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Contents

Mission of the *Academy Journal*

As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of health care architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affects all involved in those fields.

About AAH

AAH is one of 21 knowledge communities of the American Institute of Architects (AIA). AAH collaborates with professionals from all sectors of the health care community including physicians, nurses, hospital administrators, facility planners, engineers, managers, health care educators, industry and government representatives, product manufacturers, health care contractors, specialty subcontractors, allied design professionals, and health care consultants.

AAH currently consists of approximately 6,000 members. Its mission is to improve both the quality of health care design and the design of healthy communities by developing, documenting, and disseminating knowledge; educating design practitioners and other related constituencies; advancing the practice of architecture; and affiliating and advocating with others that share these priorities.

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Big Growth Needs Big Data

Kate Renner, AIA, EDAC, LSSCE, LEED AP BD+C, and Kaitlyn Badlato, Assoc. AIA, WELL AP, LEED Green Assoc., HKS Health Fellowship, HKS, Inc.

ABSTRACT

As hospitals continually grow to meet the demands of advances in medicine and technology, there is a desire for facilities to become leaner, more flexible, and efficient, without compromising the quality of care. Trends toward private inpatient rooms, patient- and family-centered care models, and the adaptation of acuity adaptable or universal rooms have resulted in patient rooms that are 77% larger than they were in 1980 (Schneider, 2009). Subsequently, inpatient units have also grown, shifting the models of care and causing increases in staff travel distances and decreases in patient-direct visibility (Harper et al., 2014). As the demand for space increases, owners are seeking design opportunities to optimize space and save costs.

Benchmarking, when integrated into the design process, provides the means to confidently design right-sized facilities by utilizing key metrics to baseline and optimal targets for performance and outcomes (McCabe, 2001). Several benchmarking programs developed by architecture firms and industry-wide organizations, such as the Construction Industry Institute (CII), capture these metrics as a means for evaluation, assessing how a facility's design and construction performs against other industry leaders across the United States. In conjunction with the CII Health Care Benchmarking Program, a study of 32 medical/surgical inpatient units and 60 inpatient rooms was conducted to identify areas of achievement, improvement, and opportunities to optimize space and operational efficiency throughout the design phases of a project.

Introduction

Today's hospitals struggle to find a balance between providing the highest quality of care, patient and staff satisfaction, operational efficiency, and spatial efficiency. The continuous evolution of patient-care models and advances in medicine have directly impacted building standards and recommendations for inpatient room and unit design, often increasing facility size. As facilities grow, clinicians are continually faced with challenges in providing optimal care, maintaining effective communication, and promoting efficient operations, while adapting to larger care environments.

Examination of previously constructed facilities can provide accurate data and inform the design of future projects. Benchmarking, the systematic process of measuring one's performance against recognized leaders to determine best practices, is a continuous exercise that can be applied to identify the appropriate size for facilities (National Research Council, 2005).

In its simplest form, benchmarking helps organizations identify areas of achievement and improvement to define a better, more successful outcome (McCabe, 2001). The value of an assessment is recognized in the numerous metrics that can be used to measure the performance of a healthcare facility. Metrics evaluating space planning, program space requirements, and operations are used to accurately determine the appropriate size of a patient room, department, or facility. It is important to understand that there is no "one size fits all" solution; it is necessary to go beyond the numbers and understand what conditions and variables were responsible for generating them. Understanding these conditions and analyzing multiple metrics will help deliver insights for both planning performance gaps and best practices.

Trends in health care that impact growth

Inpatient units have evolved from the open room 1860s Nightingale Wards to today's single-occupancy room model, impacted by trends in patient-family centered care, acuity adaptability, in-room clinical services, and patient size. This shift in patient care has led to improved clinical outcomes while also resulting in a significant increase in room size and a further increase in inpatient unit size.

Now in its seventh edition, the *FGI Guidelines* has provided performance-driven standards for American health facility design since 1947. These guidelines have continued to evolve and are maintained and updated by a multidisciplinary group of experts to reflect advances in medicine and patient care (Facility Guidelines Institute, 2017). Today, some version of the *FGI Guidelines* has been adopted by 36 states (American Society for Healthcare Engineering, 2015).

