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Analysis of the Right Sizing Approach to Healthcare Space Planning

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ANALYSIS OF THE RIGHT SIZING APPROACH TO HEALTHCARE SPACE PLANNING

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ABSTRACT

Achieving optimal spatial design in healthcare facilities is crucial for efficient operations and high-quality patient care. This study investigates the application of the right-sizing approach to healthcare conceptual design, with a specific focus on the Medical-Surgical Unit (MSU) and Intensive Care Unit (ICU) departments within inpatient wards. Utilizing a robust methodology, foundational parameters and constraints were established to align with the functional requirements of a 100-bed hospital case study. Through a systematic process, industry practitioners contributed valuable insights via surveys, facilitating the quantification of parameter rankings essential for spatial decision-making. Analysis of the data revealed significant correlations between parameters, emphasizing their interconnected nature and their impact on spatial design decisions. Key factors such as nurse observation, nurse station location, and efficiency emerged as crucial considerations, highlighting the significance of patient safety, workflow optimization, and resource allocation. Furthermore, a comparison of parameter rankings with criteria outlined by the Department of Defense (DoD) and the Facility Guidelines Institute (FGI) unveiled disparities and provided guiding principles for determining inpatient room sizes. Beyond influencing spatial design decisions, these parameters significantly affect room sizes, departmental layouts, and overall facility size. Efficiency-driven decisions aimed at optimizing workflow and resource allocation may lead to more compact room sizes and efficient departmental layouts. Safety considerations permeate spatial decision-making processes, prioritizing infection control measures and patient privacy. Patient-centered design principles advocate for larger, more comfortable patient rooms to enhance the overall patient experience. Additionally, access to specialized care areas, such as the ICU or operating rooms (OR), influences departmental sizes and facility layouts, guiding decisions to optimize access and streamline care delivery. This research provides valuable insights benefiting various stakeholders in the healthcare industry. Hospital administrators and facility planners can leverage the findings to optimize spatial design decisions, enhancing resource utilization and patient outcomes. Architects and designers gain a deeper understanding of the parameters influencing healthcare facility design, enabling them to create environments prioritizing patient safety, comfort, and operational efficiency. Policymakers and regulatory bodies can use the research outcomes to inform guidelines and standards for healthcare facility planning and design, ultimately contributing to the improvement of healthcare delivery systems. Overall, this study offers a comprehensive framework for right-sizing approaches in healthcare design, with far-reaching implications for stakeholders committed to advancing patient-centered care and operational excellence.

Key Words: Healthcare Design, Right-sizing, Early Planning, Conceptual Programming, Inpatient

DEDICATION

In dedication to my wife, who has been my most profound inspiration. My children, who fill my heart with joy each and every day. As well as God and his unwavering Grace and blessings to challenge me beyond my known capabilities. Shining his glory and light for prosperity in my life!

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TABLE OF CONTENTS

LIST OF TABLES

Tables Page

LIST OF FIGURES

Figures Page

CHAPTER ONE

INTRODUCTION

Design feasibility is an initial step in the project life cycle to determine appropriation and continuation of capital investment. This phase identifies potential business opportunities and performs initial analysis, scoping, and Order of Magnitude Estimates (CII, n.d.). All of these are critical factors and major drivers for an organizational decision to press to the Concept Phase. Additionally, the feasibility phase has the most influential relationship to cost in comparison to the latter stages of the project life cycle (Gajjar, 2023).

"The industry today is faces broad and complex challenges that threaten every aspect of our lives. The architect's call to protect the public's health, safety, and welfare has a new and broader meaning amid challenges such as increasing climate extremes and social inequity" (AIA, n.d.) Additionally, the American Institute of Architects (AIA) has developed a Framework for Design Excellence that capitalizes on the architect's call. Specifically, with the intent for accessibility and relevance for every architect, client, and project, regardless of size, typology, or aspiration.

Healthcare alike, is defined as one of the most complex, challenging, and fastest-growing sectors in the design and construction fields (Zhou, 2014). The early design phase (feasibility) aligns complexities with functionality, which is critical to spatial configuration and functional performance. The complexity in Hospital design is deciphered through systematic design methodologies and computational design tools that satisfy adjacency requirements, project site specifications, surrounding buildings, and environmental factors (Cubukcuoglu et al., 2021). Systematic design is an iterative process to generate solutions to performance-based problems, including practical experience, research, and theory (UCF, 2022). A healthcare typology of systematic design is commonly known in the healthcare industry as Evidence-Based Design (EBD). EBD is a dynamic process utilizing performance-based evidence to inform hospital layout, environment, and functionality (UFC 4-510-01, 2022; Rafeeq et al., 2020; CII, 2013). Computational design supplements EBD through tools such as Building Information Modeling (BIM), Computer Aided Drafting (CAD), and best practices in the project lifecycle. It is critical to understand the design factors influencing the challenges and complexities of the healthcare sector, especially, in the feasibility stage, where an unsuitable layout presents a waterfall effect on the operational and cost performance of the healthcare facility.

Healthcare Facilities Classes and Types

Healthcare facilities differ from most other sectors (Sharma et al., 2021). The facility layout design necessitates the inclusiveness of typologies, network infrastructure, and spatial configurations to maximize performance. However, classification knowledge of the facility type is vital in generating appropriate design layouts for accurate data to drive spatial allocation. There are two distinct types of healthcare delivery platforms in the United States, namely inpatient and outpatient or a combination thereof. Each platform is broken down into healthcare levels, occupancy types, and specializations (Sharma et al., 2021). Figure 1 illustrates the hierarchical levels of healthcare, which deduces a more granular focus in planning metrics involved from overall facility sizing down to room sizing (Sharma et al., 2014).

Inpatient healthcare delivery is defined as a patient that is admitted requiring at least one overnight stay; longer than a continuous 24-hour timeframe (DoD Instruction 1341.12, 2019). It provides healthcare services to patients admitted to a hospital and may include bed and board, nursing services, diagnostic or therapeutic services, and preventative medicine services. In addition, a hospital may discharge functions of a clinic to facilities on the medical campus or off campus but in the network. Inpatient care is sub-categorized based on services and product lines provided within the facility.

Outpatient healthcare delivery is a single entity or organization that provides routine care or degrees of specialization either embedded in support of an inpatient platform or freestanding with patient support being less than 24 hours. Typically, outpatient healthcare services are provided during daily business hours.

Figure 1: Healthcare Delivery Hierarchical Levels (Sharma, 2013)

It is important to display the healthcare hierarchical structure as it presents multiple complexities in the planning of healthcare facilities. Primary Care is the first level of care and is general in nature with a focus on people versus disease. The first level provides a wide range of care professionals and services most utilized by the healthcare system population (O'Reilly et al., n.d.). Secondary, Tertiary, and Quaternary Care increase the level of patient acuity and specialization necessary to support complex health conditions. These services range from cancer treatment, sudden infections, burn treatment, and other medical and surgical interventions. As the level of healthcare delivery rises based on patient acuity, the rate of inpatient stays and mortality increases (Mehaffey et al., 2017)

Moreover, the hierarchical level of care also correlates to the facility design's complexity. Primary care facility design, or an industry-adopted term for Medical Office Building (MOB) (Sharma et al., 2014), has become more common in modern medicine in response to population utilization. Freestanding clinics - MOBs are the least complex and provide a wide variety of services. In some organizations, MOBs are not fully dislocated from the inpatient platform. For example, organizations utilizing campuses may decant primary care services from the main hospital and place them proximate on campus for support. This maximizes key adjacencies in the hospital to align with secondary, tertiary, quaternary, and critical access levels to functional support spaces such as ORs and procedure rooms . However, the clinical aspects of specialties in secondary and tertiary care have recently prompted movements towards MOBs in an effort to reduce cost bottom line and complexities from less acute services.

The Idea

The knowledge of healthcare facility types and classifications is foundational in applying the right sizing approach. Each type has specific and necessary factors for the development of spatial planning that led to efficient operations, patient satisfaction, and access to care. Based on the background study, inpatient facilities have the greatest impact on the right sizing approach, as do the inputs of information [parameters and constraints]. Therefore, the aim of this study will seek to extract parameters and constraints, rank them, and develop a common standard for right-sizing.

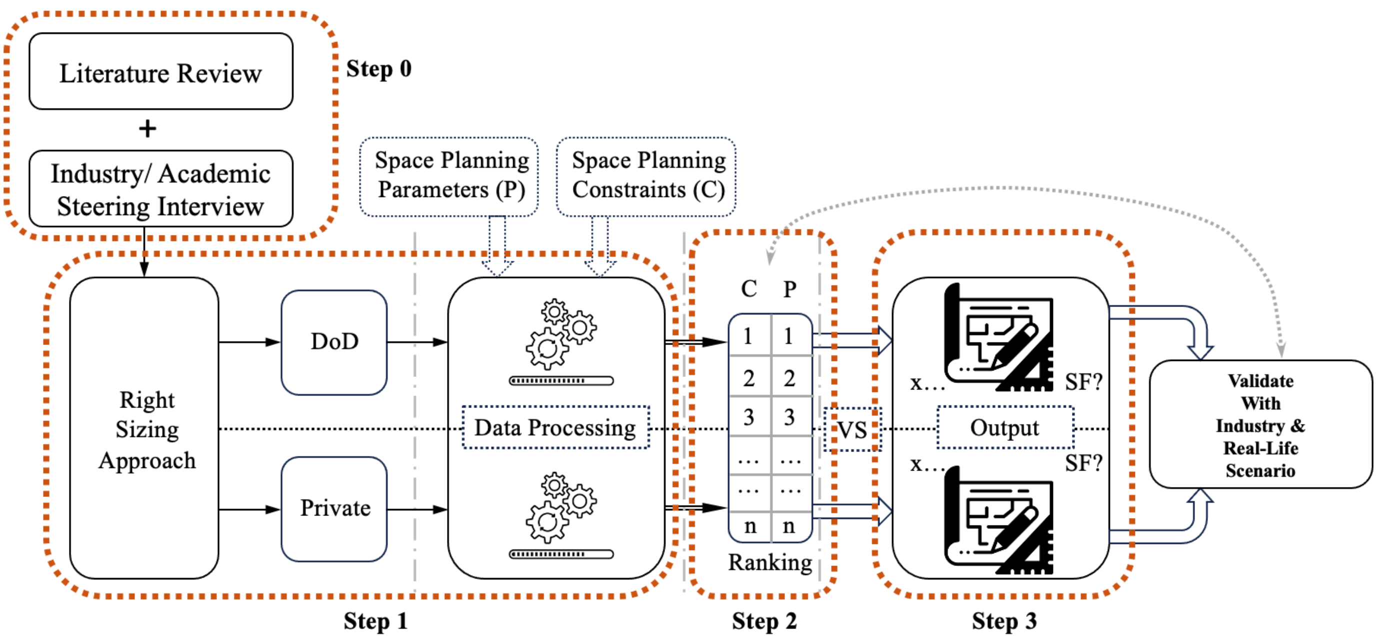


Figure 2: Stepped Idea Diagram

Each step of the idea (Figure 2) is part of a linear process with strategically placed feedback loops for constant re-processing. The DoD and Private organizations must remain separated as they have distinctly different criteria and regulations. However, it is hypothesized that when collecting and ranking parameters and constraints [Step 2} that consistent repetition will take place. Thus, this organizational limitation will only influence the hierarchy or ranking of factors. The output will be tested via an independent case study and validated by an industry expert focus group to mitigate biases in the data. Ultimately, the common ranking of parameters and constraints as inputs to the right sizing approach to inpatient healthcare facilities becomes the standard for programming during the conceptual phase of design.

Research Purpose and Objectives

Literature and criteria in the body of knowledge as well as publicly available resources are limited in decerning the right size approach to healthcare design. Healthcare design is complex in nature requiring input from stakeholders [Hospital Administrators, Staff, Facility Managers, Designers, and Builders] to ensure the right size approach in the healthcare setting (HCM-Architects, 2019; Helber et al., 2016; Liao et al., 2023; Cubujcuoglu et al., 2022; Reno et al., 2014). The objective and subjective environment of design inputs based on individual stakeholders and organizations has led to inconsistency in healthcare facility layouts. Straining sustainable design practices to combat overbuilding and underbuilding that consistently impact patient safety, environment, and experience.

1. Document the Current Right-Sizing Approach in the Healthcare Industry

Documenting and evaluating the current right-sizing approach initiates a basic understanding of how it is applied in the healthcare industry. Exposing nuances of complexities prevalent in healthcare design identified throughout the body of knowledge on this subject. Codes, criteria, standards, and best practices are a starting point of this documenting process, as the DoD makes this publicly available. According to Walter (2022), many private healthcare organizations capitalize on the DoD space planning criteria as a right-sizing baseline. Hence there is the need to differentiate the right sizing approach of DoD and Private healthcare applications. This distinction may appear counterintuitive; however, the baseline application in private design is not definitive of DoD criteria. Thus, necessitating individual entity analysis to clarify and reveal additional parameters and constraints critical to the right sizing approach and common factors.

It is expected that interviews and surveys of industry experts will provide valuable data to supplement the documentation process. Additionally, steering committee involvement allows for real-time feedback and input to align discovery with the documentation objective.

2. Identify and Prioritize Healthcare Design Parameter/ Constraints by Impact Level in Ranking Order

Parameters and constraints are vital to design as these elements shape and inform the overall final product. Identification will be made through the documentation process of the DoD and private organizations right-sizing approach. Design parameters are qualitative and quantitative aspects of the physical and functional characteristics of a component, device, product, or systems that are input to its design process (DoDI 5000.2, 2022). At the same time, design constraints are limitations or restrictions in the design process imposed by internal and external factors (UXPin, 2023). Each play a role in the design process and effect the approach to right-sizing.

Many parameters and constraints are predicted based on the literature review of the DoD space planning criteria. Therefore, it is critical to establish a ranking hierarchy of parameters and constraints and their impact on to the right sizing approach. Ultimately, influencing healthcare facilities space allocation. The reemphasis on the segregation of DoD and private organizations healthcare processes ties back to the documenting step. The implementation of these feedback loops intends to expose differing parameters and constraints through regulatory criteria that may only apply to one or both organization types.

This study will also utilize a collection of case studies to develop trend data that can lead to better evaluation and analysis of the hierarchical ranking. It will be important to ensure that facility data such as size, services offered, and classification are associated with the best possible outcomes.

3. Compare DoD and Private Healthcare Sizing Outcomes for a Common Set of Program Requirements to Formulate Standardized the Right Sizing Approach.

Analysis of the approaches by both federal and private healthcare organizations is necessary to mitigate challenges to define a method that ensures the right-sized design to maximize holistic value to the owner, designer, and patients. To accomplish this objective, a comparison of the ranked factors in DoD and private healthcare informs a standardized right-sizing approach. The comparison analysis will develop new programming requirements for a common set of parameters and constraints that when applied to an independent case study, developing a best-case outcome for decision-making.

Research Significance

The spatial typology focus of room type is the initial element in determining a hospital's best layout. Room types and their sizes make up departments and functional areas with additional factors such as circulation (corridors, waiting areas, etc.) and operational support spaces (electrical, mechanical, communication, etc.). Because of this, it is imperative to ensure that the room type and sizes meet the functional and operational needs of the hospital facility. The Department of Defense (DoD), through space planning criteria, has defined room sizes and types based on workload, staffing, and room function, to name a few, that the private sector utilizes as a conceptual foundation for program development (Walter, 2022). Thus, the main aim of this study is to present an analytical approach to exploring defined impact factors that lead to justifying and standardizing the room sizes based on type for spatial optimization in hospital design (outpatient and inpatient). Due to the nature of specialty clinics that operate in outpatient and inpatient settings each department that takes on this characteristic in the DoD space planning criteria, will be analyzed in each aspect element. Due to this, clinical departments that have similar factors may be consolidated under one umbrella structure. In turn this understanding and standardized approach will develop a foundation for designers, owners, facility managers, and medical administrators to adopt the results for optimal space planning in future hospital designs.

CHAPTER TWO

LITERATURE REVIEW

The literature review focuses on the underpinning of facility layout design throughout all sectors to discern relative considerations and factors that are determined throughout the body of knowledge. The relevance of facility design can begin to inform healthcare planning and space allocation principles interpreted within the industry. Additionally, the broad knowledge of literature can influence the necessary granularity needed in this section to pinpoint gaps in criteria and the body of knowledge specific to healthcare design. Therefore, the following information takes a holistic approach to expose the current available information and its relatability to the topic and objectives.

Previous Research Work in Healthcare Spatial Planning

Spatial layout in the healthcare sector is quite challenging. However, it is not apparent until one takes on the role of a stakeholder with dynamic buy-in. Recently, research was conducted at an inpatient healthcare hospital in southwestern United States that was predicated on a mission change to implement trauma level 2. This major change in the operations of the hospital required a spatial assessment of the facility to determine how these new mission requirements could bed down in the current facility. It became evident during a feasibility study that a renovation project was necessary to meet the demand and resourcing of trauma level 2. The major limitation was the facility spatial layout to accommodate the growth.

As the programming for the reallocation of space commenced to allow for the mission expansion. An inadvertent discovery of a connection between outpatient [emergency department] and inpatient [MSU and ICU] space planning, revealing a direct relationship of ED inputs defined the inpatient space allocation. This Federal facility required the stringent requirements in the DoD space planning criteria. Therefore, this impactful relationship was not incorporated in how space was created.

After the fact, research was conducted to best understand how this came about and was presented through multiple baseline case studies and interviews to couple with the criteria and regulation mandate of Federal healthcare facilities. Through the analysis of the baseline case study and application of a pilot study, the research findings identified the root cause; Unscheduled patient admits from ED trauma drive an unexpected growth in inpatient space allocation. Resulting in a 291% increase in total inpatient bed capacity (ICU: 340%; MSU: 217%; L&D: 180%) with the ED unscheduled trauma admissions having the highest impact on the inpatient growth.

The research identified a gap in the federal criteria and paves the way for additional analysis in the right sizing approach for both federal and private sectors in hospital design. Parameters and constraints that are employed by the DoD space planning criteria become an all-encompassing complex problem. However, the ranking towards application in right sizing approach is made by designers and or decision makers project to project. With the parameters and constraints highly influencing the outcome of the right sizing approach. It is necessary to develop a common ranking of these factors in the right sizing approach of hospital design to maximize inconsistencies in facility size, operational incongruencies, and patient satisfaction.

Spatial Planning Industrial & Manufacturing Sectors (FLP)

Facility layout design is an important issue for any industry, as poor layout may degrade the overall efficiency of the production system (Leno et al., 2012). However, the facility layout problem must be first identified. The facility layout problem (FLP) is defined as the placement of facilities, with the aim of determining the most effective arrangement in accordance with some criteria or objectives under certain constraints, such as shape, size, and orientation (Hosseini-Nasab et al., 2017). While FLP is well researched in the industrial and manufacturing sectors since the 1960's, this process is limited in application to healthcare facilities.

FLP involves the process of physically arranging all the production factors that make up the production system so it can suitably and efficiently comply with the organization's strategic objectives (Perez-Gosende et al., 2021). The specific characteristics of FLP includes two phases; Phase I notes block layout planning to determine structures of size and shape of department. While phase II considers material flow planning and operational functionality of the factory floor setting. These two phases are subdivided into categories for better granularity namely, block layout, material handling systems (MHS), block department formation, and intra-block/ detailed layout (Leno et al., 2012). MHS or material handling costs (MHC) are the most significant indicators of the efficiency in a facility layout. Proven by manufacturing research to show that more than 35% of system efficiency is lost due to incorrect layouts (Rippon et al., 2013).

Much like the manufacturing and industrial sectors, the healthcare sector depends on early development of spatial configuration to mitigate significant impacts to the functional performance of the facility (Li et al., 2023). Likewise, hospital layout design studies have traditionally focused on transportation costs as an objective. Assimilating to the manufacturing sectors focus on MHS, a cost driven objective of production and efficiency (Cubukcuoglu et al., 2021). However, the healthcare industry has received little attention in literature compared to other facilities with the use of FLP solutions (Tongur et al., 2019).

FLP Typology in Healthcare

FLP is trending in a positive direction within the body of knowledge to generate solutions in healthcare design. Three commonly used solution approaches in either single or multi-floor problems are applied namely, quadratic assignment problem (QAP), heuristic approaches, and mixed-integer programming (MIP) (Tongur et al., 2019). However, research has shown when FLP is applied to a healthcare facility, optimal facility layout is achievable with respect to interfacility interactions and material handling cost (Lee et al., 2002; Azadivar et al., 2000; Lacksonen et al., 1997). Tongur et al. (2019) identifies further use of FLP in healthcare facility planning through other mathematical methods but determined the limited studies in the healthcare-built environment. Hosseini-Nasab et al. (2017) highlights the limitation towards use of FLP in the healthcare setting.

Noting the common objective in models to minimize MHC is only possible with finite data points in advance of planning as well as neglecting qualitative factors such as, relationships of adjacent facilities, safety, and layout flexibility.

Qualitative in addition to quantitative factors are vital to healthcare facility functionality coupling expert knowledge of clinicians, designers, and organization leaders (Cubukcuoglu et al., 2022; Bayrazadeh et al., 2018; Reno et al., 2014). Computational design techniques have a positive outlook on spatial configuration by shifting attention from geometric layouts towards developing a typological network structure of functionality flows (Cubukcuoglu et al., 2022). Moreover, the healing environment identifies with both quantitative (air quality, noise control, lighting, etc.) and qualitative (access to social support, reduction of environmental stressors, and positive distraction, etc.) factors inclusive of physical and non-physical elements (Rafeeq et al., 2021). Baramzadeh et al. (2018) discusses the approach of healthcare facilities design to incorporate these qualitative factors early in the design process through a common language with designers for a right-size. Where decisional outcomes impact room size, location of equipment, intra-room zoning, and door locations to name a few. The qualitative aspects provide another layer of complexity when approaching healthcare facility size as each organization may adopt their own internal strategy for what aligns with their facility's strategic objectives. However, through collaboration of all stakeholders these unknown elements are unveiled by a direct link between network structures of movement potentials and probabilities, leading to spatial configuration advantages.

FLP's use in healthcare facility planning, in general aligns with its origin to solve and reduce transportation costs of materials in the industrial sector. The relationship to healthcare sub-divides transportation into staff, patients, and material. However, the relationship presents a problem in hospital design as FLP's focus on the objectiveness of transportation is not inclusive of vital qualitative elements specific to architecture. Further, the use of FLP in hospital design is not commonly known in practice by architects or engineers. Thus, Cubukcuoglu et al. (2022) proposes the use of MIP techniques in hospital layout design with integrated with hierarchical methodology to integrate required architectural design and features of hospital layouts for critical decisions. Likewise, Bulter et al. (2017) utilizes an optimization model for facility layout and simulations model to capture the complexities of the hospital operations.

Spatial Planning in the Healthcare Environment

Healthcare facilities are highly complex building that encompass multi-tiered services based on patient needs. Services (departments) in the healthcare sector regarding spatial planning are traditionally based on many different user's interfaces while satisfying standards, architectural requirements, and engineering aspects (Carr R.F., 2007). These principles apply to the built environment through many lenses including designers, organizational leaders, staff, and patients with each imposing critical influence. Compounding spatial analytical methods and techniques through data , geometric, or topological relations to support decision-making in layout planning (Nourian, 2016). Spatial planning and programming are critical to develop an appropriate scoped program.

It is especially important for healthcare facilities during pre-planning to understand and define clinical interdependencies that result in lean and efficient use of space.

DoD Criteria for Spatial Planning

The DoD space planning criteria is a regulation required for healthcare design and programming and is used by medical planners, designers, and equipment planners. The overall objective of this criteria is to outline a standard to generate spatial allocation based on a specified department scope for either reconfiguration or new design. This set of documents breakdown each department as well as occupancy type (inpatient, outpatient, or ancillary). Its output for spatial allocation is built on a dynamic approach of objective and subjective factors by each occupancy type.

Objective factors [parameters] are based primarily on formulations that account for the population served (determined service area), workload (averaged historical), and staffing (manning document). Population serviced accounts for types of patient acuity that will be received at the facility, thus determined the facility type (Hospital, Outpatient Ambulatory Care Center, or Troop Clinic). Workload is the main parameter for determining how much clinical space is earned. For example, in an outpatient clinic, examination space will be calculated by the number of historical encounters divided by the predetermined number of one exam rooms maximum annual production. Staffing is the final objective consideration as this number is known and can be captured by the manning document. Staffing generates the space for offices or support functions in the clinic. Staffing while finite as a parameter to determine space in the DoD, it may not be as important to other organizations as the DoD has duties above and beyond the clinical needs of the department. It is critical to note that based on facility classifications, this study may utilize MOB parameters only when the outpatient setting directly ties to the inpatient setting. As such below are DoD inpatient formulations that receive data inputs to structure outputs of space allocation.

$$\text{Annual Admissions} = \left(\frac{(Population\ Served)(Annual\ Admission\ per\ 1{,}000\ Served)}{1{,}000}\right) \text{------ (i)}$$

- Annual Admissions: the total projected annual admissions based on the population served.
- Population served: a collection of available in network patients that are enrolled at the hospital.
- Annual Admission per 1,000 served: the total average percentage of admittance of 1,000 enrolled at the hospital. This metric will fluctuate based on patient population acuity (i.e. age, healthiness, etc.).

$$\text{Average Daily Patient Load (ADPL)} = \left(\frac{(Annual\ Admits)(Average\ Length\ of\ Stay\ (ALOS)}{365}\right) \text{ - (ii)}$$

- Average Daily Patient Load (ADPL): the projected average of daily inpatient admits, both scheduled and unscheduled.
- Annual Admits: the collective historical data for annual admissions.
- Average Length of Stay (ALOS): the average of the time a patient will stay within the inpatient ward. This metric will fluctuate based on the acuity of the ward type (i.e. the typical ICU has a higher ALOS as the acuity of the patients are higher)

$$\text{Occupancy Rate (\%)} = \left(\frac{Occupied\ Bed\ Days}{Total\ Bed\ Days}\right) x\ 100 \text{ ------ (iii)}$$

- Occupancy Rate (%): Is the expected rate at which the patient occupancy is projected. Based on the staffing model as well as the patient acuity this metric may be adjusted. Additionally, the occupancy rate identifies the availability of beds, for example an occupancy rate of 60% deems a 40% capacity collateral for unscheduled admissions. This metric become a risk mitigation and fail safe to eliminating diversion.
- Occupied Bed Days: Are the day in which each patient occupies a single bed in the inpatient ward.
- Total Bed days: Is the total available bed days based on the bed capacity in the inpatient ward.
- Note: ADPL and Occupancy rates are sensitive to variations that affect data such as seasons, patient diversion such as to bed shortage, or departmental capacity.

$$\text{Number of Projected Inpatient Beds} = \left(\frac{ADPL}{Occupancy\ Rate}\right) \text{ ------ (iv)}$$

- Note: See previous metric definitions in formula “ii” and “iii”, respectively.

Subjective factors are built based on a list of survey questions within the DoD space planning criteria [Example in Appendix A]. These factors discuss relationships for adjacencies of other departments, local functional flows, as well as local leadership positions that do not follow that standard hierarchy for permanent space or cannot be mathematically calculated. In many cases the space planning for these is through discussions during user interviews and differ at each healthcare facility.

While the objective and subjective factors play a vital role in the final determination of the conceptual programmed spaces that make up the departments. The DoD is specific as to the size (square feet) of each room in the space planning criteria. With proportions to be determined by the planner or designer during the "test fit" validation phase. For example, the interior size of a typical office with one staff member is 100 square feet. These predetermined sizes are published through feedback of equipment planners, medical consultants (nurses, doctors, etc.), and medical planners (Carr R.F., 2007).

The validation of the objective and subjective factors through the DoD lens in the space planning criteria chapters drive the right sizing for all healthcare facilities. This lens defines the totality of the feasibility cycle from strategic vision/ objectives (business case, economic analysis, etc.), department size, room size, to room furniture fixtures and equipment (FFE). All-inclusive by credible input by the DoD subject matter experts, lessons learned, and critical problem solving by planners.

Civilian – Non-Federal (Private/ Public/ Non-Profit)

Civilian organizations follow a less formalized method to space planning than the Federal sectors. Guidance in many cases utilizes the DoD space planning criteria as a baseline to supplement Facilities Guidelines Institute (FGI) and specifics related to space planning (Walters, 2022). However, Owners or a hire there of (Architect, Medical Planner, etc.) are utilized, either internal or as a design consultant, to decipher and build the functional program. There is little literature associated with this process as in most cases it is proprietary to the organization, including but not limited to metrics that inform functional programming. Discussions with multiple industry partners (architects/ medical planners) in the civilian sector have confirmed this conceptual methodology.

Right Sizing vs. Optimization

The term right-sizing as a planning mechanism is necessary and leans toward facility efficiency, even at the project execution level. Gary L. Vance (2015) defines "right-sizing" as "the process of defining and separating user group wants from user group needs in terms of the healthcare-built environment". Right sizing was introduced in the healthcare industry back in the late 1980's in an effort to address two factors in the operational environment (Zuerlein, 1996). The first factors address the financial implications of having overbuilt facilities that we a response to the late 1950 to 1970 focus on inpatient centered care versus the more recent outpatient centered care method (Zuerlein, 1996). The second is the shifting of resources to support the mission of cost, quality, and access to care. Moreover, right sizing has taken a negative connotation as it previously was directly linked to downsizing. Downsizing for this study is defined as a reduction or elimination of resources to align costs of a facility, both operational and functional. Conversely, right sizing is the movement to appropriately distribute resources that efficiently address implication of operations or functional performance. Right-sizing is a life-cycle concern that is strategic through design performance that reduces over building, facility operations, and allocation of capital resources (Latimer et al., n.d.). While the right sizing approach in the healthcare industry is not a new method, the overall application to utilizing this method proactively instead of reactive is the current trend. As such the aim of this study begin to dissect the application of right sizing in the conceptual design phase, specifically in facility space planning (Cubukcuoglu et al., 2021).

Right sizing in a conceptual design approach that must comply with design regulations, complexities, and implications related to but not limited to staffing, workflow adjacencies, business case, and organizational goals of spatial hospital configuration. Right sizing is applied at multiple different scales in healthcare design, from room sizes to facility massing. Additionally, right-sizing is commonly attributed to a solution that solves over and under building. However, it is incumbent among design professionals, owners, and medical planners to apply the right-size approach proactively. This approach is not tied to predictive aspects of future facility design, but most closely tied with historical trends and alignment to apply current known complexities of design parameters and constraints for a "best fit" facility design.

The term right-sizing in the healthcare community has continued to evolve in response to predictive measures of modern medicine such as spatial optimization. The evolution towards optimization beyond the predictive factors, responds to modern technological advances in the healthcare operations and facility design. For example, the modern flexible state of rooms or departments in hospitals addresses the optimal solution for operational efficiencies and workflow coupled with facility floor plate reduction.

While right sizing design has evolved into a more sophisticated and complex method of optimization, this study maintains a focus on its fundamental principles to identify parameters and constraints. The exploration of optimization approaches will be reserved for future investigation, allowing for a comprehensive evaluation, analysis, and synthesis of these methodologies.

