial functionality for Rizgary hospital by the authors.

Rizgary Hospital in figure 13 demonstrates the same spatial logic and outcome as Azadi: the nurse-station–ward distance is within the 30 m threshold, and sightlines from the station to ward entrances are clear. Both indicators therefore passed with 0% non-compliance, confirming that the plan supports quick access and reliable visual supervision.

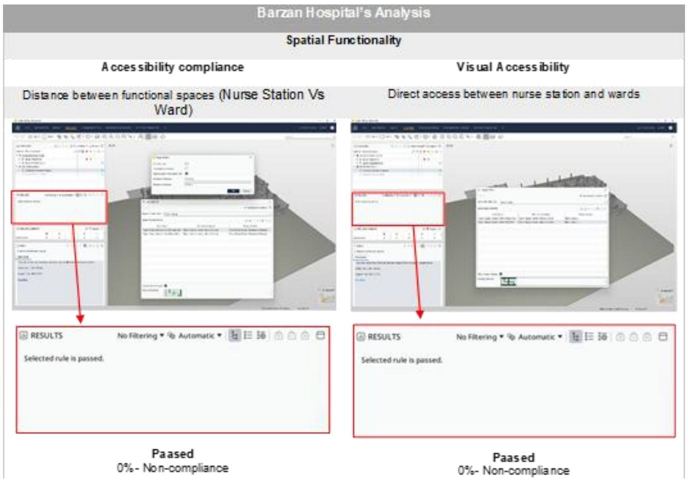

Figure 14. Checking a spatial functionality for Barzan hospital by the authors.

Barzan Hospital's inpatient unit meets both indicators: the nurse-station–ward distance stays within the ≤30 m criterion, and the route provides direct. Sightlines from the station to ward entries are clear, supporting rapid supervision and response. Accordingly, both checks passed with 0% non-compliance, See figure 14.

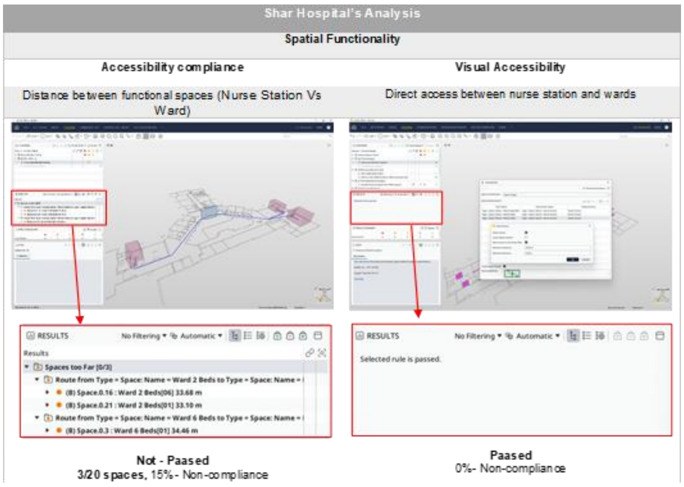

Figure 15. Checking a spatial functionality for Shar hospital by the authors

Shar Hospital in figure 15 shows a mixed outcome: Direct access between the nurse station and wards passed, but the distance check not-passed, with three wards exceeding the ≤30 m threshold. Overall, proximity non-compliance is present while access continuity is compliant, implying longer travel to the far rooms.

