A Comparison of the Present and Proposed OR Department of Cardinal Santos Medical Center, Using Evidence-Based Design Criteria

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Abstract

Designing Surgery Departments in the Philippine setting is a challenge for architects. The lack of information on how to validate design elements can lead to calculable consequences determined by the hospital's turnover time and profit. Often, any architect who will explore a way to design these departments would initiate a trial-and-error design process because of the lack of knowledge and information to the needs of both the patients and the staffing – nurses, doctors, office staff, etc.

This design problem is called Design Dilemma by Lauren Thomas (2010). Design Dilemma is experienced whenever a design problem, such as how to design an Operating Department, leads into a paralysis from the analysis due to the complexity of the users involved, as well as the lack of formal experimentation into the relationship between facility design and its effects on the operations. Ultimately, it results to a design qualified by the number of surgery cases served per day. Krupka, & Sandberg (2006) stated that operating room management focuses on reducing wasted time to perform more cases in regular business hours, reduce overtime, or provide a better experience for staff and patients. All of this will be contextualized into Philippine medical facilities which hospital architects in the country need as a guide to newer hospitals in the future.

Keywords: evidence-based design, healthcare design, hospital design, surgical department, modified-delphi method

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I. Introduction

1.1. Background of the Study

Reference.MD (2012) defines the Surgery Department as the Hospital department which "administers all departmental functions and the provision of surgical diagnostic and therapeutic services" (par. 1). Its other names would include "Hospital Surgery Departments; Departments, Hospital Surgery; Surgical Service, Hospital; Surgery Departments, Hospital; Department, Hospital Surgery; Hospital Surgery Department" ("Surgery Department Definition' 2012, par. 1).

1.2. Surgical Research and Development in the Philippines

Limson, et al. (1999) discuss a summary of the research and development of Surgery Department in general as follows: "progress and development in surgical research has been slow. Much of this can be attributed to poor economic conditions with a consequent low priority given to research in other areas as well".

1.3. Evidence-based Design

The Philippine Journal of Surgical Specialties, the official publication of the PCS, has been in existence since 1946, along with later journal publications in obstetrics and gynecology, ophthalmology, orthopedics, urology, and thoracic and cardiovascular surgery. Despite these avenues for publication, there remains a lack of institutional direction and support given for surgical research, except for a few selected university training programs. Financial incentives are few and confined to sponsorship of research competitions. Furthermore, there are very few surgeons with full-time careers in research. Likewise, economic conditions have influenced the influx and development of new surgical technology. Although advances in communications and information technology have made the Filipino surgeon up-to-date with the latest surgical advances, applications of this new technology have been limited to a few, well-financed private medical centers in urban areas. ("Surgery in the Philippines", 1999, par. 21-22).

In the 1980s, Evidence-based design or EBD began to take form in the United Kingdom as a response to the wide array of problems faced by the healthcare industry. Some of these problems included healthcare-related infections and sub-optimal work environments brought upon by a system that, at the time, would have been considered below international standards. Evidence-based design adapts the philosophies of evidence-based medicine into an architectural application. Evidence-based medicine refers to the diligent and prudent utilization of the best current evidence in the decision-making of an individual patient's medicine prescriptions and welfare. It is a method of prescribing the best possible medical interventions in terms of effectiveness and efficiency, through the means of scientifically gathered evidence. In the same vein, evidence-based design is an approach to aid designers in their decision-making with the use of established research and bodies of knowledge with regards to the effects of these design interventions on the users, its affordability, and manageability.

Numerous studies have been made on the different architectural elements of healthcare facilities such as: materials, texture, ambience, layout, color, wayfinding, accessibility, etc. These studies have shown that there is a kind of causal correlation between negative and/or positive health outcomes and the built environment. The living conditions of various healthcare-related cases have been investigated as well, of which include the living conditions and wayfinding of patients with Alzheimer's disease and elderly patients. These studies observed and measured the patients' health, such as depression, stress, recovery period, and the patients' experiences.

Roger Ulrich and colleagues showcased a review of evidence in the USA, supporting the case that healthcare environments have an impact on its users. The NHS Health Building Notes and Health Technical Memoranda from the UK are based upon evidence. ("Journal of Health Services Research & Policy", 2009, pp. 194-195).

1.4. Importance of Evidence-based Design

To determine an irrefutable performance of a facility design, certain indicators must be used as evidence to countercheck the experience of the user and vice versa: by testing the existing hospitals and subjecting them in a comparative analysis, the researcher could come up with more empirical data and analysis regardless of department.

Evidence-based design is highly prioritized in medical research because of its irrefutability, as well as its reliability. Evidence-based Medicine (EBM) and Evidence based Design (EBD) are related as a research methodology. The process of gathering information and cross-checking using evidence has been reliably sourced as a precedent on design of hospitals or other healthcare facilities to ensure the safety or effectiveness of a design proposal before it is approved for construction.

In the context of the Philippine practice of design, EBD can already be practiced by professional architects to solve a variety of design problems or challenges. However, in the field of hospital design, sometimes the experience of the architect might not be sufficient for the factors that were uncommon to other typologies, such as infection control, space efficiency, among others. Thus, there is a need for further research using EBD.

1.5. Eminence-based Medicine

On the other hand, Eminence-based medicine refers to a "clinical decision that is made by relying purely on the opinion of a medical specialist or any prominent health professionals rather than relying on critical appraisal of scientific evidence available". Many may think that prominent health professionals possess more skills and knowledge; therefore, their opinion on a particular health matter is sufficient to justify a clinical decision. However, in doing so, there is a risk of introducing logical fallacies into practice by using arguments from authority to support decision-making. It is true to say that an expert would have more knowledge than a lay person, and their years of experience increase their credibility; however, their opinion is not valid unless it is based on scientific evidence ("Eminence-based Medicine vs Evidence-based Medicine", 2016, par. 2).

The term "Eminence-based Design" was coined by Salcedo (2017) in his presentation about the "Latest Innovative Concepts in Healthcare Architecture at UP College of Architecture as part of an assignment from Arch 221 design class of Ar. Richard Rinen. Ar. Miguel Andres Salcedo used this term to represent hospital facility designs that were based on the personal preferences and opinions of the owner, in this case a doctor at Lourdes Hospital in Quezon City.

Contextualizing to Eminence-Based Medicine, Eminence Based Design is a design process for healthcare facilities relying only on the opinion of the medical doctor, possibly the owner or the chief of medicine, but can also be observed among subordinates. This design process can hinder the effectiveness of an architectural design of a hospital, particularly the surgical department.

Rydenfalt (2014) emphasized the importance of efficiency in the surgical department by stating that in the operating room, anesthesiologists, anesthetist nurses, circulating nurses, scrub nurses, and surgeons meet as a team, in different constellations, to provide surgery for the patient (Ryndenfalt, 2014. p. 2, par. 1). Operating room management focuses on reducing time wasted to perform more cases in regular business hours, reduce overtime, or provide a better experience for staff and patients (Krupka, et al., 2006. p. 1, par. 1).

The fact that Eminence-Based Design is an architectural design brought upon by an opinion of a different professional (the doctor) can affect the overall performance of the surgical department. Evidence-Based Design is aspiring to address this problematic occurrence, not to mention the design dilemma which states the paralysis of conceptualizing a surgical department due to the complexity of different users at play: the staff and the patient.

1.6. Major Surgical Procedures

Makati Medical Center (2018) disclosed on their annual report their major surgical procedures for the year 2018 as follows:

1. Laparoscopic Cholecystectomy
2. Exploratory laparotomy
3. Open appendectomy
4. Total Abdominal Hysterectomy
5. Bilateral salphingo-oophorectomy
6. Complete thyroidectomy
7. Open cholecystectomy
8. Laparoscopic appendectomy
9. Hemorrhoidectomy
10. Modified radical mastectomy

From the list above, it is observed that, in terms of volume, the majority of surgical procedures conducted in the given year are not related to organ transplant.

1.7. Major Surgical Procedures

The Commission released its seminal report in April 2015 titled "Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic growth". Among the report's most substantive contributions was a global consultative process leading to recommendations for global adoption of six core indicators of national surgical system strength.

From this number, two indicators measure a surgical system's preparedness for delivering surgical care: the proportion of the population within two hours' travel time of a surgical hospital and the number of surgical, anesthetic, and obstetric specialists per 100,000 populations. Meanwhile, two measures realized access to safe surgery, namely the surgical volume per 100,000 populations each year and the perioperative mortality rate. Finally, since access cannot be conferred without affordability, the last two indicators examine the risk of impoverishment and catastrophic expenditures that people might experience by seeking surgical care. Together, these indicators allow for a rapid assessment of strength and weakness in a surgical system, defining opportunities for improvement for national governments ("The Lancet Commission on Global Survey", 2015. p. 4, par. 2).

1.8. Surgical Volume

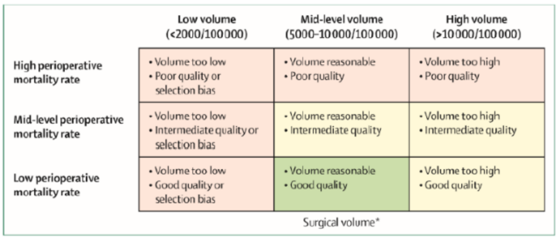
Surgical Volume is the number of procedures undertaken in an operating theater per 100,000 population per year in each country. A procedure is defined as the incision, excision, or manipulation of tissue that needs regional or general anesthesia, or profound sedation to control pain ("The Lancet Commission on Global Surgery", 2015, p.7, par. 3).

1.9. Surgical Volume as indicator

Data confirm that it is predominantly High-Income Countries (HICs) that meet the Lancet Commission on Global Surgery target of 5,000 procedures per 100,000 populations for surgical volume. The Weiser model relies exclusively on healthcare spending per capita: the volume of surgical procedures in countries spending more per head on healthcare was higher than that in countries spending less per head on healthcare. This model was designed to provide global estimates of surgical volume, rather than country-specific estimates, though it also provides the latter.

Primary data were collected from countries to examine the accuracy of these country-specific estimates ("The Lancet Commission on Global Surgery", 2015, p.25, par. 3). The researcher determines that as an indicator of the number of procedures undertaken in an OR per 100,000 populations in the Philippine context, a unit of measurement of the efficiency of a certain facility design can be identified and will be sampled in this thesis.

The figure below (see Figure 1. POMR matrix) from The Lancet Commission on Global Surgery presents the consequence of Surgery Volume to perioperative mortality rate. For this figure, the quality of the facility is being analyzed through quantitative data, expressed by Surgical Volume as a form of measurement.



	Low volume (<2000/100000)	Mid-level volume (5000-10000/100000)	High volume (>10000/100000)
High perioperative mortality rate	• Volume too low • Poor quality or selection bias	• Volume reasonable • Poor quality	• Volume too high • Poor quality
Mid-level perioperative mortality rate	• Volume too low • Intermediate quality or selection bias	• Volume reasonable • Intermediate quality	• Volume too high • Intermediate quality
Low perioperative mortality rate	• Volume too low • Good quality or selection bias	• Volume reasonable • Good quality	• Volume too high • Good quality

Surgical volume*

Figure 1. POMR matrix.
Source: The Lancet, Meara JG, Leather AJ, Hagander L, et al., Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development, page 44, Copyright (2015), with permission from Elsevier.

Figure 1. POMR Matrix

Source: from the author

II. Problem Setting

2.1. Rationale

Why do we need Evidence-Based design? One important point that should be established in this thesis project is the fact that the design process is a complex architectural enterprise, and yet, in general, very few Filipino writers delve into architecture research. The need for a facility design that has been conceived using evidence-based design can greatly affect the wellness of its users, as well as the staff and the patient. The Ariadne Report emphasized this further by stating that the consequences of limited evidence-based decisions include propagation of designs that are low value, expensive, and even potentially harmful to patients ("Mass Design Group, & Ariadne Labs", 2017. p. 3, par 2).

2.2. Statement of the Problem

2.2.1. Main Problem

What is the best way to evaluate the design of a surgery department? This inquiry requires evidence to validate its irrefutability; therefore, there is a need to use designs that can be backed up with quantitative analysis and data. This is radically different from design that came from qualitative principles, which tends to become subjective or refutable.

2.2.2. Sub Problems

The following sub-problems are identified to supplement the main problem and break down the inquiry into specifics to be tackled in this thesis:

1. How do different factors affect the generation of appropriate facility design? This will be a benchmark for the general efficiency of an operating department.
2. How can certain factors be utilized as precedent to facility design? This inquiry will delve into the details of peculiar designs beyond standards or provisions that might become experimental in nature.
3. What is the role of existing Surgical Departments in the Philippines as basis for future design proposals? This inquiry will guide the researcher into determining the correct methodology and unit of measurement to uncover the evidence needed to conclude the research.
4. What could be the design elements that need investigation when comparing and analyzing Surgical Departments in the Philippines? This will be the guiding inquiry to limit the focus of the research to the cases which had the greatest number of demands (on average) to most Level 3 Hospitals in the country. In this case, at least the top 3 cases will be considered.

2.3. Goal of the Study

The study aims to validate the effectiveness of local Operating Department facility designs by measuring them within the quantitative premises of evidence-based design, which is scarcely written about in the Philippine context. Filipino architects and designers tend to rely on standards or building codes without refuting its effectiveness in application, as validated by the Ariadne report in the international context. Evidence-based design of the built environment may provide an underutilized platform for creating scalable improvements in healthcare ("Mass Design Group, & Ariadne Labs", 2017. p. 3, par 1).

2.4. Objectives

1. To create a design based on the data processed in the study using the project site which shall be chosen based on a rubric.
2. To address the design dilemma identified by Thomas (2010) and eminence-based design in the context of the operating department of hospitals.
3. To create a conjecture study using evidence-based design.

2.5. Significance of the Study

The importance of undertaking this study comes from the history of designing hospitals in the Philippines: in its early days, hospitals were conceived with no regard to the implications of design to its users or to flow, designed through a trial-and-error process, or based on international standards that are not always applicable to the local setting and culture. Arguably, the effects of these designs may be intangible, but its implication to the overall performance of an operating room can be drastic. Nevertheless, no research has been conducted to thoroughly investigate these designs.

Krupka and Sandberg (2006) cited the importance of facility design to the efficiency of an OR: Operating rooms are high-cost / high-revenue environments. In an era of rising costs and declining reimbursement, it is essential to optimize the effectiveness of the operating room suite, maximizing throughput of profitable cases while minimizing the costs of necessary but profitable procedures (https://cutt.ly/Hwl7W7T, 2006, par. 1). As health systems evolve, clinical environments have shifting needs. But even when changes are anticipated, contingency planning is seldom informed by empirical evidence of what does and does not work ("Mass Design Group, & Ariadne Labs", 2017. p. 3, par 2).

2.6. Scope and Limitations

Facilities will be identified using methods similar to the modified Delphi selection method ("Mass Design Group, & Ariadne Labs", 2017. p. 5, par 1).

1. Online solicitation process
2. Selected to maximize cohort diversity

Research methods will be provided in consideration to the ethical aspect of the study. No human testing is needed to complete this study. For details, please refer to Chapter 5 Research Methodology (5.4 Research Ethics Context).

2.7. Assumptions

2.7.1. Evidence-based design is not fully systematized in healthcare design in the Philippines.

2.7.2. Designing Surgical Departments / Operating Rooms in the Philippines might be problematic because its design dilemma is not well understood.

2.7.3. Western principles in hospital design deviates from Filipino culture; thus, there is a need to integrate local culture and values, which will give insight in identifying movement systems during the conceptualization of space programs.

2.8. Hypothesis

2.8.1. The researcher hypothesizes at the beginning of this research the following:

2.8.2. The surgery department should be the most important development in the hospital and must be prioritized in terms of site development, location, and space allocation.

2.8.3. Facilities involved in this paper can give insights on how facility design performs and how it affects surgery case accommodation and efficiency. To measure this, an evidence-based approach is prescribed.

2.9. Definition of Terms

2.9.1. Design Dilemma

A critical decision for which there is no clear, obvious solution (Thomas, 2010).

2.9.2. Eminence-based Medicine

Refers to a clinical decision that is made by relying purely on the opinion of a medical specialist or any prominent health professional rather than relying on critical appraisal of scientific evidence available (Nhi Le, 2016).

2.9.3. Evidence-based Design (EBD)

The process of basing decisions about the built environment on credible research to achieve the best possible outcomes ("The Center for Health Care Design", 2019).

2.10. Glossary

2.10.1.ASC

Ambulatory Surgery Clinic

2.10.2. CSMC

Cardinal Santos Medical Center

2.10.3. CSSR

Central Sterile Supply Room

2.10.4. DOH

Department of Health

2.10.5. LDR

Labor & Delivery Room

2.10.6.MHC

Mid-Coast Hospital

2.10.7. OR

Operating Room/s

2.10.8. PGH

Philippine General Hospital

2.10.9. SV

Surgery Volume

2.10.10. VRPMC

Victor R. Potenciano Medical Center

II. Review of Related Literature

3.1. Healthcare Facility Design and Floor Plans, Fast Nurse (2018), Available at: http://www.fastnurse.com/surgicenter-design.html

The Healthcare Consulting Company covers Medical Consultation and Procurement of Equipment and Supplies for Hospitals. They also present recommendations and information regarding Surgery Center Designs and Floor Plans.