The number of patients permitted in a medical/surgical inpatient room has evolved as studies have demonstrated the benefits of a single-occupancy room, including reductions in length of stay, medication errors, patient transfers, infection rates, noise levels, and sleep disturbances, and increases in patient satisfaction and privacy (Chadbury et al., 2004). In 1987, the maximum

FIGURE 1

ROOM LISTING	1987 NEW CONSTRUCTION-MINIMUM CLEAR FLOOR AREA	2001 NEW CONSTRUCTION-MINIMUM CLEAR FLOOR AREA	2006 NEW CONSTRUCTION-MINIMUM CLEAR FLOOR AREA	2010 NEW CONSTRUCTION-MINIMUM CLEAR FLOOR AREA	2014 NEW CONSTRUCTION-MINIMUM CLEAR FLOOR AREA
ACUTE CARE					
PRIVATE ROOM	100	100	120	120	120
MULTIPLE BEDS	80	120	100	100	100
INTERMEDIATE CARE					
PRIVATE ROOM	n/a	n/a	150	150	150
MULTIPLE BEDS	n/a	n/a	120	120	120
INTENSIVE / CRITICAL CARE					
PRIVATE ROOM	120	200	200	200	200
MULTIPLE BEDS	100	200	200	200	200

***CLEAR FLOOR AREA:** THE FLOOR AREA OF A DEFINED SPACE THAT IS AVAILABLE FOR FUNCTIONAL USE EXCLUSIVE OF TOILET ROOMS, CLOSETS, LOCKERS, WARDROBES, ALCOVES, VESTIBULES, ANTEROOMS, GENERAL CIRCULATION,AND AUXILLARY WORK AREAS. FLOOR SPACE BELOW SINKS, COUNTERS, CABINETS, MODULAR UNITS, OR OTHER WALL-HUNG EQUIPMENT THAT IS MOUNTED TO PROVIDE USABLE FLOOR SPACE COUNTS TOWARD "CLEAR FLOOR AREA."

FGI patient room size requirements for new construction: 1987-2014
Image credit: HKS; Source: *FGI Guidelines*

number of patients in a room was four, decreasing to two in the 2001 edition, and one patient per room in the 2006 edition. The minimum clear area of a patient room in a medical/surgical nursing unit identified by the FGI Guidelines increased in 2006, from 100 sq ft to 120 sq ft (Facilities Guidelines Institute, 2014). While the minimum clear area remains the same, recommendations in the Appendix of the Guidelines states that "in new construction, single patient rooms should be at least 12 feet wide by 13 feet deep (or approximately 160 sq ft)" (Facilities Guidelines Institute, 2001). This reflects the need for larger rooms to accommodate changing care models, increased space for equipment, and dedicated space for family members to be present in the patient room without impeding care. A key piece of equipment—the patient bed— has increased in size, growing from seven feet long to upwards of nine feet in recent years, with an added increase for bariatric patient beds, which may be over four feet wide. This increase not only requires more space in the patient room, but also requires additional clearances in corridors for maneuvering, increasing circulation space in inpatient units.

The patient- and family-centered care (PFCC) approach focuses on creating partnerships among healthcare practitioners, patients, and families that lead to the best outcomes and enhance the quality and safety of healthcare (American Hospital Association, 2004). This model has been shown to decrease readmission rates and length of stay while increasing staff and patient satisfaction scores (Planetree, 2014). The FGI Guidelines recommend a clear area of 250 sq ft in hospitals with a PFCC model, with a 15' clear dimension. The ripple effect of this recommendation includes longer corridors, increased unit size, and added clinical support areas to support staff efficiency.