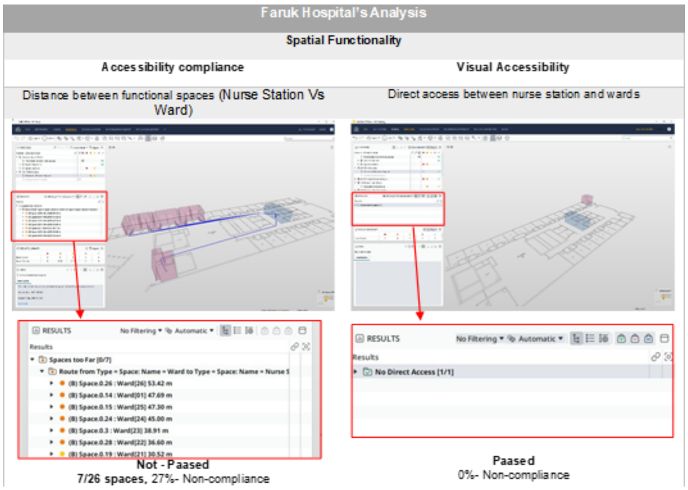

Figure 16. Checking a spatial functionality for Faruk hospital by the authors

Faruk Hospital presents a split result see figure 16. Visual accessibility passes with continuous direct access from the nurse station to ward entrances (0% non-compliance). In contrast, distance compliance fails: 7 of 26 wards (27%) exceed the ≤30 m threshold, implying longer travel times.

Overall, this is a foundational part of results: they represent visually what is meant by spatial compliance in this study, filling the between the abstract criteria and actual layouts of hospitals. The mention of these illustrations at the beginning of the research makes the research clear and well agreed upon what pass and not pass results are before proceeding to the actual analyses of data.

Explanation of Evaluation Method

To systematically assess the spatial relationship between nurse stations and wards in the eight selected hospitals, a structured evaluation system was employed. The core of this method is a compliance grading scale ranging from 0 to 5, reflecting the percentage of spaces that fail to meet the required spatial relationship (specifically, distance and direct access between nurse stations and inpatient wards):

- 0: Full compliance (all tested spaces passed), 1: 1–20% of spaces non-compliant, 2: 21–40% non-compliant, 3: 41–60% non-compliant, 4: 61–80% non-compliant, 5: 81–100% non-compliant.

For example, if a hospital has 25 wards and only 2 do not pass the compliance check (distance exceeding 30 meters), the non-compliance percentage is 8%. According to the scale, this hospital would be assigned a score of 1, representing minor non-compliance (1–20%). This approach provides an objective, quantitative means to compare and visualize compliance across different hospitals.

Evaluation and Quantitative Results

Table 2 summarizes non-compliance on two indicators—(i) Ward–Nurse-station proximity and (ii) Direct Access—using the 0–5 scale (0 = full compliance; 5 = worst). Most hospitals achieve full compliance on both indicators—Azadi, Zakho, Rizgary, and Barzan all score 0/0, indicating both acceptable ward–nurse-station proximity and continuous direct access. Shar shows a minor shortfall on distance (1/0) but retains intact access routes. Shiryan registers small issues on both measures (1/1), suggesting localized over-distance pairs and a few broken links. Faruk shows a clearer distance-driven pattern (2/0) with access continuity preserved. Medi performs weakest overall (2/5), combining notable over-distance with widespread loss of direct routes, making it the highest priority for intervention. Overall, the non-compliance burden is concentrated in distance (four sites >0) and only two sites show direct-access failures.

Government hospitals. Azadi, Zakho, Rizgary, and Barzan each score 0/0, indicating full compliance on both distance and direct access. Shar registers a minor shortfall on proximity (score = 1) while maintaining perfect direct access (0). The group means are therefore extremely low: 0.2 for proximity and 0.0 for direct access. In practice, this pattern reflects centrally located, open nurse stations with short, direct route geometry to all wards.

Private hospitals. Performance is more variable and, on average, weaker. Shiryan shows small, localized gaps (1/1). Faruk presents distance-related non-compliance (2) while keeping direct access intact (0), indicating that routes are continuous but over the desired length threshold. Medi performs worst overall, combining moderate proximity deviation (2) with widespread lack of direct access (5). Group means rise to 1.6 (proximity) and 2.0 (direct access), confirming both a higher burden and greater dispersion of issues within the private cohort.

Table 2. Evaluation of Hospitals from 0-5 by the authors.