The "FLOW" Design by Fast-Nurse Accreditation Consulting focuses on users' experiences within the Department as well as the Architectural layout aspect of the facility. The factors consider aesthetics while also promoting safety, privacy and maximizing efficiency for the staff, practitioners, patients, relatives, and visitors. It is expressed through the arrangement of the Department areas, including operating rooms, storage/equipment rooms, staff break room, and lounge areas. Also taken into consideration are the walls, window, and the circulation of hallways.

The methods conducted shows emphasis on the circulation of traffic flow and the sizes of each room, allowing efficient and easy movement and access in each given area. It segregates the spaces depending on its relation to the function of the room. The method also suggests separating zones to avoid cross-contamination between surgical departments and common areas and facilities while giving the opportunity for patients to be accompanied by a relative. The layout is designed to be centralized for both staff and visitors. "FLOW" method by Fast-Nurse Accreditation Consulting can serve as reference for furthermore review in order to achieve efficient circulation in surgical departments.

3.2. Designing Capacity for High-Value Healthcare: The Impact of Design on Clinical Care in Childbirth, MASS Design Group (2016), Available at https://massdesigngroup.org/sites/default/files/file/2017/170223_Ariadne%20Report_ Final.pdf

Conditions and outcomes within Childbirth services vary. As such, this paper provides ample insight regarding healthcare delivery both in terms of quality and process—as a basis for evidence-based design, specifically, the factors that thoughtful design can address to best achieve users' safety, experience, and affordability.

Childbirth ranges from healthy natural births to the worst case, ill patients in need of emergency surgery. As a visual reference, there are shows and movies which depict very dramatic yet quite realistic medical scenes (Grey's Anatomy, Patch Adams, etc.). Surgical birth or Cesarean delivery are frequent, varying from 7% to 70% of childbirth services across American hospitals. Unfortunately, approximately half (45%) seem to be unnecessary, especially since it impacts negatively on safety, experience, and affordability for the patients. Surgical complications, physical and psychological suffering, and about $5 billion spending (in the US) per year could have been avoided.

The research was conducted as a one-year exploratory study. Findings provide opportunities to improve healthcare delivery overall. Authors found that the greatest predictor for the need of cesarean delivery lies on the facility where the expecting mother will give birth because Hospital Design appears to affect patient safety, satisfaction, staff effectiveness, and overall quality care.

Consider this analogy: identical seeds are tested for comparison. One is planted in barren land. The other is planted in rich soil. They each grow; however, each plant's life quality often reflects the environment it was exposed to. A harsh environment results in a noxious life. Meanwhile, a nurturing environment results in a healthy life. It is because the environment heavily affects mood and feelings. In turn, the users of the space would likely maintain the mood. The researchers gained insights and lessons through their involvement in small & large-scale design interventions. It gave them the conclusion that facility design influences, either hindering or helping, the users (health workers and patients), which were mostly evident in the health staff's procedures, patients' experience, and other survey data.

This research, by Ariadne Labs, essentially concludes that High-Value healthcare is achievable through thoughtful hospital design via evidence-based means. Of course, there is always room for improvement which evidence-based design naturally utilizes.

3.3. Administrative Order 2016-0042 (A.O. 2016-0042), DOH, 2016, Manila: Department of Health
Administrative Order (A.O.) No. 2016-0042 entitled Guidelines in the Application for Department of Health Permit to Construct (DOH-PTC) states that a permit must be issued upon compliance with required documents prior to the actual construction of the said facility. It is also required that there should be substantial alteration, expansion, renovation, increase in the number of beds or for additional services.

Under Section V.B.7, within 15 working days, the HFSRB or RO will approve or disapprove the application for a Department of Health Permit to Construct (DOH-PTC) and inform the applicant of the status whether it approved or disapproved. The Department of Health Permit to Construct (DOH-PTC) will be duly signed by the HSFRB Director or the Regional Director for the approved applications and the disapproved one will be returned, together with the documents and findings to the applicant.

Once approved, they must submit a progress report or statues on the construction for both new and existing health facility every six (6) months until the completion of the project. It is mentioned that the permit will be revoked or will be sufficient ground for the imposition of sanctions based on the provisions of Administrative Order No. 2016-0042 and other related issues, if any unauthorized deviation from approved floor plans or if there are any violations of the above condition. If the facilities are to be found violating any provision of the rules and regulations and its related issuances, and/or commission or omission of acts by the owners or the management of a hospital or health facility under this shall be penalized through the issuance of:

A. A Cease-and-Desist Order of the construction if the health facility is new and unlicensed
B. A Cease-and-Desist Order of the construction and operation of the area not included in the approved PTC and/or imposition of other sanctions based on other related issuances if the health facility is already existing and licensed.

For the previous issuances that are inconsistent or contrary to the provisions of this Order shall be deemed impliedly revoked but those provisions shall remain valid and in force if any provision or part of this Orders is declared unauthorized or rendered invalid by any court of law or competent authority.

3.4. Advancing Evidence-Based Healthcare Facility Design: A Systematic Literature Review, Farouq Halawa, Sreenath Chali Madathil, Alice Glittler, Mohammed T. Khasawneh, (2019), Available at: https://www.researchgate.net/publication/341608703_Advancing_evidence-based_healthcare_facility_design_a_systematic_literature_review

Change is constant and apparent in the recent construction and renovation of healthcare facilities that continue to push for the development of evidence-based designs that help improve the quality outcome of a patient's recovery during his or her stay within the premises of the healthcare facility. Results of numerous complex medical research has brought forth more redesigning project proposals within hospitals in the United States of America (USA).

According to research, the structural form and intricate design elements may be a challenge; however, there have been over 23% newly constructed hospitals and over 22% renovated hospitals in the USA that have thought about evidence-based designs that support the whole healthcare facility and affect the psychological environment of the patients and medical staff that dwell and work within the area. It is tested and proven through extensive medical studies conducted that certain design elements have a great impact in the improvement of healthcare spaces as it focuses on supporting crucial aspects, such as the operational, environmental, experiential, clinical, and organizational objectives. Evidence-based design will not only provide a high-performing and versatile environmental experience for patients and medical staff but will also be more cost-efficient as the design ideas linked to the patients' medical records will be put into consideration for the redesigning of the said patient's facility or preferred environment in order to help the patient function better.

Most of the hospital designs in the Philippines are currently not up to par with the standards of applying the advancing evidence-based designs unlike in the United States of America; however, it would be a huge improvement if they begin following the process of those healthcare facilities that use their scientific studies and complex medical research from understanding the specific special needs of every patient and documenting what kind of environmental factors affect their psychological and physical aspect to improve on the patient's recovery and the well-being of both patients and medical staff within the space. That way, both the economic factor and the users' experience may be optimized from the more enhanced engineered designed programs within the facilities when both researchers and designers collaborate on the future of hospital architecture.

3.5. Evidence Based Design and healthcare: an unconventional approach to hospital design, Alfonsi, E., Capolongo, S., & Buffoli M. (2014), Available at: https://www.researchgate.net/publication/261882158_Evidence_Based_Design_and_healthcare_an_unconventional_approach_to_hospital_design

Evidence Based Design (EBD) is a scientific analysis methodology that emphasizes the use of data acquired to influence the design process in hospitals. It measures the physical and psychological effects of the built environment on its users. EBD uses formularization of hypothesis, testing/analyzing and outcome gathering as a framework.

EBD assumption: decentralized nurse stations reduce staff's walking time and increase patient-care time, especially when supplies are also decentralized and located close to the nurse stations. This research presents different case studies and different results as well. One of the considered aspects focused on the effects of nurses' unit distribution. In this project, nursing stations with computer access were decentralized and additional workspaces were provided outside each patient room, as well as supplies stores.

Through EBD observation, the authors noticed that efficient unit design helped in reducing nursing staff walking, and the saved time was thus translated to patient-care activities. A recent study has demonstrated that the lack of a central nurse station sometimes affects communication between the personnel and new trainees.

Hybrid solutions (a central nurse station + some decentralized smaller ones) are currently under review to perform a better result in staff-work effectiveness. Furthermore, for what concerns decentralized supplies, it is important to notice that it is always quite difficult to find room enough for a number of satellite disposals.

Strong evidence demonstrates the positive effects of distractions such as nature, art, music, companion animals in the improvement of patient healing. View of nature (real or simulated, for an exposure of 3–5 minutes at most) is assigned to reduce negative emotions such as fear, anger, and sadness. The benefits are demonstrated by clinical studies as well. Contact with nature or nature's image reproductions produces a quick drop in the stress levels and, subsequently, physiological changes in blood pressure, heart activity, muscle tension, and brain electrical activity occur. Those positive effects are valid for anyone, but they particularly produced significant outcomes for hospital patients.

3.6. The evidence-based design wheel, Kahler Slater Architects Inc. (2007), Available at: https://www.healthcaredesignmagazine.com/architecture/evidence-based-design-wheel/

As reported in a recent review of the literature, single patient rooms have shorter length-of-stays, fewer medication errors, lower costs, higher occupancy rates, lower rates of hospital-acquired infection, fewer patient transfers, increased privacy and control, less noise, fewer sleep disturbances, and higher patient satisfaction.

Noise negatively affects patients and staff, yet hospitals are notoriously noisy places. Noise disrupts sleep, impedes healing, and causes stress. Sound levels in hospitals (typically 65-85dB, comparable to a loud restaurant or heavy street traffic) result from a cacophony produced by a combination of sources: people walking, talking, and simply doing their jobs; buzzes, beeps, and alarms from equipment; and the many hard surfaces that are easy to keep clean but do little to absorb noise. Reducing noise can be achieved by adopting a systemic approach to sound control that requires attention at four levels: noise-attenuating materials selection and installation, proximal location of support spaces and equipment, operational and behavioral changes by staff, and equipment maintenance.

Patients in rooms with windows, particularly windows with pleasant views to nature, have shorter recovery times and fewer complications, and request less pain medication. Employees with access to windows and nature views experience less stress, better health, and higher job satisfaction. The bright light, either natural or artificial, can improve patient outcomes, affecting such factors as depression, agitation, sleep, circadian rest/activity rhythms, and length of stay. Sunlight has been linked with shorter stays, lower stress, less pain, lower intake of pain medication, and even lower mortality. For staff, ensuring that appropriate, nonglare light levels are brought to the tasks at hand can improve staff accuracy and effectiveness.

Research has repeatedly demonstrated the emotional and physiological benefits of visual and physical access to nature: stressful and negative emotions decrease while pleasant emotions increase. Patients viewing nature recover faster, have less stress, anxiety, and pain, and require less pain medication. Gardens located in healthcare settings offer patients, visitors, and staff the opportunity for direct interaction with the restorative, calming effects of nature.

The term “positive distractions” refers to several socio environmental features—music, laughter, pets, and realistic art (preferred over abstract by most patients), as well as natural elements such as trees, flowers, and water—the presence of which improve mood and relieve stress. These positive distractions attract and sustain attention, produce positive reactions, and alleviate stress and anxiety.

In public areas, different types of furniture arrangements can either discourage or promote social interaction. For example, seating arranged around the perimeter of a room (as in the archetypal healthcare waiting area) and large open dining areas furnished with long banquet tables (such as in the typical hospital cafeteria) are institutional, noisy, and inhibit interpersonal interaction. Arrangements that promote social interaction in waiting areas include comfortable, supportive furniture positioned in small, flexible groupings, with seating placed at right angles. Large dining areas should be subdivided with tables seating four to encourage social interaction, enhance relative privacy, and improve eating behavior.

Poor air quality and ventilation allow the transmission of bacteria and put patients and staff at risk of hospital acquired infections. The type of air filter, direction of airflow, air pressure, air changes per hour, humidity, and ventilation system maintenance have all been linked to infection rates. The risk of infection can be reduced through the careful design and maintenance of hospital HVAC systems, use of HEPA filtration, and implementation of preventive measures during renovation and construction.

The three main flooring options for healthcare settings—carpet, vinyl, and rubber—each have unique benefits and limitations. Based on findings from our own research, we advise clients that flooring decisions for patient care areas be made on the basis of materials performance in line with four (often divergent) criteria: infection control, ease of maintenance, potential to contribute to a systemic program for sound control, and specific patient population needs and preferences. Disorientation in built environments is embarrassing and stressful, wastes time and, in some cases, is even fatal. Support for wayfinding depends on more than signage and colored lines on the floor—a good wayfinding program requires an integrated, coordinated system in which three elements—human behavior, environmental design, and organizational policies and practices—all work in harmony to ensure that patients, visitors, and staff can effectively navigate the environment.

Workstations that are close to patients result in fewer errors, decrease nurses’ travel time and distances covered during the day, increase nurses’ time spent caring for patients and families, and improve job satisfaction. Decentralized workstations that incorporate supplies are convenient, improve delivery time, and reduce supply costs. Patients and staff in healthcare settings benefit from improved ergonomic designs of furniture and equipment. Among patients, injuries such as falls decrease in environments that are designed from an ergonomically conscientious perspective. Patient comfort during medical procedures and hospital stays is improved with thoughtfully designed furnishings. Improved ergonomic designs of patient beds, assistive equipment, and workstations reduce stress and injuries among staff.

IV. Theoretical Framework

4.1. Theories Relevant to the Problem

Two important theories will be used for this research: (1) patient-based design and (2) staff-based design. However, both will be represented by Evidence-Based Design and Lean-led Hospital Design, respectively, as the formal indicators of their effectiveness.

While Evidence-Based Design is a tool to measure the effectiveness of a study, it also has the capacity to combine the qualitative insights of the research and the quantitative view of the subject. On the other hand, Lean-led Hospital Design is a guiding principle for obtaining insights from users but also validates technical considerations, such as motion economics, thus, making the hospital “lean” from excessive design aspects.

4.1.1. Evidence-Based Design (EBD)

Evidence-Based Design (EBD) is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes. Included in this process are the following eight steps:

- Define evidence-based goals and objectives.
- Find sources for relevant evidence.
- Critically interpret relevant evidence.
- Create and innovate evidence-based design concepts.
- Develop a hypothesis.
- Collect baseline performance measures.
- Monitor implementation of design and construction.
- Measure post-occupancy performance results.

A large and growing body of evidence attests to the fact that physical environment impacts patient stress, patient and staff safety, staff effectiveness, and quality of care provided in hospitals and other healthcare settings. Basing healthcare facility planning and design decisions on this evidence to achieve the best possible patient, staff, and operational outcomes is what evidence-based design is all about.
(https://www.healthdesign.org/certification outreach/edac/about, 2019, par. 1-3).

To see The Center for Health Care Design's diagram of the EBD process, refer to Figure 2 below.

4.2. Theoretical Framework

A theoretical framework consists of concepts and, together with their definitions and reference to relevant scholarly literature, existing theory that is used for your study. The theoretical framework must demonstrate an understanding of theories and concepts that are relevant to the topic of your research paper and that relate to the broader areas of knowledge being considered. The theoretical framework is most often not something readily found within the literature (University of Southern California, 2018).

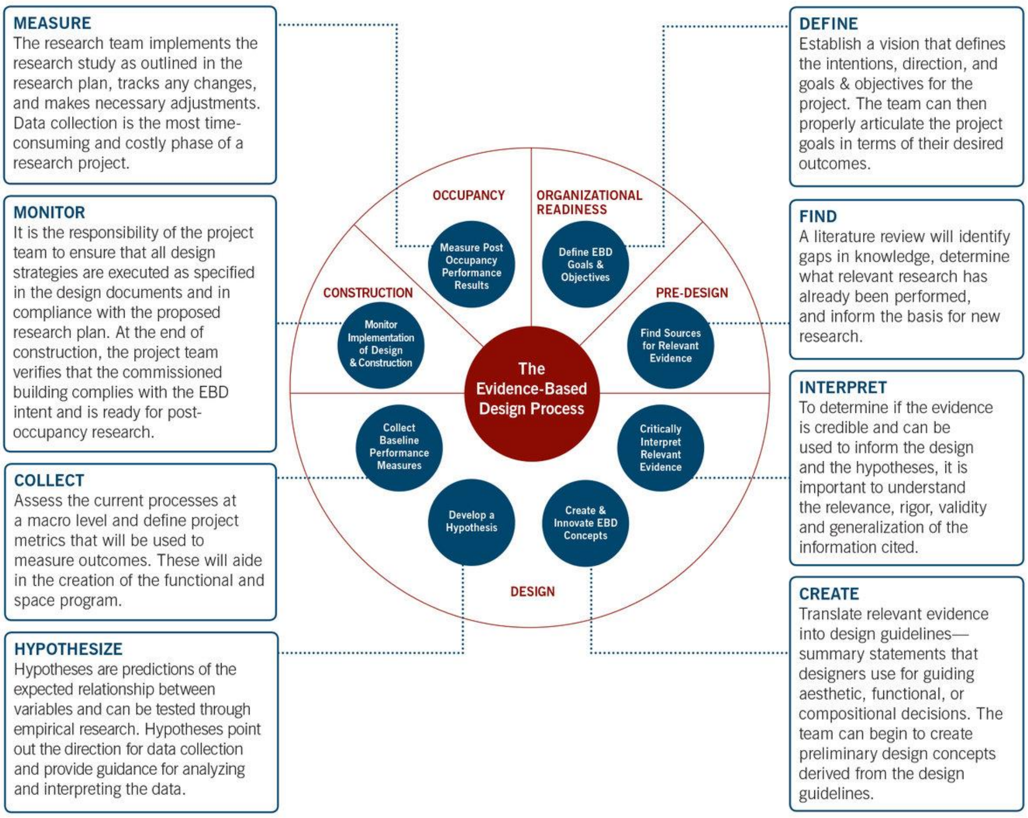


Figure 2. Evidence-based Design Process
Source: The Center for Health Care Design

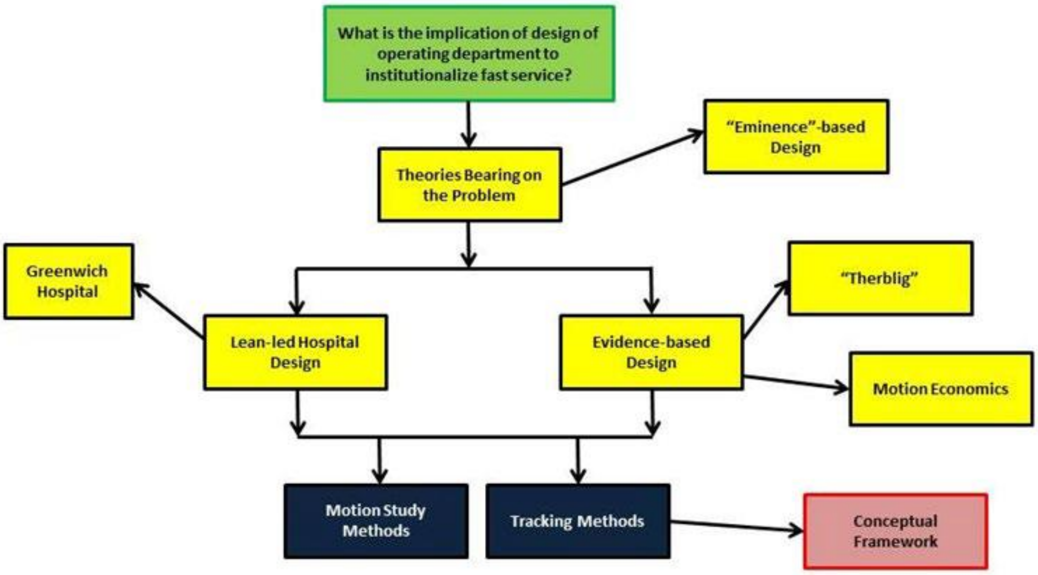


Figure 3. Theoretical Framework
Source: from the author

4.3. Conceptual Framework

A conceptual framework represents the researcher's synthesis of literature on how to explain a phenomenon. It maps out the actions required during the study given his previous knowledge of other researchers' point of view and his observations about research. It is the researcher's "map" in pursuing the investigation (SimplyEducate.me, 2012). See figure 4.