Parameters, Constraints, and Factors

The design of inpatient hospital spaces, including zoning, stacking, routing, and the location of nurse stations, family lounges, and patient beds, has a significant impact on patient outcomes and satisfaction (Abinama, 2015; Laursen, 2014; Jamshidi, 2020). These factors can influence patient-centeredness, safety, effectiveness, efficiency, timeliness, and equity in healthcare delivery based on the built environment (Abinama, 2015; Zhao, 2009), as shown in Figure 3. For example, the use of natural elements, such as plants and music, can reduce patient anxiety and stress (Laursen, 2014), while the layout and visibility of

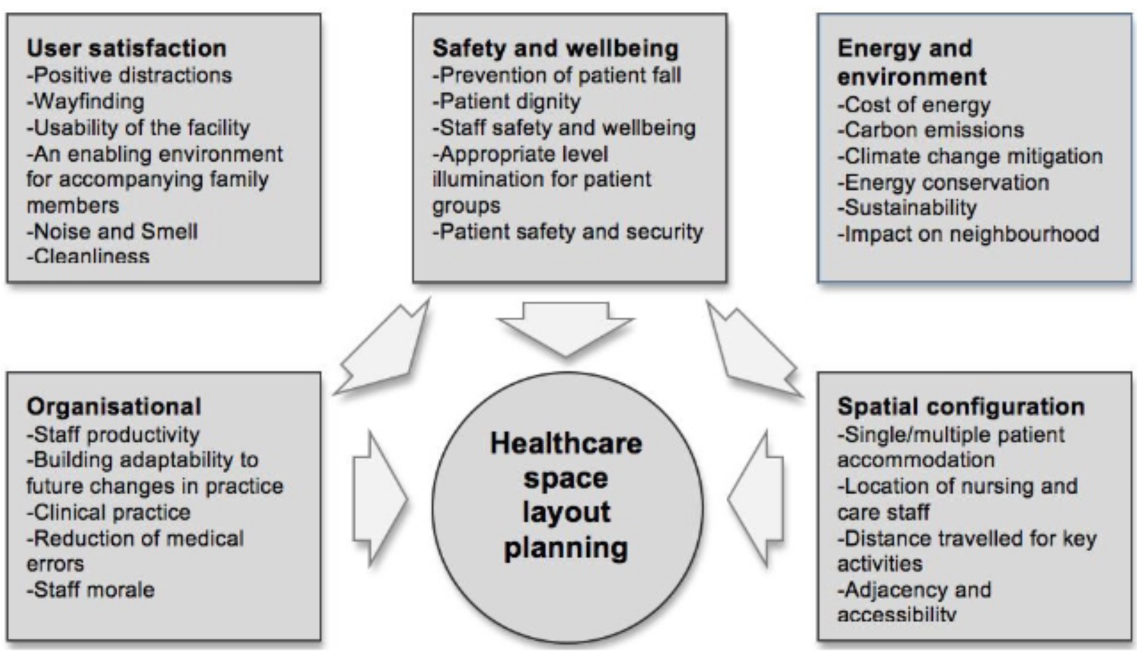


Figure 3: Factors influencing the healthcare space layout planning (Zhao et al., 2009)

medical equipment can affect patient outcomes (Jamshidi, 2020). Therefore, the design of inpatient hospital spaces should be carefully considered to optimize patient care and outcomes.

A range of best practices factors in healthcare space planning have been identified. Castro (2013) emphasizes the importance of space design quality, particularly in terms of organization, flexibility, and adaptability, for the well-being of patients and staff. Zhao (2013) highlights the need for evidence-based design, which considers the impact of the physical environment on healthcare indicators, and the integration of user perception in space layout planning. Cawood (2016) underscores the value of human-centered design in creating optimal non-clinical workspaces for hospital staff, involving them in the design process. Fogliatto (2019) proposes a method that integrates lean principles and systematic layout planning techniques to enhance the efficiency of materials and information flows in healthcare facilities. These studies collectively underscore the importance of a holistic, evidence-based, and user-centered approach to healthcare space planning.

Table 1 maps literature to parameters that are apparent in affecting the right-sizing approach to space planning within the MSU and ICU wards. Halawa et al. (2020) identifies the limited research specific to the entire inpatient setting, where the current body of knowledge extensively studies nursing areas within inpatient wards and EDs.

Table 1: Factors Identified from Literature

ID	Parameters/ Factors	Referenced Literature
P01	Stacking	Cubukcuoglu et al., 2022; Zhao et al., 2009
P02	Zoning	Cubukcuoglu et al., 2022; Jiang et al., 2017; Zhao et al., 2009
P03	Routing	Cubukcuoglu et al., 2022; Jiang et al., 2017
P04	Nurse Station Location	Castro, 2013; Chaudhury et al., 2005; Halawa et al., 2020; Michael et al., 2000; Zhao et al., 2009
P05	Family Lounge	Abinama, 2015; Laursen, 2014
P06	Single Beds	Abinama, 2015; Baramzadeh et al., 2018; Castro, 2013; Chaudhury et al, 2005; Halawa et al., 2020; lavender et al., 2015; Zhao et al., 2009
P07	Multiple Beds	Castro, 2013; Halawa et al., 2020; Jamshidi, 2020; Lavendar et al., 2015; Zhao et al., 2009
P08	Nurse Observation	Halawa et al., 2020;Miller & Swensson, 1995;Zhao et al., 2009
P09	Staff Support Areas	Ley-Chavez et al., 2016
P10	Medical Supply	Ley-Chavez et al., 2016
P11	Access to Ancillaries	Cubukcuoglu et al., 2022
P12	Communication to Ancillaries	Hua et al., 2012
P13	Access to ED	Halawa et al., 2020; Zamani, 2018
P14	Access to ICU	Li et al., 2018
P15	Access to OR	Lavender et al., 2015
P16	Access to HK	Hua et al., 2012
P17	Patient Centeredness	Cawood, 2016; Zhao et al., 2009

ID	Parameters/ Factors	Referenced Literature
P18	Safety	Fogliatto, 2019; Halawa et al., 2020; Hua et al., 2012; Lavender et al., 2015 Zhao et al., 2009
P19	Effectiveness	Zhao et al., 2009
P20	Efficiency	Fogliatto, 2019; Halawa et al., 2020; Mayhew et al., 1982
P21	Timelessness	Castro, 2013;
P22	Equity	Halawa et al., 2020; Mayhew et al., 1982

Summarization of Literature Gaps

Several significant gaps exist in the current literature regarding the right-sizing approach, stemming from various factors. One primary contributor to these gaps is the limited insight into how private organizations undertake right-sizing, with the Department of Defense (DoD) being the sole publicly available reference. Private entities often maintain confidentiality regarding financially sensitive information, thus hindering a comprehensive understanding of their approaches.

Furthermore, the literature lacks extensive exploration of Facility Layout Planning (FLP) as a design strategy within the healthcare sector. While FLP typically addresses spatial layout considerations such as transportation costs and staff circulation, it overlooks numerous other critical parameters and constraints essential for comprehensive right-sizing strategies, such as the complex behavioral and practical workflows within the healthcare environment.

Additionally, existing studies predominantly focus on DoD space planning criteria, which may not fully align with the needs and nuances of the private healthcare sector. This limitation becomes apparent, concerning variations in room sizes, utilization factors of gross square footage, and equipment layouts crucial for effective healthcare facility design.

Another noteworthy gap is the insufficient consideration of design approaches by both federal and private healthcare organizations. The current body of knowledge lacks a comprehensive assessment and ranking of parameters and constraints, let alone empirical testing through independent case studies for thorough analysis and evaluation.

To address these gaps, this study aims to develop a unified ranking system for parameters and constraints, aiming to fill these voids through a collaborative effort. By doing so, it endeavors to contribute to the advancement of best practices in right-sizing approaches during conceptual healthcare design.

CHAPTER THREE

METHODOLOGY

This study employs a comprehensive 5 step methodology aimed at achieving three objectives; 1. Identifying the right-sizing approach in DoD and Private healthcare organizations, 2. Identifying and prioritize design parameters in the inpatient setting (MSU & ICU) impacted by the right-sizing approach, and 3. Apply mixed-methods approach to establish implementation of factors on the right-sizing approach through an independent case studies functional program. Iterative feedback loops throughout the methodology from industry practitioners, enhanced scope definition and detailed analysis. The overall methodology, depicted in Figure 4, is rooted in the right-sizing approach for conceptual healthcare design, complemented by a thorough review of literature, criteria, and case studies distinguishing processes between private and Department of Defense (DoD) organizations. By integrating these qualitative and quantitative approaches, this study aims to establish a robust dataset for ranking, maximizing reliability, and predicting optimal outcomes in the right-sizing approach to healthcare design.

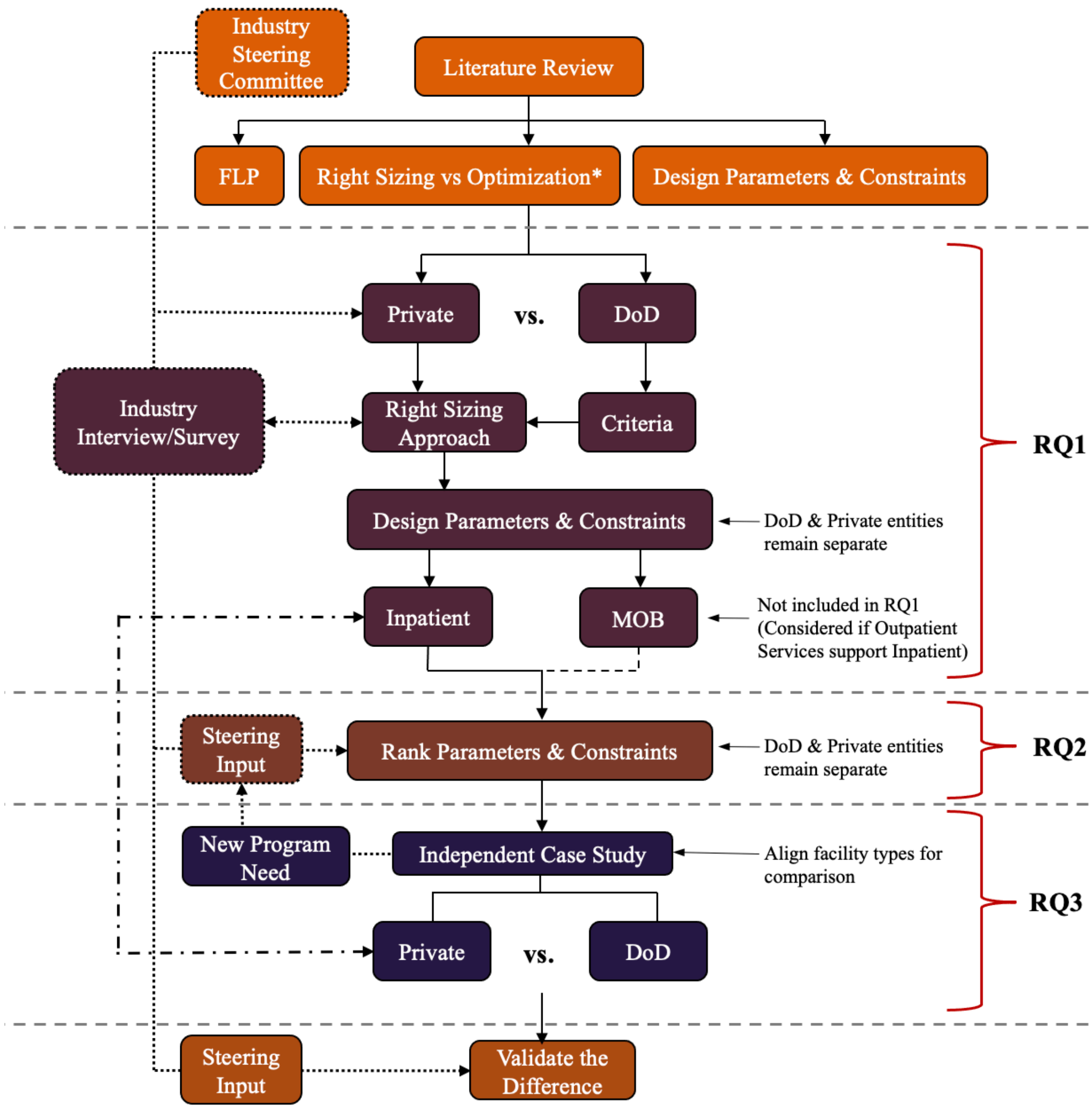


Figure 4: Research Methodology - Overview

Step 0 – Background Review

The study gathered background data; information was sourced from peer-reviewed publications using platforms like Google Scholar and Science Direct, along with other relevant criteria and regulations for space allocation on the inpatient setting. Additionally, establishment of an industry steering committee supplement data collection efforts, aiding in the identification and definition of parameters and constraints emphasized on right-sizing approach.

Step 1 – The Current Right Sizing Approach (RQ1)

The development of the studies survey, for impact of parameters and constraints, paralleled industry interviews from private organizations. The collective process of inputs from Step-0 and differentiation in DoD and private sector approaches towards right-sizing of inpatient wards (MSU & ICU) influenced scope of parameters. Iteratively recycled amongst industry practitioners, refining the survey through feedback loops for final determination of published survey scope.

Step 2 – Rank Parameters and Constraints (RQ2)

A mixed-methods approach identified factors, quantitatively ranked by impact using statistical methods namely, mean, PCA, RII, and AHP to determine a common rank. Spearman's pairwise comparison influence decision making in the AHP method as well as attributing to the discovery of significant relationships among parameters. analysis and data collection, structured around a five-step process, each serving as a prerequisite to align with the research objectives. Qualitative methods, including interviews, surveys, and industry input, will capture vital data points from industry experts for ranking purposes. Concurrently, quantitative methods such as descriptive statistics and factor analysis will provide objective, data-driven decision-making through statistical rigor.

Step 3 – Compare Programming for Decision Making (RQ3)

An independent case study became the baseline to compare the criteria and regulation data collected from private and DoD sectors. Applied via each specific sectors approach (Figure 5) were run through the case study to determine the functional requirement of MSU and ICU space allocation. This case study is important to not only establish gaps that may be present in each sector, but it allows for the ranked parameters to reinforce the output of spatial impacts to the inpatient wards.

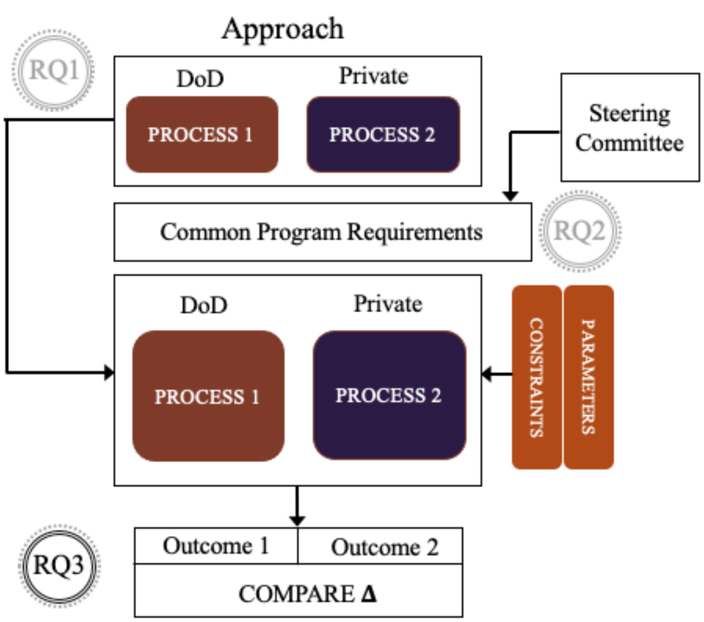


Figure 5: Sector Based Method Approach - Applying Parameters & Constraints

Step 4 – Validation

The final step is the validation of results and impacts of parameters on space allocation in the inpatient wards. To ensure industry credibility, engagement with the steering committee is paramount for the right-sizing methodology established.

CHAPTER FOUR

DATA COLLECTION & ANALYSIS

Space Allocation for MSU & ICU – Functional Requirements for 100 Bed Hospital

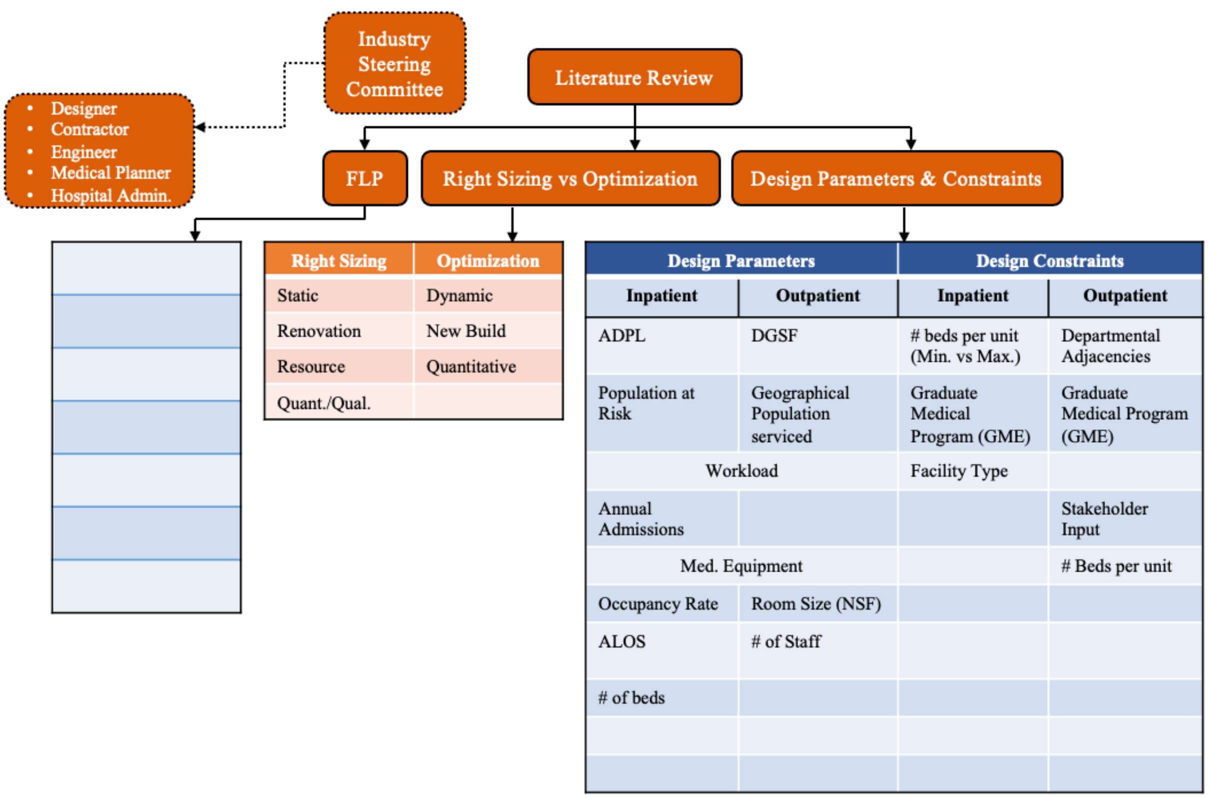
The process of data collection and analysis, as outlined in the methodology, unfolded systematically, commencing with the establishment of foundational parameters and constraints. These were meticulously crafted to align with the functional requisites of a 100-bed hospital independent case study. The objective here was to lay the groundwork for a standardized ranking system specifically tailored to meet the unique demands of the MSU and ICU departments within the broader context of the inpatient ward. Through a methodical approach, each parameter and constraint were scrutinized to ensure its relevance and applicability to the specific functions and operational dynamics of these critical healthcare units.

Subsequently, the data collected from the survey served as a valuable resource for the quantitative generation of parameter rankings, providing empirical insights derived directly from industry practitioners. This data not only facilitated the establishment of rankings but also served as a benchmark for comparing the criteria set forth by the Department of Defense (DoD) and the Facility Guidelines Institute (FGI) concerning inpatient room sizes. The comprehensive analysis presented in Appendix C offers a detailed breakdown of the functional programming associated with each criterion, offering a nuanced understanding of how these parameters align with the spatial requirements of MSU and ICU settings. Through this meticulous process, the study aimed to provide a robust framework for informed decision-making in healthcare facility design, ensuring optimal spatial allocations that cater to the diverse needs of patients and healthcare professionals alike.

Data Collection

Step 0 – Background Review

This step of the study focuses on three primary areas: Facility Layout Planning (FLP), the comparison between right-sizing and optimization methodologies, and the identification of design parameters and constraints. These areas have emerged as significant themes throughout the literature review and are foundational to the application of the right-sizing approach in healthcare design. Previous research has highlighted gaps



Right Sizing	Optimization
Static	Dynamic
Renovation	New Build
Resource	Quantitative
Quant./Qual.	

Design Parameters		Design Constraints	
Inpatient	Outpatient	Inpatient	Outpatient
ADPL	DGSF	# beds per unit (Min. vs Max.)	Departmental Adjacencies
Population at Risk	Geographical Population serviced	Graduate Medical Program (GME)	Graduate Medical Program (GME)
Workload		Facility Type	
Annual Admissions			Stakeholder Input
Med. Equipment			# Beds per unit
Occupancy Rate	Room Size (NSF)		
ALOS	# of Staff		
# of beds			

Figure 6: Step 1- Process Example to Identifying Parameters & Constraints

in hospital space allocation methodologies, underscoring the need to address the impact of various factors in this study regarding the right-sizing approach.

FLP, traditionally associated with the manufacturing and industrial sectors for space planning, has recently garnered attention in the realm of inpatient hospital design. Several international studies (Reno et al., 2014; Li et al., 2023; Tongur et al., 2020; Michelak et al., 2002) have applied FLP methods to healthcare design, revealing its significance in identifying constraints and parameters such as transportation routes (staff and patient circulation), gross square footage requirements, and spatial adjacencies. These studies utilize quantitative approaches such as heuristic algorithms, stochastic models, and simulations to optimize facility layouts. Notably, Li et al. (2023) introduced a systematic approach that incorporates human behaviors, particularly staff movement patterns analyzed through heat mapping, albeit with limited documentation of parameter and constraint hierarchy. The integration of FLP findings in the background review illuminates key components of the right-sizing approach, facilitating the identification of parameters and constraints.

This maximizes data collection by integrating various approaches to right-sizing, aiming to characterize the parameters and constraints typical to inpatient spatial planning. While the Department of Defense (DoD) provides systematic (metric driven) criteria outlining baseline parameters and constraints through for healthcare departments, these may not encompass all relevant factors. Additionally, the methodologies of private organizations are not publicly available. To address this gap, a steering committee comprised of key industry experts was formed to enhance exposure and identify characteristic features of the right-sizing approach throughout the study. The steering committee functions as an advisor in the feedback loop for industry concurrence and validation.

Step 1 – The Current Right Sizing Approach (RQ1)

In Step 1, data collection involved gathering factors from the Department of Defense (DoD), complemented by information obtained from the background study. An initial internal analysis organized the parameters and constraints thematically according to department. This process included screening for anomalies and conducting further research

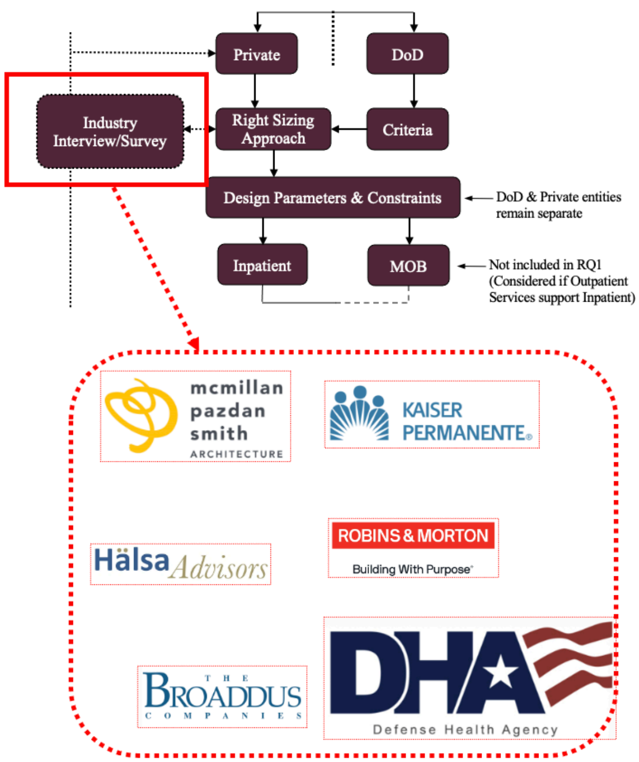


Figure 7: Industry Practitioner Advisors

to ensure a comprehensive evaluation. Given the challenge of accessing non-publicly available data related to space planning in private organizations, the need for focus groups and interviews emerged as a primary strategy for obtaining insights from these entities. These insights became paramount to the development of the survey and recruiting industry practitioners including but not limited to, medical planners, owners, and designer stakeholders.

Initial Focus Group Process

The focus group process conducted by the author comprised several key steps aimed at maximizing understanding and insight. Initially, private industry focus group discussions were organized, drawing on Department of Defense (DoD) parameters and constraints to establish a foundational understanding. These discussions, were semi-structured interviews, aimed to explore the concept of right-sizing criteria within the private sector context while also identifying commonalities across different sectors.

The focus group participants were provided with background information and presented with various themes encompassing criteria. Through collaborative discussions, they defined twenty-two (22) key parameters that significantly influence inpatient space allocation, as shown in Table 2. These parameters formed the foundation of this study and were subsequently included in the survey to collect rankings from practitioners participating in the research.

Table 2: Categorized Parameters Impacting MSU and ICU Right-Sizing

Parameter Theme	Parameter ID	Parameter Description
Facility layout	P01	Stacking
	P02	Zoning
	P03	Routing
Inpatient Internal Parameter	P04	Nurse Station Location
	P05	Family Lounge
	P06	Single Beds
	P07	Multiple Beds
	P08	Nurse Observation
	P09	Staff Support Areas
	P10	Medical Supply
	P11	Access to Ancillaries
	P12	Communication to Ancillaries
External Inpatient Parameter	P13	Access to ED
	P14	Access to ICU
	P15	Access to OR
	P16	Access to HK
Right-Sizing Decisions	P17	Patient Centeredness
	P18	Safety
	P19	Effectiveness
	P20	Efficiency
	P21	Timelessness
	P22	Equity

Throughout the study, the focus group method remained consistent, serving as a mechanism for ongoing validation and refinement. By employing this iterative process, the author conducted vector checks to ensure the accuracy and integrity of the data and findings, ultimately enhancing the credibility of the study results.

The Survey Process

The survey process in this study was structured to integrate the gathered data and formulate a comprehensive survey aimed at assessing the impact parameters and constraints, spatial room ranges, and common grossing factors relevant to the right-sizing approach. Prior to dissemination within the healthcare design industry, a pilot study was conducted as well as coordination with Clemson IRB (IRB2024-0170) to ensure questionnaire clarity and relevance to the study objectives. Internal revisions were made based on the pilot survey findings, followed by soliciting expert feedback to validate the survey's conciseness, accuracy, and applicability to the healthcare design field.

Expert feedback was sought from individuals with extensive experience in healthcare design, including healthcare owners, architects, and medical planners with a minimum of 10 years' expertise. Their insights were instrumental in refining the survey questions to enhance comprehensiveness and specificity. Table 1 illustrates the feedback received from subject matter experts (SMEs) and the corresponding adjustments made to the survey questions based on their recommendations.

Table 3: SME Survey Feedback

Subject Matter Experts (SME)	**Feedback**
SME #1 (Designer)	• Suggested defining "pre-planning" for better understanding of programming vs. budgetary applications • Suggested realigning factors that impact size on a 0 to10 point scale for better granularity of choices. • Recommended adding factors, "private patient room" and "Semi-private/ shared patient room" to inpatient ward parameters
SME #2 (Owner – Facility manager)	• Suggested considering factors for hospital renovations as this project type encompasses more constraints

Subject Matter Experts (SME)	Feedback
SME #3 (Owner – Project Manager)	• Recommended adding "other" answer choices for elaboration on differing organizational processes not provided by answer choices.

The survey encompassed two main sections:

1. Background demographics, including participants' names, industry sectors, organizational affiliations, and years of industry experience.
2. Right-sizing approach criteria, parameters, and constraints specific to various healthcare departments, such as outpatient care (primary care and emergency department), inpatient care (medical-surgical unit, intensive care unit, labor, and delivery), surgical (operating room), and ancillary (laboratory, radiology, and pharmacy). Each parameter and constraint were defined based on literature review or validated through interviews with industry experts and feedback from the steering committee. Table 4 provides some example of survey questions from each department focused on the right-sizing approach.

Table 4: Departmental Survey Question Examples

Type of Service	Department	Question Example
Outpatient Care	Primary Care (Family Health)	• Historical workload data is used to determine the total departmental exam rooms? • Patient population is a major factor in the right-sizing approach?
	Specialty Clinics (Secondary & Tertiary Care)	• What is your organizational "exam room to provider" ratio in outpatient clinics?

Type of Service	Department		Question Example
	Emergency Department		• The impact to Emergency Department (ED) size has decreased with the increased build out of freestanding ED's?
Inpatient Care	Medical Surgical Unit		• What is the minimum SF of a single-occupant medical surgical unit licenses bedroom with attached toilet/ shower? • Please identify the impact of the below inter-departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)
	Intensive Care Unit		• Nurse station sizing and placement is a major constraint to inpatient right-sizing. • Please identify the impact of the below inter-departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)
	Labor & Delivery		• What is the typical range size (SF) of the LDRP room?
Surgical Care	Operating Room	General	• General and specialty ORs are driven by workload to determine the number of rooms in the right-sizing approach? • Utilization factors (displayed in percentage) are the amount of time the room is in operation for services. Sub-specialty ORs (urology, endoscopy, etc.) in the right-sizing approach have a design utilization factor of?
		Hybrid	• The size range (SF) of a combined conventional surgical suite and medical imaging (Hybrid OR) including all associated suite support spaces (control room, equipment room, system component room, etc.) is?
		Procedure	• Sub-specialty procedure rooms (urology, endoscopy, etc.) for less invasive procedures that require patient sedation, are best integrate as part of the OR suite in the right-sizing approach?

Type of Service	Department	Question Example
Ancillary	Laboratory	• The right-sizing approach to laboratory is based on equipment placement and functional process?
	Radiology	• The right-sizing approach to ancillary waiting areas is based on wait times and in-person visits.
	Pharmacy	• A major contributor to right-sizing a pharmacy is the number of annual scripts.
Facility Miscellaneous	Common Area	• What grossing factor is used in the right-sizing approach for BGSF in conceptual design?
	Facility Impacts (Layout)	• In the right-sizing approach for hospital design, what is the impact of routing? (0 having the least impact and 10 having the highest impact) • Please identify the impact of the below external departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)

* See Appendix B for full survey questionnaire

The survey utilized Likert scale ranging from 0 to 10 to gauge the impact of each factor, with 0 indicating the least impact and 10 signifying the highest impact; True/ False; and Likert scale, Strongly Agree, Agree…Strongly Disagree questions. The survey targeted healthcare practitioners directly or indirectly involved in the outcomes of right-sizing healthcare design, including owners, designers, construction managers, and medical planners.

Additionally, the survey included questions to gather data on space allocation size measured in square feet (SF). These questions were informed by literature and criteria, with adjustments made to accommodate variations above and below the allocated minimums. This allowed for the collection of spatial variances in room types by respondents, which will be analyzed in subsequent steps to determine minimum square footages for space allocation parameters.

In accordance with the objectives, focus groups and survey results (Appendix F) revealed the right-sizing approach by both the DoD and Private sectors, as shown in Figure 8.

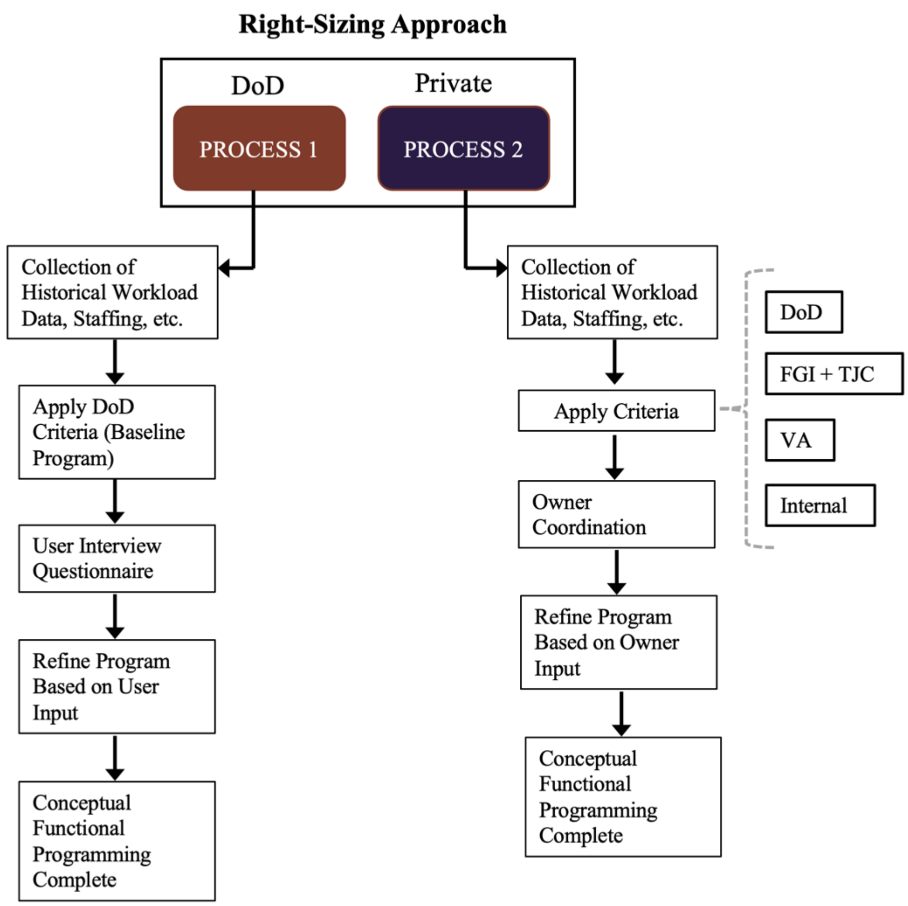


Figure 8: Right-sizing Approach by Sector

The right-sizing approach for each sector follows similar processes, except for the applied criteria. The DoD implements DoD space planning criteria to generate the baseline functional program, while the private sector applies multiple criteria to include but not limited to DoD, FGI (inclusive of TJC), VA, as well as internal space planning as produced by the survey findings. Moreover, the results prove that application of criteria in a static approach of right-sizing is the differentiator between the applied approach of the DoD and private sectors. Therefore, this result is carried through the remaining steps in the methodology.