Hospitals		**Spatial functionality**	
		Ward vs Nurse station	***Direct Access***
Government	Azadi	0	0
	Zakho	0	0
	Rizgary	0	0
	Barzan	0	0
	Shar	1	0
Mean		**0.2**	**0**
Private	Shiryan	1	1
	Medi	2	5
	Faruk	2	0
Mean		**1.6**	**2**

The following chart for Figure 17 further visually encapsulates these findings, converting the numeric evidence from Table 1 into a readily comprehendible form. Comparison (Government vs Private). The chart shows a stark ownership gap on both indicators. Government hospitals are essentially compliant: the group mean for Ward–Nurse-station distance is 0.2, and Direct Access is 0.0 (no observed breaks). Private hospitals perform markedly worse, with mean non-compliance of 1.6 for distance and 2.0 for direct access. In practical terms, government layouts tend to keep stations centrally located with continuous corridors, while private layouts more often exhibit over-long routes and interrupted/direct-access losses (e.g., enclosed stations or broken corridor links). This confirms that private facilities carry the larger remediation burden: selective route-shortening where distance alone is high (e.g., Faruk) and more substantial re-opening/re-routing where direct access fails (e.g., Medi).

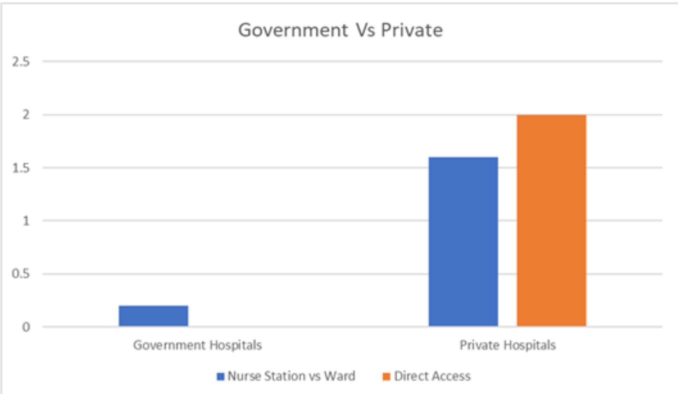

Figure 17. Non-compliance scores for ward–nurse station proximity and direct access across government and private hospitals by the authors.

Altogether, the table 2 and Fig 17 present a general picture of the results of the spatial assessment, which will serve as a basis of the further comparative analysis in the following sections.

Discussion

Two patterns are salient. First, central, open, and visually permeable nurse-station placement (e.g., Azadi, Zakho, Rizgary, Barzan) aligns with full compliance on both indicators (0/0), confirming the practical value of compact, sightline-rich ward clusters in which each ward entrance sits within the distance cut-off and on a continuous, direct route. Second, non-central or enclosed/offset stations (most clearly Medi; with localized outliers in Shiryan, and distance overages in Shar and Faruk) are associated with elongated walking paths, interrupted sightlines, and broken corridor continuity, driving higher non-compliance—most acutely at Medi (2 for proximity; 5 for direct access). These are not merely geometric quirks; they translate into slower staff movement, weaker real-time visual coverage, and higher wayfinding load, precisely the operational risks the two indicators are designed to surface.

At the hospital level, five sites are either fully compliant or near-compliant on distance and direct access: Azadi (0/0), Zakho (0/0), Rizgary (0/0), Barzan (0/0), and Shar (1/0, with a small tail of over-distance rooms). Among the private cohort, patterns diverge: Shiryan shows localized shortfalls (1/1), Faruk shows a distance burden with routes still continuous (2/0), and Medi concentrates the heaviest remediation need by coupling moderate distance deviation with widespread direct-access loss (2/5). Read together with the figure-specific narratives, the aggregated scores indicate a clear design-to-use signal: centralized, open stations correlate with compliant proximity and direct access; enclosed or offset stations correlate with over-distance pairs and discontinuous routes.