4.4. Methodological Framework

A more concise approach to create a comparative analysis is to relate the survey to the floor plan analysis, as per the methodological framework (See Figure 4), the needs of the staff and the insights of architect will be reflected on the survey and will be used as justification for the rationalization of the design elements that will be prioritized in data analysis. Analysis and Evaluation will be applied using visual language (floor plans, diagrams, etc.) and will be the conclusion of this research as the recommended design elements that qualifies as "good" design practice for a hospital surgery department. See figure 5.

4.5. Research Flowchart

Looking at Figure 6, a more specific method has been developed to extract and synthesize data gathered for the research. This will bridge the gap between the design and the outcome of hospital design. Explanation for each flowchart are as follows:

1. Documentation phase: wherein the research must gather all necessary data, including existing hospital floor plans, surgery case outcomes, related literature, etc.
2. Definition phase: establishing what is the principle of EBD and its importance.
3. Goal setting phase: finding an outcome within the surgery department that can be related to design, in this case surgery case per day has been potentialized as such.
4. YES/NO phase: once the lancet has been established as the main reference the researcher can ask whether it is enough of an outcome, if not, the researcher can look for another reference.
5. Evaluation phase: once the outcome and the design has been established, design elements can be ranked upon importance using surveys to medical personnel who use surgery departments. This will be the basis upon which the surgery department can be measured.
6. Analysis Result: The outcome on evaluation phase can be used now to establish a scoring of existing design and comparing different results on different samples.
7. Testing: This analysis can now be used as a precedent to create a proposed surgery department and can also be used as a base case/ improved case study.
8. Recommendation and future development: all outcomes can now be used as a precedent for future researchers.

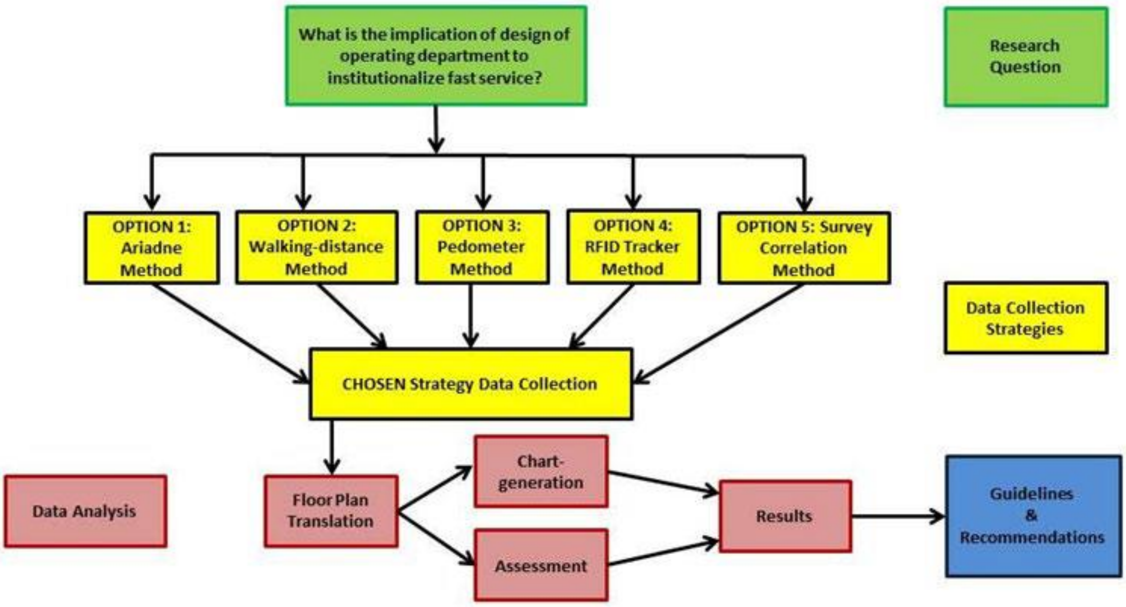


Figure 4. Conceptual Framework

Source: from the author

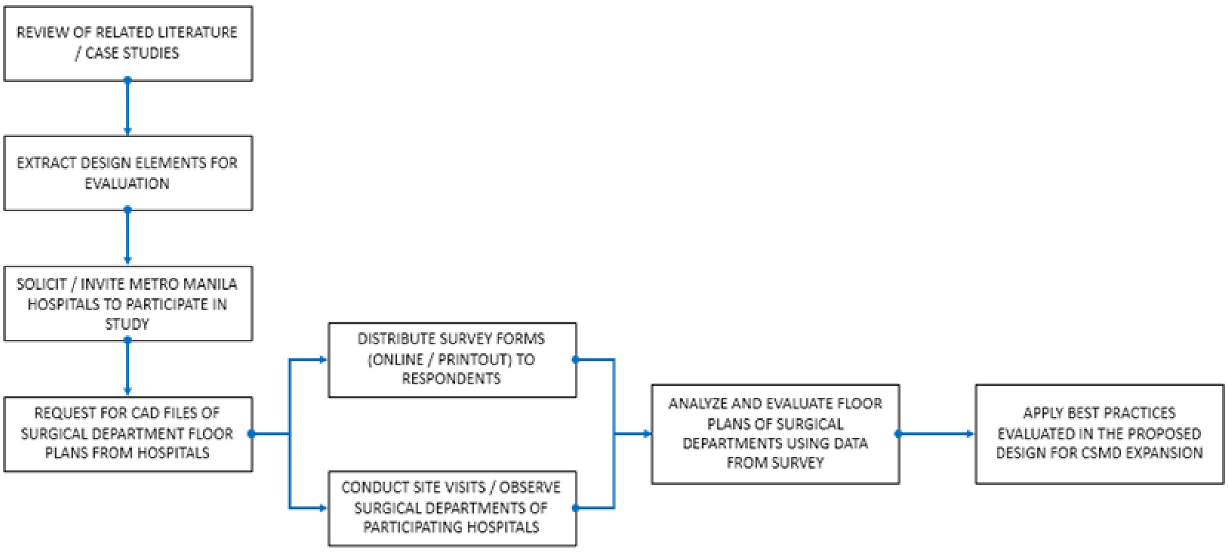


Figure 5. Methodological Framework

Source: from the author

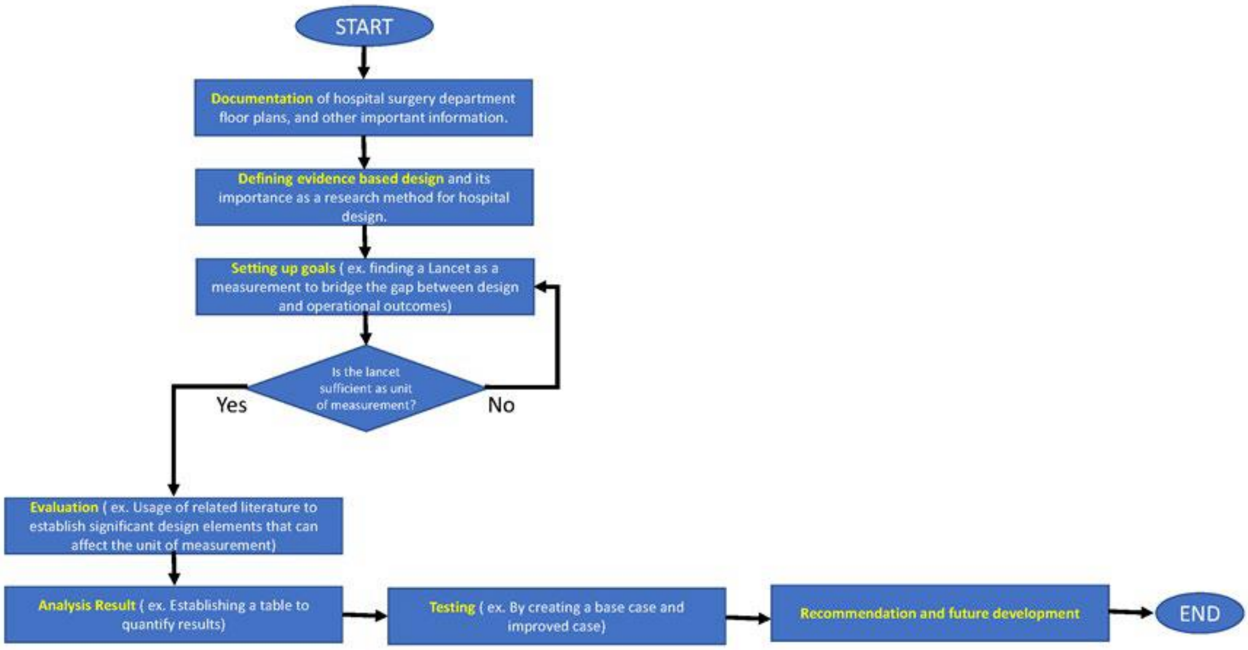


Figure 6. Research Flowchart

Source: from the author

V. Research Methods

5.1 Formal Selection of Research Methods

By Rationalizing the chosen methodology, the researcher can determine whether the research method is the best within the context of time, research ethics, as well as how results produced can affect the conclusion and recommendation of the whole thesis paper.

Table 1. Methodology Selection Chart

#	Research Methods	Characteristics			Data Collection Strategies			Research Ethics	TOTAL POINTS	REMARKS
		Variable will be a lesser influence	Can compare different scales	Can give different insights	Floor plan analysis	Survey	Site Visit	Research Ethics Committee Feasibility		
1	"Ariadne" research methodology								6	Chosen
2	Walking-distance methodology								5	
3	Pedometer method								3	
4	RFID indoor tracking method								3	
5	Survey-correlation method								6	Chosen

LEGEND:
- applicable/ compatible (1 POINT)
- not applicable/ not compatible (0 POINT)

Source: From the Author.

From the reviews of Chapter 5, the researcher has established the pros and cons of using each research methodology. One of the most important aspects of the research is the "Research Ethics Committee Feasibility", which allows data to be retrieved without the use of human testing or without the need to disrupt an actual operation during fieldwork, such as the walking-distance method, pedometer method, and RFID indoor tracking method which includes human tracking, detection, or global positioning systems. This data gathering that heavily relies upon technology is not feasible because of the time and high cost of buying all the equipment needed to accommodate all samples.

Thus, there is a need to find alternative methods that could get similar data. This is where the Survey Method and Ariadne or Modified-Delphi Method comes into play. Ariadne Method inherently addressed this problem when the Mass Design Group experienced the same problem on their research about Labor and Delivery Rooms in the United States of America (2017). However, not all findings of the Modified-Delphi method could give a well-rounded perspective of the samples, which is why it is necessary to incorporate the Survey Method to validate the data to be collected from the former. The mixed-methodology between Modified-Delphi method and Survey Method is what the researcher will utilize in this thesis paper.

5.2 Establishing Design Element Using the Modified Delphi Selection Process

A design element is the data to be used as "evidence" for this research to be derived from the Ariadne Method, which has been sourced form experts in the United States using a selection method called, "Modified-Delphi method" (Mass Design Group, 2017).

"We used a Modified-Delphi consensus management process with the board to prioritize among the design elements identified through our prior research and the literature. Before meeting in person, board members completed a survey rating the relative impact of design elements on clinical decision-making during childbirth care and shared their hypotheses on the mechanisms behind these links based on their experiences. We presented the survey results to the board members at an in-person meeting and then conducted a moderated discussion to explore areas of disagreement. (Mass Design Group & Ariadne Labs, (2017. p.8, par. 2). The following design elements had been established by the case study, in no particular order:

- Presence of Overflow Spaces
- Ratio of L&D Rooms to ORs
- Proximity of Workspaces and Rooms
- Interdisciplinary Work and Rest Spaces
- Patient Accessible Spaces
- Prominence of Fetal Monitoring
- Number of L&D Rooms
- Labor Support Equipment Access
- Type of L&D Rooms (LDR & LDRP)
- Nature/Outdoor Views
- Room Demand
- Room Standardization
- Comfort
- Family & Guest Amenities
- Staff Amenities or Support Spaces
- Number of ORs
- L&D Room Size

5.3 Respondent's Profile

In the extent of the researcher's network, 30 solicitations from doctors and nurses were distributed. Of this number, 16 committed to answering the survey provided, which is close to 18 respondents of the similar US study using the same survey. Given the respondents' varying backgrounds and facilities employed in, experiences expressed on the data provided showed different scales, location, and hospital Levels. As per Table 2.0 below, there are seven (7) Medical Doctors (MD) and nine (9) Registered Nurses (RN) 2. who responded to the survey.

Table 2. Profile of 16 Respondents

Timestamp	Profession (MD, or RN)	Name of the Hospital (where respondent work, or where respondent will apply the survey)	
Respondent 1	MD	Victoria Surgical Center	1
Respondent 2	MD	Healthfirst	2
Respondent 3	MD	Cebu Doctors, UC MED	3
Respondent 4	MD	JRRMMC	4
Respondent 5	MD	East Avenue Medical Center	5
Respondent 6	MD	Region 1 Medical Center	6
Respondent 7	MD	Makati Medical Center	7
Respondent 8	RN	Skyline Hospital and medical center	1
Respondent 9	RN	Skyline Hospital and Medical Center	2
Respondent 10	RN	ManilaMed	3
Respondent 11	RN	St. Luke's Medical Center	4
Respondent 12	RN	Kairos maternity and general hospital-muzon, csjdm, bulacan	5
Respondent 13	RN	Skyline Hospital medical Center	6
Respondent 14	RN	Philippine heart center	7
Respondent 15	RN	Dr. Jose N. Rodriguez Memorial Hospital	8
Respondent 16	RN	Healthway Medical	9

Source: From the Author.

The survey was used to rationalize which design element from the Modified-Delphi selection produced by the related literature will have the highest impact on the local context, which will become the primary source of the researcher in determining findings, analysis, and synthesis for this study.

5.4 Theoretical Sampling

All the respondents were chosen based on their experience working in a surgical department or any hospital department for that matter. The survey is one way to organize common themes of the respondent's experience and validate design elements that the researcher speculated and researched from the Ariadne report through Modified-Delphi selections.

5.5 Survey Instructions

The goal of the survey is to determine which Design Elements have the highest impact on the Users (Surgeons, Staffs, Nurses, Doctors, etc.) and become the basis of evidence needed for the design process to come up with the best possible Surgery Department. The instructions given to the respondents as follows:

1. Write the name and email address of the respondent. (This is to return the result of the survey and provide a glimpse of the data analysis and synthesis of the thesis after submission of the thesis book. See Figure 7 below.

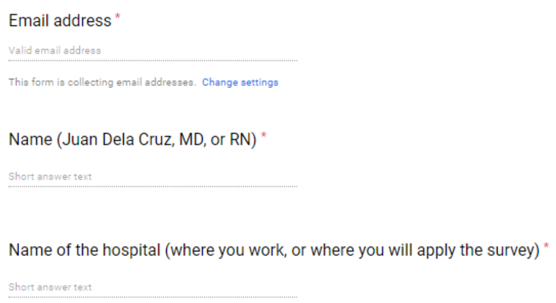


Figure 7. Sample profiling of respondents
Source: From the author.

2. Indicate the hospital where you will apply the rubrics: composed of LOW IMPACT, MEDIUM IMPACT, and NO IMPACT.

3. Using the rubric, respondents are asked to choose the appropriate impact level by checking the corresponding circle. See figure 8.