Data Analysis

Step 2 – Rank Parameters and Constraints (RQ2)

Step 2 applied mixed methods of the qualitative (focus groups and interviews) and quantitative (survey responses) data collected to develop a common ranking of parameters through data analysis. Figure 9 maps the data analysis process to determine ranking and significance among parameters.

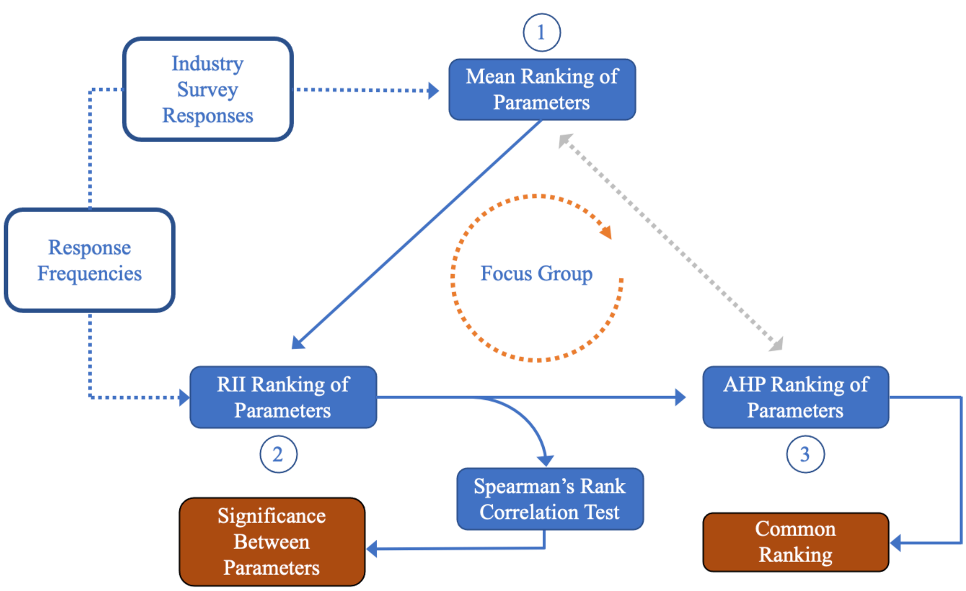


Figure 9: Quantitative Analysis Process Mapping

Ranking Analysis – Mean (Stage 1)

The survey asked respondents to rank twenty-two factors based on their impact to the MSU and ICU right-sizing approach. To analyze the data quantitively, descriptive statistics were generated, where the mean of each response was utilized for ranking of each parameter identified from the survey and background data collection. Table 5 provides the parameters mean value and the initial ranking.

Table 5: Mean Response Ranking

ID	Parameters	Mean Value	Rank
P01	Stacking	6.0666	11
P02	Zoning	5.9666	13
P03	Routing	5.9	14
P04	Nurse Station Location	7.7	3
P05	Family Lounge	3.8	21
P06	Single Beds	7.6	4
P07	Multiple Beds	2.1333	22
P08	Nurse Observation	7.8333	2
P09	Staff Support Areas	5.3666	17
P10	Medical Supply	6.6333	8
P11	Access to Ancillaries	6.8	6
P12	Communication to Ancillaries	4.5333	19
P13	Access to ED	7.7666	16
P14	Access to ICU	6.7333	7

ID	Parameters	Mean Value	Rank
P15	Access to OR	6.0333	12
P16	Access to HK	4.5	20
P17	Patient Centeredness	6.6	9
P18	Safety	7.0333	5
P19	Effectiveness	5.8666	15
P20	Efficiency	7.9333	1
P21	Timelessness	6.2333	10
P22	Equity	5	18

Ranking Analysis – Principal Component Analysis (PCA)

Sullivan and Artino (2013), highlight the unclear meaning of descriptive statistics, such as means and standard deviations, when applied to Likert scale responses. Where experts have contended that the focus of central tendency is best found in frequencies (percentages of responses in each category), Spearman rho assessments, and Principal Component Analysis. It became imperative to model non-parametric and parametric test to determine if correlation or underlying components provided additional statistical impact on the rankings. Therefore, the author applied PCA in the statistical software SPSS with the survey data set. PCA is robust and parametric test, providing a comprehensive, objective, and significant evaluation of latent variables of the right-sizing approach to overcome data distortion. However, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests are necessary to ensure PCA is appropriate for the data set. The Bartlett's Test of Sphericity provided positive data significance of '$p < 0.001$. KMO measure of sampling adequacy is also necessary to align in the range of 0.5 – 0.7, consequently the data set measured 0.374, failing the criteria to continue utilizing PCA for analysis. Therefore, PCA was not viable, requiring another analysis methods for rank decision making.

Ranking Analysis – Relative Importance Index (RII)

In-suite with the existing literature, non-parametric tests such as frequencies of respondents ranking on the right-sizing approach was utilized. The frequencies became inputs to the Relative Importance Index (RII) to assess the weighting of the factors for decisional ranking. The RII method evaluates the response data and provides clarity in ranking.

$$RII = (\sum P_i X_i)/N(n) \text{------------------ (v)}$$

Where RII =relative importance index; P_i = weight given to each attribute (0 – 10); X_i = number of respondents that chose the same weight of P_i; n = the highest scale weight (10); N = total number of participants (31) (Gunduz et al., 2019). Table 6 lists the initial RII rank for all factors associated with the right-sizing approach.

Table 6: RII Initial Parameter Ranking

ID	Parameters	RII Value	Rank
P01	Stacking	0.600000	13
P02	Zoning	0.603226	T10
P03	Routing	0.596774	14
P04	Nurse Station Location	0.767742	T2

ID	Parameters	RII Value	Rank
P05	Family Lounge	0.380645	21
P06	Single Beds	0.751613	4
P07	Multiple Beds	0.222581	22
P08	Nurse Observation	0.783871	1
P09	Staff Support Areas	0.541935	16
P10	Medical Supply	0.661290	8
P11	Access to Ancillaries	0.683871	5
P12	Communication to Ancillaries	0.461290	19
P13	Access to ED	0.577419	15
P14	Access to ICU	0.670968	7
P15	Access to OR	0.603226	T10
P16	Access to HK	0.454839	20
P17	Patient Centeredness	0.638710	9
P18	Safety	0.680645	6
P19	Effectiveness	0.483871	17
P20	Efficiency	0.767742	T2
P21	Timelessness	0.603226	T10
P22	Equity	0.483871	18

Ranking Analysis – Spearman's Rank Correlation Test

Additionally, to maximize the precision of the data and initial ranking using RII, Spearman's Rank Correlation Test was computed to analyze different factors positive or negative correlations by the following formula.

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \text{ -------------- (vi)}$$

Were ρ = Spearman correlation coefficient ('r' value); d_i = difference between respondents' frequency to each factor; n = total number of factors (22). Spearman's coefficient ('r" value) is between -1 (negative correlation) and +1 (positive correlation). Table 4 summarizes Spearman's correlation value for each factor's comparison. Showcasing the factor pairwise correlations based on significance identified by '*' , p value < 0.05 or '**', p value <0.01. These have been bolded and highlighted in Table 7 for ease of understanding the data.

Table 7: Spearman's Correlation Computation Values

ID	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22
P01	1	0.257	0.216	-0.162	.487**	0.061	0.206	0.295	0.335	0.022	0.236	.391*	0.195	0.252	0.175	0.001	0.151	-0.15	0.074	-0.146	-0.09	0.159
P02	0.257	1	.439*	0.192	0.219	0.202	-0.24	0.28	0.16	0.125	-0.105	0.24	0.227	0.241	0.184	0.174	0.297	0.017	0.327	0.308	0.112	0.012
P03	0.216	.439*	1	0.011	.516**	-0.14	0.048	0.006	0.178	-0.062	0.3	0.319	0.147	-0.11	0.181	0.238	0.095	0.212	.472**	0.17	-0.215	0.335
P04	-0.162	0.192	0.011	1	-0.061	.385*	-0.02	0.176	0.222	0.213	0.036	0.257	0.319	-0.03	-0.14	0.064	0.208	.385*	.364*	.516**	0.353	0.224
P05	.487**	0.219	0.516**	-0.061	1	0.121	0.163	0.061	0.186	-0.181	.490**	0.151	0.338	0.049	0.2	0.103	0.243	0.141	0.242	-0.185	-0.207	0.21
P06	0.061	0.202	-0.148	0.385*	0.121	1	-0.31	-0.164	0.015	-0.04	-0.271	-0.07	0.334	0.293	0.235	0.319	-0.006	-0.01	0.132	0.277	0.001	-0.034
P07	0.206	-0.24	0.048	-0.023	0.163	-0.31	1	0.211	.375*	-0.154	.380*	0.091	0.002	0.04	-0.21	-0.05	0.062	0.271	-0.212	-0.243	-0.117	0.02
P08	0.295	0.28	0.006	0.176	0.061	-0.16	0.211	1	0.081	.540**	.394*	0.275	0.151	0.013	0.232	-0.22	0.346	0.035	-0.026	0.259	0.332	0.173
P09	0.335	0.16	0.178	0.222	0.186	0.015	.375*	0.081	1	0.137	0.253	0.337	0.31	0.048	-0.06	0.254	.415*	0.153	0.248	0.087	0.128	.518**
P10	0.022	0.125	-0.062	0.213	-0.181	-0.04	-0.15	.540**	0.137	1	0.224	.368*	-0.04	-0.21	0.3	-0.10	0.342	0.173	0.175	.529**	.476**	0.315
P11	0.236	-0.10	0.3	0.036	0.490**	-0.27	.380*	.394*	0.253	0.224	1	0.243	0.024	-0.18	0.026	0.077	0.172	0.302	0.35	0.09	0.142	.486**
P12	.391*	0.24	0.319	0.257	0.151	-0.07	0.091	0.275	0.337	.368*	0.243	1	0.211	-0.11	0.121	-0.12	0.079	0.249	0.185	0.131	0.302	.393*
P13	0.195	0.227	0.147	0.319	0.338	0.334	0.002	0.151	0.31	-0.045	0.024	0.211	1	0.26	.356*	0.256	0.009	0.082	-0.098	-0.074	0.225	0.355
P14	0.252	0.241	-0.115	-0.036	0.049	0.293	0.04	0.013	0.048	-0.215	-0.179	-0.10	0.26	1	.413*	0.061	-0.016	-0.342	-0.257	-0.015	-0.064	-0.286
P15	0.175	0.184	0.181	-0.139	0.2	0.235	-0.21	0.232	-0.065	0.3	0.026	0.121	.356*	.413*	1	0.06	0.108	-0.205	-0.049	0.052	0.193	0.067
P16	0.001	0.174	0.238	0.064	0.103	0.319	-0.05	-0.226	0.254	-0.101	0.077	-0.12	0.256	0.061	0.06	1	0.209	-0.005	0.248	0.199	-0.153	0.302
P17	0.151	0.297	0.095	0.208	0.243	-0.01	0.062	0.346	.415*	0.342	0.172	0.079	0.009	-0.01	0.108	0.209	1	0.021	0.203	0.33	0.205	0.229
P18	-0.15	0.017	0.212	.385*	0.141	-0.01	0.271	0.035	0.153	0.173	0.302	0.249	0.082	-0.34	-0.20	-0.01	0.021	1	0.288	0.041	0.307	0.213

ID	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22
P19	0.074	0.327	**.472****	.364*	0.242	0.132	-0.21	-0.026	0.248	0.175	0.35	0.185	-0.09	-0.25	-0.04	0.248	0.203	0.288	1	**.502****	0.025	0.293
P20	-0.146	0.308	0.17	**.516****	-0.185	0.277	-0.24	0.259	0.087	**.529****	0.09	0.131	-0.07	-0.01	0.052	0.199	0.33	0.041	**.502****	1	0.3	0.323
P21	-0.09	0.112	-0.215	0.353	-0.207	0.001	-0.11	0.332	0.128	**.476****	0.142	0.302	0.225	-0.06	0.193	-0.15	0.205	0.307	0.025	0.3	1	**.382***
P22	0.159	0.012	0.335	0.224	0.21	-0.03	0.02	0.173	**.518****	0.315	**.486****	**.393***	0.355	-0.28	0.067	0.302	0.229	0.213	0.293	0.323	**.382***	1

** Correlation is significant at the 0.05 level (2-tailed)*
*** Correlation is significant at the 0.01 level (2-tailed)*

Ranking Analysis – Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) has been widely utilized by many researchers to organize and analyze complex decision making (Gunduz et al., 2019). To maximize multi-criteria decisions to determine the common ranking, AHP is computed. AHP engages pairwise relative importance comparisons for each criterion, translating subjective opinions into measurable numeric relations. Improper conceptualization of data hierarchy may result in inconsistency in pairwise comparisons. Therefore, the use of initial ranking via RII and understanding of Spearman's correlation through survey data frequencies, influence the multi-level hierarchical structures of AHP. In addition, the computation of the consistency ratio measured the precision and accuracy of the selected weights (Saaty, 1977). Gunduz et al. (2019), states that a consistency ratio lower than 0.1 is acceptable, where the analysis calculated compliance at 0.098, as shown in Table 4.

This study applies Gunduz et al. (2019) seven step AHP process. Mathematically this method is based on the solution of an Eigenvalue problem.

1. Identify the problem objective
2. Identify the problem criteria
3. Assign relative weights for each criterion
4. Develop the AHP structure
5. Develop the pairwise matrices for comparison. The formula for pair wise matrix as shown below:

$$[A_{ij}], where\ i, j = 1, 2, \ldots, \text{-----------(vii)}$$

A = pairwise comparison value; *i* = parameters (*i* = 20); *j* = parameters (*j* = 20)

The pairwise comparison requires a square matrix m*m with use of the formula above, where '*i*' is compared to '*j*'.

6. Check the consistency ratio to be less than 0.1 determined by the Eigenvalue
7. Calculate priority weights to generate the overall ranking of parameters. The summation of each column for each pairwise comparison matrix is calculated and normalized with the sum of each column.

Focus Group Refinement to Parameters

A 20 by 20 matrices of factors were compared to determine a common rank with priority weights. It must be noted that during the AHP analysis, engagement of the steering committee took place. This supplemented the decision-making necessary for assigning relative weights for each criterion. During the process, the steering committee participants refined the parameters from the initial rankings. Consensus and practical knowledge eliminated 'family lounge' and combining 'single beds' with 'multiple beds' to maximize decision making on the right-sizing approach. Thus, reduced the overall parameters from 22 to 20 for the AHP computation. Table 8 shows the values for the pairwise comparison and Table 9 shows the normalized values. Inputs to determine the new priority weights of the 20 parameters that affect the right-sizing approach based on the decision matrix for the common ranking. However, the RII initial ranking was utilized by the author to generate the pairwise matrix for consistency in the analysis. Therefore, the "PXX" parameter shown in the AHP tables are out of numeric order.

Table 8: AHP Parameter Pairwise Comparison Values

ID	P08	P04	P20	P06	P11	P18	P14	P10	P17	P02	P15	P21	P01	P03	P13	P09	P19	P22	P12	P16
P08	1.000	1.000	3.000	2.000	9.000	1.000	5.000	3.000	3.000	4.000	8.000	9.000	8.000	8.000	8.000	8.000	6.000	6.000	7.000	8.000
P04	1.000	1.000	1.000	1.000	9.000	2.000	4.000	3.000	3.000	2.000	4.000	8.000	9.000	8.000	7.000	8.000	6.000	6.000	7.000	8.000
P20	0.330	1.000	1.000	2.000	6.000	3.000	3.000	8.000	2.000	1.000	8.000	8.000	5.000	5.000	3.000	9.000	7.000	4.000	9.000	7.000
P06	0.500	1.000	0.500	1.000	7.000	2.000	5.000	2.000	3.000	5.000	5.000	6.000	5.000	5.000	3.000	7.000	3.000	4.000	8.000	4.000
P11	0.110	0.110	0.170	0.140	1.000	0.120	0.500	0.330	0.140	1.000	1.000	2.000	3.000	1.000	1.000	5.000	2.000	2.000	4.000	9.000
P18	1.000	0.500	0.330	0.500	8.000	1.000	4.000	8.000	1.000	3.000	2.000	5.000	7.000	7.000	2.000	9.000	5.000	4.000	9.000	9.000
P14	0.200	0.250	0.330	0.200	2.000	0.250	1.000	3.000	0.250	4.000	1.000	3.000	7.000	2.000	1.000	7.000	6.000	6.000	9.000	6.000
P10	0.330	0.330	0.120	0.500	3.000	0.120	0.330	1.000	0.500	1.000	1.000	2.000	2.000	1.000	2.000	3.000	2.000	2.000	4.000	8.000
P17	0.330	0.330	0.500	0.330	7.000	1.000	4.000	2.000	1.000	3.000	2.000	4.000	6.000	1.000	2.000	8.000	5.000	3.000	7.000	8.000
P02	0.250	0.500	1.000	0.200	1.000	0.330	0.250	1.000	0.330	1.000	2.000	2.000	1.000	1.000	3.000	7.000	5.000	3.000	6.000	4.000
P15	0.120	0.250	0.120	0.200	1.000	0.500	1.000	1.000	0.500	0.500	1.000	1.000	3.000	4.000	2.000	7.000	1.000	1.000	6.000	4.000
P21	0.110	0.120	0.120	0.170	0.500	0.200	0.330	0.500	0.250	0.500	1.000	1.000	2.000	2.000	1.000	8.000	3.000	2.000	6.000	9.000
P01	0.120	0.110	0.200	0.200	0.330	0.140	0.140	0.500	0.170	1.000	0.330	0.500	1.000	2.000	1.000	7.000	1.000	3.000	7.000	5.000
P03	0.120	0.120	0.200	0.200	1.000	0.140	0.500	1.000	1.000	1.000	0.250	0.500	0.500	1.000	1.000	1.000	1.000	1.000	8.000	6.000
P13	0.120	0.140	0.330	0.330	1.000	0.500	1.000	0.500	0.500	0.330	0.500	1.000	1.000	1.000	1.000	9.000	3.000	2.000	6.000	4.000
P09	0.120	0.120	0.110	0.140	0.200	0.110	0.140	0.330	0.120	0.140	0.140	0.120	0.140	1.000	0.110	1.000	0.500	0.500	1.000	1.000

ID	P08	P04	P20	P06	P11	P18	P14	P10	P17	P02	P15	P21	P01	P03	P13	P09	P19	P22	P12	P16
P19	0.170	0.170	0.140	0.330	0.500	0.200	0.170	0.500	0.200	0.200	1.000	0.330	1.000	1.000	0.330	2.000	1.000	2.000	4.000	1.000
P22	0.170	0.170	0.250	0.250	0.500	0.250	0.170	0.500	0.330	0.330	1.000	0.500	0.330	1.000	0.500	2.000	0.500	1.000	3.000	2.000
P12	0.140	0.140	0.110	0.120	0.250	0.110	0.110	0.250	0.140	0.170	0.170	0.170	0.140	0.120	0.170	1.000	0.250	0.330	1.000	2.000
P16	0.120	0.120	0.140	0.250	0.110	0.110	0.170	0.120	0.120	0.250	0.250	0.110	0.200	0.170	0.250	1.000	1.000	0.500	0.500	1.000

Consistency Ratio = 0.098 < 0.1

Table 9: Normalized Values from Pairwise Comparisons

ID	P08	P04	P20	P06	P11	P18	P14	P10	P17	P02	P15	P21	P01	P03	P13	P09	P19	P22	P12	P16
P08	0.157	0.134	0.310	0.199	0.154	0.076	0.162	0.082	0.171	0.136	0.202	0.166	0.128	0.153	0.203	0.073	0.101	0.113	0.062	0.075
P04	0.157	0.134	0.103	0.099	0.154	0.153	0.130	0.082	0.171	0.068	0.101	0.148	0.144	0.153	0.178	0.073	0.101	0.113	0.062	0.075
P20	0.052	0.134	0.103	0.199	0.103	0.229	0.097	0.219	0.114	0.034	0.202	0.148	0.080	0.096	0.076	0.082	0.118	0.075	0.080	0.066
P06	0.079	0.134	0.052	0.099	0.120	0.153	0.162	0.055	0.171	0.170	0.126	0.111	0.080	0.096	0.076	0.064	0.051	0.075	0.071	0.038
P11	0.017	0.015	0.018	0.014	0.017	0.009	0.016	0.009	0.008	0.034	0.025	0.037	0.048	0.019	0.025	0.045	0.034	0.038	0.036	0.085
P18	0.157	0.067	0.034	0.050	0.137	0.076	0.130	0.219	0.057	0.102	0.050	0.092	0.112	0.134	0.051	0.082	0.084	0.075	0.080	0.085
P14	0.031	0.033	0.034	0.020	0.034	0.019	0.032	0.082	0.014	0.136	0.025	0.055	0.112	0.038	0.025	0.064	0.101	0.113	0.080	0.057
P10	0.052	0.044	0.012	0.050	0.051	0.009	0.011	0.027	0.028	0.034	0.025	0.037	0.032	0.019	0.051	0.027	0.034	0.038	0.036	0.075
P17	0.052	0.044	0.052	0.033	0.120	0.076	0.130	0.055	0.057	0.102	0.050	0.074	0.096	0.019	0.051	0.073	0.084	0.056	0.062	0.075

ID	P08	P04	P20	P06	P11	P18	P14	P10	P17	P02	P15	P21	P01	P03	P13	P09	P19	P22	P12	P16
P02	0.039	0.067	0.103	0.020	0.017	0.025	0.008	0.027	0.019	0.034	0.050	0.037	0.016	0.019	0.076	0.064	0.084	0.056	0.053	0.038
P15	0.019	0.033	0.012	0.020	0.017	0.038	0.032	0.027	0.028	0.017	0.025	0.018	0.048	0.076	0.051	0.064	0.017	0.019	0.053	0.038
P21	0.017	0.016	0.012	0.017	0.009	0.015	0.011	0.014	0.014	0.017	0.025	0.018	0.032	0.038	0.025	0.073	0.051	0.038	0.053	0.085
P01	0.019	0.015	0.021	0.020	0.006	0.011	0.005	0.014	0.010	0.034	0.008	0.009	0.016	0.038	0.025	0.064	0.017	0.056	0.062	0.047
P03	0.019	0.016	0.021	0.020	0.017	0.011	0.016	0.027	0.057	0.034	0.006	0.009	0.008	0.019	0.025	0.009	0.017	0.019	0.071	0.057
P13	0.019	0.019	0.034	0.033	0.017	0.038	0.032	0.014	0.028	0.011	0.013	0.018	0.016	0.019	0.025	0.082	0.051	0.038	0.053	0.038
P09	0.019	0.016	0.011	0.014	0.003	0.008	0.005	0.009	0.007	0.005	0.004	0.002	0.002	0.019	0.003	0.009	0.008	0.009	0.009	0.009
P19	0.027	0.023	0.014	0.033	0.009	0.015	0.006	0.014	0.011	0.007	0.025	0.006	0.016	0.019	0.008	0.018	0.017	0.038	0.036	0.009
P22	0.027	0.023	0.026	0.025	0.009	0.019	0.006	0.014	0.019	0.011	0.025	0.009	0.005	0.019	0.013	0.018	0.008	0.019	0.027	0.019
P12	0.022	0.019	0.011	0.012	0.004	0.008	0.004	0.007	0.008	0.006	0.004	0.003	0.002	0.002	0.004	0.009	0.004	0.006	0.009	0.019
P16	0.019	0.016	0.014	0.025	0.002	0.008	0.006	0.003	0.007	0.008	0.006	0.002	0.003	0.003	0.006	0.009	0.017	0.009	0.004	0.009
Sum	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

The average of each parameter row in Table 6 was taken to determine the final common priority weight and rank.

Triangulation Analysis for Common Rank Determination

To ensure the robustness of the findings, a triangulation approach was employed between quantitative methods. This involved cross-referencing the background information with the coding of focus group discussions, thereby enhancing the reliability and validity of the quantitative data to refine the common ranking of parameters and constraints. The triangulation of focus group results was instrumental in shaping the survey themes and questionnaire, facilitating the systematic collection of ranking in application of the right-sizing approach process by each sector. Ultimately, answering research question two, finalizing a common rank towards application of a methodology of parameters and constraints input to the right-sizing approach of MSU and ICU departments.

Step 3 – Compare Programming for Decision Making (RQ3)

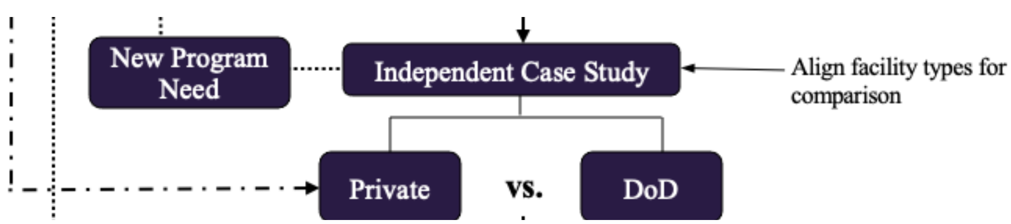


Figure 10: Step 3 - Comparing DoD and Private Functional Programming

Step 3 introduced an independent case study of an inpatient platform functional program, specifically focusing on the MSU and ICU departments. The case study is set in an undisclosed location in the United States of America (USA). The facility categorized as healthcare occupancy, serves a population over 50,000 beneficiaries with a total capacity of 105 licensed beds, comprising of 19 ICU beds, 67 MSU beds, and 14 L&D beds (no included in this study). These previously resulting key characteristics namely, criteria and parameters, were applied to the case study for standardization of the functional programming.

Given the systematic nature and public availability of DoD space planning criteria, a federal hospital platform was selected for comparison with private criteria. A summary of survey responses identified 20 percent of the 71 responses utilized Facility Guidelines Institute (FGI) as their organization's criteria for the right-sizing approach, with an additional 24% using criteria references by The Joint Commission, which relies on FGI standards. ("Design Criteria - Facility Guidelines Institute (FGI) | Hospital and Hospital Clinics | Environment of Care EC | the Joint Commission"). Consequently, the combined use of FGI and TJC criteria accounted for 44% of the survey population (Figure 10).

Therefore, FGI and DoD Space Planning criteria are established to develop the function program for both DoD and private sectors.

Comparison of the functional programs between DoD and private space planning criteria for MSU and ICU inpatient wards are necessary to differentiate the impacts on sector use of criteria for spatial allocation. Therefore, the functional program for the DoD will provide a side-by-side comparison to the FGI applied criteria for the private sector. Appendix C showcases the comparison between criteria for MSU and ICU, revealing FGI's limitation to specify allocated room sizes for all functional program spaces.

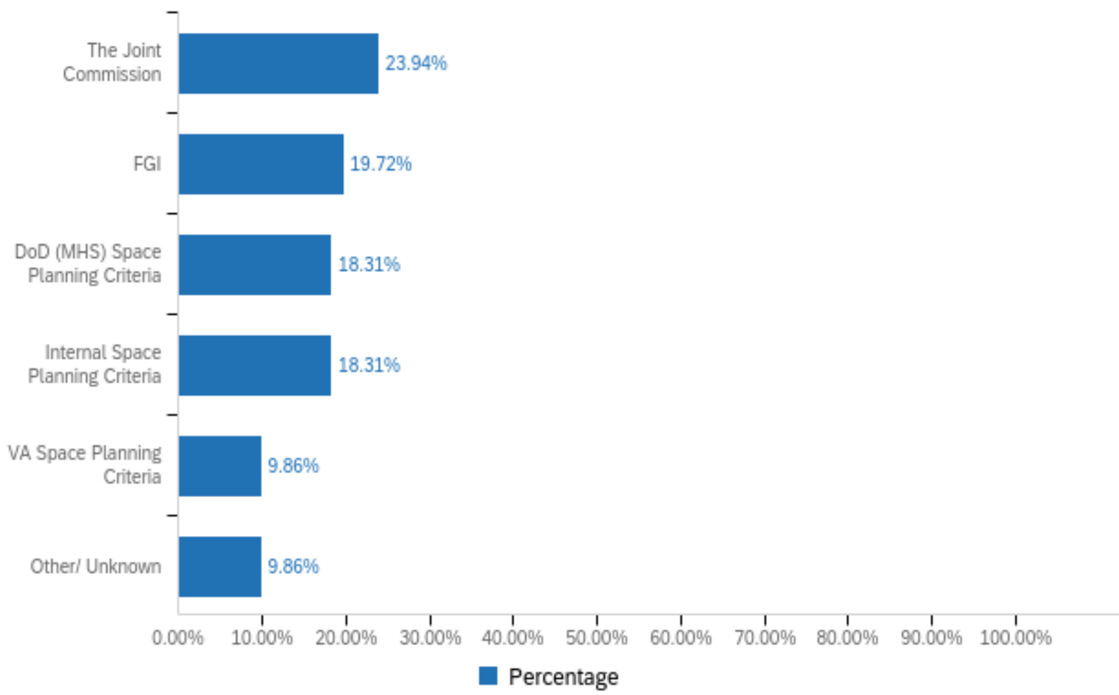


Figure 11: Survey Results - Healthcare Design Criteria

MSU and ICU single patient bedrooms were the only available spaces in the right-sizing approach to result in given ranges based on DoD, FGI, and survey results. MSU's single patient bedroom ranged from 280 -360 SF; while ICU single patient bedrooms ranged from 270 – 350 SF (shown in Figure 11). These ranges support flexibility and adaptability trends in current healthcare space allocation, directly tied to the right-sizing approach. Although these results could not be established for all functional program rooms in MSU and ICU, it opens the door for a future extension of research. Providing valuable autonomy to designers and medical planners in the right-sizing approach, focusing on incorporation of future needs of modern healthcare delivery.

Furthermore, the practical application of criteria and case studies unveiled the essential methodology for appropriately sizing MSU and ICU departments (refer to Figure 12).