When grouped by ownership, the contrast sharpens. Government hospitals (Azadi, Zakho, Rizgary, Barzan, Shar) average 0.2 for proximity and 0.0 for direct access—essentially compliant layouts, with central stations and continuous corridors the norm. Private hospitals (Shiryan, Medi, Faruk) show higher and more dispersed burdens, with means of 1.6 (proximity) and 2.0 (direct access). In aggregate, distance accounts for most of the non-compliance (four sites > 0), while direct-access failures are concentrated in just two sites (Shiryan, Medi). This profile suggests that many private-sector issues can be addressed first by route shortening and station re-centering, reserving heavier works for places where corridor continuity is broken.

From a pragmatist standpoint, the rule-based evidence directly informs proportionate remedies. For score = 1 cases (e.g., Shar's distance tail; localized issues in Shiryan), targeted fixes—decluttering pinch points, doorway policy adjustments, micro-realignments, and micro-signage—are adequate and minimally disruptive. Where distance alone is elevated but routes are continuous (e.g., Faruk 2/0), options include re-locating/expanding the station toward centroid, introducing a satellite sub-station, or opening strategic cross-links to shorten paths. Where direct access is widely absent (e.g., Medi 2/5), layout-level interventions become necessary: re-opening enclosed stations, re-stitching corridor continuity, or reconfiguring partitions to restore direct connections. Because the checks are repeatable, the same workflow can be re-run after each intervention to verify improvement—turning compliance into a living operational property rather than a one-off certificate.

Finally, the 0–5 scale continues to prove communicative for non-technical stakeholders. It compresses complex path/access conditions into an interpretible signal while preserving denominators and raw pair counts in the figures/tables, enabling quick decisions (e.g., where to act first) without sacrificing auditability (traceable pairs, routes, and parameter sets). As the study scales eight cases, this dual visibility—simple scores plus traceable evidence—helps prioritize low-effort, high-yield improvements (distance tails and local breaks) before committing to structural re-openings, especially in resource-constrained private settings.

Implication: With eight cases, the overall message strengthens rather than changes: station centrality and permeability are the strongest, most reusable levers for achieving simultaneous gains in speed, oversight, and cognitive simplicity. BIM-driven checks make these levers actionable, ensuring that each adjustment is evidenced, proportionate, and verifiably better on re-check.

Conclusion and Recommendations

In this study, the improvement of spatial relationships in the hospital is not only an engineering feat, but an anthropocentric necessity, and the direct results will directly affect the experience of patients, their safety and the efficiency of employees. The study aimed at investigating whether or not the flexible, data-driven planning could support the dynamic response of health facilities to the actual conditions by filling in the gap between BIM technology and more practical design approach which relies on the idea that the facility should be adapted to the actual conditions. The findings indicate that the hypothesis was correct, i.e., the practical application of BIM as the evidence tool, particularly in combination with a set of formally stated evidence-based proxies of distance and visibility, makes it possible to develop a hospital layout that would facilitate both operational excellence and care based on compassion. We have come to the conclusion that the governmental hospitals with the help of a leading regulatory tradition and well-established work processes perform the best in terms of perfection of the spatial layout: nurse stations and patient departments are no more than three steps away, as well as visible and open, which leads to the smooth flow of people and quick response. Contrary to this, these standards are not always accompanied in the case of private hospitals indicating the role of resource availability, planning strategies, and regulatory actions. These disparities solidify the idea that spatial efficiency is not only a characteristic of building design, but also of the greater environment in which hospitals exist. One of the variables in this study was the distance between the nurses stations and wards that proved to be very crucial. Attempting to reduce this distance as much as possible and to include the direct visual access, hospitals had more possibilities to contribute to patient safety, effective workflow of the staff, and their overall satisfaction. The practical application of BIM allowed reviewing the spatial planning and correcting it iteratively, making the environments of hospitals more flexible and stable.

To advance these gains, private hospitals in particular should prioritize investment in BIM and adopt clear spatial standards, using regular audits to ensure compliance. Such steps will help foster healthcare environments where both care and efficiency thrive together, and where the human experience is always at the center of design.

Future research: Use BIM beyond compliance checks to simulate emergency response and wheelchair maneuverability, maximizing operational value.

Conflicts of Interest: The authors declare no conflict of interest.

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