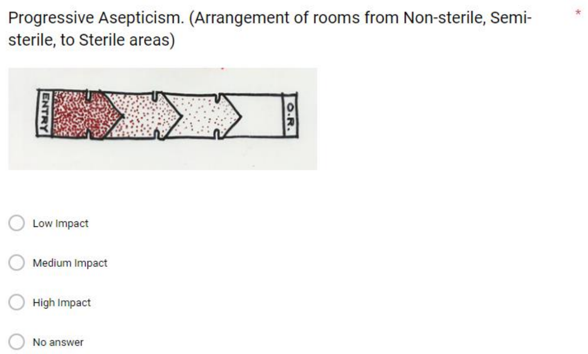


Figure 8. Sample questions from the structured questionnaire for the respondents
Source: From the Author.

5.6 Survey Rubrics

The following are the details regarding the rubrics of the survey. The terminologies came directly from the Ariadne case study which Mass Design Group used in the Modified-Delphi selection process to establish the design elements of the US equivalent of the survey.

- Low Impact – implies that the design element has the least important or overall effect on the operations of the staff / nurse / doctor.
- Medium Impact – implies that the design neither has the effect nor unimportant in the overall operation of the staff / nurse / doctor.
- High Impact – implies that the design is a priority. The most important design element according to the users (staff / nurse / doctor). Its role as a facility design is perhaps for the benefit of the staff. Hence a design element which is staff-oriented, but it can also be patient-centered design whenever the respondents declared them as such. For this thesis, the respective design elements which as the majority "High Impact" will be considered as the design elements needed across the board.
- No Impact – implies that respondent either:
  - Has no experience on the corresponding design element.
  - It is not available from the existing hospital applied;
  - Or has not commented whatsoever from the respective design element for personal reasons.

VI. Findings

6.1 Survey Results

In Figure below, the line graph depicts the raw data of the survey after a week of data collection. Because some of the design elements have been exclusively for Labor & Delivery Departments, the researcher finds equivalent design elements that will be important for General Surgery Departments.

The design elements that are exclusively for Labor & Delivery department are as follows:

- Type of L&D Rooms to ORs
- Type of L&D Rooms (LDR vs LDRP)
- Number of L&D Rooms
- L&D Room Size

Meanwhile, the alternative or equivalent design elements that were integrated by the researcher are as follows:

- Progressive Asepticism
- Dirty & Clean Corridors
- Collaborative Spaces
- Distance Between ORs

6.2 Hierarchy of Survey Results

Looking at Table 3, the top identified Design Elements then are: 1.) Unit Layout/ Facility Size, 2.) Comfort, 3.) Progressive Asepticism, 4.) Staff Amenities or Support Spaces, 5.) Dirty and Clean Corridors, 6.) Distance between Nurse Station to ORs, 7.) Patient Accessible Spaces, 8.) Labor Support Equipment Access (CSSR Access), 9.) Interdisciplinary Work & Rest Spaces, and 10.) Collaborative Spaces.

6.3 Comparison of Local and US Survey

Table 4 summarizes the differences between the local survey and its US equivalent. Data gathered from both surveys shows that overflow spaces are the most important design element, although in the context of the US survey, design elements are oriented toward the Labor & Delivery Department, while the local survey is oriented toward the General Surgery department.

Similar design elements between the two survey results also surfaced as important across the board: Interdisciplinary Work & Rest Spaces, Patient Accessible Spaces, CSSR Access, and Staff Amenities or Support Spaces.

Table 3. Methodology Selection Chart

		3
		High Impact
	Room Demand	93.80%
	Comfort	93.80%
	Progressive Asepticism	87.50%
	Staff Amenities or Support Spaces	75.00%
	Dirty and Clean Corridors	75.00%
	Distance between Nurse Station to ORs	68.80%
	Patient Accessible Spaces	62.50%
	Labor Support Equipment Access (CSSR Access)	62.50%
	Accessibility of Call Rooms	56.30%
	Collaborative Spaces	56.30%
Design Element	Proximity of Workspaces and Rooms	50.00%
	Presence of Overflow Spaces	50.00%
	Number of ORs	50.00%
	Room Standardization	43.80%
	Nature/ Outdoor Views	37.50%
	Family & Guest Amenities	25.00%
	Ratio of L&D Rooms to ORs	12.50%
	Type of L&D Rooms (LDR vs LDRP)	N/A
	Prominence of Fetal Monitoring	N/A
	Number of L&D Rooms	N/A
	L&D Room Size	N/A

Source: From the Author.

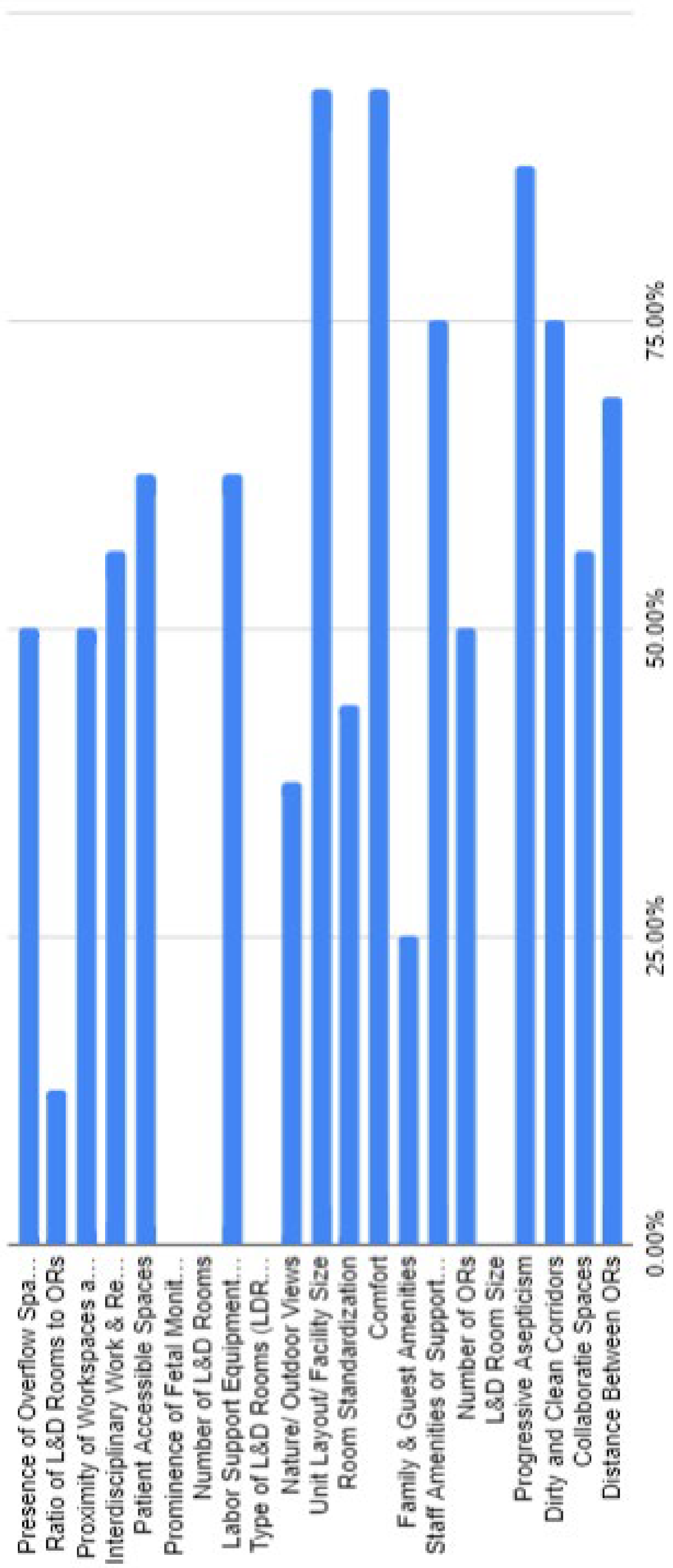


Figure 9. Raw data for results of survey
Source: From the Author

Table 4. Comparison between local and US surveys

	LOCAL SURVEY		US SURVEY
1	Room Demand	1	Presence of Overflow Spaces
2	Comfort	2	Ratio of L&D Rooms to ORs
3	Progressive Asepticism	3	Proximity of Workspaces and Rooms
4	Staff Amenities or Support Spaces	4	Accessibility of Call Rooms
5	Dirty and Clean Corridors	5	Patient Accessible Circulation
6	Distance between Nurse Station to ORs	6	Prominence of Fetal Monitoring
7	Patient Accessible Circulation	7	Number of L&D Rooms
8	Labor Support Equipment Access (CSSR Access)	8	Labor Support Equipment Access (CSSR Access)
9	Accessibility of Call Rooms	9	Nature/ Outdoor Views
10	Collaborative Spaces	10	Room Standardization
		11	Staff Amenities or Support Spaces

Source: From the Author

6.4 Design Element Overview

One of the biggest challenges when researching healthcare facilities is to address variability and how to create a cohesive data. The case study discussed in previous chapters tackled and addressed this challenge, which led to the methodology adapted by this paper. As Mass Design Group puts it, "A number of key differences between facilities are readily seen at the scale of the facility floor plan: the overall size and shape of the unit; whether the unit is contained on a single floor or is spread across multiple wings or levels of a larger building complex; and whether nursing stations are located centrally or are distributed throughout the unit. Other metrics required a systematic method of transforming design elements into quantitative metrics to identify variation between facilities: the distance a nurse must travel between labor and delivery rooms (LDRs), the ratio of collaborative staff spaces to total staff spaces, and the percent of circulation (area used for moving from one area to another, like a corridor) accessible to laboring patients. As described above, we organized these metrics around the capacity, workload, and motivation framework. In addition, several design elements relating to cultural/contextual factors emerged as important, but difficult to measure quantitatively" (Mass Design Group & Ariadne Labs, 2017. p. 11, par. 1).

Table 5 below presents the results categorized by the following general design elements characteristics: Capacity, Workload, Motivation & Accountability, and Contextual & Cultural Factors. Each design element will be discussed in detail in succeeding paragraphs.

Table 5. General Characteristics of the Design Elements Chosen by Local Respondents

CAPACITY *Design elements that impact the availability of a facility to accommodate unexpected surges in patient volume or acuity* (Mass Design Group & Ariadne Labs, 2017. p. 11, par. 2). > **Room Demand:** annual cases per number of ORs	**WORKLOAD** *Design elements that impact the effort required by clinicians to deliver [surgical] care* (Mass Design Group & Ariadne Labs, 2017. p. 11, par. 2). > **Distance from Nurse Station to ORs**: average distance from nurse station to ORs
MOTIVATION & ACCOUNTABILITY *Design elements that impact the willingness of clinicians to expend effort to [surgical] care* (Mass Design Group & Ariadne Labs, 2017. p. 11, par. 2). > **Collaborative Spaces:** ratio of total staff area to collaborative staff spaces > **Accessibility of Call Rooms:** maximum distance from call room to ORs > **Staff Amenities & Support Spaces**: ratio of total unit area to staff support area	**CONTEXTUAL & CULTURAL FACTORS** *Design elements that may impact a number of other contextual and cultural factors that are not easily characterized with quantitative measurements* (Mass Design Group & Ariadne Labs, 2017. p. 11, par. 2). > **Accessibility of labor support equipment (CSSR Access)** > **Patient Accessible Circulation** > **Comfort** > **Progressive Asepticism** > **Dirt & Clean Corridors**

Source: From the Author.

6.5 Capacity

Capacity design elements theoretically impact the availability of space to perform the core functions of the facility (Mass Design Group & Ariadne Labs, 2017. p. 13, par. 1).

6.5.1 Room Demand

Room Demand depicts the annual surgery cases per number of ORs. According to Mass Design Group's hypothesis, a higher ratio of annual delivery volume to total area of a unit or facility decreases capacity per birth and increases treatment intensity (Mass Design Group & Ariadne Labs, 2017. p. 13, par. 5).

As for the researcher's interpretation of Room Demand, Facility Size must be related to a certain indicator to determine the optimal number of ORs. In the local setting and in the case of this paper, the Surgical Volume factor of 5,000 surgery cases per 100,000 populations is chosen as the said indicator.

6.6 Workload

Workload design elements theoretically impact the effort required by clinicians to care for patients. Travel distances required to be taken by staff can have a significant impact on the amount of effort required to perform work duties in a given shift (Mass Design Group & Ariadne Labs, 2017. p. 23, par. 1).

6.6.1 Distance from Nurse Station to ORs

Mass Design Group hypothesized that increased distances from nurse station to labor and delivery room increase workload for staff and increase treatment intensity (Mass Design Group & Ariadne Labs, 2017. p. 23, par. 3). For the local equivalent, similarly, the researcher hypothesizes that after obtaining an average distance from existing facilities, the distance of Nurse Station to ORs for proposed design standards should be BELOW average length (to be measured in meters).

6.7 Motivation and Accountability

Motivation and accountability design elements theoretically impact the willingness and/or accountability of clinicians to exert effort in caring for patients. These were among the most exploratory elements measured and included maximum distance from call room to labor and delivery room, ratio of total unit area to staff support areas, and ratio of total staff area to collaborative spaces (Mass Design Group & Ariadne Labs, 2017. p. 31, par. 1).

6.7.1 Collaborative Spaces

Mass Design Group hypothesized that higher ratios of total staff areas to collaborative staff areas impede communication and team decision making capacity, increasing treatment intensity (Mass Design Group & Ariadne Labs, 2017. p. 31, par. 2). For the local equivalent, the researcher hypothesizes that after obtaining an average distance from existing facilities, the collaborative space for proposed design standards should be ABOVE average length (to be measured in meters).

6.7.2 Accessibility of Call Rooms

Mass Design Group hypothesized that greater distance from call rooms to labor and delivery rooms makes it difficult to manage long labors, thus increasing treatment intensity (Mass Design Group & Ariadne Labs, 2017. p. 31, par. 4). For the local equivalent, the researcher hypothesizes that after obtaining an average distance from existing facilities, the distance of Call Rooms to ORs for proposed design standards should be BELOW average length (to be measured in meters).

6.7.3 Staff Amenities & Support Spaces

Mass Design Group hypothesized that higher ratio of total unit area to staff support area decreases staff capacity to manage labor, increasing higher treatment intensity decisions (Mass Design Group & Ariadne Labs, 2017. p. 31, par. 5). For the local equivalent, the researcher hypothesizes that after obtaining an average distance from existing facilities, the distance of Nurse Station to ORs for proposed design standards should be ABOVE average length (to be measured in meters).

6.8 Contextual & Cultural Factors

One challenge in evaluating design elements in isolation is that they are likely to interact and pose collective influence on the activities of the facility. For example, the annual deliveries per room, ratio of staff space to staff support space, and average distance from Labor & Delivery Rooms (LDRs) to nursing stations may all influence cesarean rates. Moreover, design may impact a number of other contextual and cultural factors that are not easily ascertained with quantitative measurements. Examples of these contextual and cultural factors that were identified included accessibility of labor support equipment, prominence of technology, presence of natural light, and patient accessible circulation (Mass Design Group & Ariadne Labs, 2017. p. 39, par. 1). Also included are the design elements that were added by the researcher to replace Labor & Delivery Room design elements such as Comfort, Progressive Asepticism, and Dirty & Clean Corridors.

6.8.1 Central Sterile Supply Room

Mass Design Group hypothesized that increased access to labor support equipment increases resources to manage physiologic labor, reducing treatment intensity (Mass Design Group & Ariadne Labs, 2017. p. 39, par. 2). For the local equivalent, the researcher hypothesizes that after obtaining an average distance from existing facilities, the distance of CSSR to ORs for proposed design standards should be BELOW average length (to be measured in meters).

6.8.2 Patient Accessible Circulation

Mass Design Group hypothesized that higher ratio of total unit area to staff support area decreases staff capacity to manage labor, increasing higher treatment intensity decisions (Mass Design Group & Ariadne Labs, 2017. p. 39, par. 5). For the local equivalent, the researcher hypothesizes that after obtaining an average distance from existing facilities, the distance of Nurse Station to ORs for proposed design standards should be ABOVE % of total unit circulation space available to patients (to be measured in percentage).

6.8.3 Comfort

The researcher hypothesizes that meeting the DOH's minimum of 2.32 square meters per staff should be contextualized to the existing situation of a particular hospital or facility to establish the quality of comfortability. Thus, creating area per staff ABOVE the average of established existing value should be the basis rather than meeting the minimum as prescribed by DOH alone.

6.8.4 Progressive Asepticism

The researcher hypothesizes that the separation of public corridor, Semi-sterile Corridor, and Sterile Corridor should be made clear using permanent partition to be justified as having "High" quality and will merit ten (10) points in the results summary (see Table 9). Any configurations other than this will be classified as either in Low, which will merit only five (5) points, or medium quality, which will merit seven (7) points since these conditions compromise infection control. Progressive Asepticism is one of the functions in the department that affect design according to Ar. Prosperidad Luis (2016) wherein the rooms are arranged from dirty corridor (public zone), semi sterile corridor (buffers), and sterile corridor (the most sterile area and the ORs).

6.8.5 Dirty & Clean Corridors
Ar. Luis (2016) explained that the clean and dirty stream of traffic should be segregated as much as possible. This design element is also an infection control feature and one of the functions in the surgery department that affect facility design.

The hypothesis is that, in order to facilitate utmost infection control, there must be a separation between dirty corridors (where maintenance, waste collection, janitor, or cleaners of ORs are moving around) and clean corridors (where patient and staff would move).