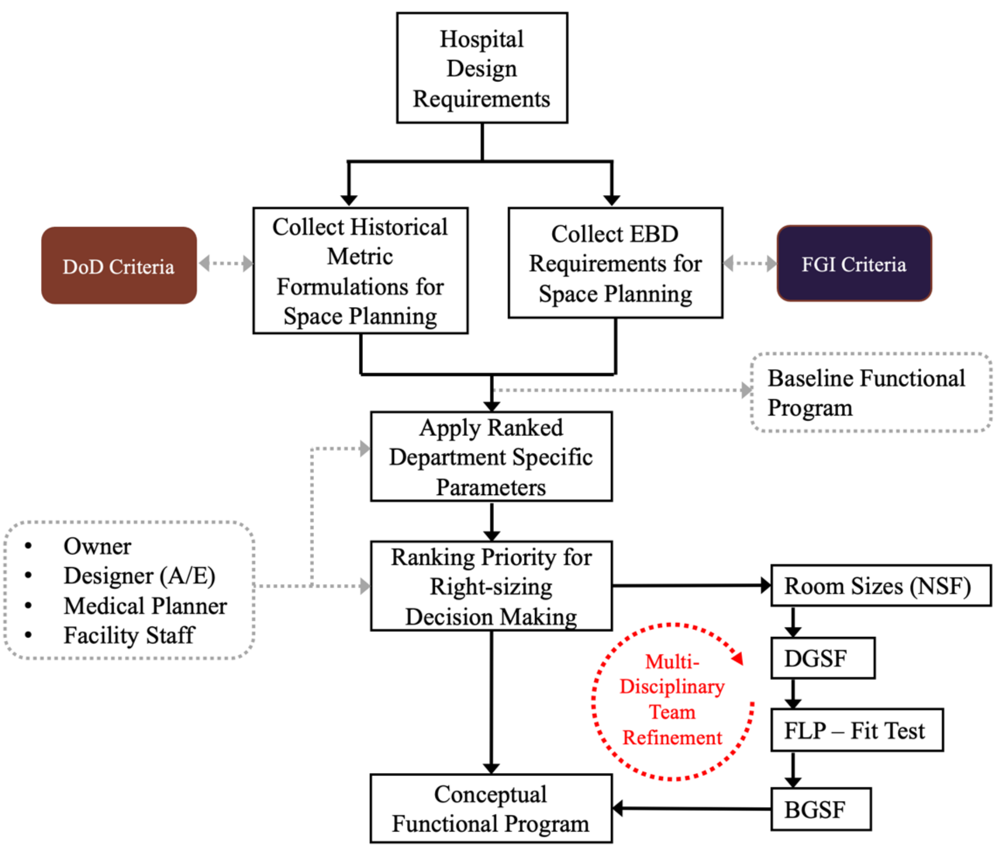


Figure 12: Right-sizing Methodology for MSU & ICU

This underscores the pressing need to modernize the processes employed between the DoD and the private sector for the sizing approach, as depicted in Figure 13. These criteria supplant the mere implementation of parameters and constraints, playing a pivotal role in determining the overarching baseline functional program. Consequently, this marks the initial phase of the methodology utilized in this study, culminating at the baseline functional program stage. A subsequent phase of the research entails applying parameters and constraints dynamically to the baseline program to optimize space allocation within the inpatient platform.

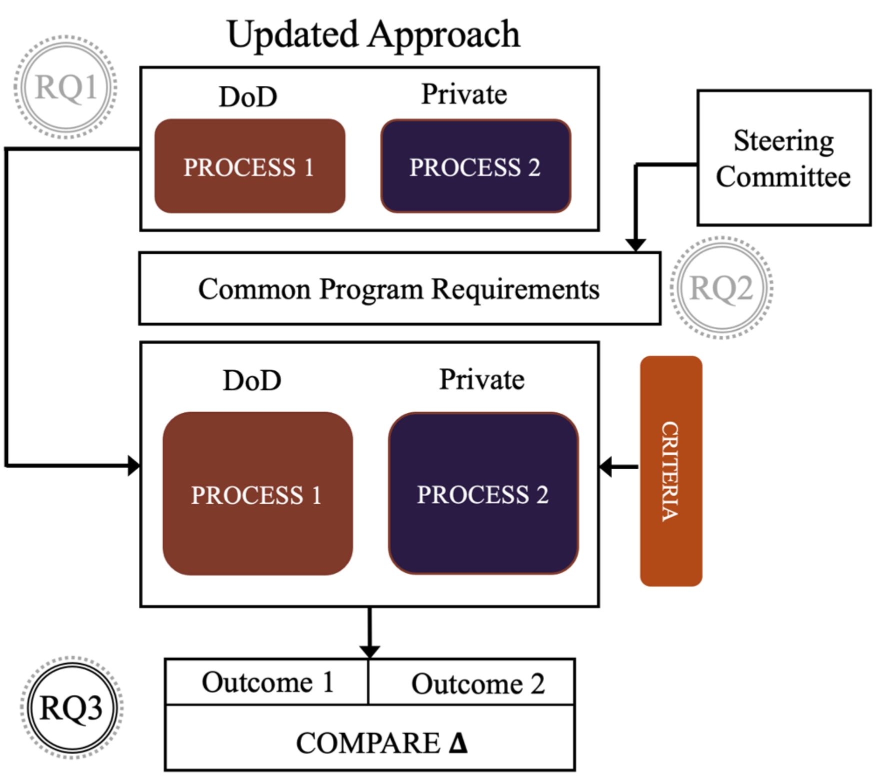


Figure 13: Updated Application of Criteria in Sector Process

The study's central discovery lies in defining a static baseline functional program, achieved by synthesizing DoD and FGI criteria. Appendix E showcases the finalized baseline functional program for MSU and ICU, furnishing vital departmental net and gross square footage data crucial for informed resource allocation in early planning phases. This aids in mitigating cost and design risks.

Step 4 – Validation

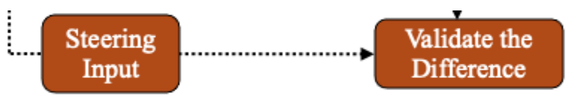


Figure 14: Step 4 - Validation of Ranking

In this final step, consensus was achieved through coordination with the steering committee across preceding steps, spanning from literature review to ranking parameters and constraints, ultimately culminating in the development of the methodology to establish the baseline functional program. These steps collectively led to the refutation of the hypothesis, indicating that the influence of criteria surpassed that of parameters and constraints in the application of the right-sizing approach for MSU and ICU departments. The validation confirmed a methodology for implementing criteria in right-sizing the baseline functional programming of MSU and ICU, paving the way for future research to optimize space allocation using the ranked parameters and constraints.

CHAPTER FIVE

RESULTS

Results and Discussion

Healthcare space planning and programming for a right-sized approach involves a comprehensive strategy, integrating criteria, regulations, and expertise from subject matter experts to optimize operational efficiencies and ensure patient safety. Criteria serve as a primary driver in the right-sizing approach for inpatient healthcare facilities, leveraging operational metrics and evidence-based design methods to determine bed capacity effectively.

Key metric factors such as ADPL, occupancy rate, and annual admission rates are instrumental parameters that guide designers in assessing the healthcare needs for inpatient services. However, beyond the systematic metric-based approach to right-sizing, some additional parameters and constraints necessitate a deep understanding of healthcare operations. Requiring practitioners' active involvement through focus groups, as demonstrated in this study, to provide critical insights and feedback.

Survey Results

The observations derived from the survey extend beyond the mere collection of data for ranking parameters and constraints in the right-sizing approach in MSU & ICU. While ranking remains an objective, the survey offers valuable insights into current practices in healthcare right-sizing, particularly regarding the utilization of best practice calculations incorporating historical workload data. Notably, 86% of respondents reported using historical workload to determine departmental sizing, highlighting a systematic and quantitative approach consistent with the DoD space planning criteria.

Furthermore, the survey revealed that 72% of respondents agreed that there is minimal change in the size of inpatient platform facilities due to virtual healthcare trends. This finding suggests that virtual healthcare may not be a significant parameter affecting the right-sizing approach, eliminating it as a pending consideration.

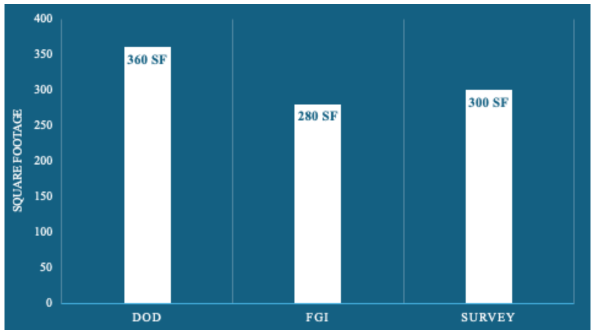
Another critical aspect of the right-sizing approach is understanding room square footages, particularly the range in which inpatient rooms fluctuate based on design parameters.

Inpatient Ward Bedroom Sizing (MSU & ICU)

While the DoD provides clear guidelines for room square footages, private sector criteria, such as those outlined by the FGI appear to be more ambiguous. For instance, FGI space requirements for an ICU bedroom include specific clearances and "clear floor area" specifications, leaving room for interpretation by designers. This ambiguity can make it challenging to achieve a truly right-sized approach. To address this, the survey included multiple questions regarding inpatient ward room sizing to obtain practitioners' perspectives on the range of room sizes. The survey results will be compared to both DoD and FGI criteria for inpatient room sizing to establish minimum values for baseline right-sizing. The following charts in figure 15 illustrate the comparison between survey results and established criteria, providing valuable insights for achieving optimal room sizing in inpatient wards.

Single Patient Bedroom Sizes	Criteria Square Footage Comparison Results	Room Sizing: Max. vs Min.

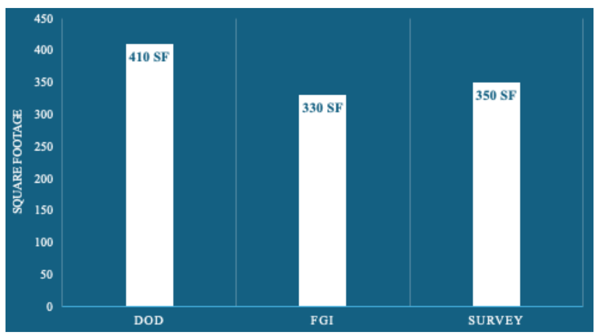
MSU Room: Criteria Square Footages



Maximum = 360 SF

Minimum = 280 SF

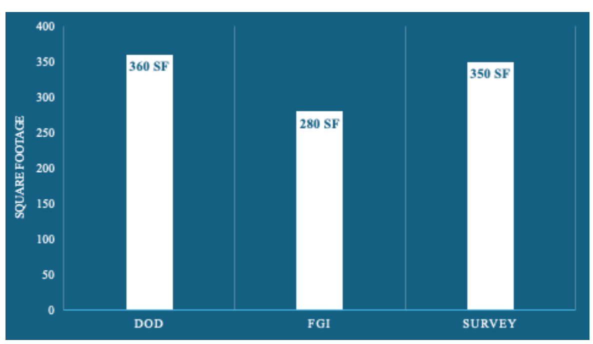
MSU Room with Shower: Criteria Square Footages



Maximum = 410 SF

Minimum = 330 SF

ICU Room : Criteria Square Footages



Maximum = 350 SF

Minimum = 270 SF

Figure 15: Inpatient Bedroom - Space Planning Criteria Comparison

By comparing the survey data collected from industry practitioners with regulated criteria for inpatient bedroom space allocation, a range has been established. The FGI offers the minimum, most conservative square footage requirements for each room type in MSU and ICU spatial allocation. Interestingly, the survey results reveal a middle ground between FGI and DoD criteria, with DoD prescribing the highest square footage requirements. This observation indicates that the criteria is mostly a guideline for design professionals when developing functional programming, likely requiring expertise of the healthcare organizations needs for right-sizing. Nevertheless, by determining a minimum and maximum range, this knowledge gap can be overcome, particularly during the early planning stage of project development.

Common Parameter Rank Results

The common ranking of parameters in right-sizing approach was achieved through a progressive process involving mean, RII, and AHP methods. Each statistical method generated its rank for each parameter, as summarized in Table 10.

Table 10: Quantitative Method Comparisons

ID	Parameter	Mean Method	RII Method	AHP Method
P01	Stacking	11	13	13
P02	Zoning	13	T10	10
P03	Routing	14	14	14
P04	Nurse Station Location	3	T2	2
P05	Family Lounge	21	21	N/A[1]
P06	Single Beds	4	4	4
P07	Multiple Beds	22	22	N/A[1]
P08	Nurse Observation	2	1	1
P09	Staff Support Areas	17	16	16
P10	Medical Supply	8	8	8

ID	Parameter	Mean Method	RII Method	AHP Method
P11	Access to Ancillaries	6	5	5
P12	Communication to Ancillaries	19	19	19
P13	Access to ED	16	15	15
P14	Access to ICU	7	7	7
P15	Access to OR	12	T10	11
P16	Access to HK	20	20	20
P17	Patient Centeredness	9	9	9
P18	Safety	5	6	6
P19	Effectiveness	15	17	17
P20	Efficiency	1	T2	3
P21	Timelessness	10	T10	12
P22	Equity	18	18	18

The comparison of results reveals refinement from the statistical approach to determine the ranking, with fewer ties evident in the AHP ranking. This provides assurance that the final ranking using AHP is robust evidence to prioritize parameters in a specific order. This exhaustive quantitative assessment identifies the parameters affecting Medical Surgical Units (MSU) and Intensive Care Units (ICU) right-sizing approach.

The AHP ranking of parameters delineates the value of each weight on the right-sizing approach to the inpatient platform (Table 12). The top 50% of cumulative AHP priorities weigths contribute 83% of the value towards right-sizing approach, specifically nurse observation (14%), nurse station location (12%), efficiency (11.5%), inpatient beds (10%), Safety (9.3%), Patient centeredness (6.8%), access to ICU (5.5%), zoning, (4.3%), medical supply (3.4%), Access to OR (3.2%). These results are depicted graphically in Figure 16, showcasing a combination chart that superimposes the individual priority weights of the parameters and there cumulative weights.

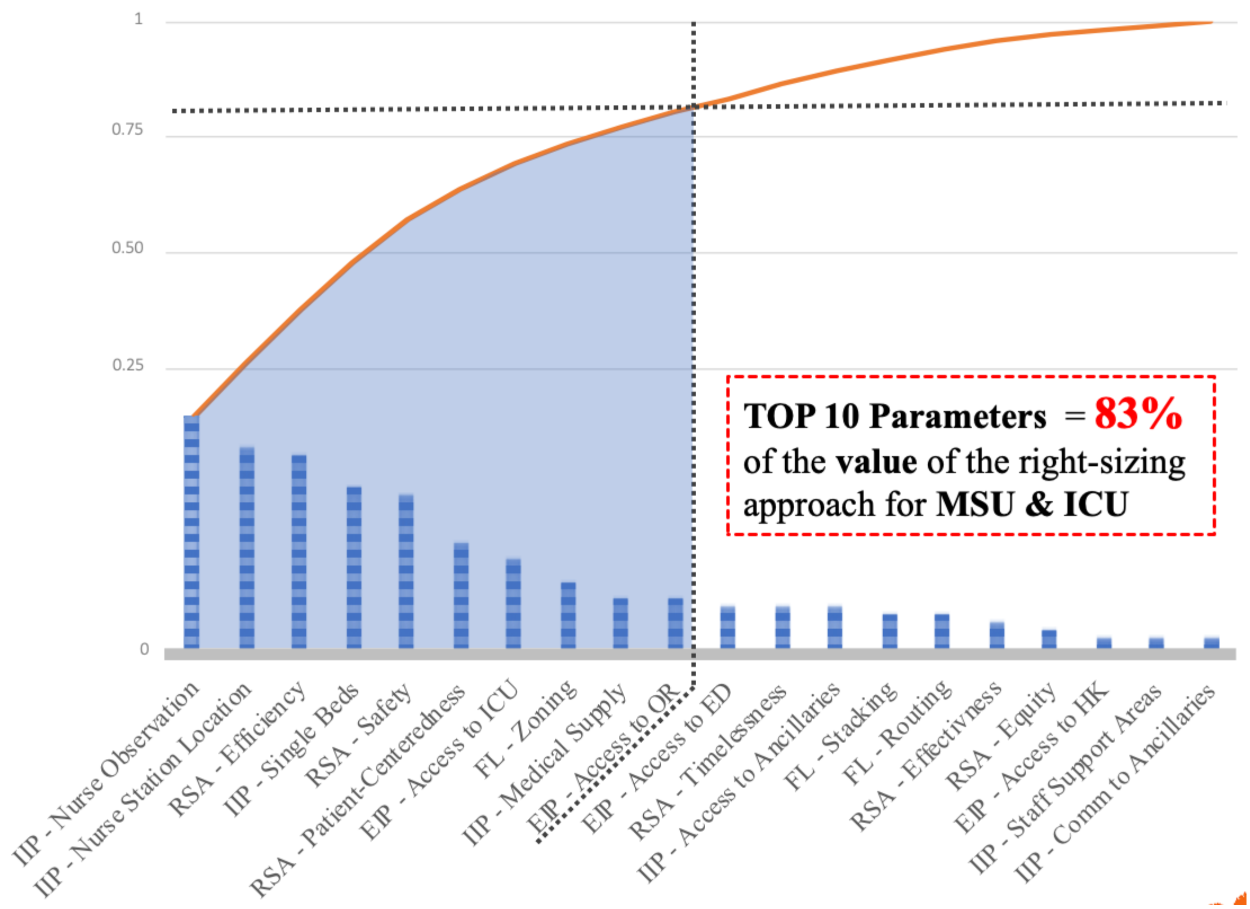
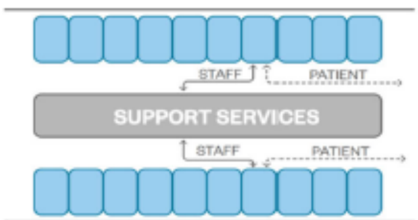
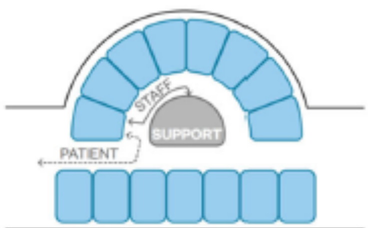
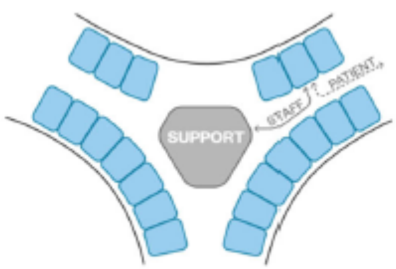


Figure 16: Final Parameter Ranking – 83% of the right-sizing value

Notably, the final ranking of parameters highlights ‘nurse observation’ and ‘nurse station location’ as the two most critical parameters in the right-sizing approach for inpatient wards. These factors play a pivotal role in patient care and operational efficiency. However, subfactors such as centralization/ decentralization of the nurse station or staff availability may influence sizing and location decisions. Literature and focus groups engagement have provided insights into these considerations, emphasizing the importance of layout decisions in optimizing nurse station location and observation efficiency. Halawa et al. (2020), diagramed three inpatient ward layouts namely, racetrack, y-shaped, and radial, (Table 11) highlighting advantages and disadvantages inclusive to nurse station location and observation. Thus, reiterating the necessary decisions for nursing parameters in the right-sizing approach of the inpatient setting.

Table 11: Inpatient Unit Layout Options

Layout Option	Description	Advantages	Disadvantages
Racetrack Layout		• Supports centralized and decentralize configurations • Enables visibility between team station and patient rooms	• Optimization of the level of centralization of support equipment and nurse stations is required
Y-shaped Layout		• Suitable for units with many patient rooms	• Low visibility from the central nurse station
Radial Layout		• Associated with shorter overall nurse walking distance • Allows high visibility from the central station to various rooms	• May contribute to more interruptions • Suitable from smaller units

Halawa et al. (2020)

Table 12: Final Common Parameter Ranking

Parameter ID	Priority Weight	Rank
P08 – Nurse Observation	0.142923647	1
P04 – Nurse Station Location	0.119977645	2
P20 - Efficiency	0.115332773	3
P06 – Inpatient Beds	0.099055597	4
P18 - Safety	0.093746977	5
P17 – Patient Centeredness	0.068094291	6
P14 – Access to ICU	0.055379296	7
P02 - Zoning	0.042707931	8
P10 – Medical Supply	0.034646705	9
P15 – Access to OR	0.032735369	10
P13 – Access to ED	0.029918658	11
P21 - Timelessness	0.029032971	12
P11 – Access to Ancillaries	0.027449294	13
P01 - Stacking	0.024790425	14
P03 - Routing	0.023919685	15
P19 - Effectiveness	0.01752056	16
P22 - Equity	0.016976969	17
P16 – Access to HK	0.008952055	18
P09 – Staff Support Areas	0.008617498	19
P12 – Comm. to Ancillaries	0.008221655	20

Parameter Correlations to Practical Application

One of the primary objectives of this study is to rank individual parameters, shedding light on their interrelationships and significance. Utilizing the Spearman correlation test, we gained a deeper understanding of how each parameter is interconnected, as depicted in Figure 17.

Analysis revealed that twenty-one out of twenty-two parameters exhibit pairwise significance with at least one other parameter, all showing statistically positive correlations. This positive relationship suggests that changes in one parameter tend to influence others positively and vice versa. A total of forty-nine significant pairwise comparisons ($p < 0.05$) were observed, accounting for 10% of the total comparison count. Notably, four parameters—Nurse Station Location, Medical Supply, Communication to Ancillaries, and Equity—had four significant pairwise correlations, while another four—Routing, Family Lounge, Effectiveness, and Efficiency—had three significant pairwise correlations.

Furthermore, the pairwise correlation offers practical insights into the application of parameters, particularly in the context of evidence-based and facility layout planning design strategies. For instance, parameters such as 'safety' align closely with evidence-based practices, focusing on infection control, patient safety, and accessibility. While safety is highly relevant in the inpatient environment, its principles are equally applicable across other departments within the healthcare facility.

The Table 13 below illustrates significant correlations among the parameters, highlighting their relevance to evidence-based and facility layout planning design strategies, particularly in MSU and ICU. These findings not only inform specific design considerations for MSU and ICU but also contribute to a holistic approach to facility design. Demonstrating the complexity of design parameters effects on healthcare design and the criticality of decision making.

Table 13: Top Parameter Pairwise Correlations

Parameter for Pairwise Correlation	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Overall Rank
		4 Significant Pairwise Comparisons			
Nurse Station Location	Single Beds	Safety[1]	Effectiveness[1]	Efficiency[1]	1
Medical Supply	Nurse Observation	Access to Ancillaries	Efficiency[1]	Timelessness[1]	9
Communication to Ancillaries	Family Lounge	Multiple Beds	Nurse Observation	Equity[1]	20
Equity	Staff Support Areas	Communication to Ancillaries	Access to Ancillaries	Timelessness[1]	17
		3 Significant Pairwise Comparisons			
Routing	Stacking[2]	Family Lounge	Effectiveness[1]	-	15
Family Lounge	Zoning[2]	Routing[2]	Communication to Ancillaries	-	N/A
Effectiveness	Routing[2]	Nurse Station Location	Efficiency[1]	-	16
Efficiency	Nurse Station Location	Medical Supply	Equity[1]	-	3

[1] Evidence-Based Design Factors – Patient Safety

[2] Facility Layout Planning Factors

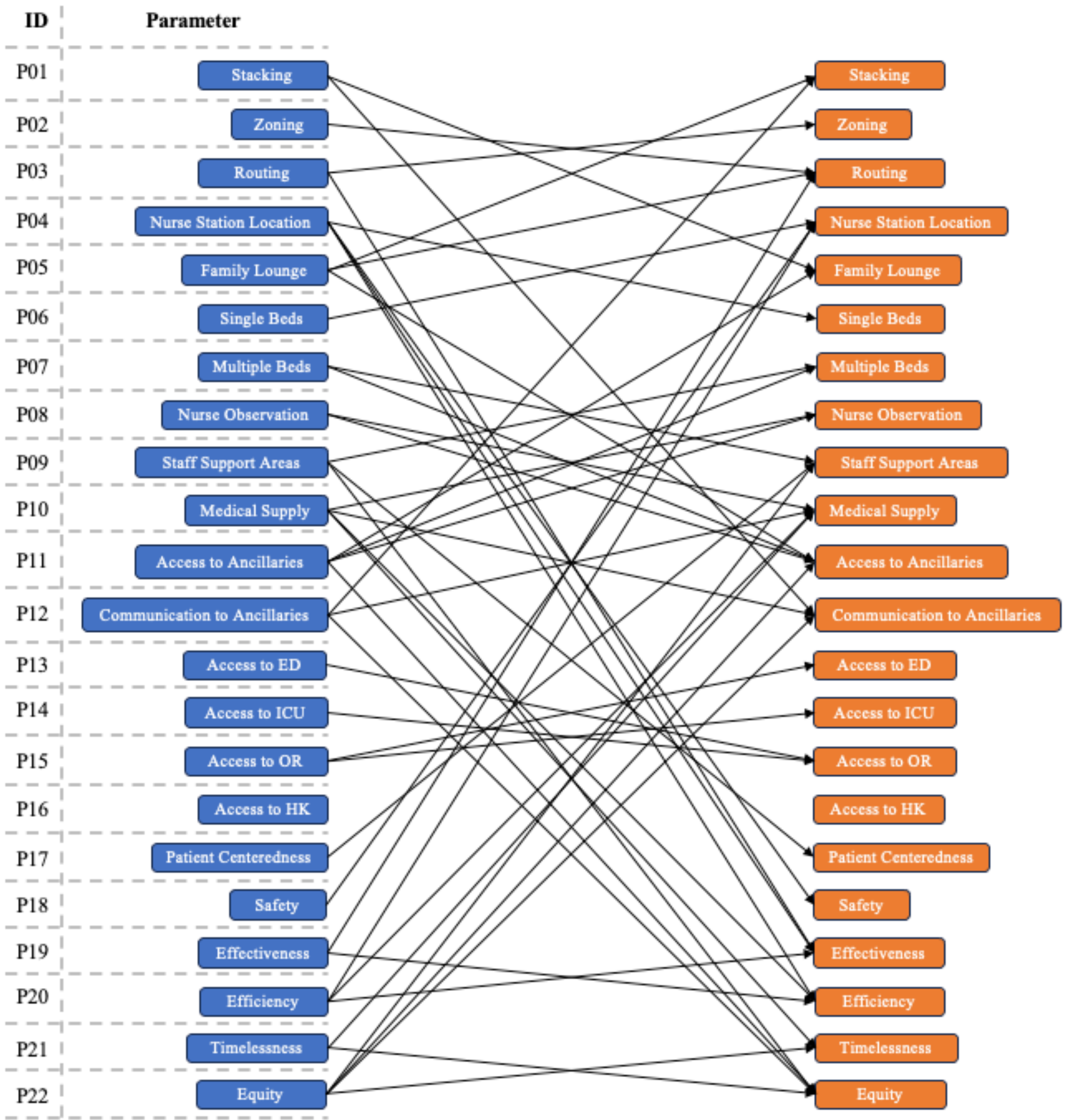


Figure 17: Significant Pairwise Correlations Between Parameters

Parameters Ranking Influence on Spatial Design Decision Making

In the context of designing MSU and ICU, several parameters hold significant influence over spatial decision-making for achieving optimal right-sizing approaches. Among these parameters, nurse observation emerges as a critical factor, pivotal for ensuring patient safety and care within these healthcare environments. The strategic placement and visibility of observation areas and nurse stations are essential spatial considerations, facilitating continuous monitoring of patient conditions and enabling prompt responses to emergencies. Complementing the aspect of observation, the location of nurse stations plays a vital role in MSU and ICU design, dictating their proximity to patient rooms, clinical areas, and support services. This positioning optimizes workflow efficiency and enhances communication among members of the healthcare team, underscoring its importance in spatial decision-making processes. Moreover, the imperative of efficiency permeates spatial design considerations, guiding decisions aimed at layout optimization, workflow streamlining, and resource allocation within MSU and ICU settings. This emphasis on efficiency seeks to minimize unnecessary movement and maximize operational effectiveness, aligning with the overarching goal of achieving right-sized healthcare environments.

Central to spatial design in MSU and ICU settings is the thoughtful allocation and arrangement of inpatient beds, which serve as fundamental elements within these healthcare environments. Decisions surrounding bed spacing, orientation, and accessibility are paramount, as they directly impact patient comfort, safety, and the delivery of efficient care. Furthermore, safety considerations permeate spatial decision-making processes, encompassing infection control measures, emergency preparedness, and risk mitigation strategies. Spatial design strategies are aimed at creating environments that prioritize patient safety, minimize hazards, and promote a culture of patient-centered care.

Patient-centeredness emerges as a guiding principle in MSU and ICU design, influencing decisions related to space allocation, environmental comfort, and patient privacy. By prioritizing patient well-being, autonomy, and dignity, spatial design endeavors to create healing environments conducive to positive patient outcomes. Additionally, access to specialized care areas, such as the ICU or operating rooms (OR), is a critical aspect of MSU and ICU design, with spatial decisions prioritizing proximity and connectivity to facilitate swift access for patients requiring specialized interventions or urgent medical procedures. Overall, a comprehensive understanding of these parameters and their influence on spatial design decision-making is imperative for achieving optimal right-sizing approaches in MSU and ICU environments.

Parameters Impact on Room, Departmental, and Facility Right-Sizing

In addition to influencing spatial design decisions within MSU and ICU, the parameters discussed earlier significantly impact room sizes, departmental sizes, and the overall size of healthcare facilities.

Firstly, the parameter of efficiency, which emphasizes the optimization of workflow and resource allocation, directly affects room sizes and departmental layouts. Design decisions aimed at improving efficiency may involve streamlining processes, reducing redundant spaces, and optimizing the utilization of available square footage. This can result in more compact room sizes, efficient departmental layouts, and ultimately, a reduction in the overall footprint of the facility.

Similarly, considerations related to safety and patient-centeredness influence room sizes and departmental layouts to ensure adequate space for infection control measures, patient privacy, and accessibility. For instance, larger room sizes may be necessary to accommodate infection prevention protocols, such as isolation rooms or negative pressure environments in response to infectious disease outbreaks. Additionally, patient-centered design principles may necessitate larger, more comfortable patient rooms and communal areas to promote healing and enhance the overall patient experience.

Furthermore, parameters like access to specialized care areas, such as the ICU or operating rooms (OR), impact departmental sizes and facility layouts. Design decisions aimed at optimizing access to these critical areas may involve strategic placement of departments in proximity to each other or the centralization of key services to minimize patient transfer times and streamline care delivery. This can result in adjustments to departmental sizes and spatial arrangements to ensure seamless transitions between different areas of the facility.

Overall, the interplay between various parameters discussed in this study significantly influences spatial design decision-making, ultimately shaping room sizes, departmental sizes, and the overall size of healthcare facilities. By carefully considering these factors and their priority and implications on spatial design, healthcare organizations can effectively achieve right-sized environments that prioritize patient safety, efficiency, and the delivery of high-quality care.

Additional Parameters Identified

The parameters for this study reflected literature and criteria, however exposure to industry practitioners revealed multiple new parameters that effect the right-sizing approach of inpatient wards, as show in Table 14.

Table 14: New Practitioner Parameters on the Right-sizing approach of Inpatient Wards

New Parameter	Parameter Impact
Adaptability/ Flexibility	Hospitals are sizing to accommodate requirements of ICU in MSU for future expansion
Nurse Station Staffing	Nurse staffing determines the size of the nurse station
MSU Observation Rooms	Multi-Patient observations rooms are relocating to MSU from the ED to solve overcrowding

While results produced new parameters these were not included in the study, however an extension of this research for incorporation will grow a better understanding of the results to MSU and ICU.

Best Practices for the Right-Sizing Approach

Metric-based best practices for right-sizing inpatient healthcare design delves into the utilization of various quantitative metrics to inform spatial allocation decisions. One crucial aspect is historical workload analysis, which involves examining past data on patient admissions, discharges, and lengths of stay to understand the facility's capacity requirements over time. By analyzing historical workload patterns, healthcare facilities can anticipate future demands and adjust spatial allocations accordingly to ensure optimal resource utilization.

Patient population demographics also play a significant role in right-sizing decisions. Understanding the demographic characteristics of the patient population, such as age distribution, medical acuity, and prevalence of specific health conditions, enables healthcare facilities to tailor their spatial designs to meet the unique needs of their patients. For instance, facilities serving an aging population may require larger rooms and specialized amenities to accommodate mobility issues and other age-related considerations.

Average daily patient load and bed days are key metrics used to assess the occupancy and utilization rates of inpatient facilities. These metrics provide insights into the frequency and duration of patient admissions, helping healthcare facilities determine the optimal number and size of patient rooms needed to accommodate varying patient volumes. By analyzing average daily patient load and bed days, healthcare organizations can identify trends, peak periods, and areas of underutilization, allowing them to optimize spatial allocations and avoid resource inefficiencies.

In addition to historical workload, patient population demographics, and occupancy metrics, other relevant metrics may include average length of stay, turnover rates, and patient acuity levels. These metrics provide valuable insights into the intensity and duration of patient care required, influencing decisions on room sizes, equipment needs, and staffing requirements. However, the application of such practices are heavily guarded by the selection of criteria utilized. Therefore best practice as applied to right-sizing of MSU and ICU must first take charge in applying metric based criteria requirements. With later refinement of the spatial optimization applying identified ranking of departmental specific parameters and constraints.