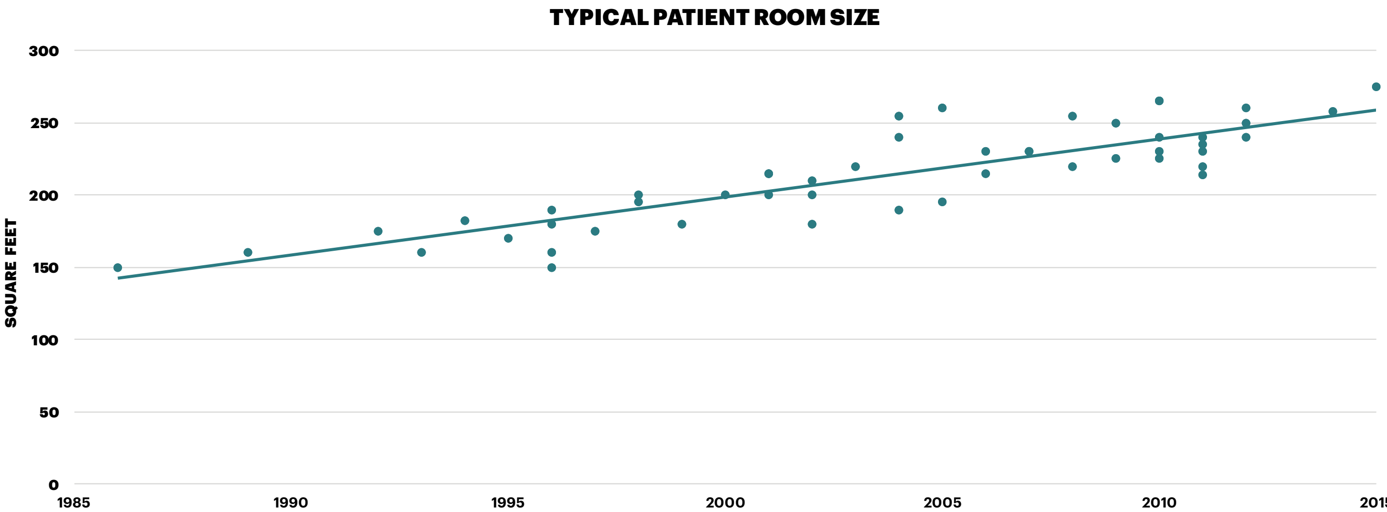
The introduction of acuity-adaptable rooms to reduce patient transfers and medical errors, while increasing patient satisfaction, is another inpatient-care trend with space implications. Acuity-adaptable rooms are inpatient rooms that can be configured to meet the needs of intensive care, stepdown, observation, and acute-care patients, enabling a patient to stay in the same room from admission through discharge (Annonio et al., 2010). For this model to be successful, each patient room must accommodate requirements for an intensive care room, increasing size and equipment needs beyond the requirements for acute-care patients. To further meet the goal of limiting patient transfers, inpatient rooms are being designed to accommodate in-room clinical procedures, including certain imaging procedures, dialysis, and physical/occupational therapy.

As a result of these trends in patient care, the inpatient unit has also increased in size. Larger patient rooms mean longer inpatient unit corridors, increased need for decentralized staff workstations and charting alcoves to maintain patient visibility, decentralized supplies, and improved technology for communication.

Understanding the implications

As health outcomes, patient experience, and operational efficiency become key drivers in the healthcare industry, it is important to understand the implications these trends have on spatial performance and, ultimately, construction

FIGURE 2



Patient room size growth: 1986-2019
Image credit: HKS

costs. The desire to include these additional functions and dedicated areas within the patient room has caused the patient room to grow by more than 77% since 1980 (Schneider, 2009). While these trends have known benefits that include improved patient satisfaction and decreased medical errors, the accommodation of these patient-experience improvements has increased the size of inpatient units and has required further shifts in the care model and the organization of the unit (Cullinan and Wolf, 2010).

An analysis of 32 units, dating between 1986 and 2014, including sixteen 36-bed, nine 30-bed, and seven 24-bed units, affirms the notion of the growing patient room and inpatient unit over time. A simple break down of the inpatient unit separates the program into four categories for analysis.