6.9 Selection of Hospitals

The researcher solicited 11 hospitals of a variety of levels over the course of six (6) months. One of the challenges in seeking data from hospitals is that most private hospitals are proprietary and do not have research in the interest of their company, which leads to non-participation in surveys. Nevertheless, four (4) hospitals agreed to participating in this study and were able to undergo the entire data gathering phase to provide significant insights—Cardinal Santos Medical Center (CSMC) being the smallest and a Level 3 Hospital, Victor R. Potenciano Medical Center (VRPMC) being a Level 3 Hospital, Philippine General Hospital (PGH) being a Level 3 Hospital, and Mid-Coast Hospital (MCH) an international Level 3 Hospital. All necessary data were retrieved over the course of this paper.

6.10 Context of Variability

The variability of respondent backgrounds, such as doctor and staff experiences (in years) and differences in equipment and technologies of each hospital are addressed in this paper by looking at the overall results of surgery cases per annum. The researcher hypothesized that, regardless of variability, facility design efficiency or performance can be calculated on the same scale if the indicator concluded by The Lancet Commission on Global Surgery (2017) is applied, especially Surgical Volume of 5,000 cases per 100,000 population.

6.11 Context of Scalability

The extreme differences between the scale, size, or Levels of each chosen hospital sample are addressed by calculating their output data to the same equation, as well as using floor plan analysis to quantify or qualify their existing facility design. On the other hand, experiences of the staff are also given validation to quantitative data whenever needed.

Table 6. Hospital Selection Chart

HOSPITAL SELECTION CHART									
#	Hospital	Type	Letter Invitation	Interview	Ocular Inspection (Observation)	Floor Plan Analysis	Number of Surgery per Year	Total members of Patients per Year	REMARKS
1	Apalit Doctors Hospital	Level 1							
2	Unihealth Hospital	Level 1							
3	Medical City	Level 2							
4	St. Lukes BGC	Level 2							
5	Paranaque Doctors Hospital	Level 2							
6	Metro Antipolo Medical Center	Level 2							
7	Asian Hospital and Medical Center	Level 2							
8	Mid-Coast Hospital	Level 3							*CHOSEN*
9	Victor R. Potenciano Medical Center	Level 3							*CHOSEN*
10	Cardinal Santos Medical Center	Level 3							*CHOSEN*
11	Philippine General Hospital	Level 3							*CHOSEN*

Source: From the Author.

6.12 Context of Indicator (Surgical Volume)

The researcher will attempt to synthesize the indicator of 5,000 surgical cases per 100,000 populations as a unit of measurement to see how the existing facility is faring compared to healthcare facilities of High-Income Countries (HICs). If local hospital owners are aspiring to have a "world-class" healthcare facility, then they need a certain unit of measurement to subject their facilities into.

6.13 Context of Survey

The survey is a crosschecker of the quantitative data of the research. For example, in the case of staff spaces, a minimum of 2.32 square meters per staff is the metric provided by DOH, but a simple observation of the existing staff spaces could determine whether this minimum is sufficient in general or for which areas it can be sufficient. This is the experiences of the users confronted by numerical data that the researcher can synthesize moving forward.

6.14 Hospital Profiles

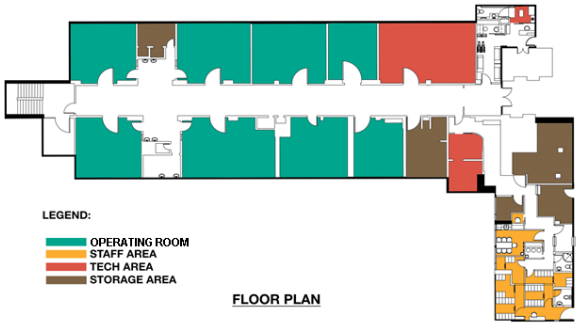
6.14.1 Cardinal Santos Medical Center

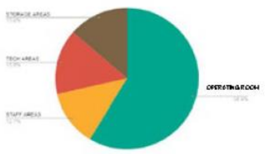
The Cardinal Santos Medical Center (CSMC), formerly known as St. Paul's Hospital of Manila, is a tertiary private-owned hospital. It was originally founded by the Maryknoll Sisters before World War II and was one of the many structures in the country destroyed by heavy artillery after the war.

On August 15, 1974, it began operation and was instituted as the Cardinal Santos Memorial Hospital in honor of the first Filipino Cardinal. The hospital was renamed Cardinal Santos Medical Center on August 1, 1988 and was entrusted into the hands of the Hospital Managers, Inc. (HMI), a private company that managed the hospital's business operations for over two decades. HMI turned over the hospital management to the Colinas Verdes Hospital Managers Corporation (CVHMC), which took over on August 15, 2008, under the leadership of Manuel "Manny" V. Pangilinan.

Under the new management team, CSMC has earned its place as one of the country's leading hospitals specializing in the fields of Cardiology, Neurosurgery, Oncology, and Rehabilitation Medicine. It is also known for its expertise in Pediatrics, Obstetrics, and Gynecology, Pulmonary Medicine, Nephrology, Urology, and Minimally Invasive Surgery (CSMC, 2019).

CSMC stands on a 3-hectare site within the residential area of Greenhills West, located in San Juan, Manila. It has 269 beds and has an estimated staff population of more than 1,010 professionals, 243 being the hospital's top surgeons.



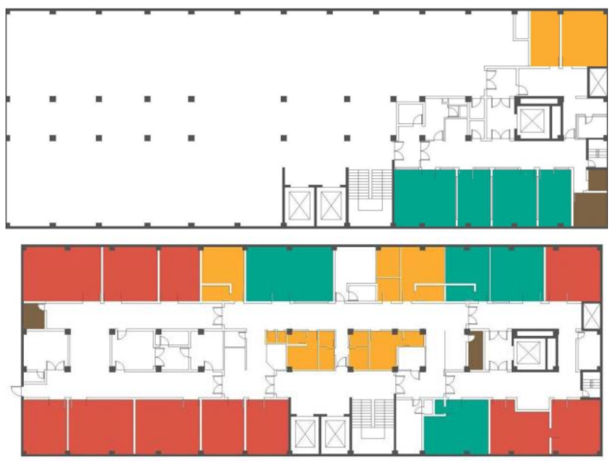


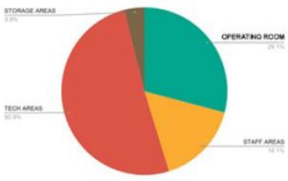
CARDINAL SANTOS MEDICAL CENTER (CSMD)		
OPERATING ROOM	332.71	41.48%
STAFF AREAS	72.18	9.00%
TECH AREAS	85.29	10.63%
STORAGE AREAS	77.14	9.62%

Number of Beds: 235
Coordinates: 14.5978° N, 121.0455° E

Figure 10. Existing floor plan of Surgery Department, Cardinal Santos Medical Center
Source: Dr. Roxas

6.14.2 Victor R. Potenciano Medical Center Victor R. Potenciano Medical Center (VRPMC) is a multi-specialty medical center located at 163 EDSA, Mandaluyong City, PH. The Hospital was first established as Polymedic General Hospital by Dr. Victor R. Potenciano, along with Col. Pelagio G. Potenciano, M.D., Arsenio G. Francisco, M.D., Mrs. Irma P.E. Potenciano, and Flora P. Caviles on September 22, 1967. The center adopted the title "VRP Medical Center" on February 28, 1998 to prevent confusion from other "Polymedic" entities in the country. Some of the services provided by the medical center are Laparoscopic Surgery, Piles, Orthopedics, Fistula Surgery and Fissure.



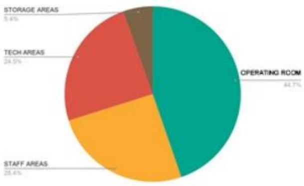


VICTOR R. POTENCIANO MEDICAL CENTER (VRPMC)		
OPERATING ROOM	150.44	29.1%
STAFF AREAS	83.39	16.1%
TECH AREAS	263.15	50.9%
STORAGE AREAS	20.21	3.9%
Number of Beds: 185		
Coordinates: 14°34'34.7"N 121°02'20.5"E		

Figure 11. Existing floor plan of Surgery Department, Victor R. Potenciano Medical Center
Source: VRPMC

6.14.3 Mid-Coast Hospital

Mid-Coast Hospital is a full-service community hospital located in Brunswick, Maine. Their 93-bed facility is an independent, not-for-profit hospital governed by a community Board of Directors (MCH, 2019). In 2019, the hospital has reportedly admitted 5.701 patients, treated 19,409 patients, and had a working force of more than 577 professional staff.

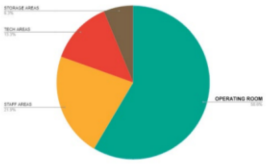


MID-COAST HOSPITAL (MCH)		
OPERATING ROOM	130.49	44.7%
STAFF AREAS	74.02	25.4%
TECH AREAS	71.63	24.5%
STORAGE AREAS	15.86	5.4%
NUMBER OF BEDS: 93		
COORDINATES: 43°54'20.6"N 69°53'28.4"W		

Figure 12. Existing floor plan of Surgery Department, Victor R. Potenciano Medical *Center*
Source: MCH

6.14.4 Philippine General Hospital

The Philippine General Hospital is a tertiary state-owned hospital administered and operated by the University of the Philippine-Manila. It is designated as the National University Hospital and the largest government facility and referral center. Being the biggest hospital in the Philippines, it is natural for PGH's facility to have the greatest number of ORs and the biggest gross floor area. It experiences all the challenges running a Surgery Department: from access distance issues to going over the demand for its High Surgical Volume of around 14,000 cases served per 100,000 populations. Nevertheless, the demands seemed to be within the expectation of the operators.



PHILIPPINE GENERAL HOSPITAL (PGH)		
OPERATING ROOM	3124.41m²	58.6%
STAFF AREAS	1167.65m²	21.9%
TECH AREAS	709.12m²	13.3%
STORAGE AREAS	335.90m²	6.3%
Number of Beds: 1500		
Coordinates: 14.5777° N, 120.9856° E		

Figure 13. Existing floor plan of Surgery Department, Philippine General Hospital
Source: PGH

6.15 Results and Findings #1 (Room Demand)

To determine the Room Demand Per Operating room, the following equation was used:

$$\text{Room Demand} = \frac{\text{Annual Case Volume}}{\text{Total no. of ORs}}$$

6.15.1 Room Demand – Cardinal Santos Medical Center (CSMC)

Figure 14. Floor plan of CSMC (Room Demand)
Source: CSMC

CSMC has a total area of 802.06 square meters, with Room Demand calculation of 909 cases per OR. CSMC has an annual surgery of 7,271 cases and has a total of eight (8) ORs.

6.15.2 Room Demand – Victor R. Potenciano Medical Center (VRPMC)

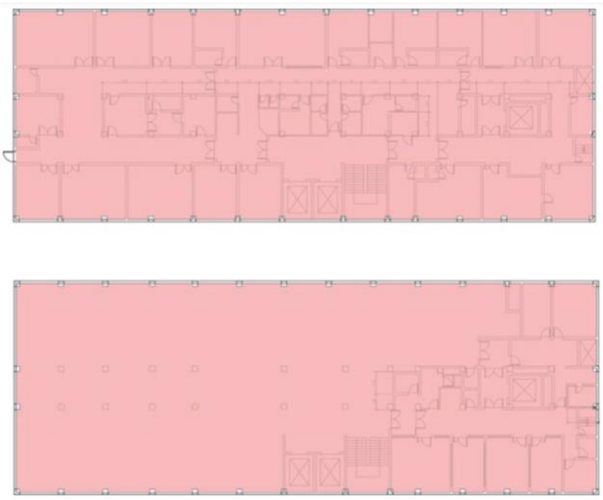


Figure 15. Floor plan of VRPMC (Room Demand)
Source: VRPMC

6.15.3 Room Demand – Mid-Coast Hospital (MHC)

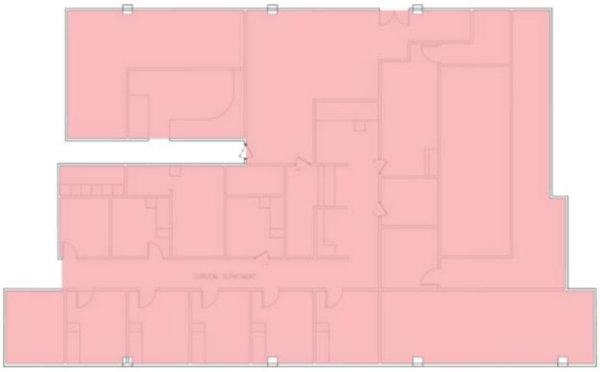


Figure 16. Floor plan of MCH (Room Demand)
Source: MCH

MCH has a total area of 823.62 square meters, with Room Demand calculation of 730 cases per OR. MCH has an annual surgery case of 5,840_cases and has a total of seven (7) ORs.

6.15.4 Room Demand – Philippine General Hospital (PGH)

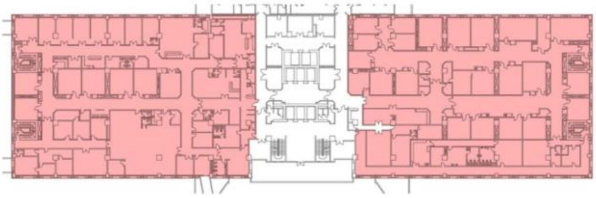


Figure 17. Floor plan of PGH (Room Demand)
Source: PGH

PGH has a total area of 5331.75 square meters, with Room Demand calculation of 1460 cases per OR. PGH has an annual surgery case of 35,040 cases and has a total of 24 ORs.

6.15.5 Floor Plan Analysis #1 (Room Demand)
Based on the computations, PGH has the highest Room Demand; however, this is since PGH has 24 ORs. To place all samples in the same level, the researcher analyzed the usage of creating an actual surgery volume from the data indicated in the table below.

Table 7. Room Demand

#	Hospitals	Number of Beds	Case per OR per DAY	# or ORs	Case of all OR per day	Room Demand
		Based on public data	Based on interview	Based on existing floor plan	Case per day x number of ORs	(Annual case volume/ number of ORs)
1	Cardinal Santos Medical Center	235	2.49	8	19.92	909
2	Victor R. Potenciano Medical Center	185	3.5	10	35.00	1277.50
3	Mid-Coast Hospital	93	2	7	14	730
4	Philippine General Hospital	1500	4	24	96.00	1460

Source: From the Author.

6.15.6 Correlation to Surgical Volume

The Surgery Volume Factor (SV Factor) is applied to bring the variable to the same level of population ratio (100,000 populations) and estimate the Surgical Volume of the hospital samples accordingly. For this, the following equation was applied:

Surgical Volume (SV) = <u>Surgery Case per OR per year</u> SV Factor
SV Factor = Total Patients /100,000 population

Computing for the Surgery Volume of each sample resulted in the following:

Table 8. Surgical Volume for each sample.

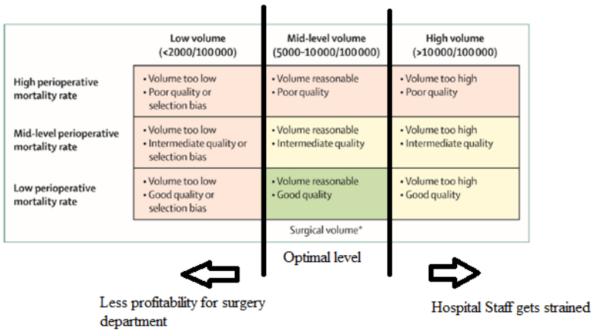
#	Hospitals	Number of Beds	Case per OR per DAY	# or ORs	Case of all OR per day	Room Demand	Annual Surgery Case per Year	Annual Patients per Year	Factor	SV (actual)	Volume Result	REMARKS
		Based on public data	Based on interview	Based on existing floor plan	Case per day x number of ORs	(Annual case volume/ number of ORs)	Room Demand x number of ORs	Based on interview/ statistical data	(Annual Patients per Year / 100,000 population)	Annual surgery case per year / Population Factor		Hypothesis: To determine the optimal number of ORs, it must relate to the Surgical Volume factor of 5000 cases per 100,000 population
1	Cardinal Santos Medical Center	235	2.49	8	19.92	909	7272	235000	2.3500	3094.47	LOW VOLUME	
2	Victor R. Potenciano Medical Center	185	3.5	10	35.00	1277.50	12775	185000	1.8500	6905.41	MID-LEVEL VOLUME	Reach mid-level volume which is the ideal surgery volume based on the lancet
3	Mid-Coast Hospital	93	2	7	14	730	5110	19409	0.1941	26327.99	HIGH VOLUME	
4	Philippine General Hospital	1500	4	24	96.00	1460	35040	868741	8.6874	4033.42	LOW VOLUME	

Source: From the Author.

From this table, it is observed that Mid-Coast Hospital has the highest volume, while CSMC and PGH has Low Volume, and only VRPMC has reached the Mid-Level Volume. Adapting The Lancet Commission on Global Surgery (2015), the researcher uses the terminologies “Low Volume”, “Mid-Level Volume”, and “High Volume” based on the analysis matrix that the Lancet published. Likewise, the surgery volume of 5,000 per 100,000 populations also came from the Lancet.