Overall, the integration of metric-based best practices, criteria from DoD and FGI, as well as the identified ranking of parameters influence of this study ensures that spatial allocations align closely with patient needs, operational efficiencies, and resource utilization goals. By leveraging metrics, historical data, and criteria influencing design decisions, a baseline in conceptual planning healthcare facilities can maximize the right-sized approach towards the allocation of space.

CHAPTER SIX

CONCLUSION

This research aims to provide valuable insights into the right-sizing approach across federal and private healthcare sectors. Disclosing an underpinning of how the right-sizing approach is executed, underscores a presence of parameters and constraints that influence the sizing of facilities, departments, and rooms. The results highlight the multifaceted nature of spatial design decision-making within healthcare settings, particularly in MSU and ICU. Through a comprehensive analysis of various parameters such as nurse observation, efficiency, safety, and patient-centeredness, it becomes evident that each factor plays a crucial role in shaping the layout, functionality, and overall size of healthcare facilities. The study's findings underscore the importance of considering a holistic approach to spatial design, one that prioritizes patient safety, operational efficiency, and the delivery of patient-centered care. By carefully balancing these factors, healthcare organizations can optimize room sizes, departmental layouts, and the overall footprint of their facilities to better meet the needs of patients and healthcare providers alike.

This comprehensive research on the right-sizing approach within the healthcare industry was guided by three primary objectives. Firstly, the study aimed to document the current methodologies employed by both the DoD and private healthcare organizations. This involved dissecting the nuances of their approaches, including codes, criteria, standards, and best practices, to understand the foundational principles driving spatial decision-making. Surveys and interviews with industry experts from both sectors provided invaluable insights to supplement this documentation process. Additionally, the involvement of a steering committee ensured that real-time feedback and input were incorporated, aligning the discovery process with the objective of comprehensively documenting the right-sizing approach in healthcare design.

Secondly, the study sought to identify and prioritize healthcare design parameters and constraints based on their impact level in ranking order. Through literature review findings and insights from case studies, a ranking hierarchy for these factors was established, with feedback loops implemented to uncover any discrepancies between the parameters and constraints encountered in DoD and private healthcare settings. This iterative approach aimed to ensure a comprehensive understanding of their influence on spatial decision-making and ultimately on the right-sizing approach.

Lastly, the comparison of DoD and private healthcare sizing outcomes served as a critical step in formulating a standardized right-sizing approach. By analyzing the ranked factors from both sectors, new programming requirements were formulated for a common set of criteria. This standardized approach, when applied to independent case studies, yielded best-case outcomes for decision-making in healthcare facility design. The comparative analysis provided valuable insights into the convergence and divergence of approaches between the DoD and private sectors, guiding the formulation of a unified methodology for achieving optimal spatial design in healthcare facilities.

Furthermore, design decision-making reveals the intricate interplay between different parameters and their impact on spatial design outcomes. Whether it be optimizing workflow efficiency, ensuring patient safety, or enhancing the patient experience, each parameter contributes to the overarching goal of achieving right-sized healthcare environments that effectively support the delivery of high-quality care.

Moving forward, it is essential for healthcare organizations to continue leveraging evidence-based design strategies and best practices in spatial planning to inform their decision-making processes. By prioritizing the integration of key parameters and constraints into spatial design considerations, healthcare facilities can strive towards creating environments that foster healing, promote efficiency, and ultimately enhance the overall quality of care provided to patients.

Limitations and Future Research

This study's methodology facilitated continuous refinement and exposure to gaps identified by industry practitioners, shedding light on areas undefined by the existing body of knowledge. The acknowledgment and collection of this information are crucial for the success of research on the unique topic of right-sizing and space allocation. Table 15 highlights gaps identified by industry professionals or observed by the author, indicating areas for future research.

Table 15: Identified Research Gaps on Right-sizing of Inpatient Wards

Knowledge Gap Source	Gap Identified	Future Research
Industry Practitioners	Parameters need specific scope definition based applicability to department	Apply departmental specific questions to each parameter
Industry Practitioners	Departments have interconnected impacts on right-sizing	Apply this study’s methodology to an entire hospital platform to refine the right-sizing approach

Industry Practitioners	Facility Layout Planning is key to the right-sizing approach	Incorporation of layout planning and its effects on the right-sizing approach
Author Observed	FGI is vague in defining SF for all spaces leaving determination up to the designer	Cross-examination of the space planning criteria from all sources is necessary to ensure right-sizing
Author Observed	Industry participation is challenging but holds the key to right-sizing knowledge	Must include robust inter-disciplinary teams dedicated to focused discussions

Industry practitioners emphasized the need for specific scope definition for parameters based on departmental applicability. Future research could involve applying department-specific questions to each parameter to ensure comprehensive coverage and relevance. Additionally, practitioners highlighted the interconnected impacts of departments on right-sizing, suggesting that the study's methodology be applied to an entire hospital platform to refine the right-sizing approach further.

Furthermore, industry practitioners emphasized the importance of FLP in the right-sizing approach. Future research could explore the incorporation of layout planning and its effects on the right-sizing approach to optimize spatial design decisions comprehensively.

The author observed that the FGI provides vague definitions for square footage for all spaces, leaving determination up to the designer. Thus, future research could involve cross-examination of space planning criteria from various sources to ensure accurate and standardized right-sizing practices.

Moreover, the challenge of industry participation was noted, highlighting the need for robust interdisciplinary teams dedicated to focused discussions. Future research should focus on establishing such teams to enhance knowledge sharing and collaboration in the field of right-sizing.

Additionally, this study was limited to interpreting survey responses from industry practitioners regarding inpatient services, and the application of criteria for space allocation was based solely on the Department of Defense (DoD) and FGI standards. Future research should collect parameters and constraints for other departments, such as surgical departments (OR), ancillaries, specialty clinics, and the emergency department (ED), to develop a comprehensive understanding of right-sizing across the entire healthcare facility.

Expanding the methodology to encompass departmental characteristics and conducting a robust cross-analysis to achieve holistic facility right-sizing is imperative for future research. Furthermore, future studies should consider the categorical size of the platform, incorporating comparative case studies to refine the standardized need for right-sizing based on the size and complexity of healthcare facilities. This will enable a better understanding of parameter ranking application and its influence on facility design in the conceptual planning stage to proceed in applying the dynamic characteristics of spatial optimization.

APPENDICES

APPENDIX A

5.1. INPUT DATA STATEMENTS. Input Data Statements are based on questions about Workload (W), Mission (M), Staffing (S) and Miscellaneous (Misc) information.

1. How many ICU / CCU beds are projected? (W)
    a. How many ICU / CCU Airborne Infection Isolation (AII) Bedrooms, greater than one, are authorized per the MTFs Infection Control Risk Assessment (ICRA)? (W)

    b. Are Anterooms for the ICU / CCU Airborne Infection Isolation (AII) ICU / CCU Bedrooms authorized per the MTFs Infection Control Risk Assessment (ICRA)? (M)
2. How many ICU / CCU Protective Environment (PE) Bedrooms are authorized per the MTFs Infection Control Risk Assessment (ICRA)? (W)
3. How many ICU / CCU Acuity Adaptable Bedrooms are authorized? (W)
4. Are Caregiver Workstations for the ICU / CCU Patient Care Area authorized? (M)
5. Is a Monitoring Station for the ICU /CCU Patient Care Area authorized? (M)
6. Is a Point-of-Care Laboratory for the ICU / CCU Support authorized? (M)
7. Is a Satellite Pharmacy for the ICU / CCU Support authorized? (M)
8. Is Decentralized Food Tray Rethermalization for the ICU / CCU Support authorized? (M)
9. How many ICU / CCU FTE positions are authorized for the ICU / CCU? (S)
    a. How many ICU / CCU FTE positions are authorized to have a private office in ICU / CCU Staff and Administration? (S)
    b. How many ICU / CCU FTE positions are authorized to have a shared office in ICU / CCU Staff and Administration? (S)
    c. How many ICU / CCU FTE positions are authorized to have a cubicle in ICU / CCU Staff and Administration? (S)
    d. How many ICU / CCU Male FTE positions are working on peak shift? (S)
    e. How many ICU / CCU Female FTE positions are working on peak shift? (S)
    f. How many ICU / CCU Respiratory Therapist FTE positions are authorized? (S)
10. Is Sub-Waiting for ICU / CCU Staff and Administration authorized?(Misc)
11. Is a Conference Room for ICU / CCU Staff and Administration authorized? (Misc)
12. Are Staff Toilet /Showers for ICU / CCU Staff and Administration authorized? (Misc)
13. Is a Scrubs Distribution Room in ICU / CCU Staff and Administration authorized? (Misc)
14. Is an ICU / CCU Graduate Medical Education (GME) / Training Program authorized? (M)
    a. How many ICU / CCU Resident and Student FTE positions are authorized? (S)

APPENDIX B

Right-sizing Approach Survey – Industry

(IRB2024-0170)

Introduction

The following questions are to help understand a little more about you. The information is very important to help decipher the data. Please know that your information will be protected by our research, and we will not reach out directly unless you agree to such terms.

Background

This survey will be used to collect data from the industry to supplement research at Clemson University. The specific the collect information will inform Mr. Johnathan Anspach's thesis, titled "The Analysis of the Right-Sizing Approach to Healthcare Space Allocation". The focus of the study is set in the pre-planning or early design phases with an emphasis on NEW inpatient and outpatient ambulatory hospital platforms. Thus, questions in this survey will include associations to inpatient, outpatient, and ancillary services.

All information collected in part to this survey will be protected by Clemson University and state regulations. All information received will be deidentified and/or aggregated to protect all participants interests.

Please provide your name and organization.

____

Please provide your contact information (email and phone number).

____

How long have you been associated with healthcare industry?

- ○ 0 - 5 years
- ○ 6 - 10 years
- ○ 11 - 15 years
- ○ 15 - 20 years
- ○ 20+ years

During your organizations pre-planning processes, what regulatory criteria are applicable to determine the functional programming size? (Select ALL that apply)

- ☐ DoD (MHS) Space Planning Criteria
- ☐ VA Space Planning Criteria
- ☐ FGI
- ☐ Internal Space Planning Criteria
- ☐ The Joint Commission
- ☐ Other/ Unknown ________________________

We care about the quality of our survey data. For us to obtain the accurate measures of your selections, it is important that you provide the most thoughtful answers to this survey.

Do you commit to providing thoughtful answers to this survey?

- ◯ I can't promise either way
- ◯ Yes, I will
- ◯ No, I will not

Do you agree to be contacted by the researcher for collection of additional information specific to this research study?

- ◯ Yes
- ◯ No

Outpatient Department

The following questions are specific to the outpatient department

What is your organizational "exam room to provider" ratio in outpatient clinics?

- ◯ 1 to 1
- ◯ 2 to 1
- ◯ 3 to 1
- ◯ 4 to 1
- ◯ 5 to 1
- ◯ N/A

Exam-Provider offices are the preferred method in hospital design.

- ○ Strongly agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Strongly disagree

Historical workload data is used to determine the total departmental exam rooms.

- ○ Strongly Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Strongly disagree

Patient population is a major factor in the right-sizing approach.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

A single outpatient primary care exam, on average, can accommodate how many annual patient encounters?

- ○ 1000
- ○ 1300
- ○ 1800
- ○ 2000
- ○ Other ____
- ○ N/A

What is the average time (minutes) for a single patient encounter in primary care?

- ○ 10
- ○ 20
- ○ 30
- ○ 40
- ○ other ____
- ○ N/A

What impact is virtual healthcare (Telehealth) making on traditional outpatient clinic facility sizing.

- ◯ Drastically Increased
- ◯ Somewhat Increased
- ◯ No Sizing Change
- ◯ Somewhat Decreased
- ◯ Drastically Decreased

What impact is virtual healthcare (Telehealth) making on the inpatient platform facility sizing? (Select all that apply)

- ☐ Reducing the size as more freestanding clinic are being built
- ☐ Increasing the size as more administrative space is necessary to accommodate Telehealth
- ☐ little change overall facility size
- ☐ Other Impacts ________________

The impact to Emergency Department (ED) size has decreased with the increased build out of freestanding EDs.

- ◯ True
- ◯ False

To enhance staff collaboration a common use of large open areas known as "bullpens" are allocated. What is the typical NSF allocated for each staff member?

- 35
- 45
- 55
- 65
- 100
- Not Considered

<u>Inpatient Departments</u>
(MSU, ICU, L&D)
The following questions are specific to inpatient departments

In the right-sizing approach for hospital design, what is the impact of zoning? (0 having the least impact and 10 having the highest impact)

	Impact on right-sizing approach
	0 1 2 3 4 5 6 7 8 9 10
Zoning	

In the right-sizing approach for hospital design, what is the impact of stacking? (0 having the least impact and 10 having the highest impact)

Impact on right-sizing approach

0 1 2 3 4 5 6 7 8 9 10

Stacking	

In the right-sizing approach for hospital design, what is the impact of routing? (0 having the least impact and 10 having the highest impact)

	Impact on right-sizing approach
	0 1 2 3 4 5 6 7 8 9 10
Routing	

Please identify the impact of the below inter-departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)

	Impact on the right-sizing approach
	0 1 2 3 4 5 6 7 8 9 10

Nurse Station Location	
Family Lounge/ Area of Respite	
Single Occupancy Bedrooms	
Multiple Occupancy Bedrooms	
Nurse to Patient Visual Observation	
Staff Support Areas	
Medical Supply Storage Location	
Communication to the Pharmacy/ Lab	

Please identify the impact of the below external departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)

	Impact on the right-sizing approach 0 1 2 3 4 5 6 7 8 9 10
Easy Access to Ancillary Departments (Lab, Radiology, Pharmacy)	
Easy Access from the Emergency Department	
Easy Access to the ICU	
Easy Access to Surgical Units (OR)	
Easy Access to House Keeping	

Nurse station sizing and placement is a major constraint to inpatient right-sizing.

- ◯ Strongly disagree
- ◯ Somewhat disagree
- ◯ Neither agree nor disagree
- ◯ Somewhat agree
- ◯ Strongly agree

Nurse station should be decentralized in the inpatient ward for maximum patient interaction.

- ◯ Strongly disagree
- ◯ Somewhat disagree
- ◯ Neither agree nor disagree
- ◯ Somewhat agree
- ◯ Strongly agree

Nurse station should be centralized for balanced patient and staff interactions.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

A single occupancy inpatient bedroom is typically 250SF?

- ○ True
- ○ False

Multiple occupancy inpatient bedrooms are typically sized to 100 NSF per licensed bed?

- ○ True
- ○ False

What is the minimum SF of a single occupant medical surgical unit licenses bedroom with attached toilet/ shower?

- ○ 100 - 150 SF
- ○ 151 - 200 SF
- ○ 201 - 250 SF
- ○ 251 - 300 SF
- ○ Other ____

Modern healthcare operations and design are limited to dual occupancy licensed beds based on factors such as infection control and family privacy?

- ○ True
- ○ False

"Step Down" units are for flexibility/ adaptability bedrooms that care for patient too acute for medical surgical unit, alleviating constrained critical care unit capacity. The incorporation of the "step down" unit model is not in addition to total licensed bed capacity of MSU and ICU, but a right-sizing approach to solve operational patient flow.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

"Step Down" units bedrooms are larger than typical single patient medical surgical licensed beds. What is the increased GSF to accommodate the patient care need in this room in comparison to the typical MSU room size?

- ○ 0
- ○ 25
- ○ 50
- ○ 75
- ○ 100
- ○ Other ____

What is the typical size range (SF) of the critical care unit licensed bedroom?

- ○ 200 - 250 SF
- ○ 300 - 350 SF
- ○ 400 - 450 SF
- ○ 500 - 550 SF
- ○ Other ____

What is the typical range size (SF) of the LDRP room?

- ◯ 200 - 300 SF
- ◯ 300 - 400 SF
- ◯ 400 - 500 SF
- ◯ 500 - 600 SF
- ◯ Other ____

The LDRP model is preferred (Same room for labor, delivery, and postpartum recovery) in the right-sizing approach rather than the traditional method of separating labor/delivery and recovery of a patient.

- ◯ Strongly disagree
- ◯ Somewhat disagree
- ◯ Neither agree nor disagree
- ◯ Somewhat agree
- ◯ Strongly agree

When design with the all-encompassing operations of the LDRP model, the right-sizing approach reduces the overall net department SF.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

Surgical Units (OR)
The following questions are specific to the surgical units

General and specialty ORs are driven by workload to determine the number of rooms in the right-sizing approach.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

Utilization factors (displayed in percentage) are the amount of time the room is in operation for services. Sub-specialty ORs (urology, endoscopy, etc.) in the right-sizing approach have a design utilization factor of?

- ◯ 60
- ◯ 70
- ◯ 80
- ◯ 90
- ◯ Other ____

The room size range (SF) of general and urology/ cystoscopy OR is?

- ◯ 500 - 600 SF
- ◯ 600 - 700 SF
- ◯ 700 - 800 SF
- ◯ 800 - 900 SF
- ◯ Other ____

The room size range of cardiothoracic, neurosurgical, and orthopedic OR is?

◯ 800 - 900 SF

◯ 900 - 1000 SF

◯ 1000 - 1100 SF

◯ 1100 - 1200 SF

◯ Other ____

The size range (SF) of a combined conventional surgical suite and medical imaging (Hybrid OR) including all associated suite support spaces (control room, equipment room, system component room, etc.) is?

◯ 1400 - 1500

◯ 1500 -1600

◯ 1600 - 1700

◯ 1700 - 1800

◯ 1800 - 1900

◯ other ____

Sub-specialty procedure rooms (urology, endoscopy, etc.) for less invasive procedures that require patient sedation, are best integrate as part of the OR suite in the right-sizing approach.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

Technological advancements in surgical procedures are a major constraint in the right-sizing approach to OR suite sizes.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

A c-section OR is sized similarly to a general OR in the right-sizing approach.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

C-section ORs are part of the departmental right-sizing approach to L&D and not the main hospital OR suite.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

<u>Ancillary Departments</u>
(Lab, Radiology, Pharmacy)
The following questions are specific to the ancillary departments

Page Break

The right-sizing approach to laboratory is based on equipment placement and functional process.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

Is there a "rule of thumb" for right-sizing rooms in laboratory?

- Yes
- No

A major contributor to right-sizing a pharmacy is the number of annual scripts.

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

The right-sizing approach to ancillary waiting areas is based on wait times and in-person visits.

○ Strongly disagree

○ Somewhat disagree

○ Neither agree nor disagree

○ Somewhat agree

○ Strongly agree

The allocated NSF range for each person in ancillary waiting is?

○ 3 - 5

○ 5 - 7

○ 7 - 9

○ 9 - 12

○ Other ____

<u>Miscellaneous Questions</u>

In pre-planning and early design, grossing factors are used to calculate departmental gross SF and building gross SF.

- ◯ Strongly disagree
- ◯ Somewhat disagree
- ◯ Neither agree nor disagree
- ◯ Somewhat agree
- ◯ Strongly agree

What grossing factor is used in the right-sizing approach for BGSF in conceptual design?

- ◯ 1.35
- ◯ 1.36
- ◯ 1.37
- ◯ 1.38
- ◯ Other ____

What is the average cost ($) per SF of new hospital construction?

	200 330 460 590 720 850 980 1110 1240 1370 1500
Cost / SF	

Research has show that patient safety plays a vital role in right-sizing approach decisions. Rate each of the below factors impacting these right-sizing decisions. (0 having the least impact and 10 having the highest impact)

	Impact of right-sizing approach decisions 0 1 2 3 4 5 6 7 8 9 10
Patient Centeredness (ex. variable-acuity rooms)	
Safety (ex. infection control)	
Effectiveness (ex. natural daylight)	
Efficiency (ex. standardize room layout)	
Timeliness (ex. staff flow in rapid response)	
Equity (ex. ensuring size meets diverse needs of patients)	

Is your organization willing to share data from previous projects to supplement this research?

○ Yes

○ No

APPENDIX C

Table 16: MSU Case Study - Functional Program Criteria Comparison

MSU Functional Program	DoD Criteria[1]	Private Criteria (FGI)[2]
Waiting	120 NSF	No SF Identified
Private Patient Bedroom	262 NSF	250 SF Clear Area
Multi-Patient Bedroom	348 NSF	Not Permitted without Hospital AHJ Approval
Observation Bedroom (4 Patients)	451 NSF	Not provided in criteria
Nurse Station	265 NSF	No SF Identified
Staff Work Area (Doctor)	240 NSF	No SF Identified
Offices	100 NSF	No SF Identified
Inpatient Physical Therapy (Shared MSU/ ICU)	540 NSF	No SF Identified; Shared between units
Alcove, Crash Cart	15 NSF	No SF Identified
Clean Utility Room	100 NSF	No SF Identified
Nourishment Center	80 NSF	No SF Identified
Staff Charting	296 NSF	No SF Identified
Medication Room	120 NSF	No SF Identified
Family Lounge (Shared)	200 NSF	No SF Identified

[1] Carr R.F., 2007

[2] FGI, 2022

Table 17: ICU Case Study - Functional Program Criteria Comparison

ICU Functional Program	DoD Criteria[1]	Private Criteria (FGI)[2]
Waiting	80 NSF	No SF Identified
Consult Room	120 NSF	No SF Identified
Private Patient Bedroom	270 NSF	250 SF Clear Area
Nurse Station	15 NSF (Decentralized – 1 nurse to 2 patients)	No SF Identified
Staff Work Area (Doctor)	180 NSF	No SF Identified
Offices	100 NSF	No SF Identified
Inpatient Physical Therapy (Shared MSU/ ICU)	540 NSF	No SF Identified; Shared between units
Alcove, Crash Cart	15 NSF	No SF Identified
Alcove, Airway Cart/ EKG	15 NSF	No SF Identified
Alcove, Blanket Warmer	15 NSF	No SF Identified
Clean Utility Room	100 NSF	No SF Identified
Supply Room	120 NSF	No SF Identified
Nourishment Center	80 NSF	No SF Identified
Staff Charting	200 NSF	No SF Identified
Medication Room	100 NSF	No SF Identified

Family Lounge (Shared)	200 NSF	No SF Identified

[1] Carr R.F., 2007

[2] FGI, 2022

APPENDIX D

Focus Group 1 Discussion

Overview

Experts from the University of Arkansas, Beijing School of Architecture, UNC Charlotte, and Clemson, with Air Force and Department of Defense experience, discussed healthcare facility planning, emphasizing cost-effective solutions, strategic advisory, and project management. They explored evidence-based planning, the impact of COVID-19, and the importance of licensed staffed beds, highlighting the use of a Pearson correlation matrix and MCDA for optimization. The discussion also covered accreditation issues, budget considerations, and the practical application of statistical analysis for room sizing and design, including for dialysis and bariatric patients. The use of Kaiser Permanente and DoD software for standardization, RS means for cost estimation, and the need for updated programming software to follow trends were also noted.

Themed Discussion

1. Strategic planning, Healthcare facility, Construction management, Federal vs. private sector

A professional with a background in interior architecture from the University of Arkansas and Beijing School of Architecture discusses their role in strategic facility planning at a healthcare-focused consulting firm in Dallas, emphasizing cost-effective solutions. They outline the firm's services, including strategic advisory and project management. Another speaker, with an architecture degree from the University of North Carolina at Charlotte and studying at Clemson, shares their Air Force experience and thesis on aligning space planning practices between the Department of Defense, using Unified Facilities Criteria, and the private sector to standardize healthcare strategic planning.

2. Space allocation, Evidence based planning and design, Optimization, Inpatient bedroom

The dialogue centers on optimizing healthcare space with evidence-based planning, DoD criteria, and addressing inpatient bedroom design and the impact of unscheduled admissions. The speaker's dissertation focuses on a model for space optimization, considering COVID-19's effect on overcrowding and the necessity of licensed staffed beds for critically ill patients. They highlight the importance of proprietary information, budget issues, accreditation by the American College of Surgeons, and the use of a Pearson correlation matrix to identify significant factor relationships. The discussion also emphasizes the need for a statistical understanding to validate the model.

3. Statistical significance, Practical applications, Multi criteria decision analysis (MCDA), Analytical hierarchy method

The speaker analyzes a correlation factor's 51% significance from a two-tailed test at 0.01, emphasizing its practical application, like the relation between single beds and nurse stations, and its impact on departmental planning. They plan to use MCDA and the analytical hierarchy method for deeper analysis, aiming to refine planning through rankings based on statistical weights. The significance of variables and the importance of practical application guide the analysis aims, with a follow-up meeting for feedback on findings scheduled in over a week.

4. Healthcare facility design, Space requirements, Dialysis integration, Airborne isolation rooms

The discussion focuses on hospital room sizing for dialysis, bariatric patients, airborne isolation, and the impact of toilets, contrasting DoD's systematic criteria with private sector flexibility. It covers Kaiser Permanente's and DoD's software for facility assessment, emphasizing healthcare standardization for strategic planning and RS means for cost estimation. The dialogue highlights the need for efficient space use, research in hospital design optimization, specifically ICU and MSU units, and the importance of updating tools like programming software to keep pace with trends.

Focus Group 2 Discussion

Overview

The dialogue explores a project on right sizing and space planning, contrasting DoD and private sector approaches, and references a trauma paper related to MOMMC. It discusses employing FGI guidelines, surveys, and evidence-based design, emphasizing design trends like flexibility and sustainability. The conversation seeks feedback on the analytical hierarchy process for prioritizing design factors, including departmental and room sizes in healthcare design. It critiques the efficiency of healthcare design, mentioning software and criteria by Kaiser Permanente and the DoD, and introduces adjacency algorithms. The dialogue proposes specific research questions on efficiency and a feedback mechanism for design refinement, planning a follow-up meeting.

Themed Discussion

1. Space planning, Hospital design, Right sizing approach, Evidence-based design

The conversation covers a project analyzing right sizing and space planning, contrasting DoD and private sector methods, and referencing a trauma paper related to MOMMC. The speaker discusses using FGI guidelines and a survey to understand space planning criteria, emphasizing design trends and the importance of flexibility, wellness, and sustainability. They seek feedback from an experienced planner on their approach, mentioning evidence-based design and the analytical hierarchy process for ranking design factors. The discussion also touches on departmental and room sizes, focusing on inpatient hospital design.

2. Efficiency, Healthcare Design, Prototyping, Standardization

The dialogue focuses on healthcare design efficiency, critiquing the Facility Guidelines Institute (FGI) guidelines and discussing the use of software and criteria by Kaiser Permanente and the DoD, emphasizing adaptability and patient-centeredness. The conversation introduces the use of adjacency algorithms and the analytical hierarchy process in design criteria. It proposes specific efficiency-related questions for further research and suggests a feedback mechanism for refining design criteria. Plans for a follow-up meeting to explore these topics further are made.

Focus Group 3 Discussion

Overview

In a civilian-focused focus group, participants use RII, AHP, and Spearman's correlation to analyze survey responses for design strategies. They discuss healthcare space planning, focusing on decentralization, observation, and medical supply locations. The conversation highlights adaptability, flexibility, and future-proofing in design, with a particular emphasis on isolation rooms for infectious diseases.

Themed Discussion

1. Focus Group Session, Metrics and Evidence-Based Strategies, Space Planning and Design, Statistical Analysis and Ranking Process

In a civilian-focused focus group, participants use RII, AHP, and Spearman's correlation to analyze survey responses for design strategies. They discuss healthcare space planning, focusing on decentralization, observation, and medical supply locations. The conversation highlights adaptability, flexibility, and future-proofing in design, with a particular emphasis on isolation rooms for infectious diseases.

APPENDIX E

Hospital Case Study
(Midwestern USA – Patient Population: 50,000 – Critical Care Center)

MSU Functional Program (2 Units)	Criteria (Minimum NSF)	Room Quantity	Room Type Total SF
Waiting	120 NSF	2.25 *(Provided in increments of 16 bedrooms)*	270 NSF
Private Patient Bedroom	250 NSF	18	4,500 NSF
Multi-Patient Bedroom	348 NSF	14	4,872 NSF
Observation Bedroom (4 Patients)	451 NSF	4	1,804 NSF
Nurse Station	265 NSF	2	530
Staff Work Area (Doctor)	240 NSF	2	480 NSF
Offices	100 NSF	8	800 NSF
Inpatient Physical Therapy (Shared MSU/ ICU)	540 NSF	1	540 NSF
Alcove, Crash Cart	15 NSF	2	30 NSF
Clean Utility Room	100 NSF	2	200 NSF
Nourishment Center	80 NSF	2	160 NSF
Staff Charting	296 NSF	2	592 NSF
Medication Room	120 NSF	2	240 NSF
Family Lounge (Shared)	200 NSF	1	200 NSF

Total MSU Room SF: **15,233 NSF**

Total MSU Departmental SF: 15,233 x 1.35 = **20,565 GSF**

Hospital Case Study
(Midwestern USA – Patient Population: 50,000 – Critical Care Center)

ICU Functional Program	Criteria (Minimum NSF)	Room Quantity	Room Type Total SF
Waiting	80 NSF	1	80 NSF
Consult Room	120 NSF	1	120 NSF
Private Patient Bedroom	270 NSF	18	4,860 NSF
Nurse Station	15 NSF *(Decentralized – 1 nurse to 2 patients)*	9	135 NSF
Staff Work Area (Doctor)	180 NSF	1	180 NSF
Offices	100 NSF	2	200 NSF
Inpatient Physical Therapy (Shared MSU/ ICU)	540 NSF	0 *(Provided in MSU Functional Program)*	0 NSF
Alcove, Crash Cart	15 NSF	1	15 NSF
Alcove, Airway Cart/ EKG	15 NSF	1	15 NSF
Alcove, Blanket Warmer	15 NSF	1	15 NSF
Clean Utility Room	100 NSF	1	100 NSF
Supply Room	120 NSF	2	240 NSF
Nourishment Center	80 NSF	1	80 NSF
Staff Charting	200 NSF	1	200 NSF
Medication Room	100 NSF	1	100 NSF
Family Lounge (Shared)	200 NSF	0 *(Provided in MSU Functional Program)*	0 NSF

Total ICU Room SF: **6,340 NSF**

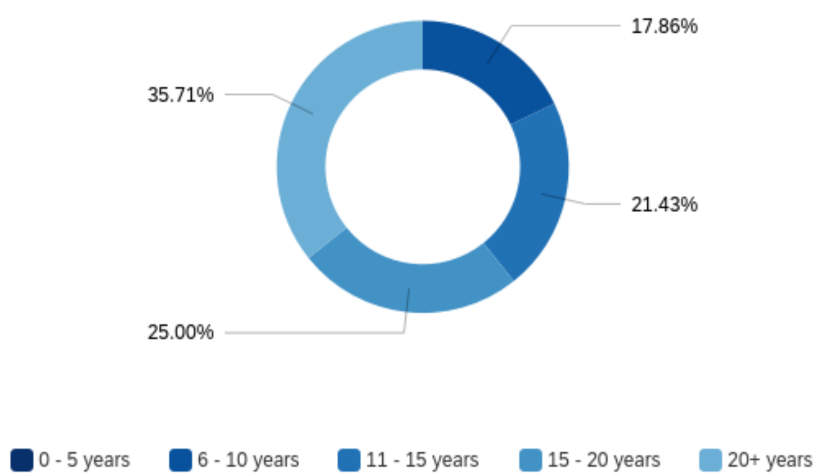
Total ICU Departmental SF: 15,233 x 1.35 = **8,559 GSF**

APPENDIX F

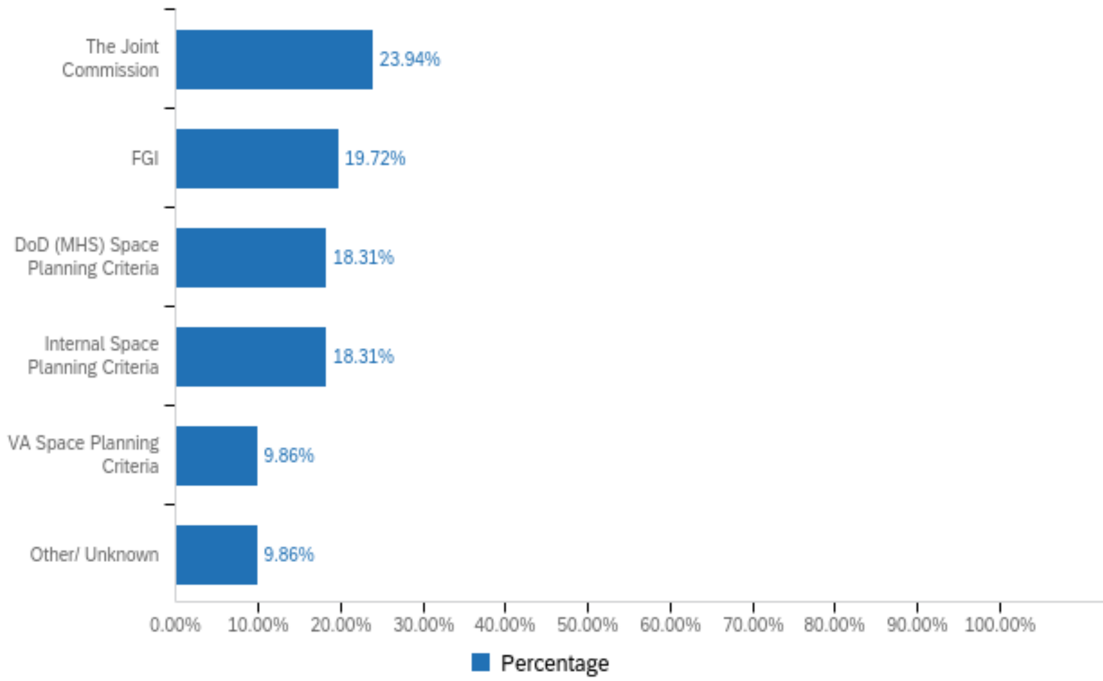
SURVEY

General Healthcare Design

Q3 - How long have you been associated with healthcare industry?