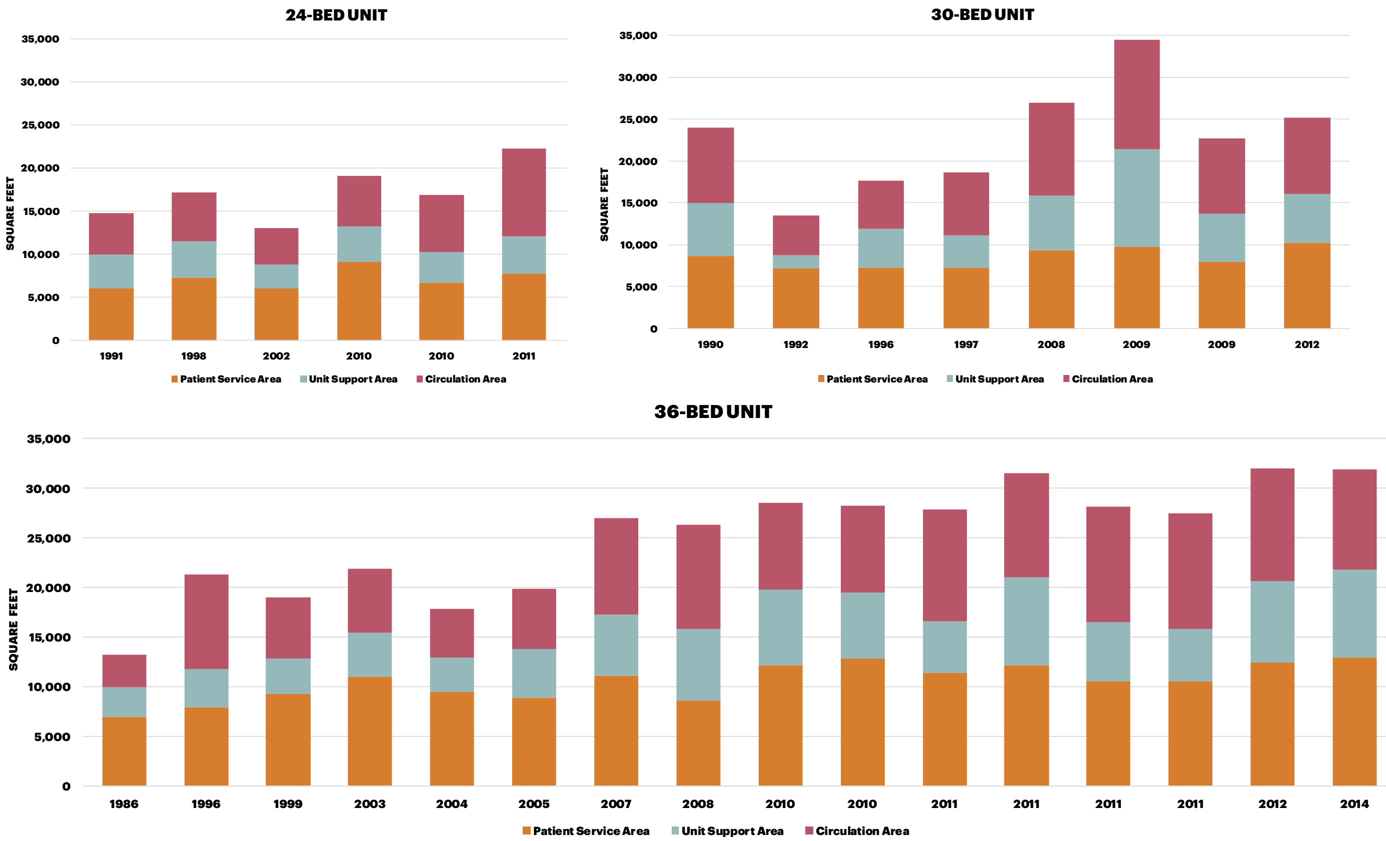
- patient service area: The net square feet of patient rooms, patient room toilets, and nurse servers
- support service area: The net square feet of clinical support areas such as medication rooms, clean supply, nurse stations, charting areas, and team rooms
- circulation area: The remaining square feet of the unit, including corridors, staff passageways, and lobbies
- building support area (not included in the inpatient unit area calculations): Vertical circulation, elevator lobbies, stairs, mechanical rooms, and significant wall shafts

Additionally, travel distances for a nursing shift are calculated using a parametric script in Grasshopper, software that analyzes the plan of the inpatient unit. This script measures the distance—using the centerline of hallways, 90-degree turns, and the center of doorways as a start and finish point—between key rooms in a series of sequences that a nurse will follow in a shift. These sequences and their frequency are modeled after current nursing models and case studies and the output reflects the average distance of all possible configurations of the chosen patient rooms to ensure validity and consistency. Once the distance is calculated, time is calculated with an equation—total miles x 15 min/mi—that suggests a moderate speed walk.