From this matrix, the ideal surgical level should be at the Mid-Level volume because Low Volume could indicate that there is less case served than the facility could potentially provide, which might affect the profitability of the hospital. Consequently, a High Volume could indicate a “surge” of cases, which means the hospital staff can get strained due to the number of cases. Therefore, Mid-Level volume is a balance between welfare for hospital staff, as well as economic development for the hospital owners.

Figure 18. Analysis matrix for surgical volumes



Source: The Commission on Global Surgery (2015)

With this, the researcher could say that from the samples, only VRPMC has the ideal volume, while the rest of the samples had either Low or High Volumes. By charting them with a score, VRPMC will have a ten (10) point, while the rest of the samples will be assigned with five (5) points.

6.16 Results and Findings #2 (Comfort)
Recommended temperatures are between 21-24°C for surgical departments and between 20-24°C for operating rooms.

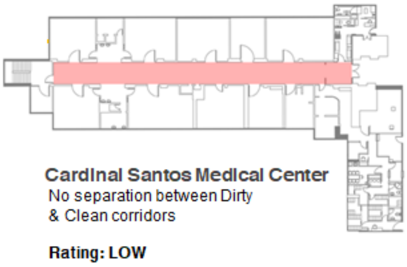
6.16.1 Floor Plan Analysis #2
Proper ventilation, temperature, and humidity are needed for successful surgical operations. ORs must be designed to provide a space relative humidity (RH) of 20 to 60 percent and a space temperature of 68 to 75°F. This is also so that staff and patients alike are comfortable and cool in the Operating Rooms and technical areas.

6.17 Results and Findings #3 (Dirty & Clean Corridors)
Upon observation, each hospital's progressive asepticism was determined and highlighted with the color red in the following illustrations:

6.17.1 Dirty & Clean Corridors – Cardinal Santos Medical Center (CSMC)
CSMC has a LOW (5 points) rating because of the lack of separation between dirty and clean corridors.

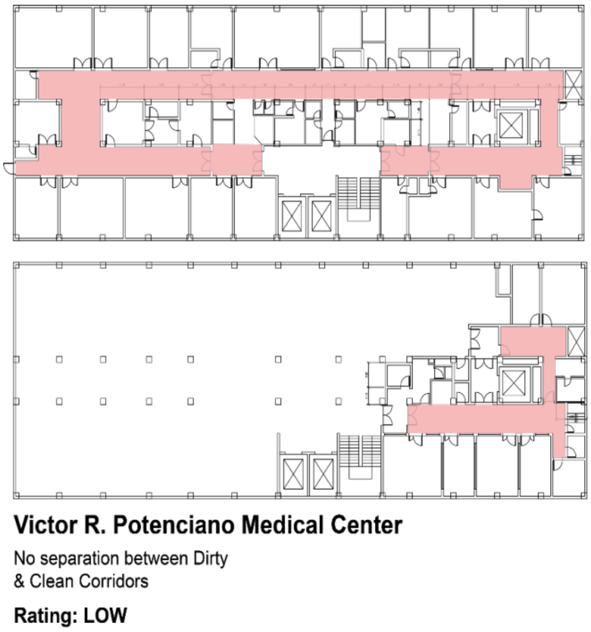
6.17.2 Dirty & Clean Corridors – Victor R. Potenciano Medical Center (VRPMC)
VRPMC has LOW (5 points) rating because of the lack of separation between dirty and clean corridors.

Figure 19. Floor Plan of CSMC (Dirty & Clean Corridors)



Source: CSMC

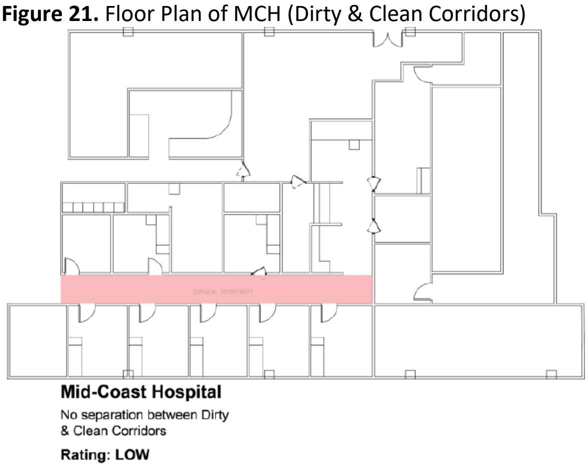
Figure 20. Floor Plan of VRPMC (Dirty & Clean Corridors)



Source: VRPMC

6.17.3 Dirty & Clean Corridors – Mid-Coast Hospital (MCH)
VRPMC has a LOW (5 points) rating because of the lack of separation between dirty and clean corridors.

Figure 21. Floor Plan of MCH (Dirty & Clean Corridors)



Source: MCH

6.17.4 Dirty & Clean Corridors – Philippine General Hospital (PGH)

PGH has a MEDIUM (7 points) rating because the separation between dirty and clean corridors are not well-defined.

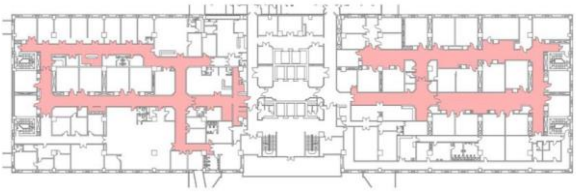


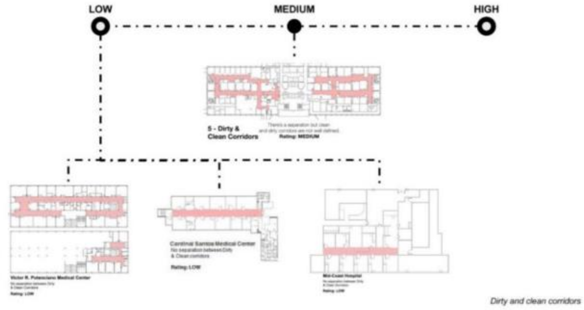
Figure 22. Floor Plan of PGH (Dirty & Clean Corridors)

Source: PGH

6.17.5 Floor Plan Analysis #3 (Dirty and Clean Corridors)

Among the data gathered for dirty and clean corridors in existing hospital facilities, FUMC is revealed to have a MEDIUM rating due to the availability of different kinds of corridors; however, its design does not distinguish between dirty and clean. Meanwhile, CSMC, VRPMC, USTH, and MCH have LOW ratings because these facilities have single corridors with sticker markings as the only barrier between sterile and semi-sterile zones. MMC has a HIGH rating due to the corridors being properly separated, marking which areas are sterile, semi-sterile, and for the public. It is speculated that to improve infection control separation of corridors must be prescribed to existing hospitals and to be considered for proposed designs.

Figure 23. Summary evaluation of hospital dirty and clean corridors



Source: From the Author

6.18 Results and Findings #4 (Distance from Nurse Station to Operating Rooms)

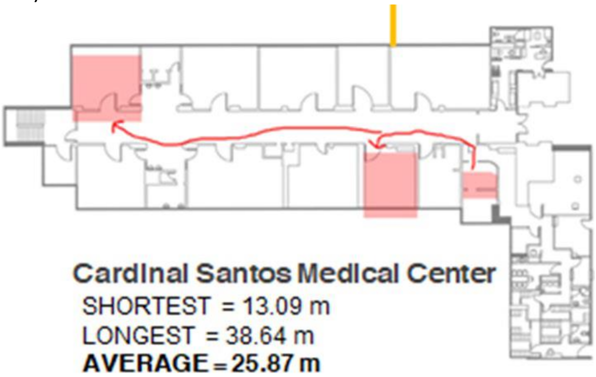
To determine the average distance of each sample hospital's Nurse Station to the OR, the following equation was used:

Average Distance = <u>Smallest Distance + Longest Distance</u> 2

6.18.1 Distance from Nurse Station to OR – Cardinal Santos Medical Santos Center (CSMC)

The average distance is 25.87 meters between Nurse Station to OR.

Figure 24. Floor Plan of CSMC (Distance from Nurse Station to OR)

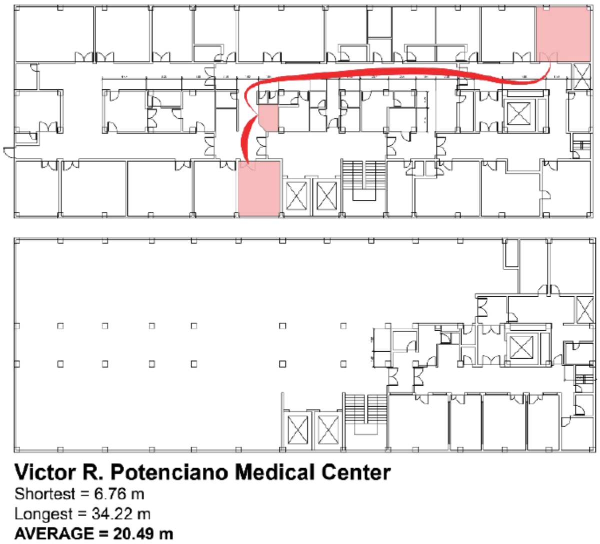


Source: CSMC

6.18.2 Distance from Nurse Station to OR – Victor R. Potenciano Medical Center

The average distance is 20.49 meters between Nurse Station to OR.

Figure 25. Floor Plan of VRPMC (Distance from Nurse Station to OR)

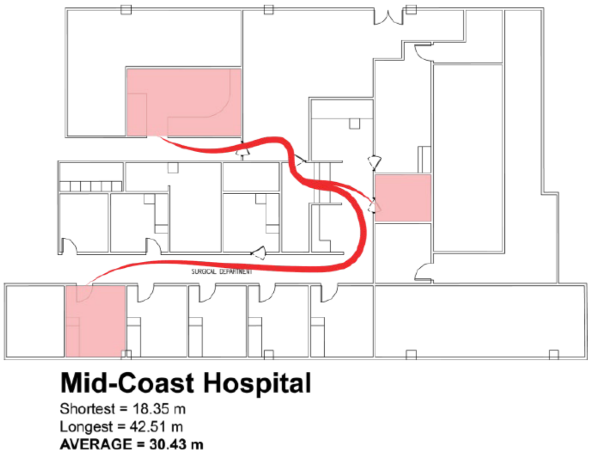


Source: VPRMC

6.18.3 Distance from Nurse Station to OR – Mid-Coast Hospital (MCH)

The average distance is 30.43 meters between Nurse Station to OR.

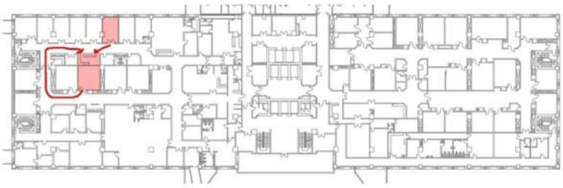
Figure 26. Floor Plan of MCH (Distance from Nurse Station to OR)



Source: MCH

6.18.4 Distance from Nurse Station to OR – Philippine General Hospital (PGH)
The average is 19.22 meters between Nurse Station to OR.

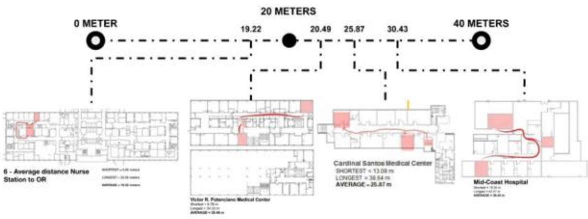
Figure 27. Floor Plan of PGH (Distance from Nurse Station to OR)



Source: PGH

6.18.5 Floor Plan Analysis #4 (Average Distance from Nurse Station to OR)
Based on data gathered, CSMC has the nearest Nurse Station by average to ORs. However, validation from interviews revealed that, apart from locating the Nurse Station near the OR, it is also imperative that the area be overlooking the recovery room, a criterion which Mid Coast, VRPMC, and PGH have met.

Figure 28. Range of average distances from Nurse Station to OR.



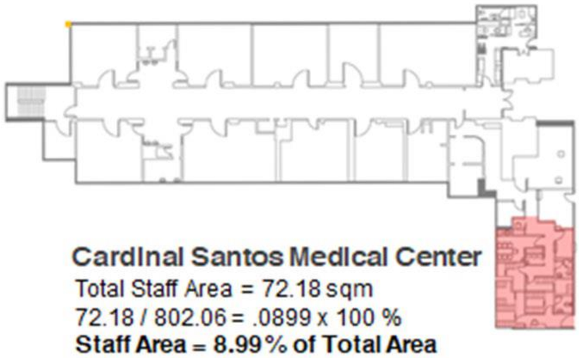
Source: From the Author.

6.19 Results and Findings #5 (Staff Amenities & Support Spaces)
To determine the Staff Support Ratio for each sample hospital, the following equation was used:

$$\text{Staff Support Ratio} = \frac{\text{Total Staff Area}}{\text{Total Unit Area}} \times 100$$

6.19.1 Staff Amenities & Support Spaces – Cardinal Santos Medical Center (CSMS)
CSMC has a total unit area of 802.06 square meters with a total staff area of 72.18 square meters. The staff support ratio is 8.99% of the Total Unit Area.

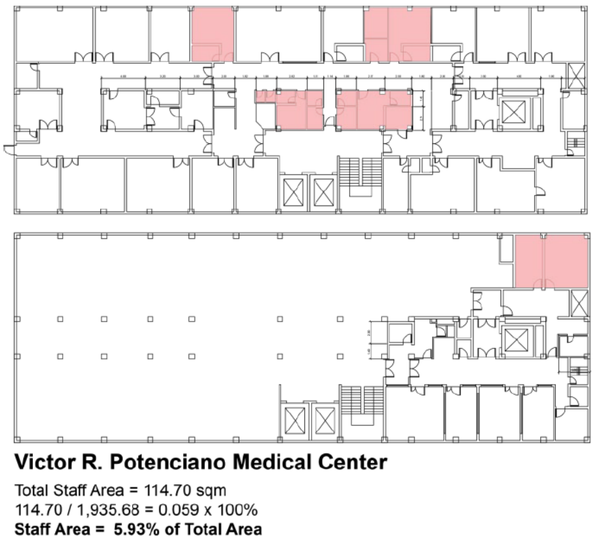
Figure 29. Floor Plan of CSMC (Staff Amenities & Support Spaces)



Source: CSMC

6.19.2 Staff Amenities & Support Spaces – Victor R. Potenciano Medical Center (VRPMC)
VRPMC has a total unit area of 1,935.68 square meters with a total staff area of 114.70 square meters. The staff support ratio is 5.93% of the Total Unit Area.

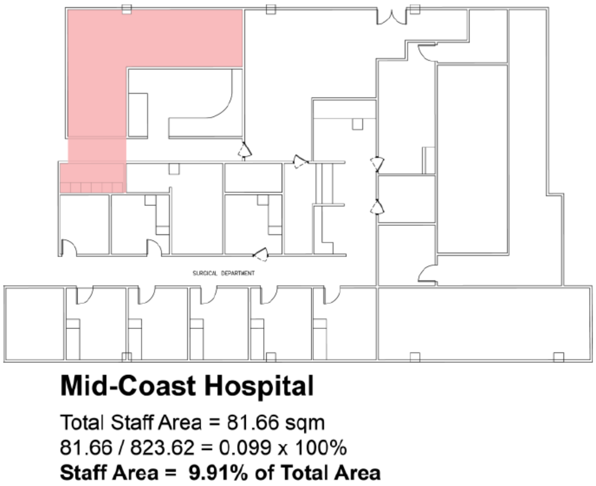
Figure 30. Floor Plan of VRPMC (Staff Amenities & Support Spaces)



Source: VRPMC

6.19.3 Staff Amenities & Support Spaces – Mid-Coast Hospital
MCH has a total unit area of 823.62 square meters with a total staff area of 81.66 square meters. The staff support ratio is 9.91% of the Total Unit Area.

Figure 31. Floor Plan of MCH (Staff Amenities & Support Spaces)



Source: MCH

6.19.4 Staff Amenities & Support Spaces – Philippine General Hospital
PGH has a total unit area of 5331.75 square meters with a total staff area of 341.21 square meters. The staff support ratio is 6.40% of the Total Unit Area.

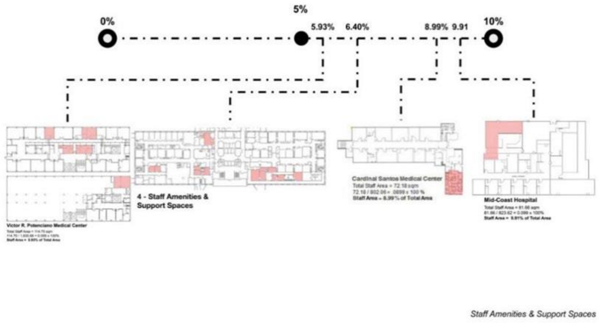
Figure 32. Floor Plan of PGH (Staff Amenities & Support Spaces)

Source: PGH

6.19.5 Floor Plan Analysis #5 (Staff Support Ratio)
Based on data gathered, Mid-Coast has the highest ratio while VRPMC has the lowest ratio of staff support to the total unit area. The average value of the six samples is calculated at 8.25%, making the average ratio of staff area to be around 10% of the total unit area.

To validate if the ratio is sufficient, the consensus amongst the hospital owners and users is that the existing staff area is still small, leading to speculation that perhaps the design staff ratio should be higher than 10%.

Figure 33. Range of Staff Support Ratio



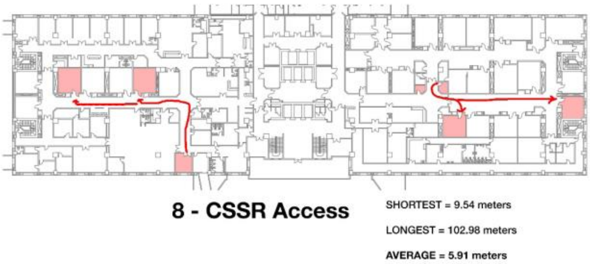
Source: From the Author.