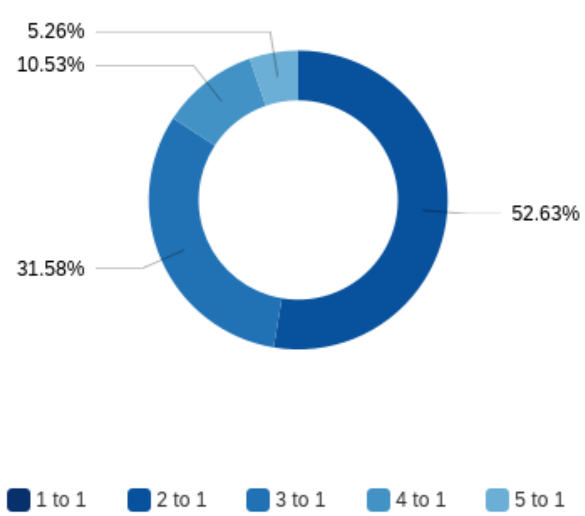


Q4 - During your organizations pre-planning processes, what regulatory criteria are applicable to determine the functional programming size? (Select ALL that apply)

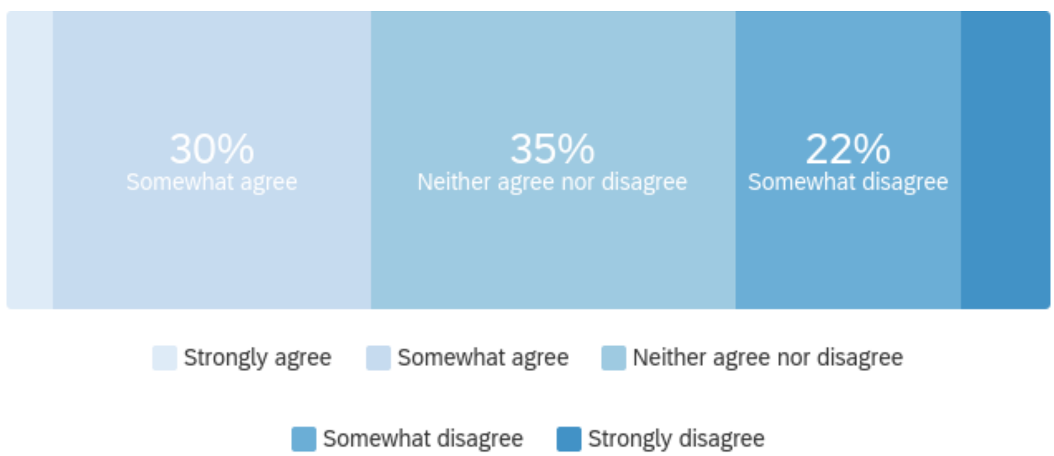


Outpatient

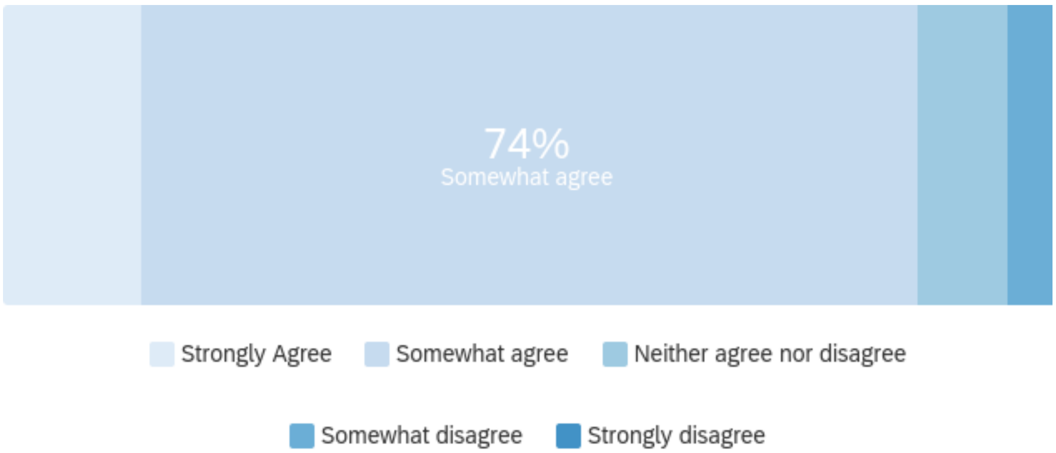
Q5 - What is your organizational "exam room to provider" ratio in outpatient clinics?



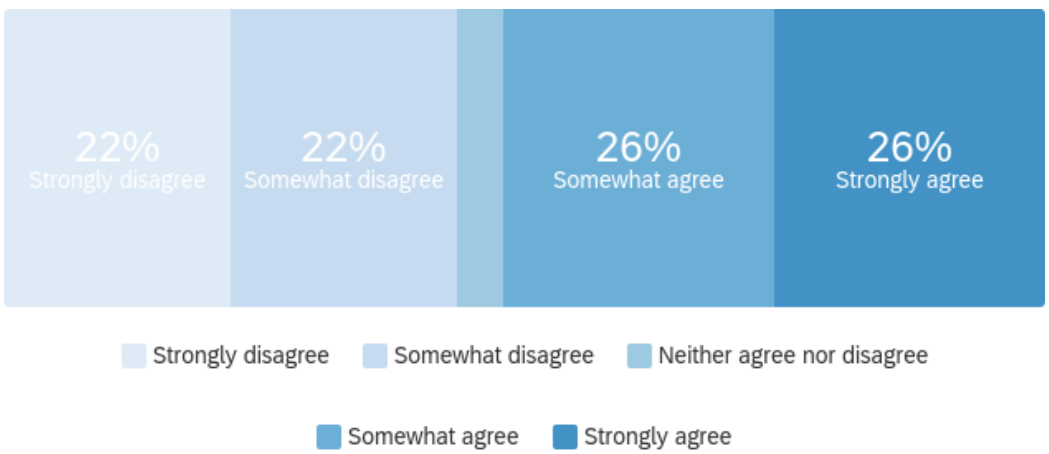
Q6 - Exam-Provider offices are the preferred method in hospital design.



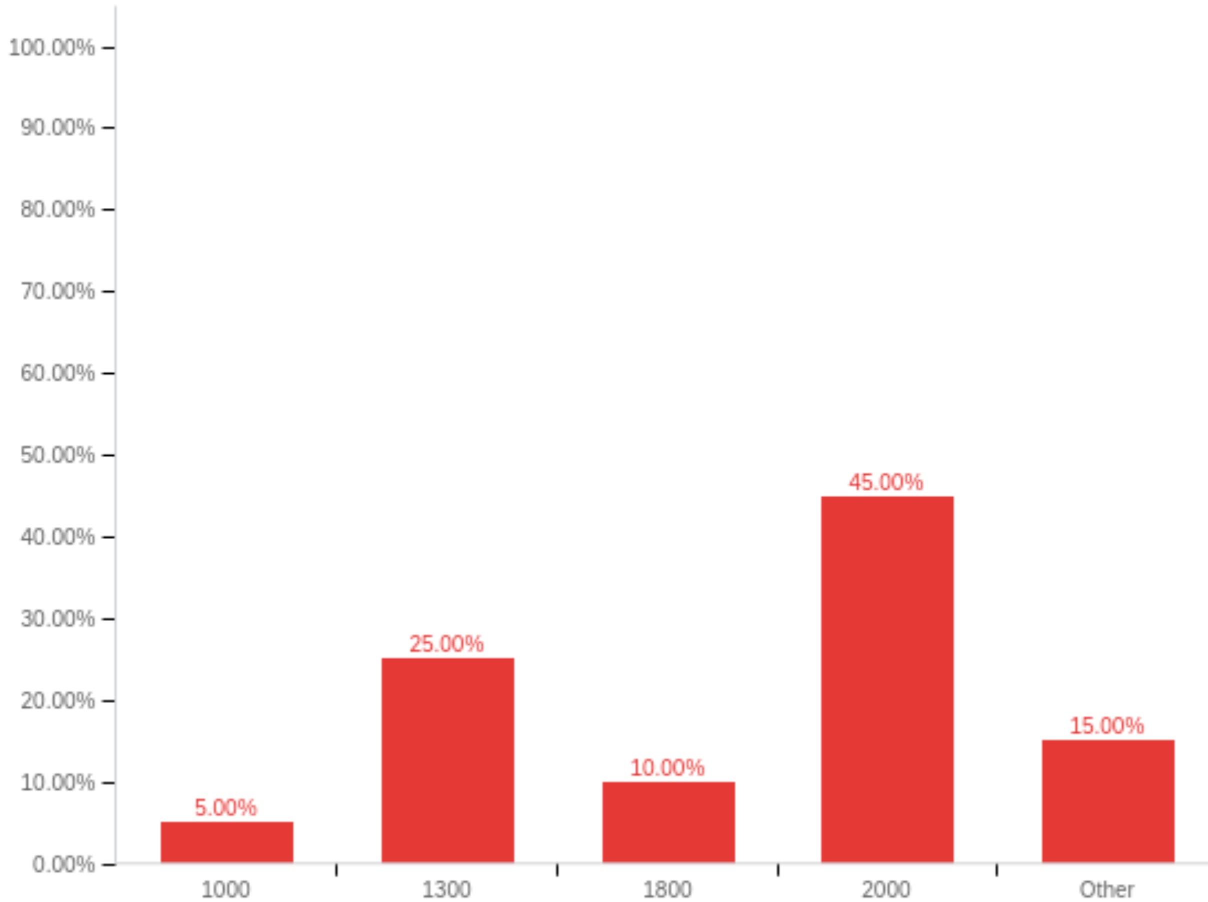
Q7 - Historical workload data is used to determine the total departmental exam rooms.



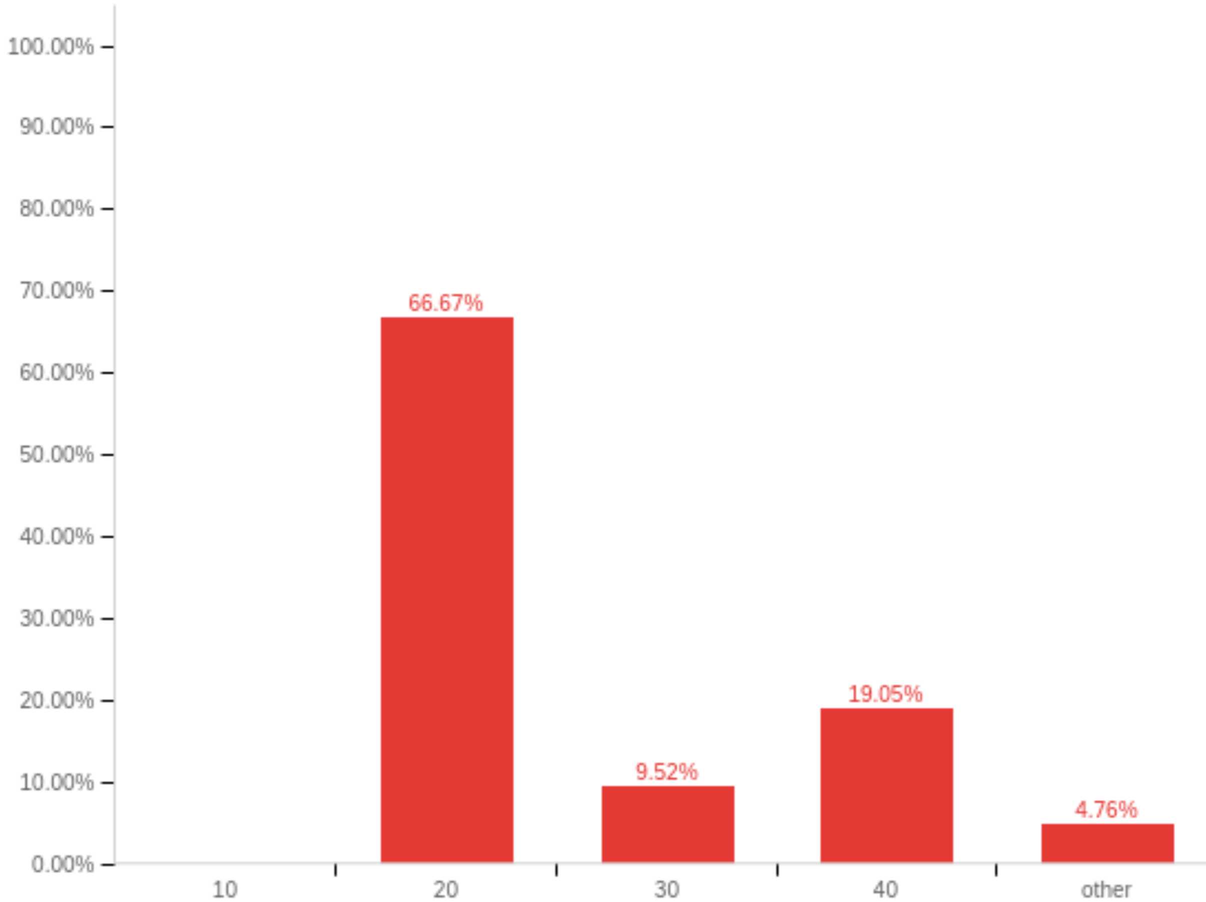
Q8 - Patient population is a major factor in the right-sizing approach.



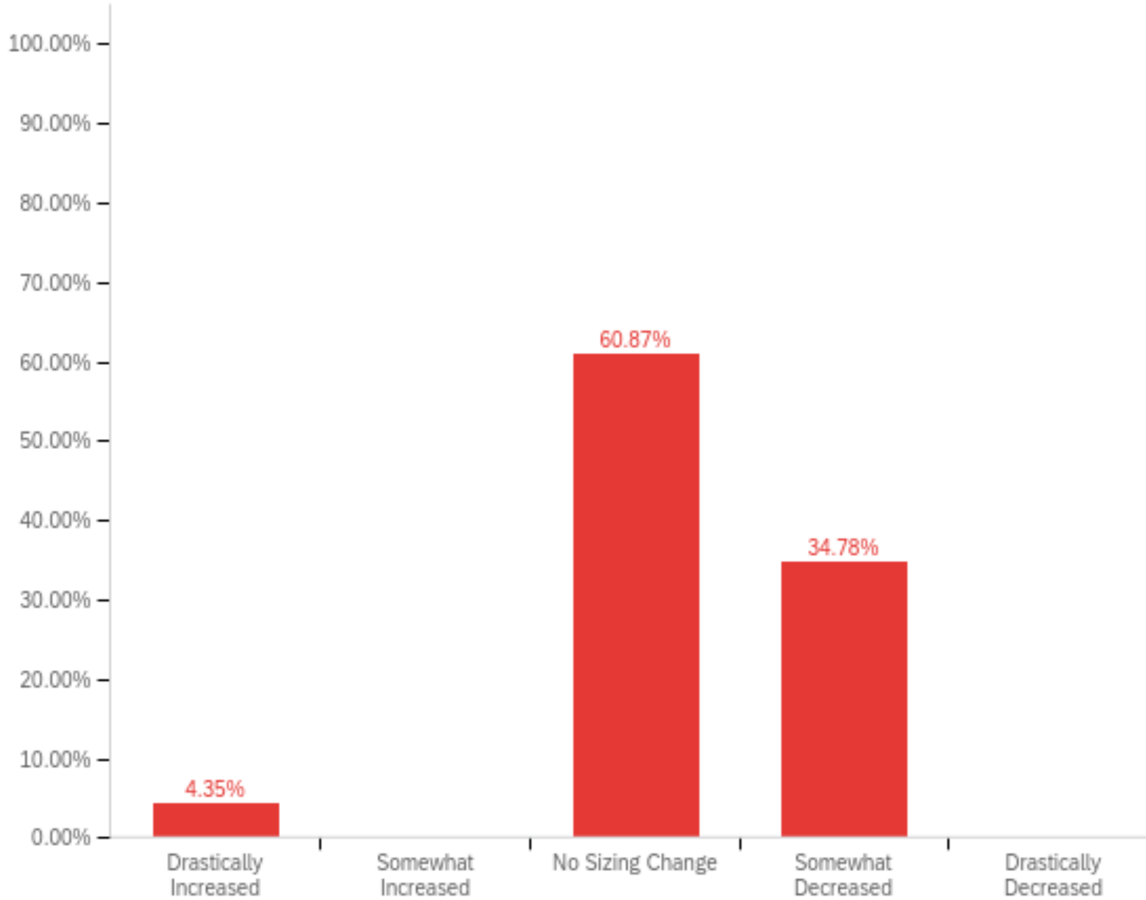
Q9 - A single outpatient primary care exam, on average, can accommodate how many annual patient encounters?



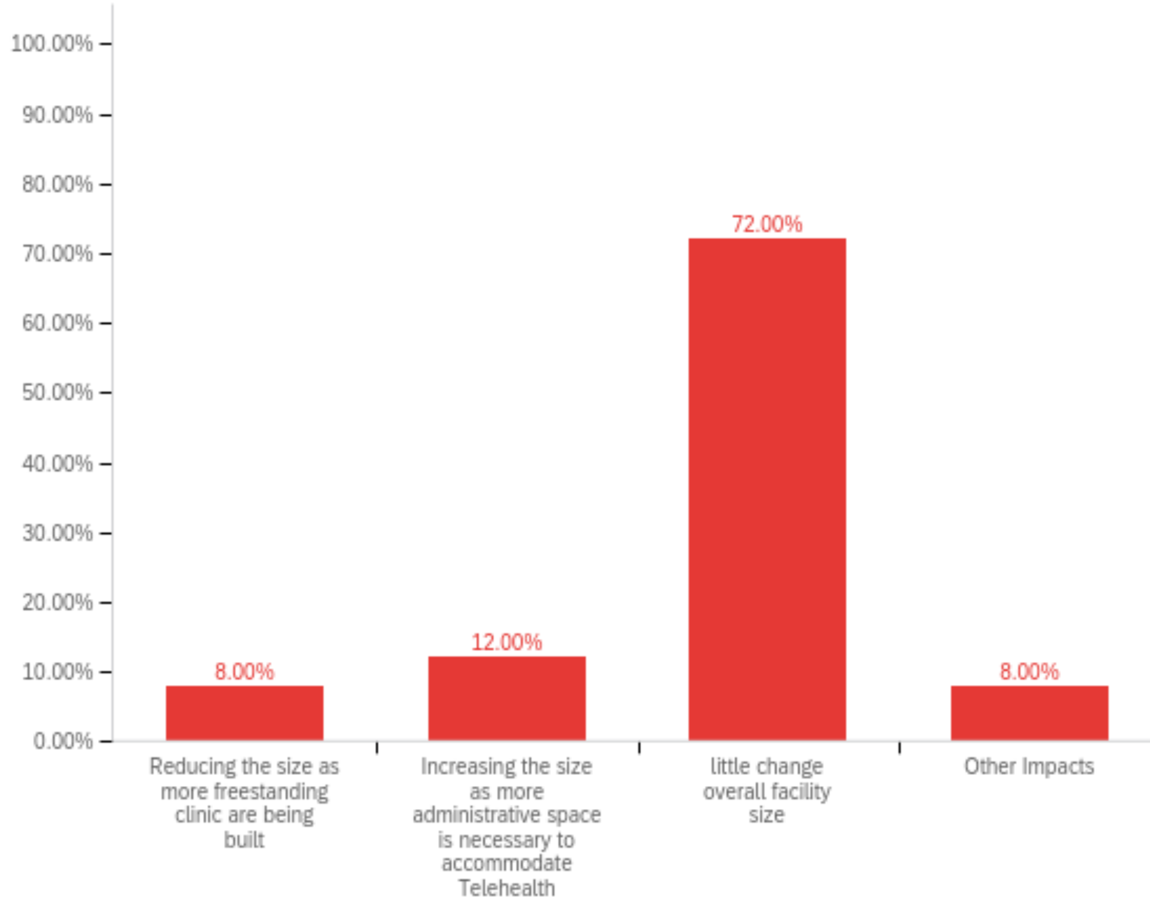
Q10 - What is the average time (minutes) for a single patient encounter in primary care?



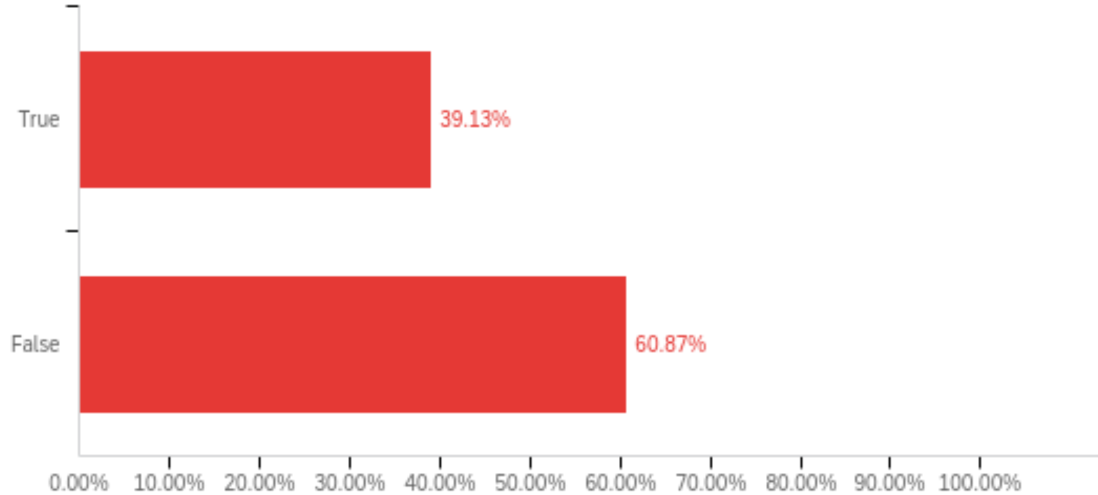
Q11 - What impact is virtual healthcare (Telehealth) making on traditional outpatient clinic facility sizing.



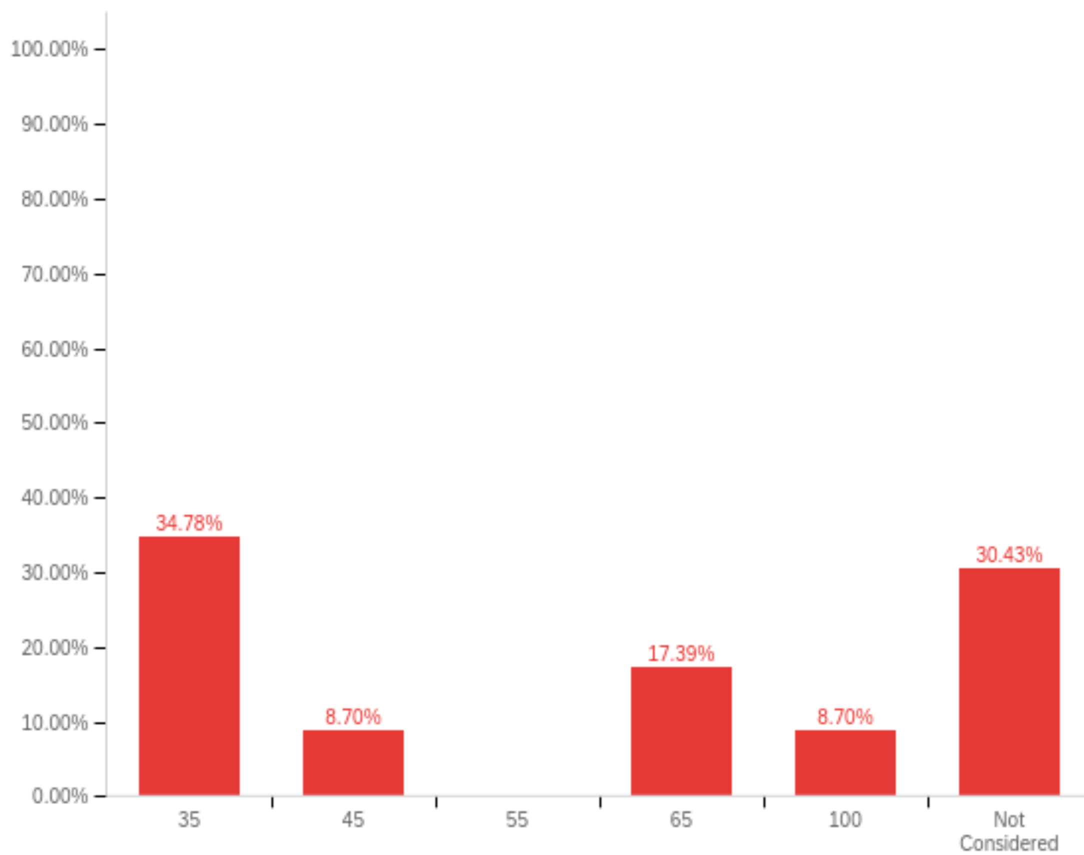
Q12 - What impact is virtual healthcare (Telehealth) making on the inpatient platform facility sizing? (Select all that apply)



Q13 - The impact to Emergency Department (ED) size has decreased with the increased build out of freestanding EDs.

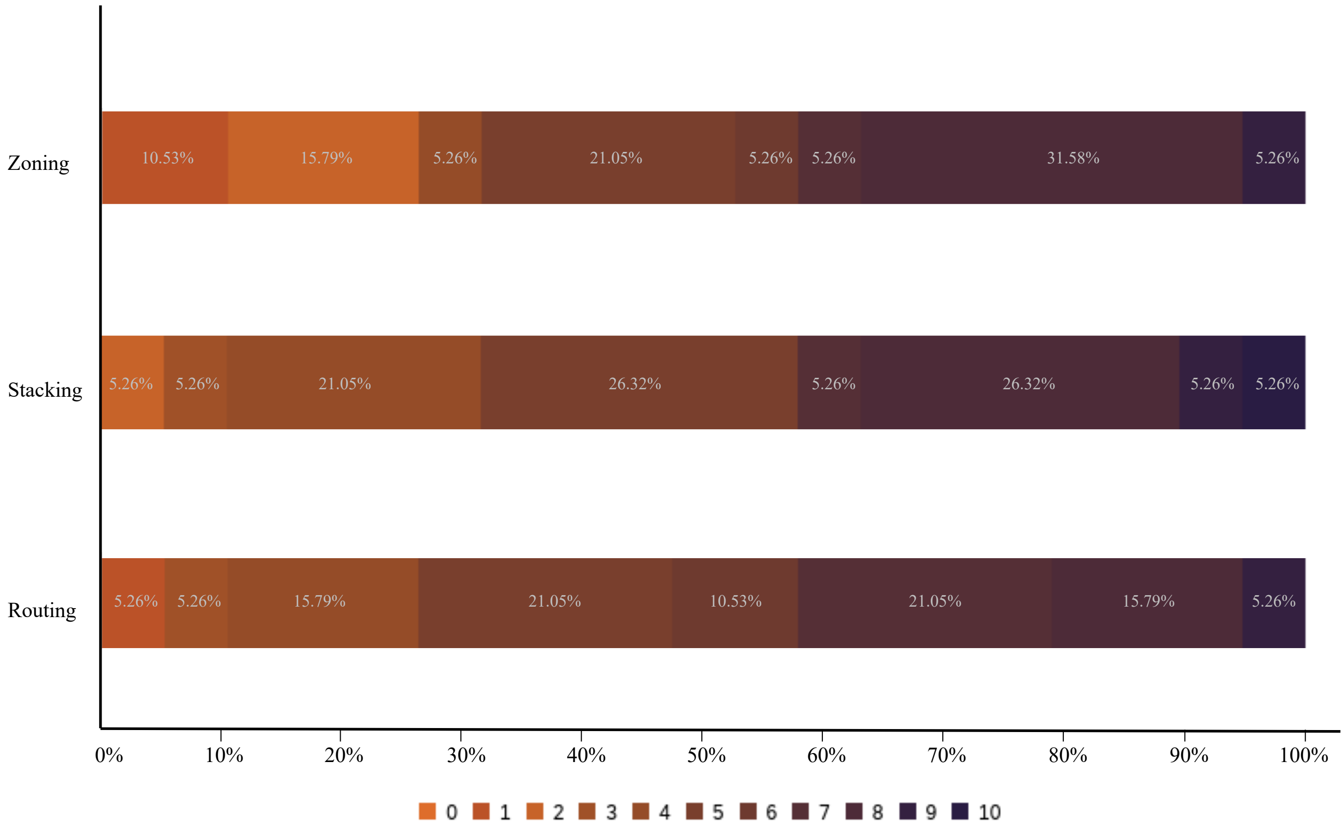


Q14 - To enhance staff collaboration a common use of large open areas known as "bullpens" are allocated. What is the typical NSF allocated for each staff member?