A comparison of a 36-bed inpatient unit constructed in 1986 to a unit of the same bed count constructed in 2014 shows a growth in the patient room of 100 sq ft (exclusive of the toilet room), a 63% increase. As shown in figure 5, the 36-bed unit as a whole had a total increase of 140%, growing at a rate of 3% each year. Despite this increase in overall unit area, the distance a nurse might travel within a typical shift decreased eight minutes, or a half-mile, each day. This recovered time provides more face time with the patient and decreases physical strain on the staff. The 2014 unit facilitates a shorter travel distance, despite being twice the size of the 1986 unit because of the unit's decentralized model.

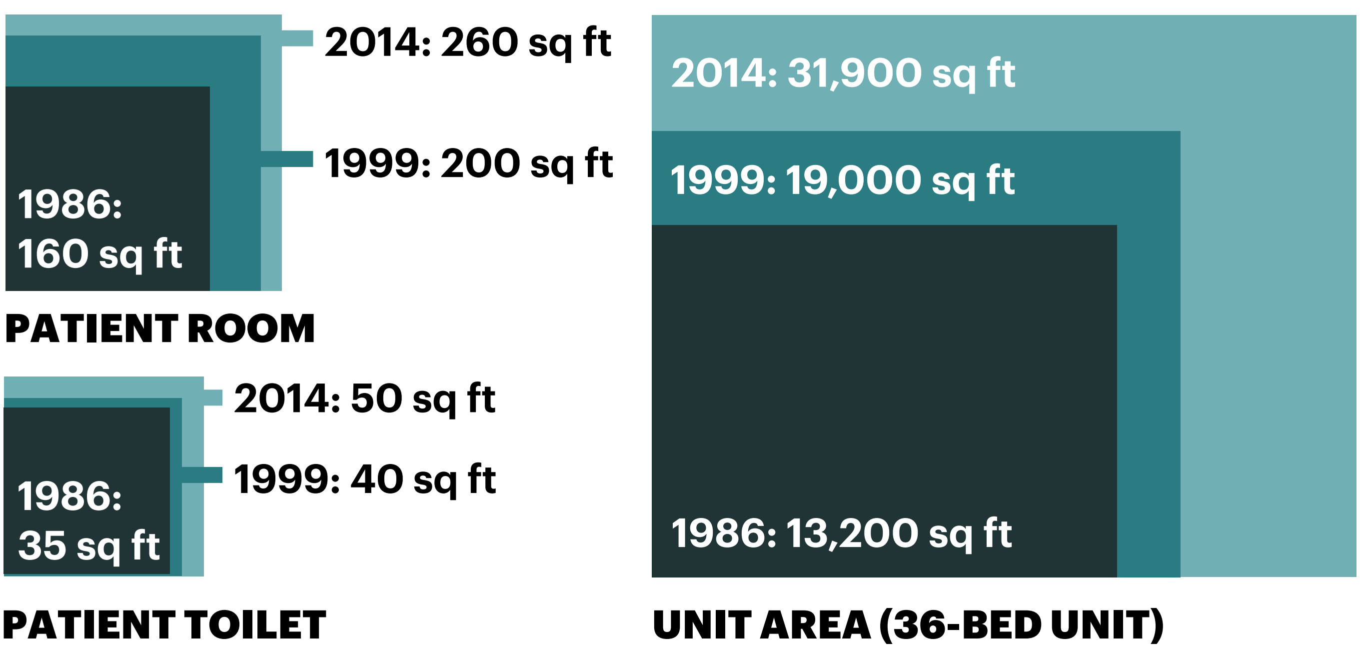
As the inpatient unit grew, the support services of the unit needed to respond; although simply enlarging the areas of support services would not be sufficient since the units are occupied by the same number of patients. The

FIGURES 3–5



Inpatient unit area growth for 24- ,30-, and 36-bed units: 1986–2014
Image credit: HKS

FIGURE 6



Growing medical/surgical patient unit and room: 1986–2014
Image credit: HKS

introduction of a decentralized unit and planning with an emphasis of access between support spaces and the patient rooms streamlined throughput of tasks throughout a shift, reduced the time spent gathering supplies, and allowed more time with the patient. To shorten travel distances for care givers, nurse servers and charting stations are added to the corridors, allowing nurses to gather supplies and chart adjacent to the patient room. Additional supply and equipment rooms with multiple points of access can also reduce travel distances while adding additional area to the unit.