6.20 Results and Findings #6 (Accessibility of Labor Support Equipment)
To determine the average distance between Central Supply Sterile Room (CSSR) to OR for each sampled hospital, the following equation was used:

CSSR Access = <u>Shortest Distance + Longest</u>
<u>Distance</u> 2

6.20.1 CSSR Access – Cardinal Santos Medical Center (CSMC)
Pgh has an average of 5.91-meter distance from its CSSR to OR.

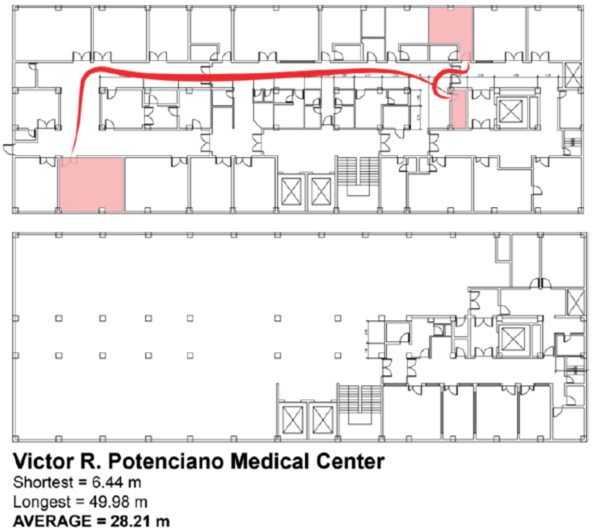
Figure 34. Floor Plan of CSMC (CSSR Access)



Source: CSMC

6.20.2 CSSR Access – Victor R. Potenciano Medical Center (VRPMC)
VRPMC has an average of 28.21-meter distance from its CSSR to OR.

Figure 35. Floor Plan of VRPMC (CSSR Access)

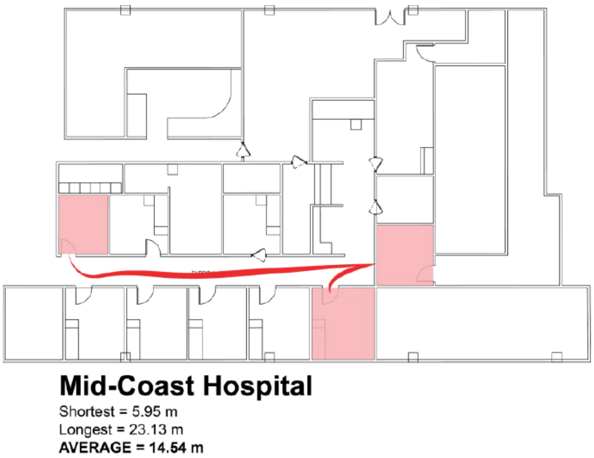


Source: VRPMC

6.20.3 CSSR Access – Mid-Coast Hospital (MCH)

MCH has an average of 14.54 meter-distance from its CSSR to OR.

Figure 36. Floor Plan of MCH (CSSR Access)

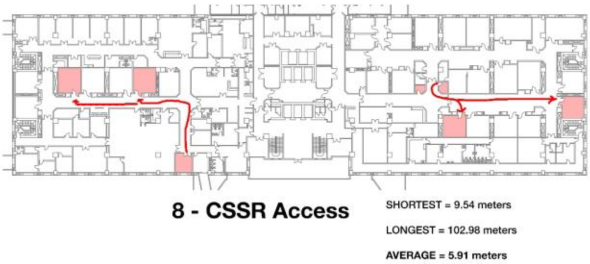


Source: MCH

6.20.4 CSSR Access – Philippine General Hospital (PGH)

PGH has an average of 5.91 meter-distance from its CSSR to OR.

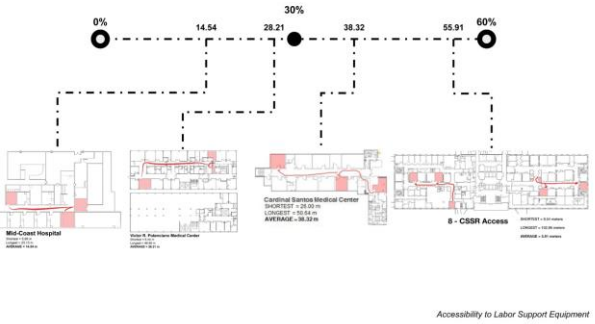
Figure 37. Floor Plan of PGH (CSSR Access)



Source: PGH

6.20.5 Floor Plan Analysis #6 (CSSR Access) Based on data gathered, PGH has the longest route from CSSR to ORs. The idea behind this design principle is that average length should be shorter, so that any contingency could be addressed within the least amount of time. On one hand, this is important in the case of CSMC, but on another, interviews with staff revealed that the proximity of CSSR is not that important as all the things that needed to be on one operation must be readily available and within the OR already.

Figure 38. Range of CSSR Access



Source: From the Author.

6.21 Results and Findings #7 (Patient Accessible Circulation)

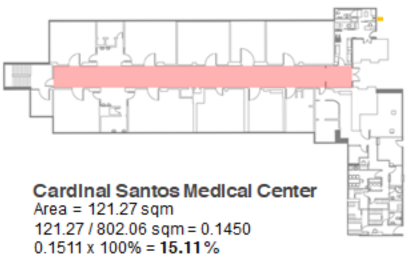
To determine the Patient Accessible Circulation, the following equation was used:

$$\text{Patient Accessible Circulation} = \frac{\text{Total Corridor Area}}{\text{Total Unit Area}}$$

6.21.1 Patient Accessible Circulation – Cardinal Santos Medical Center (CSMC)

CSMC has a circulation area of 121.27 square meters leading to 15.11% of the total unit area of the surgery department.

Figure 39. Floor Plan of CSMC (Patient Accessible Circulation)



Source: CSMC

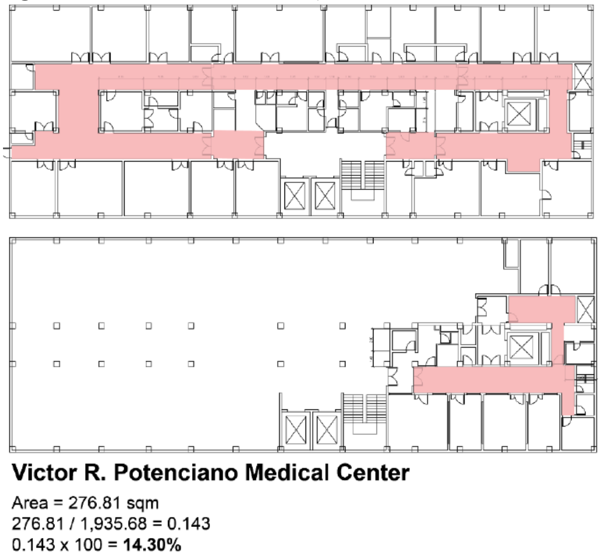
6.21.2 Patient Accessible Circulation – Cardinal Santos Medical Center (CSMC)

VRPMC has a circulation area of 276.81 square meters leading to 14.30% of the total unit area of the surgery department.

6.21.3 Patient Accessible Circulation – Mid Coast Hospital (MCH)
MCH has a circulation area of 42.82 square meters leading to 5.20% of the total unit area of the surgery department.

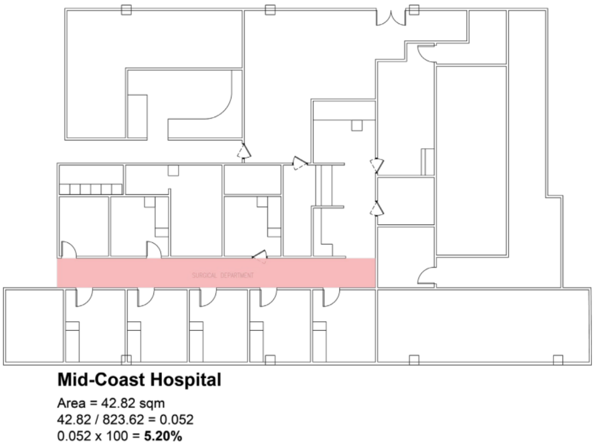
6.21.4 Patient Accessible Circulation – Philippine General Hospital (PGH)
PGH has a circulation area of 1,088.93 square meters leading to 20.42% of the total unit area of the surgery department.

Figure 40. Floor Plan of VRPMC (Patient Accessible Circulation)



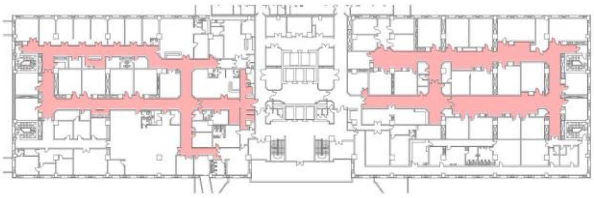
Source: VRPMC

Figure 41. Floor Plan of MCH (Patient Accessible Circulation)



Source: MCH

Figure 42. Floor Plan of PGH (Patient Accessible Circulation)



Source: PGH

6.21.4 Floor Plan Analysis #7 (Patient Accessible Circulation)
Based on data gathered, PGH has the highest Patient Accessible Circulation. The importance of not obstructing the circulation areas with equipment was also observed: there is a tendency for CSMC and VRPMC's corridor systems to use the Patient Accessible Circulation areas as temporary storage for equipment needed on stand-by. In principle, these items should have their own formal storage.

Figure 43. Range of Patient Accessible Circulation

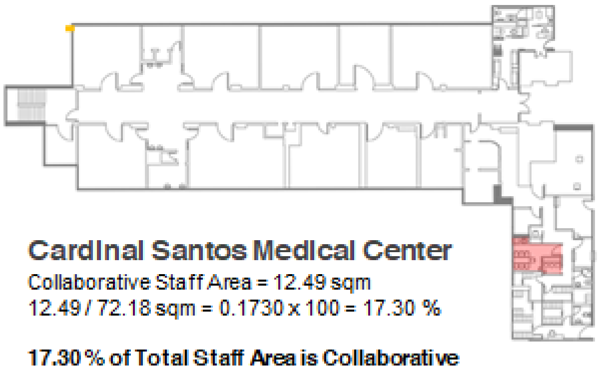
Source: From the Author.

6.22 Results and Findings #8 (Collaborative Spaces) To determine the average percentage of Collaborative Spaces for each sample hospital, the following equation was used:

$$\text{Collaborative Space} = \frac{\text{Collaborative Area}}{\text{Total Staff Area}} \times 100$$

6.22.1 Collaborative Spaces – Cardinal Santos Medical Center (CSMC)
CSMC has a collaborative staff area of 12.49 square meters, which is 17.30% of total staff area.

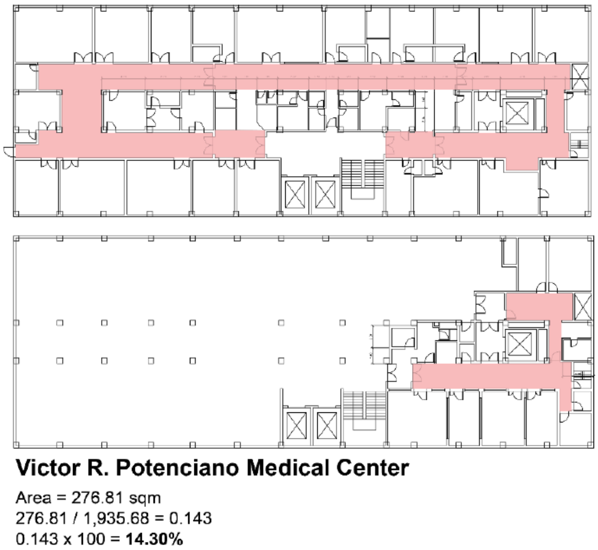
Figure 44. Floor Plan of CSMC (Collaborative Spaces)



Source: *CSMC*

6.22.2 Collaborative Spaces – Victor R. Potenciano Medical Center
VRPMC has a collaborative staff area of 34.88 square meters, which is 30.41% of total staff area.

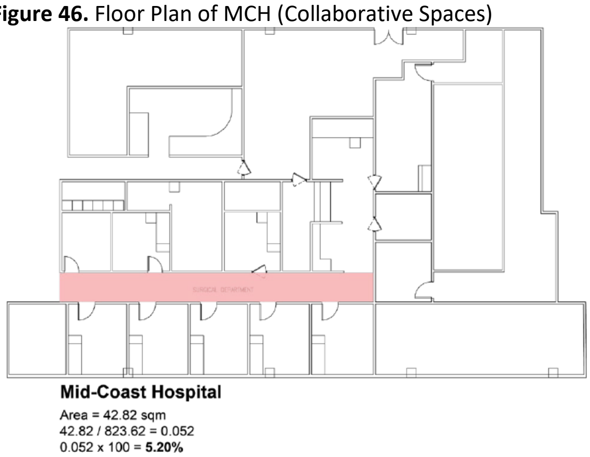
Figure 45. Floor Plan of VRPMC (Collaborative Spaces)



Source: VRPMC

6.22.3 Collaborative Spaces – Mid-Coastal Hospital
MCH has a collaborative staff area of 65.33 square meters, which is 80.00% of total staff area.

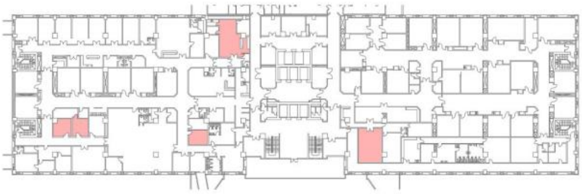
Figure 46. Floor Plan of MCH (Collaborative Spaces)



Source: MCH

6.22.4 Collaborative Spaces – Philippine General Hospital
PGH has a collaborative staff area of 311.17 square meters, which is 5.84% of total staff area.

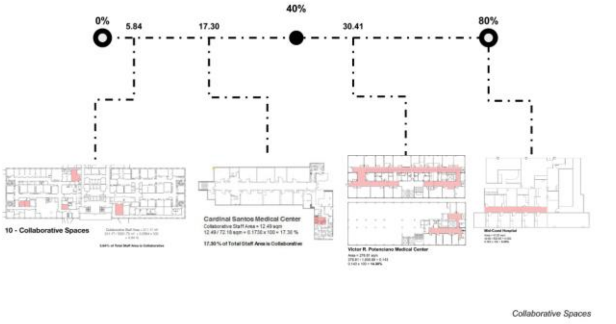
Figure 47. Floor Plan of PGH (Collaborative Spaces)



Source: PGH

6.22.5 Floor Plan Analysis #8 (Collaborative Spaces)
Based on data gathered, MCH has the biggest ratio of Collaborative Space to Total Unit Area, while PGH has the smallest. However, this does not necessarily mean that Mid-Coast has a better quality of Collaborative Spaces than PGH.

Figure 48. Range of Collaborative Spaces

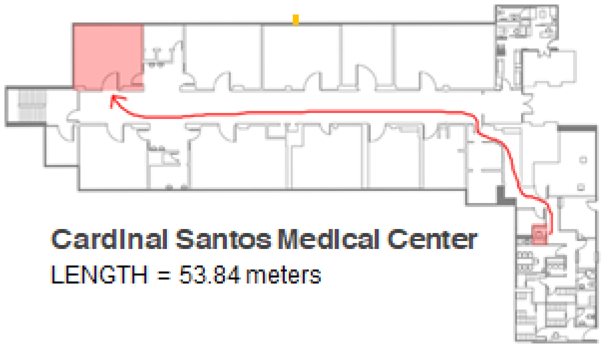


Source: From the Author

6.23 Results and Findings #9 (Accessibility of Call Rooms)

6.23.1 Accessibility of Call Rooms – Cardinal Santos Medical Center (CSMC)
CSMC has a maximum distance of 53.84 meters.

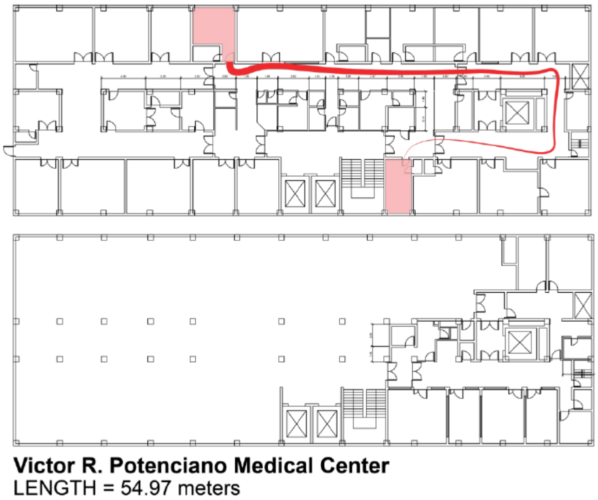
Figure 49. Floor Plan of CSMC (Accessibility to Call Rooms)



Source: CSMC

6.23.2 Accessibility of Call Rooms – Victor R. Potenciano Medical Center
VRPMC has a maximum distance of 54.97 meters.

Figure 50. Floor Plan of VRPMC (Accessibility to Call Rooms)

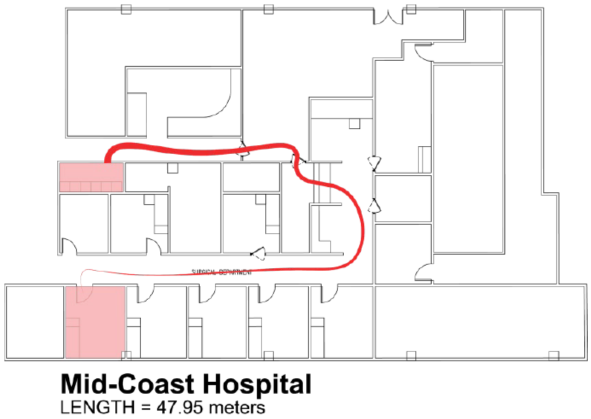


Source: VRPMC

6.23.3 Accessibility of Call Rooms – Mid Coast Hospital (MCH)

MCH has a maximum distance of 47.95 meters.