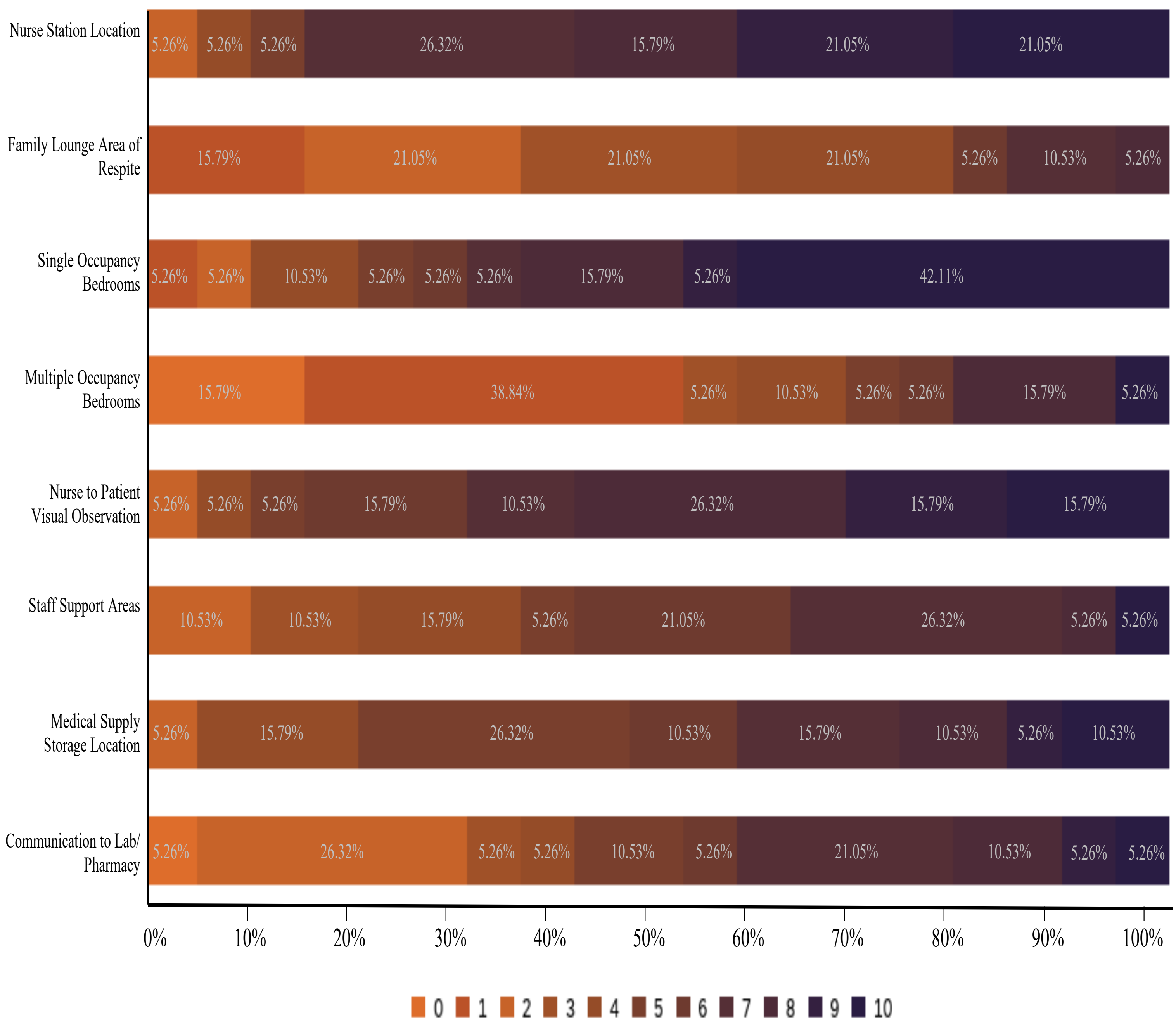


Inpatient

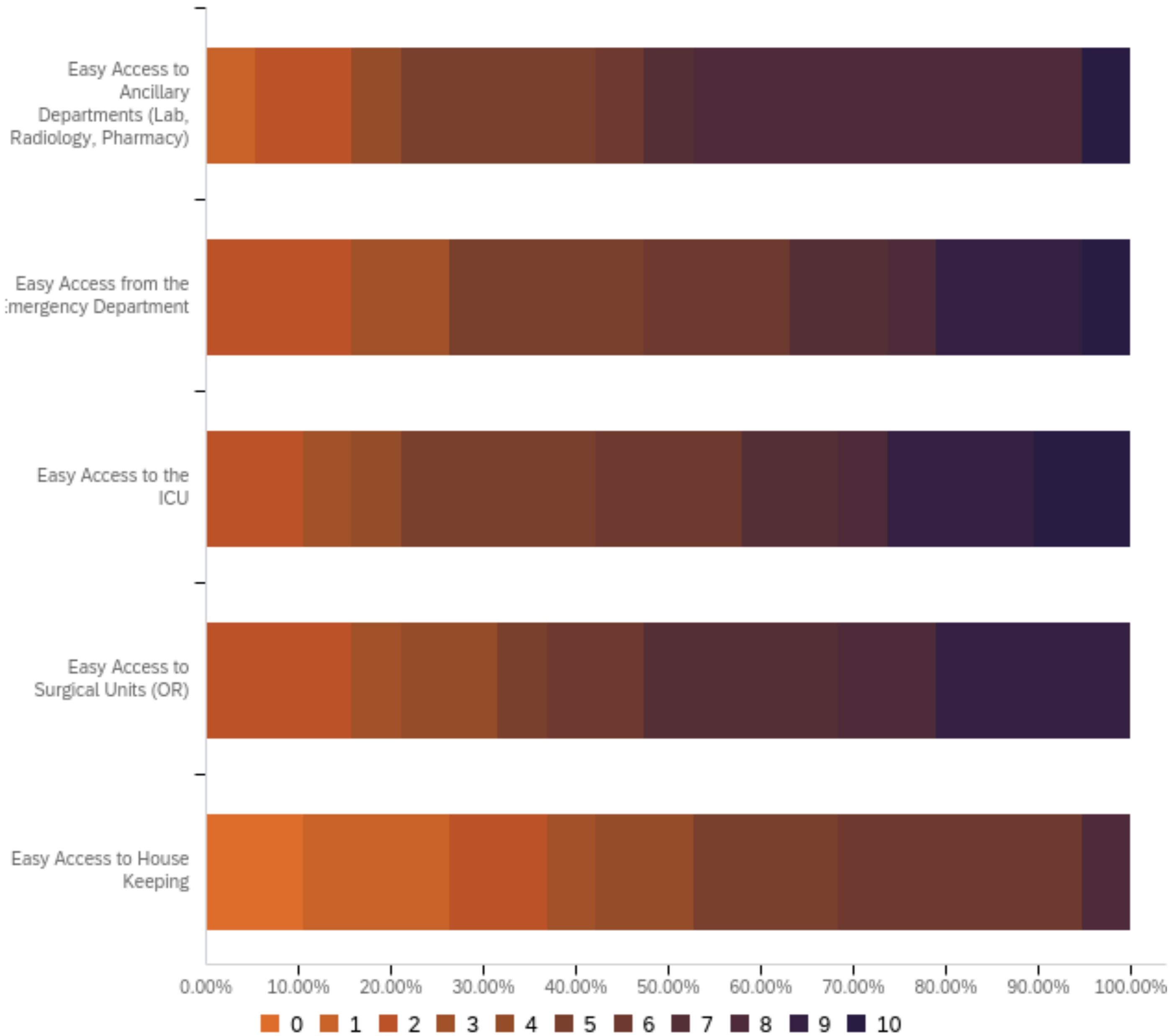
Q66 In the right-sizing approach for hospital design, what is the impact of zoning, stacking, and routing? (0 having the least impact and 10 having the highest impact)



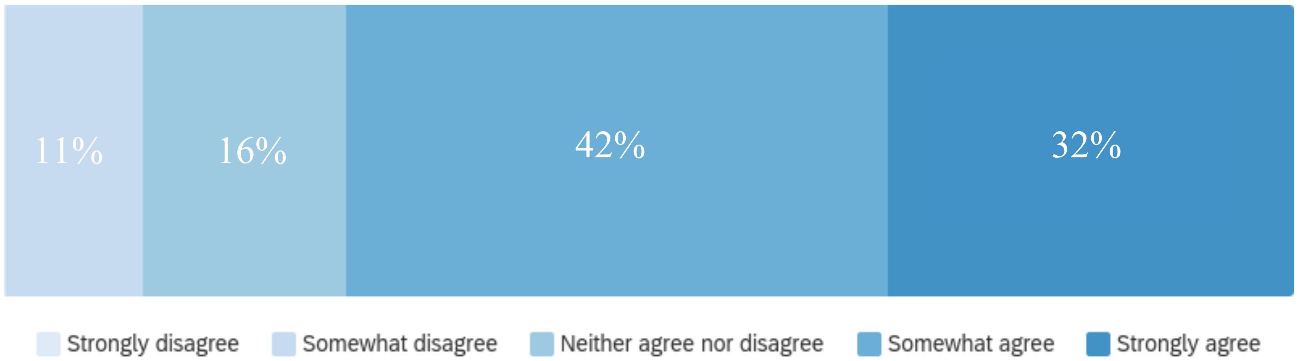
Q16 - Please identify the impact of the below inter-departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)



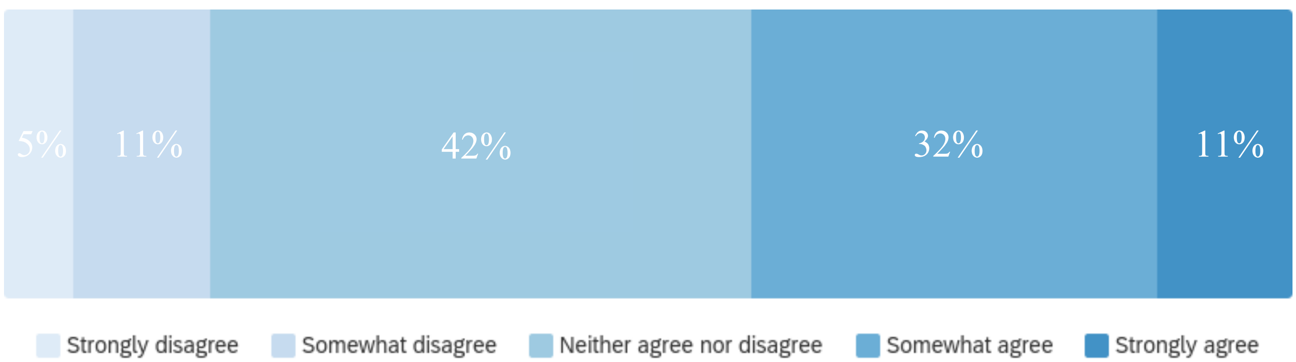
Q17 - Please identify the impact of the below external departmental factors on the right-sizing approach of inpatient wards. (0 having the least impact and 10 having the highest impact.)



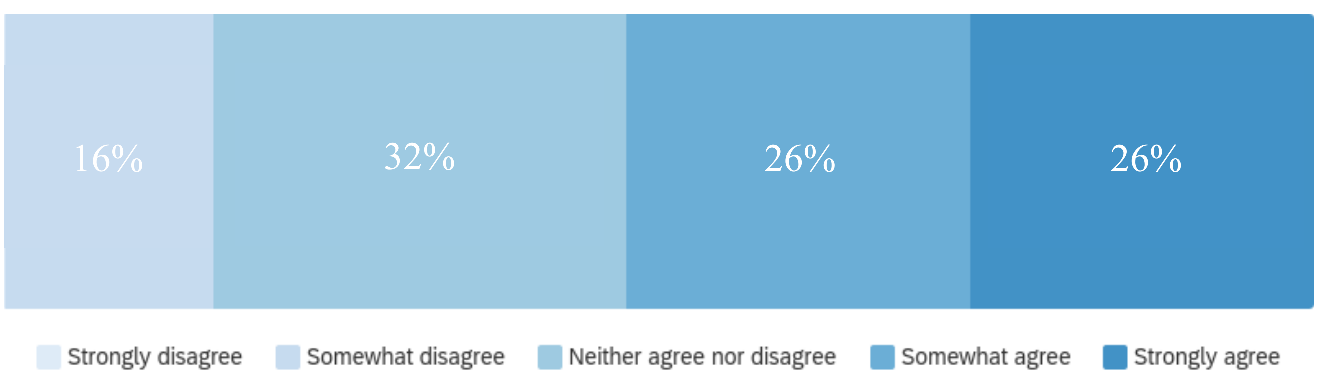
Q18 - Nurse station sizing and placement is a major constraint to inpatient right-sizing.



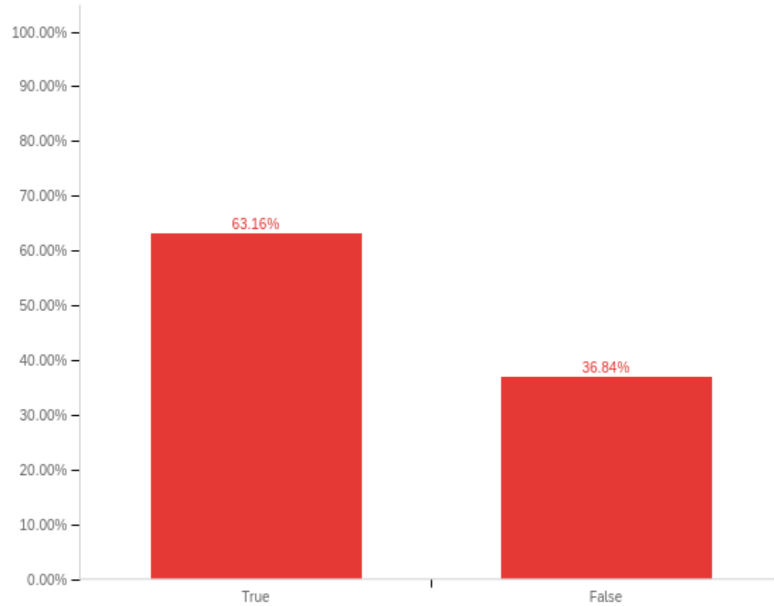
Q19 - Nurse station should be decentralized in the inpatient ward for maximum patient interaction.



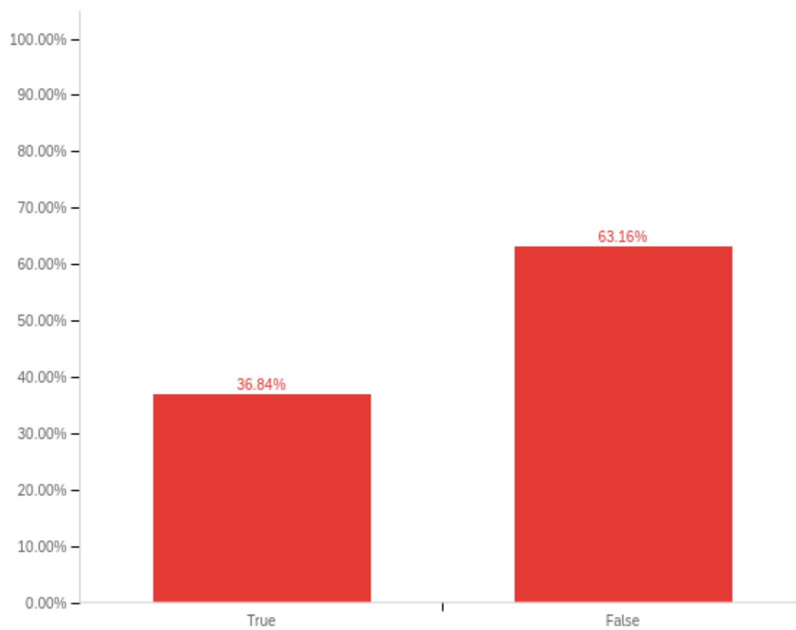
Q20 - Nurse station should be centralized for balanced patient and staff interactions.



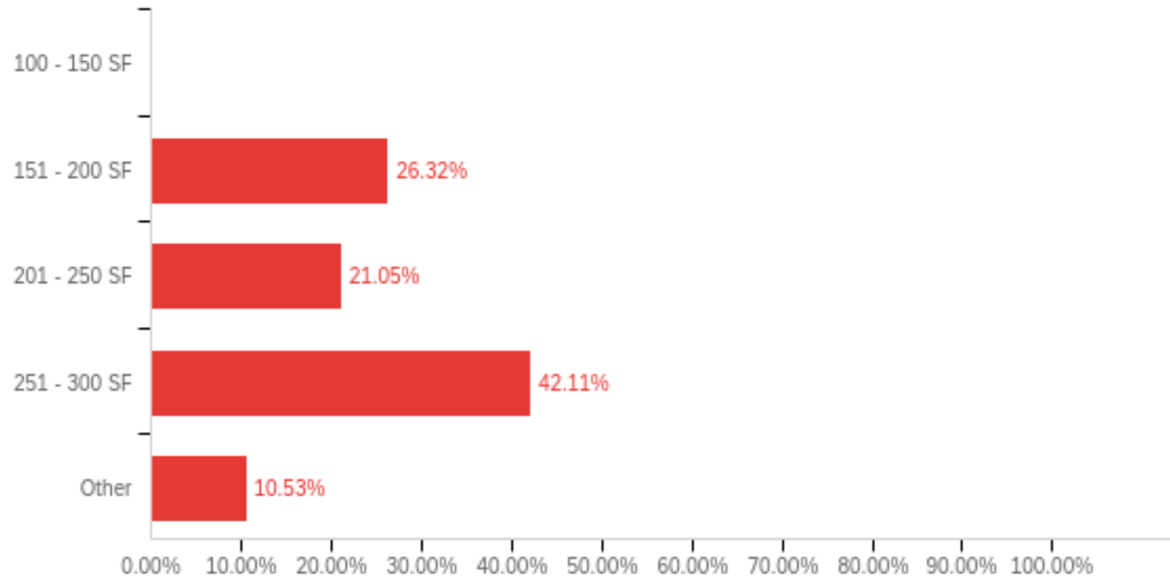
Q21 - A single occupancy inpatient bedroom is typically 250SF?



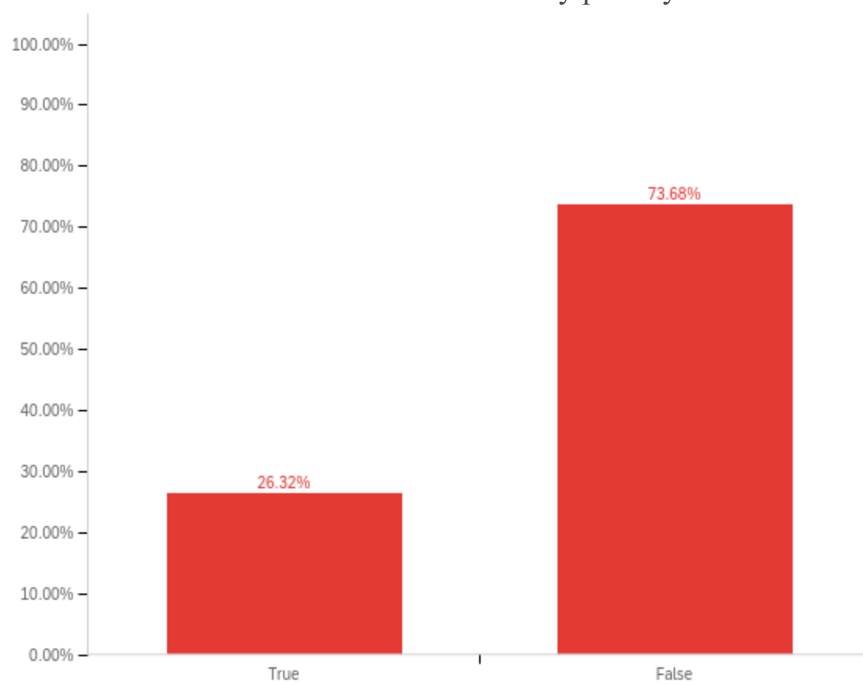
Q22 - Multiple occupancy inpatient bedrooms are typically sized to 100 NSF per licensed bed?



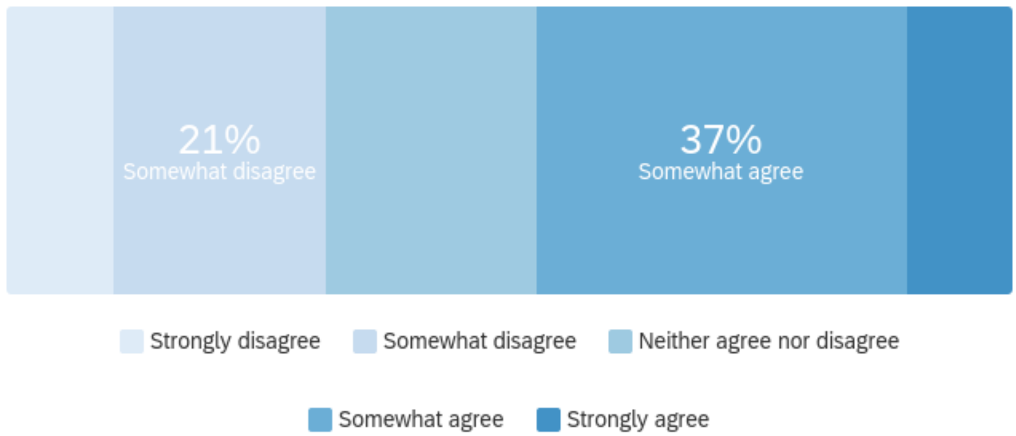
Q23 - What is the minimum SF of a single occupant medical surgical unit licenses bedroom with attached toilet/ shower?



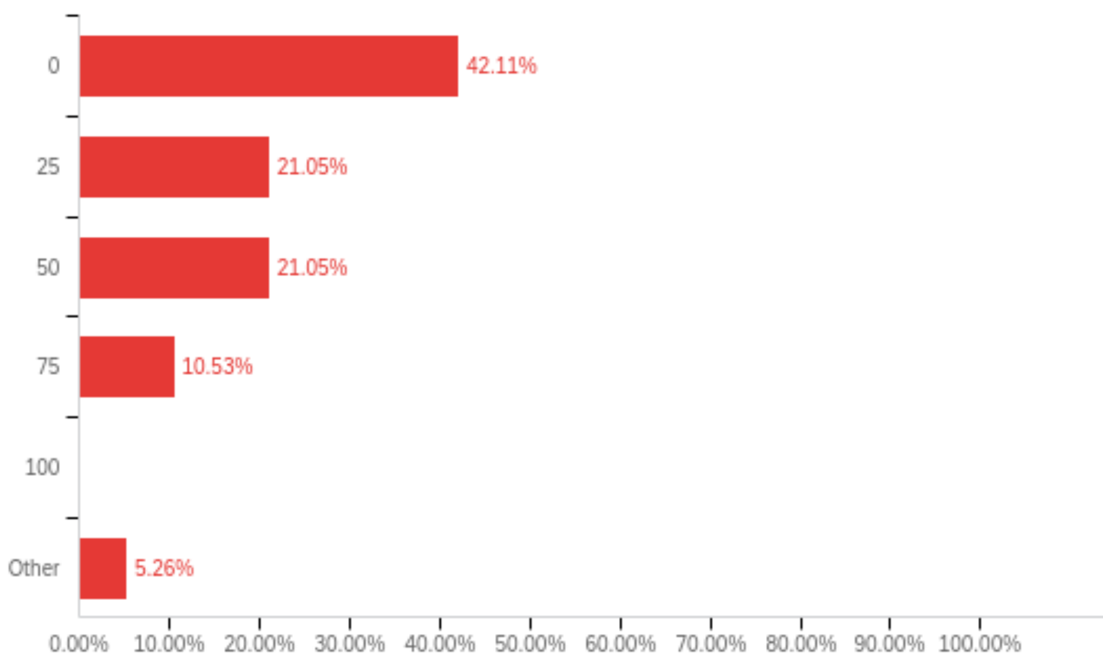
Q24 - Modern healthcare operations and design are limited to dual occupancy licensed beds based on factors such as infection control and family privacy?



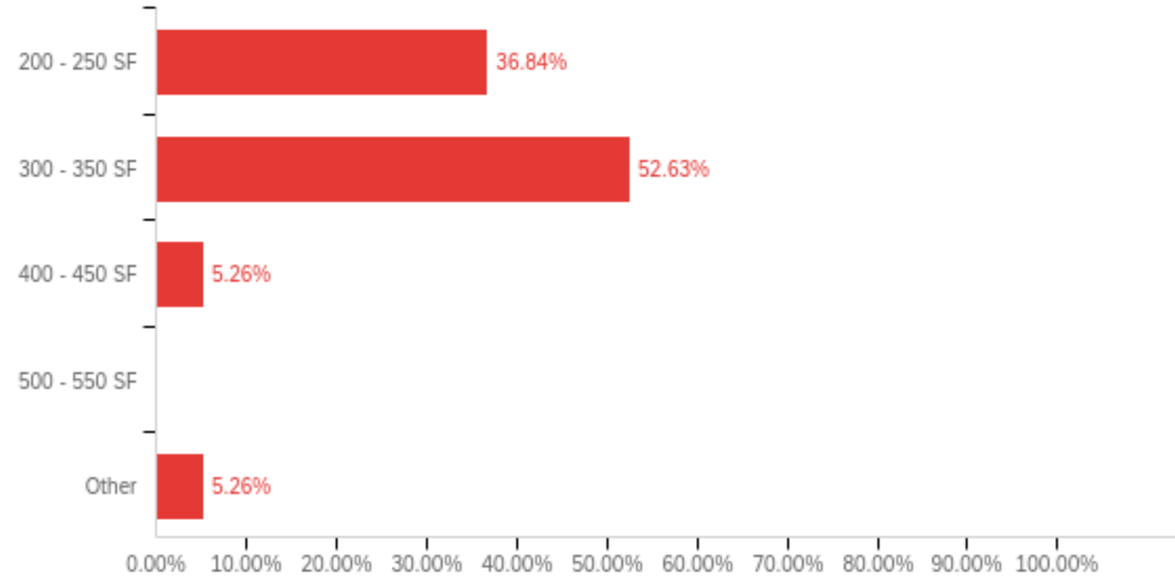
Q26 - "Step Down" units are for flexibility/ adaptability bedrooms that care for patient too acute for medical surgical unit, alleviating constrained critical care unit capacity. The incorporation of the "step down" unit model is not in addition to total licensed bed capacity of MSU and ICU, but a right-sizing approach to solve operational patient flow.



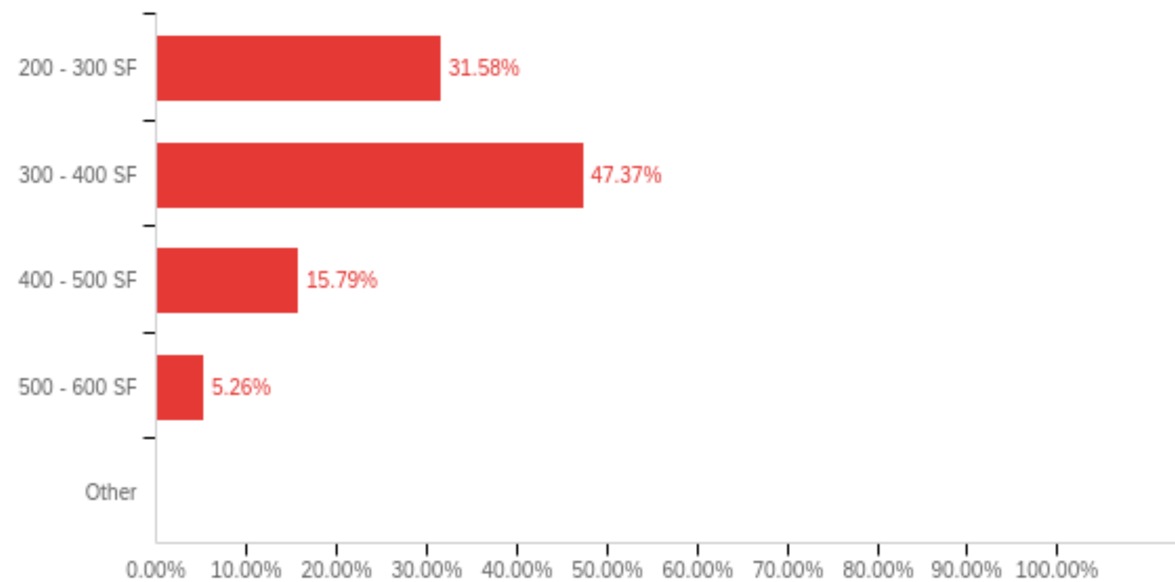
Q27 - "Step Down" units bedrooms are larger than typical single patient medical surgical licensed beds. What is the increased GSF to accommodate the patient care need in this room in comparison to the typical MSU room size?



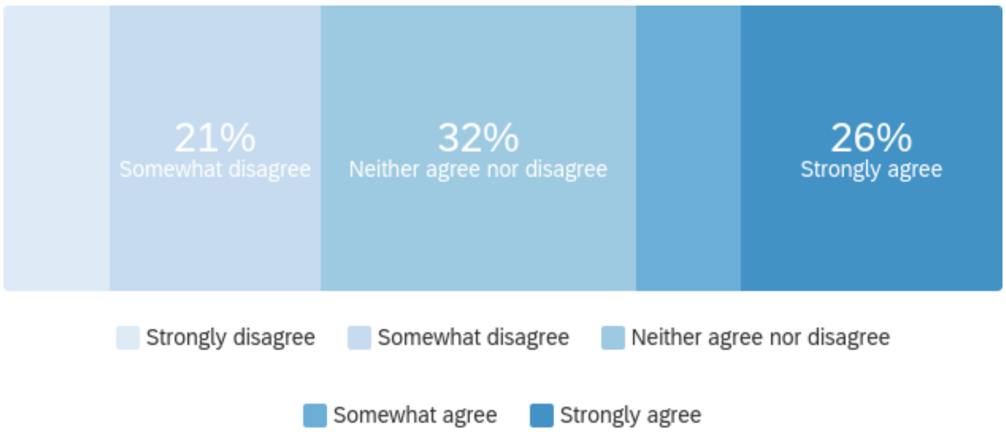
Q28 - What is the typical size range (SF) of the critical care unit licensed bedroom?



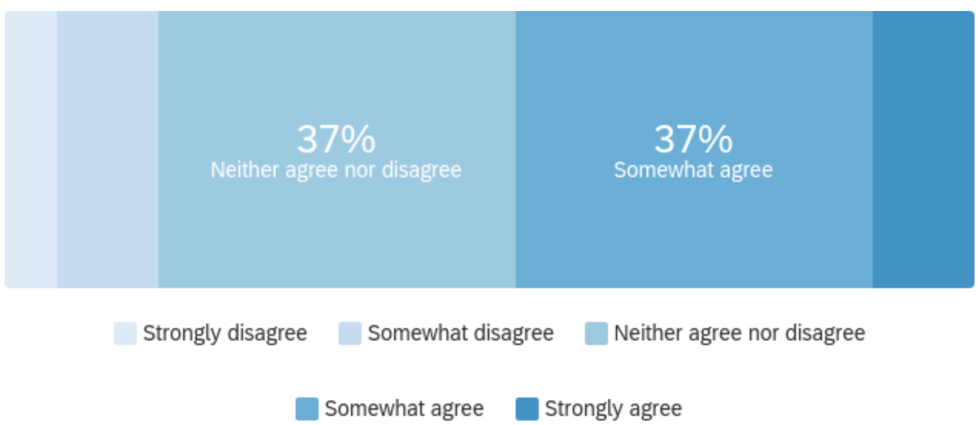
Q29 - What is the typical range size (SF) of the LDRP room?



Q25 - The LDRP model is preferred (Same room for labor, delivery, and postpartum recovery) in the right-sizing approach rather than the traditional method of separating labor/delivery and recovery of a patient.

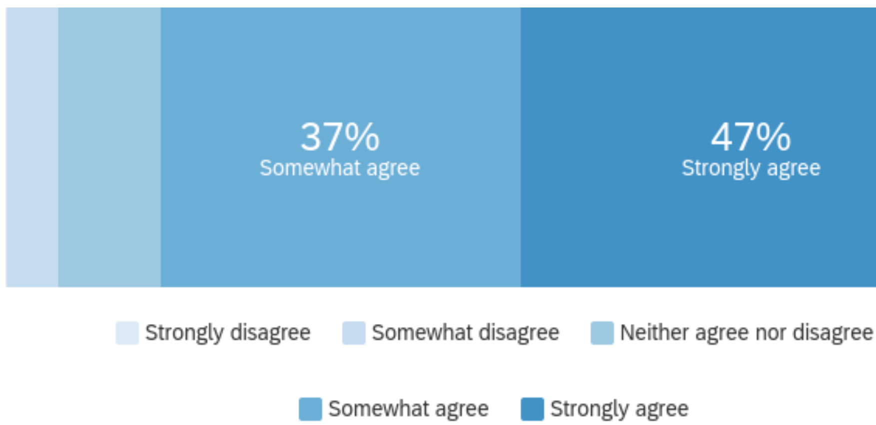


Q30 - When design with the all encompassing operations of the LDRP model, the right-sizing approach reduces the overall net department SF.