The addition of these spaces and access points can add additional area through redundancies to the unit. Across the selection of 36-bed inpatient units, units with decentralized medication rooms saw a 3% increase in unit support area and a unit-area growth of 45 sq ft/bed above the average unit area sq ft/bed for the selection.

Overall, a breakdown of unit growth from 1986 to 2014 by program in the sample of 36-bed units reveals that the growth rate of the support area and circulation areas, 192% and 211%, respectively, far surpassed the 87% patient-service-area growth rate from 1986 to 2014. Both the unit support area and the circulation of the units grew at a rate of 4% each year.

The tradeoffs between operational efficiency and spatial efficiency are difficult to weigh. Operational efficiency effects patient and staff satisfaction, can reduce medical errors, and can increase collaboration amongst the care team, whereas spatial efficiency directly impacts construction and operational costs. A balance between the two must be achieved to create a cost-effective, high-performing facility. To find this balance, architects and owners can analyze historical data of facilities implementing different strategies and models to determine the best practices for new facilities through the use of a benchmarking practice.

Strategies for benchmarking practices

A benchmarking practice can be established to evaluate and maintain the balance between cost-effective and high performing. A benchmarking practice may be established as either an internal firm evaluation or an external industry evaluation.

An internal benchmarking practice refers to collecting information on projects within a firm's portfolio and comparing them to establish general guidelines and reveal best practices. An example of an internal practice is one focused on a study of the acute care and intensive care inpatient units, isolating the space planning and program organization of the firm's designs for a critical component of a hospital.

An external benchmarking practice compares a firm's projects to projects designed by industry competitors to determine where the firm stands within the industry. This requires additional collaboration but also brings a larger reward with the cooperation and sharing of information with industry competitors.

Without industry data, there is no way to truly define "good performance," only good performance within one's firm (National Research Council, 2005). A best practice has more weight when it is defined by the industry as a whole rather than what work the firm performs alone and measured with meaningful metrics.

The Construction Industry Institute (CII) at the University of Texas at Austin has created a Health Care Benchmarking Program, available at no cost to participants, which eliminates the burden of developing a benchmarking practice for the firm. In exchange for contributing project data, this program provides access to an impartial industry database of metrics and comprehensive data on healthcare facilities across the country. The CII Health Care Benchmarking Program allows participating firms to compare their projects to others in the industry throughout all stages of design. In early phases of master planning through post occupancy evaluation, the CII Program can provide an overview of the areas of achievement and opportunities for improvement in terms of a facility's construction cost, schedule, design, and space planning.

Performance analysis of an inpatient unit

A benchmarking analysis of an acute care unit in an academic medical center compares a recently completed inpatient bed tower to five similar academic bed towers, utilizing an internal database of inpatient care units and the CII Health Care Benchmarking Program. The database of inpatient care units was utilized to analyze four key metrics, revealing the space usage and performance of the selected unit against the 50+ project database.

- Unit area/bed: The area of the inpatient unit in comparison to the number of beds it contains exposes the efficiency of the unit's footprint. The more beds that are located on an inpatient unit, the more efficient the unit.
- Percent of support area/unit area: The ratio of support service area to the inpatient unit reveals the utilization of the unit.
- Net-to-gross factor: The net-to-gross factor compares the inpatient gross area to the patient services area and the unit support area.
- Typical patient room size (exclusive of toilet rooms): A larger patient room can provide adequate space for patient care and family space. An oversized room, however, can promote inefficiency.

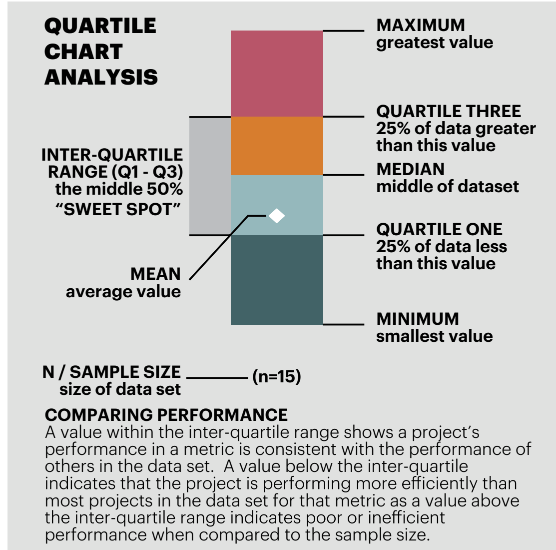
The unit-area-to-bed ratio reveals a large footprint and a high net-to-gross factor, inefficiency that can be attributed to the academic nature of the facility, requiring additional circulation to accommodate a separation of front-of-house and back-of-house functions, as well as spaces required for education throughout the facility. The patient rooms lie within the interquartile range, slightly larger than the average patient room sizes, indicating that the rooms are appropriately sized when compared to similar facilities and further indicating inefficiencies in circulation spaces.

The metrics provided by the CII Health Care Benchmarking Program were utilized to compare the performance of the selected projects, assessing the space program of the entire facility and costs to design and construct the facility.

- DGSF/BGSF: The facility is comprised of 58% department gross square feet (DGSF). This indicates that a significant portion of the building, 42%, is reserved for building support and service spaces.
- Construction cost/BGSF: The total building construction cost of the facility was less than the facilities in the CII database at $400/BGSF.
- Project cost growth: The project cost grew significantly from the initial schematic design estimate. The 25% increase is well above the average 6.6% increase; however, it is still lower than a majority of projects in the database. This increase can be attributed to the addition of multiple schematic design phases to incorporate additional programs in the new facility.

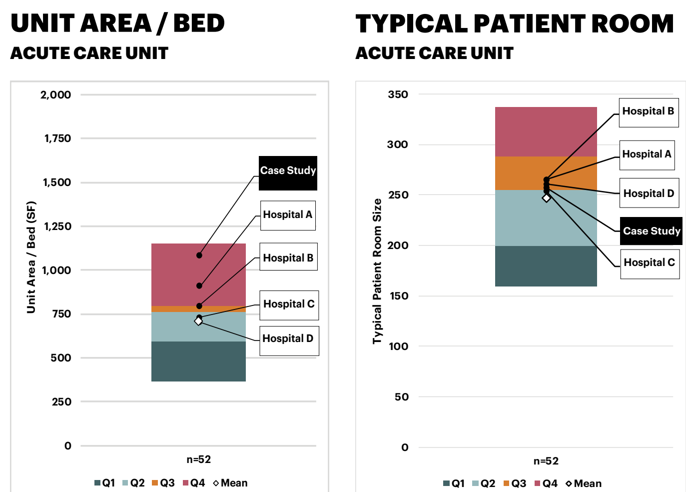
The metrics provide a holistic evaluation of a recently completed facility against several comparable facilities, highlighting both its strengths and weaknesses and serving as a road map for how to move forward with future facility design and planning. This benchmarking exercise provides the necessary framework to use past experiences of both the client and the firm to pursue a new project together, aware of common goals, areas of achievement and, most importantly, areas of improvement.

FIGURE 7



Interpreting a quartile chart
Image credit: HKS

FIGURE 8



Unit Area / Bed	
Q1 - Q3	593 - 794
Mean	707

Typical Patient Room	
Q1 - Q3	200 - 288
Mean	247

Inpatient care unit study metrics
Image credit: HKS

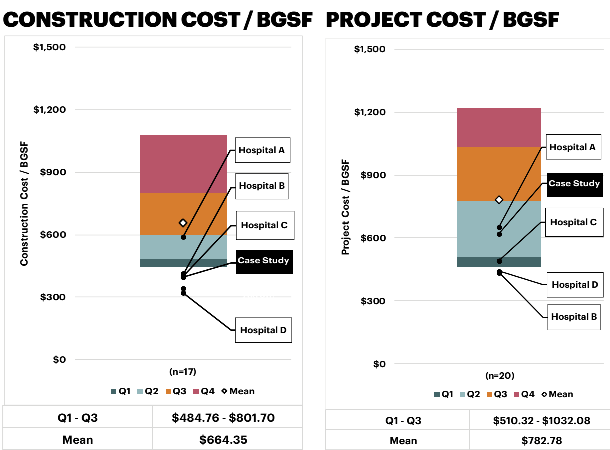
Roadmap to right sizing facilities

Before the planning and design process begins, a benchmarking assessment can compare an existing client project or selection of facilities with the desired product. This allows the client to understand and set expectations for construction performance, size requirements, and operational performance of the facility. Performing a benchmarking assessment early and throughout the process allows the team to establish targets and track them throughout the project. As the project proceeds, the project can be assessed in terms of size, cost, and project schedule, assisting clients with making key decisions throughout the project, tailored specifically to the project goals. These metrics establish a norm for the different variables that exist when designing a facility.