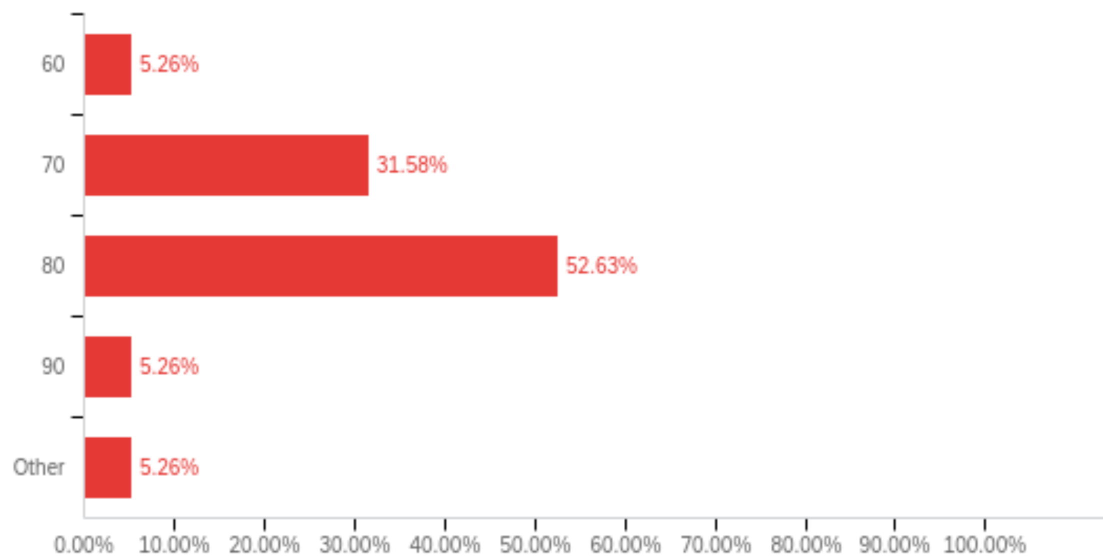


Surgical

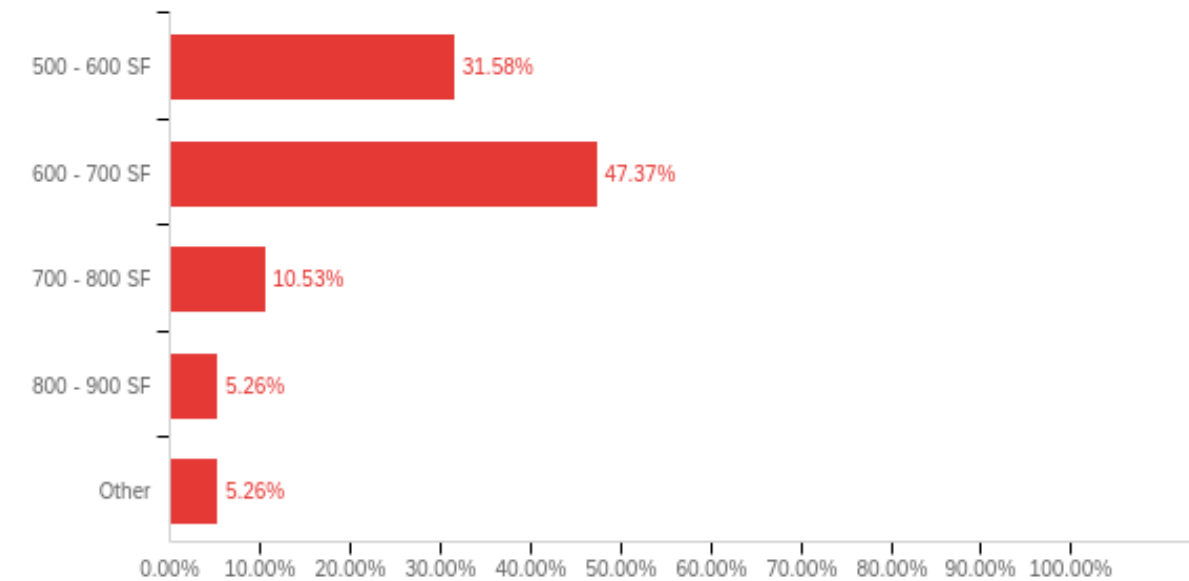
Q31 - General and specialty ORs are driven by workload to determine the number of rooms in the right-sizing approach.



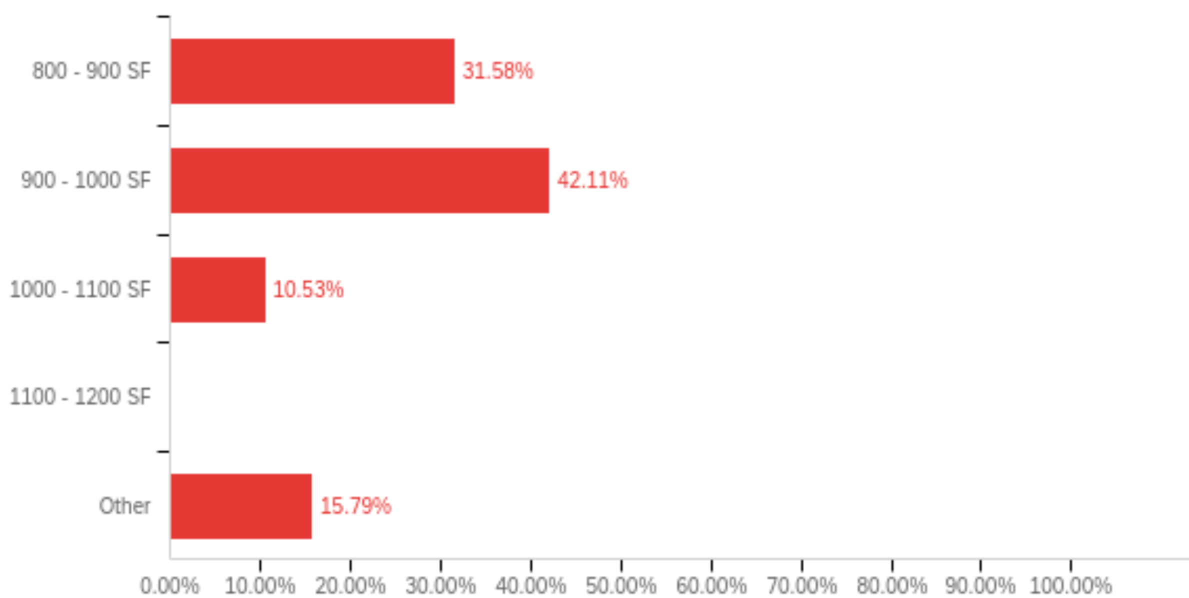
Q32 - Utilization factors (displayed in percentage) are the amount of time the room is in operation for services. Sub-specialty ORs (urology, endoscopy, etc.) in the right-sizing approach have a design utilization factor of?



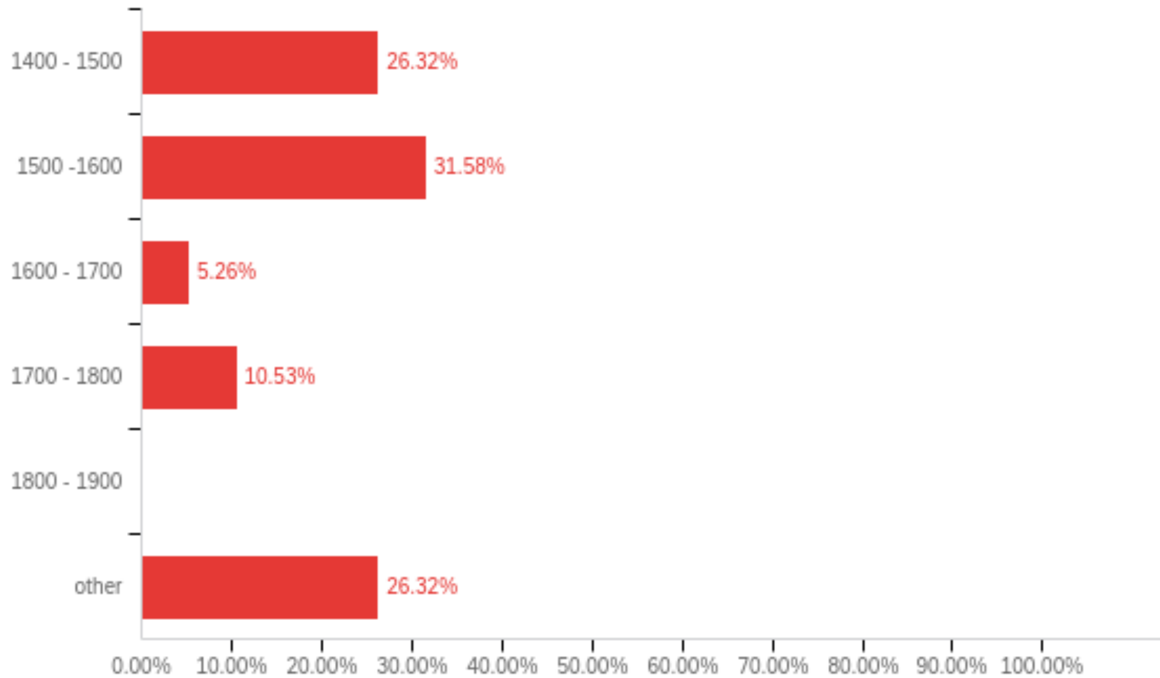
Q33 - The room size range (SF) of general and urology/ cystoscopy OR is?



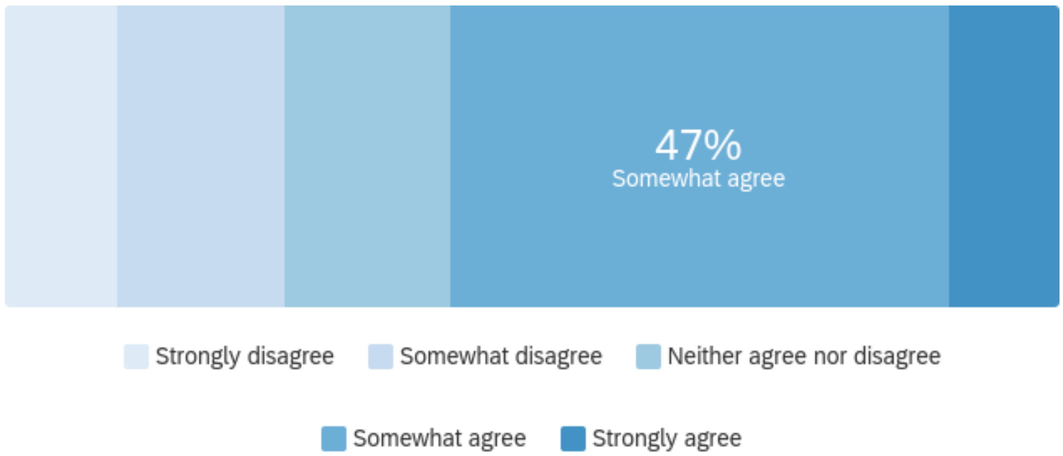
Q34 - The room size range of cardiothoracic, neurosurgical, and orthopedic OR is?



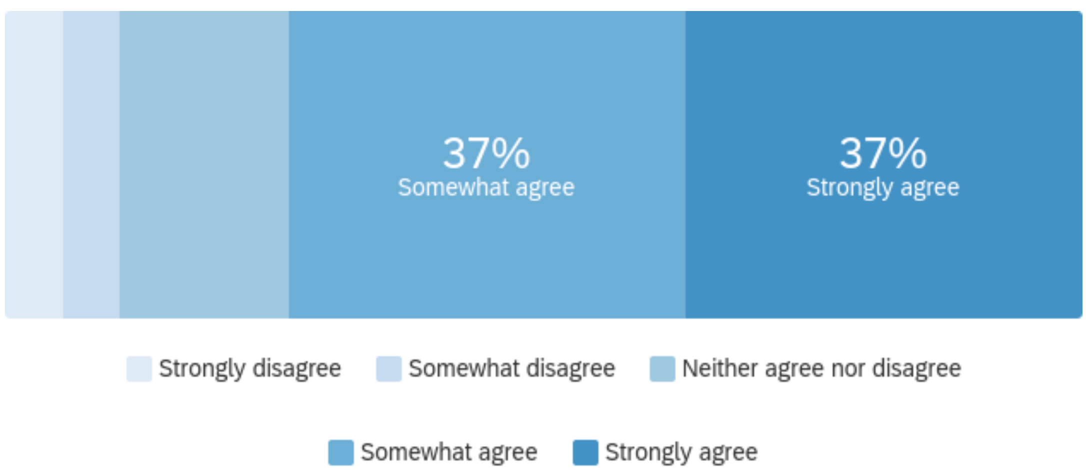
Q35 - The size range (SF) of a combined conventional surgical suite and medical imaging (Hybrid OR) including all associated suite support spaces (control room, equipment room, system component room, etc.) is?



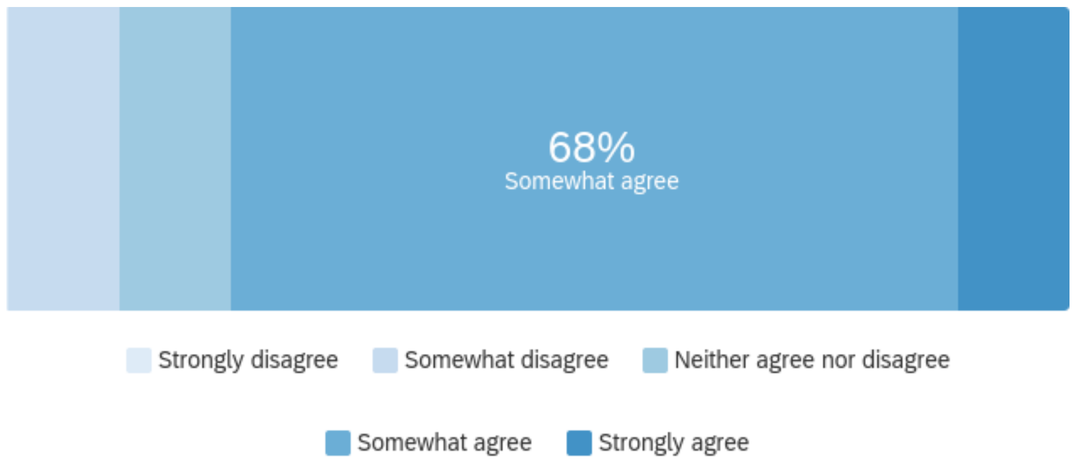
Q51 - Sub-specialty procedure rooms (urology, endoscopy, etc.) for less invasive procedures that require patient sedation, are best integrate as part of the OR suite in the right-sizing approach.



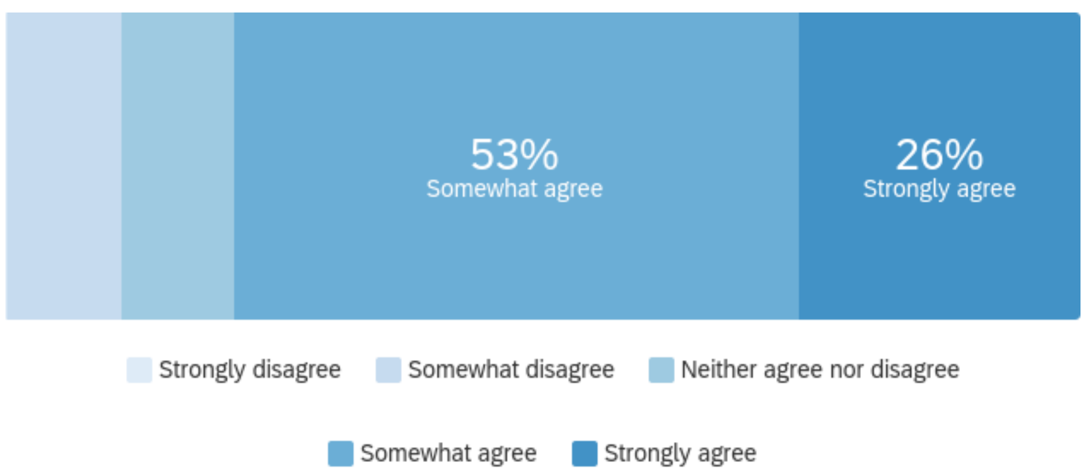
Q52 - Technological advancements in surgical procedures is a major constraint in the right-sizing approach to OR suite sizes.



Q53 - A c-section OR is sized similarly to a general OR in the right-sizing approach.

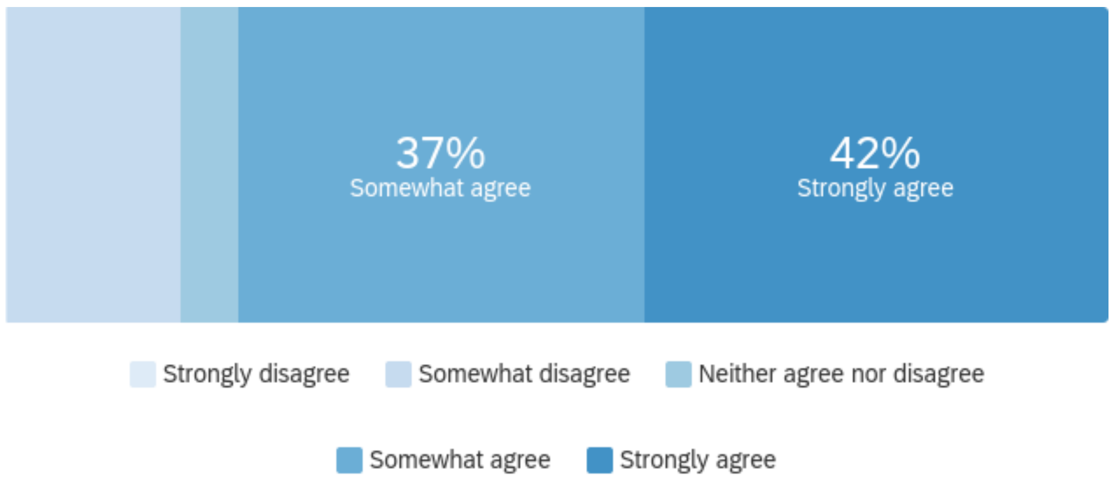


Q54 - C-section ORs are part of the departmental right-sizing approach to L&D and not the main hospital OR suite.

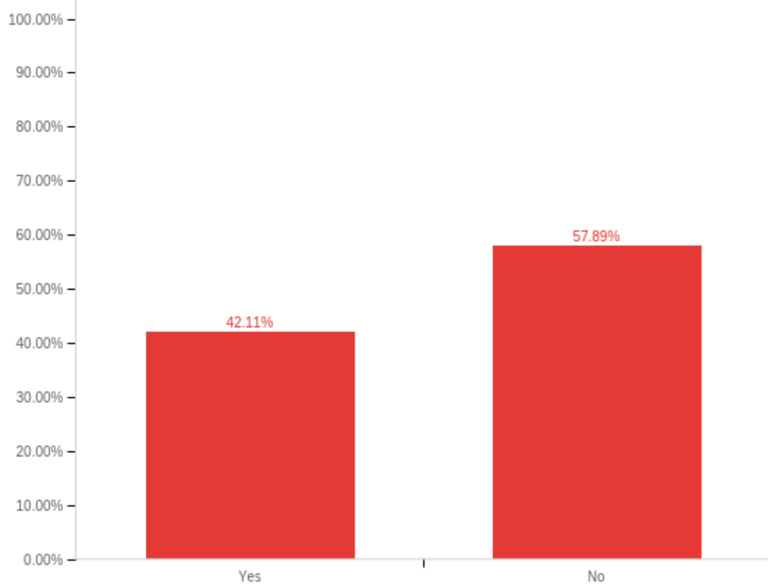


Ancillary

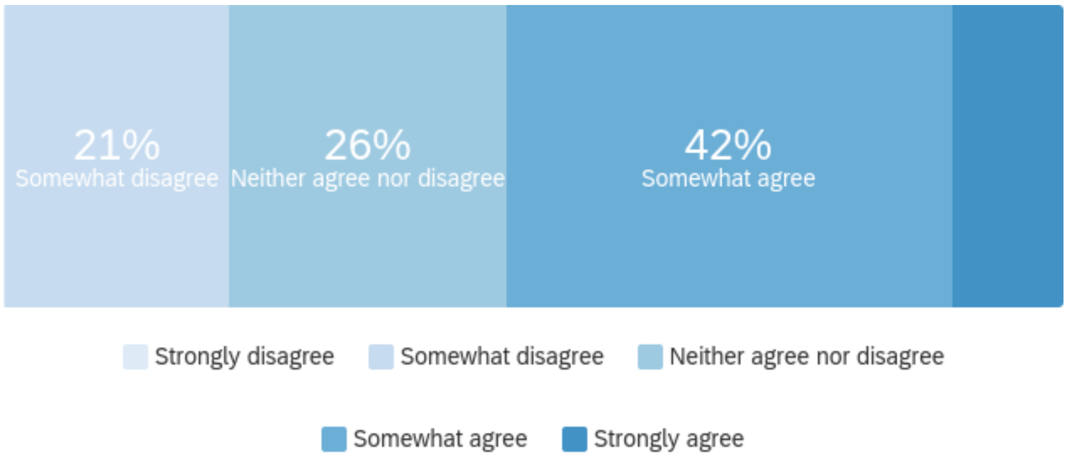
Q57 - The right-sizing approach to laboratory is based on equipment placement and functional process.



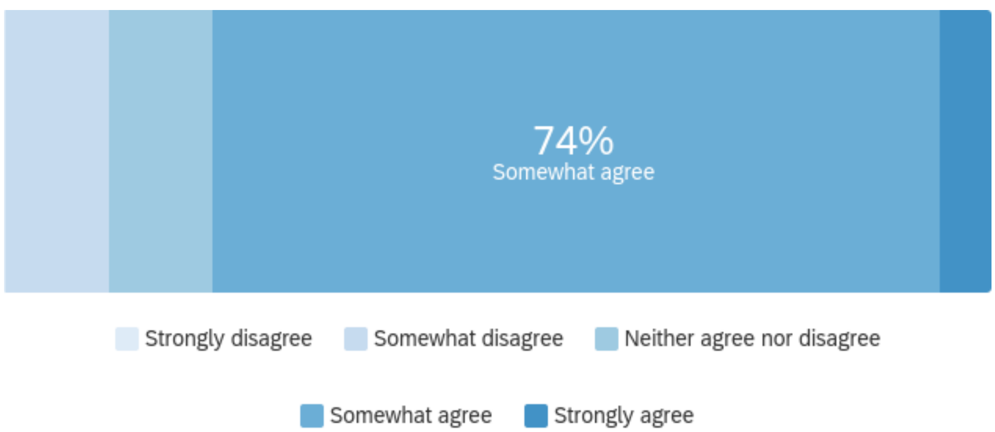
Q58 - Is there a "rule of thumb" for right-sizing rooms in laboratory?



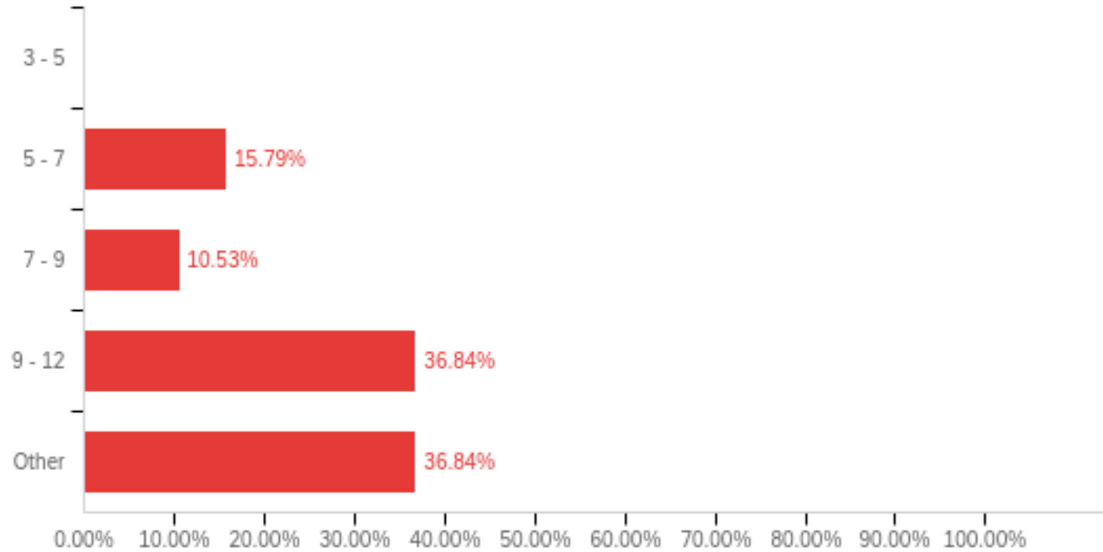
Q59 - A major contributor to right-sizing a pharmacy is the number of annual scripts.



Q60 - The right-sizing approach to ancillary waiting areas is based on wait times and in-person visits.

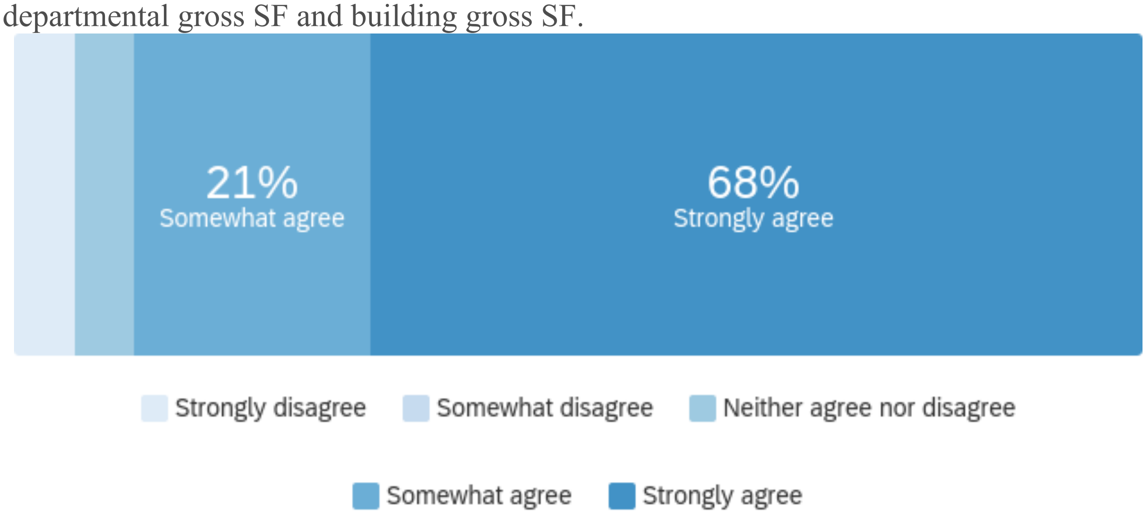


Q61 - The allocated NSF range for each person in ancillary waiting is?

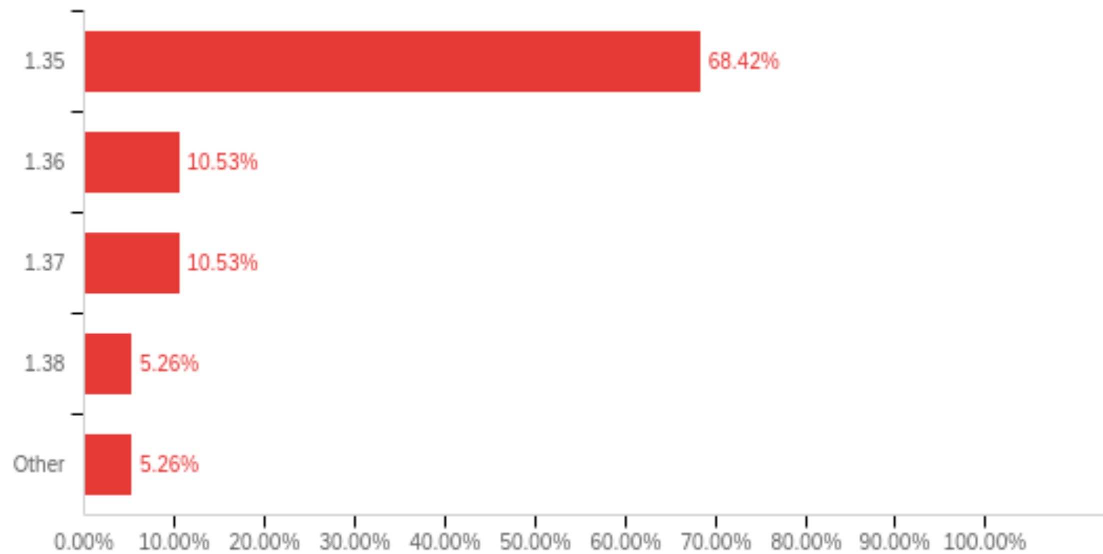


Miscellaneous

Q64 - In pre-planning and early design, grossing factors are used to calculate departmental gross SF and building gross SF.



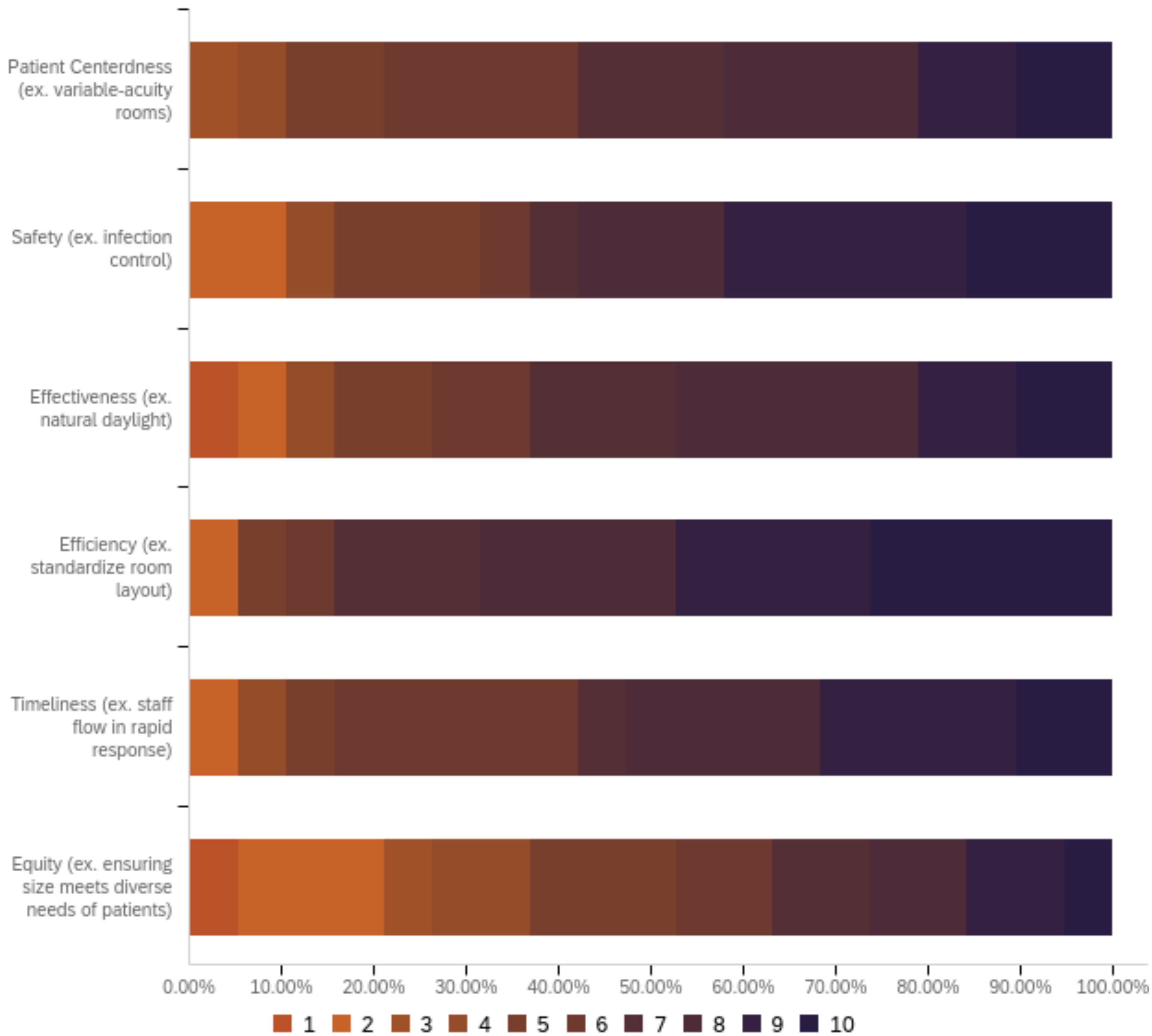
Q65 - What grossing factor is used in the right-sizing approach for BGSF in conceptual design?



Q63 - What is the average cost ($) per SF of new hospital construction?

Field	Minimum	Maximum	Mean	Std Deviation	Variance
Cost / SF	484.00	1324.00	884.68	226.35	51236.43

Q64 - Research has show that patient safety plays a vital role in right-sizing approach decisions. Rate each of the below factors impacting these right-sizing decisions. (0 having the least impact and 10 having the highest impact)



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