During the design development phase, an assessment can be made to measure the status of the project and assess its performance against key metrics to identify anomalies or changes made to the initial targets that require further review. Not all deviations from original targets or comparable projects are an indication of where adjustments are needed to provide an optimal, high performing facility; some diversions from the program may be warranted and appropriate.

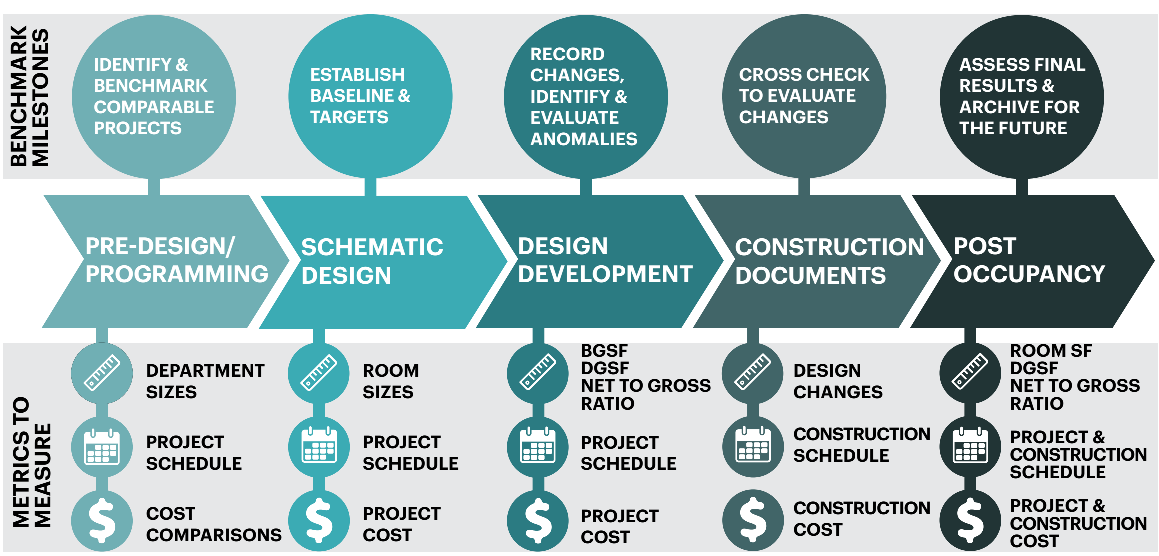
After the project is constructed, it is important to assess the final product to identify areas where the project succeeded, as well as areas that could be improved in future projects. The data collected in this stage is then archived for use on future projects.

FIGURE 9



Construction Industry Institute health care benchmarking metrics
Image credit: HKS; Source: Construction Industry Institute

FIGURE 10



Project timeline with benchmarking milestones
Image credit: HKS

Conclusion

There is no prototype or "one-size-fits-all" solution for the patient room or inpatient unit. Healthcare facilities, architects, and care providers have differing preferences and ideas for the development of a facility that go beyond the published standards and recommendations. Additionally, third-party benchmarking practices are limited in standardization, validation, and data sharing, resulting in a need to invest in more industry-wide programs—particularly those with a design focus—to increase the data and knowledge available on the healthcare facility industry. The exercise of benchmarking facilities throughout the design process provides guidance and assurance that the design delivered is within acceptable ranges. When a facility's metrics lie outside of the accepted benchmarks, it is an indication to take a closer look and justify the reasons why the facility does not meet the benchmark. A series of checks and balances and examination from multiple perspectives will produce a well-thought-out solution suitable for the new facility.

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1735 New York Avenue, NW
Washington, DC 20006

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