Figure 51. Floor Plan of MCH (Accessibility to Call Rooms)

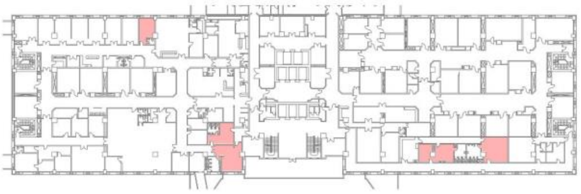


Source: MCH

6.23.4 Accessibility of Call Rooms – Philippine General Hospital (PGH)

PGH has a maximum distance of 172.50 meters.

Figure 52. Floor Plan of PGH (Accessibility to Call Rooms)

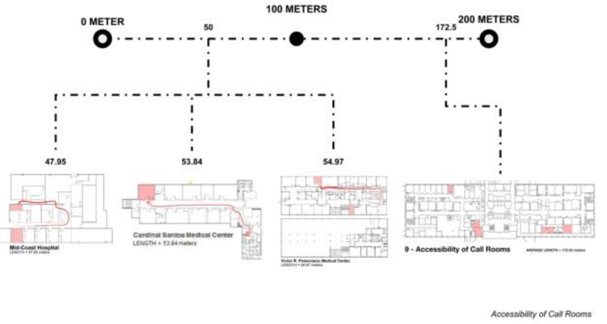


Source: PGH

6.23.5 Floor Plans Analysis #9 (Accessibility of Call Rooms)

Based on data gathered, PGH has the longest distance between Call room and OR. The importance of the call room is related to collaborative spaces—the bigger the collaborative space, the more staff could have the opportunity to engage in sharing knowledge or experiences.

Figure 53. Range of Accessibility of Call Rooms



Source: From the Author.

6.24 Results and Findings #10 (Progressive Asepticism)

Each sample hospital's corridors were labeled as public zone, semi-sterile zone, and sterile zone and color-coded accordingly.

6.24.1 Progressive Asepticism – Cardinal Santos Medical Center (CSMC)

CSMC was given a LOW (5 points) rating because the corridor zones are mixed up despite the separation of permanent partitions.

Figure 54. Floor Plan of CSMC (Progressive Asepticism)

Source: CSMC

6.24.2 Progressive Asepticism – Victor R. Potenciano Medical Center (VRPMC)

VRPMC was given a LOW (5 points) rating because the corridor zones are mixed up despite the separation of permanent partitions.

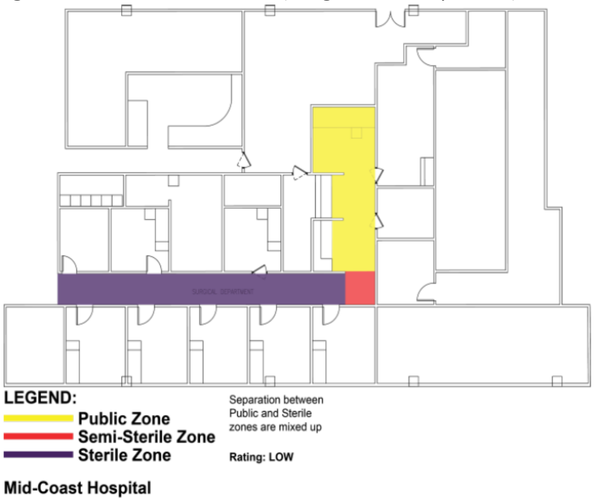
Figure 55. Floor Plan of VRPMC (Progressive Asepticism)

Source: VRPMC

6.24.3 Progressive Asepticism – Mid-Coast Hospital (MCH)

MCH was given a LOW (5 points) rating because the corridor zones are mixed up despite the separation of permanent partitions.

Figure 56. Floor Plan of MCH (Progressive Asepticism)

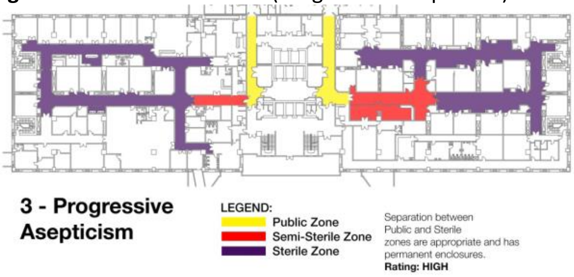


Source: MHC

6.24.4 Progressive Asepticism – Philippine General Hospital (PGH)

PGH was given a LOW (5 points) rating because the corridor zones are mixed up despite the separation of permanent partitions.

Figure 57. Floor Plan of PGH (Progressive Asepticism)

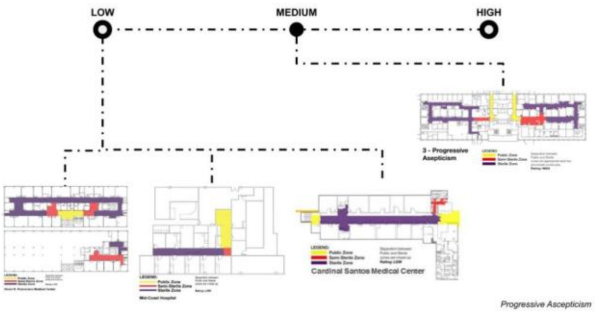


Source: PGH

6.24.5 Floor Plan Analysis #10 (Progressive Asepticism)

Based on the data gathered, PGH has the highest rating while CSMC, VRPMC, and MCH have been rated the lowest. The idea behind progressive asepticism is straightforward: the more permanent the partition, the better the separation. MMC and FUMC have met the criteria.

Figure 58. Range of Progressive Asepticism



Source: From the Author.

6.25 Results and Findings #10 (Progressive Asepticism)

Data gathered on all ten design elements produced average values based on respective indicators. Each design element merited ten (10) points, seven (7) points, or five (5) points to each hospital. With ten design element criteria given, each hospital will have a maximum total score of 100 points.

Table 7. Results Summary

#	Design Elements	Cardinal Santos Medical Center	Victor Potenciano Medical Center	Philippine General Hospital	Mid-Coast Hospital	Average/ Ideal value	Remarks
1	**Room Demand** (annual case volume/ number of ORs) - case per OR	5 (LOW VOLUME)	10 (MID-LEVEL VOLUME)	5 (LOW VOLUME)	5 (HIGH VOLUME)	5000-1000 surgery volume / 100,000 population (Mid-Level Volume)	**Hypothesis:** To determine the optimal number of ORs, it must relate to the Surgical Volume factor of 5000 cases per 100,000 population. (NOTE: Mid-Level Volume is at 5000-1000 SV per 100,000 population)
2	**Comfort** (Staff Area/ Number of doctors) - area per staff	10 (23°C)	10 (23°C)	10 (23°C)	10 (23°C)	23°C	**Hypothesis:** Must be at around 23°C
3	**Progressive Asepticism** (level of separation between deep zones)	5 (LOW)	5 (LOW)	10 (HIGH)	5 (LOW)	HIGH	**Hypothesis:** Must be HIGH.
4	**Staff Support Ratio** (Total unit area/ staff support area)	10 (8.99%)	5 (5.93%)	7 (6.40%)	10 (9.91%)	7.81 %	**Hypothesis:** Must be ABOVE average
5	**Dirty & Clean Corridors** (level of separation bet. dirty and clean corridors)	5 (LOW)	5 (LOW)	7 (MEDIUM)	5 (LOW)	HIGH	**Hypothesis:** Must be HIGH
6	**Average distance** Nurse Station to OR [in meters]	7 (25.87)	10 (20.49)	10 (19.22)	5 (30.43)	24.01 meters	**Hypothesis:** Must be BELOW average
7	**Patient Accessible Circulation** (% of total unit circulation space available to patients)	10 (15.11%)	10 (14.30%)	10 (20.42%)	5 (5.20%)	13.76%	**Hypothesis:** Must be ABOVE average
8	**CSSR Access** (Average distance supply to OR) [in meters]	7 (38.32m)	10 (28.21)	5 (55.91)	10 (14.54)	34.25 meters	**Hypothesis:** Must be BELOW average
9	**Accessibility of Call Rooms** (Maximum distance from OR to call rooms) [in meters]	10 (5.84)	10 (54.97)	5 (172.5)	10 (47.95)	82.32 meters	**Hypothesis:** Must be BELOW average
10	**Collaborative Spaces** (Total staff area/ collaborative space area)	7 (17.30%)	7 (30.41%)	5 (5.84%)	10 (80%)	33.39%	**Hypothesis:** Must be ABOVE average
	TOTAL	76	82	74	75		

Highest rated Design Element

Source: From the Author.

From this table, VRPMC is shown to have achieved the highest rated design elements with a score of 82, followed by CSMC (76), MCH (75), and PGH (74). The researcher hypothesized that to establish an ideal value for each design element, an average can be computed using the precedent values taken from the design elements, respectively. However, the importance of the summary table can also be taken to see which design elements from each sample can be improved depending on its context.
Average values have also been computed to see if any indicators have been applied, which is the case for Design Elements such as Comfort. As it is, the researcher speculated that to use this as evidence, the comparative analysis should be synthesized in two ways:

1. Use the Results Summary as basis or evidence, which is the case for a proposed design. The process of using existing samples will be the precedent where the new design should be based upon to establish learnings and speculate that the new design is the best surgery department design based on the correlation on the Results Summary.
2. Use the Results Summary as a unit of measurement, which is the case for existing hospital surgery departments. To make the Results Summary chart more empirically sound, built hospital surgery department facility designs could be evaluated to determine if their facility is efficient based on its correlation on the summary chart, implying that the hypothesis was met, and the users underwent a cross checking procedure.

VII. Synthesis

7.1 Thesis

Evidence-based design is an approach to use empirical data to validate which design is good and which is not. This can be achieved by getting the statistical data of sample designs and use them as precedence on new designs or a measurement guide for existing facility designs.

7.2 Anti-Thesis

Eminence-based design is equally important as the experience of the respondents and users are more in touch with the reality of the surgery department procedures and operations despite the lack of validity using statistical data. The users know what is good and not on their facility designs and could adapt to any design imperfections they face due to lack of space that comes along with the growth of the hospital.

Figure 59.

Source: From the Author.

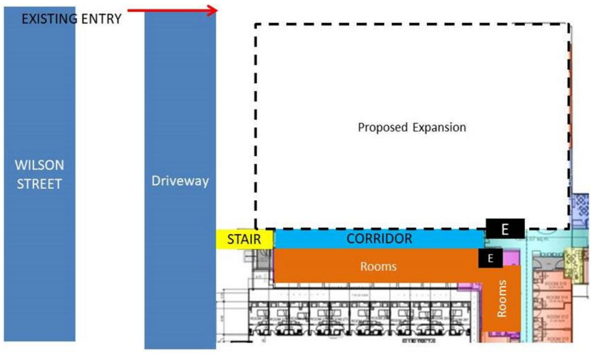
7.3 Synthesis

The process of designing a responsive surgical department must be able to use statistical data from precedent design elements while addressing the complexity of staff's need by inquiring doctors, nurses, and staff through interview, survey, or focus group discussion (See Figure 59). This duality of quantitative analysis and qualitative consultation will address design dilemma not only because the design can respond to population variability and growth as indicated by Surgical Volume, but also the complex things that comes along designing a surgical department like the need for collaborative spaces in staff or the need to have a more comfortable space per occupant.

7.4 CSMC Proposed Design (Mode of Expansion)

Looking at the figure below, CSMC will utilize airspace adjacent to the existing surgery department for expansion.

Figure 60. Proposed expansion for a new surgery department in CSMC



Source: From the Author.

7.5 CSMC Proposed Design (Floor Plan)

The proposed expansion will increase CSMC's floor area by 800 square meters. Additional operating rooms can now be accommodated, and infection control can be addressed using separate corridors. For instance, doctors and staff will use sterile and semi-sterile corridors, while the maintenance staff who will collect waste has a dedicated corridor only for them. The patient and visitors can now be accessible from the public areas, wherein a transfer bay acts as a buffer between the sterile and non-sterile areas.

Figure 61. Proposed design of CSMC Surgery Department expansion.

Source: From the Author

7.6 CSMC Operation Corridors

The figure below shows the Operation Corridors of the CSMC Surgery Department expansion. The corridors are highlighted corresponding to their respective category, as seen with those labeled as "disposable", being the corridors where waste collectors are allowed through, and those labeled as "non-sterile", being corridors that are adjacent to Public Areas. This layout allows for a safe and low-risk circulation for patients, health staff, and maintenance staff.

Figure 62. Operation corridors of the proposed CSMC Surgery Department expansion

Source: From the Author

7.7 CSMC Inpatient Flow (Entry)

The figure below showcases the path of entry for Inpatients. This path goes as Transfer Bay-Pre-Op-OR, giving priority to Inpatients and avoiding collision with medical staff and maintenance.

Figure 63. Entrance Inpatient Flow of proposed CSMC Surgery Department expansion.

Source: From the Author.

7.8 CSMC Outpatient Flow (Entry)

The figure below shows the way of entry for Outpatients. The footpath for Outpatients also starts at the Transfer Bay but with little collision with the footpath for Inpatients. However, there is some overlap between the two footpaths in Pre-Op. What little overlap the two footpaths have is not observed in their respective ORs and ASC ORs.

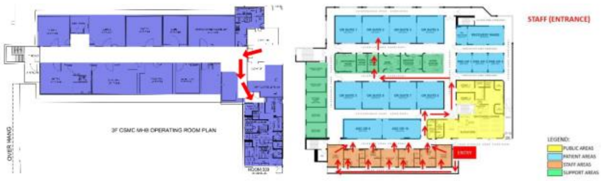
Figure 64. Entrance Outpatient Flow of proposed CSMC Surgery Department expansion.

Source: From the Author.

7.9 Staff Movement (Entry)

Staff Movement starts from the Staff Areas near the ASC ORs and the Waiting Area and has easy access to Public Areas, Patient Areas, and Support Areas.

Figure 65. Staff movement of proposed CSMC Surgical Department expansion.



Source: From the Author.

7.10 Waste Collection / Maintenance Movements Waste Collection / Maintenance Movements gains access to corridors adjacent to the ORs and ASC ORs to be able easily maintain and clean these areas.

Figure 66. Waste collection / maintenance of proposed CSMC Surgery Department expansion.

Source: From the Author.

7.11 Nursing Ward Location

The Nursing Ward is located at the center of the ORs, Pre-Ops, and Recovery Ward to quickly provide aid to patients.

Figure 67. Nursing Ward location of proposed CSMC Surgery Department expansion.

Source: From the Author.

7.12 Supply Center Location

The Supply Center is located central to the ORs to efficiently accommodate patients. With the proposed Supply Center, staff will be able to reach patients in 10-20 seconds.

Figure 68. Supply Center Location of proposed CSMC Surgery Department expansion.

Source: From the Author.

7.13 Qualitative Criteria for Surgery Department Designs

Without using other existing hospital surgery departments, a "good" surgery department design can still be achieved. The following qualities that are not part of the "Ariadne" research methodology but had been researched as integral qualities for a surgery department are as follows:

- Corridor Separation: Dean Christopher Espina (2020) pointed out the importance of infection control by segregating the staff, patient, waste collection, and visitors through different types of corridor systems inside the surgery department. This criterion can easily be observed for existing and for future development of hospital ORs. An update of this due to the COVID-19 pandemic is that staff must have a dedicated corridor accessible only for them to prevent any unwanted person to be infected via nosocomial infection or due to exposure to their Personal Protective Equipment (PPEs).
- Progressive Asepticism: Even before the pandemic, observance of laminar flow (using HVAC to prevent pathogens from entering the patient's body) is of utmost importance within the surgery department. Therefore, being able to provide clean air
- conditioning system for ORs must be prioritized. This can become challenging because of the pandemic; therefore, mechanical design solutions must be coordinated accordingly to prevent nosocomial infections.
- Distance of supply to OR: Even without depending on existing samples, it is imperative to locate the Central Supply and Sterile Room (CSSR) to Operating Rooms to obtain materials needed by the doctor as soon as possible.

7.14 Surgical Volume Speculative Results (CSMC Floor Plan)

Table 10. CSMC Surgery Volume Base Case & Improved Case

#	BASE CASE	Number of Beds	Case per OR per DAY	# or ORs	Case of all OR per day	Room Demand	Annual Surgery Case per Year	Annual Patients per Year	Factor	SV (actual)	Volume Result	REMARKS
		Based on public data	Based on interview	Based on existing floor plan	Case per day x number of ORs	(Annual case volume/ number of ORs)	Room Demand x number of ORs	Based on interview/ statistical data	(Annual Patients per Year / 100,000 population)	Annual surgery case per year / Population Factor		**Hypothesis:** To determine the optimal number of ORs, it must relate to the Surgical Volume factor of 5000 cases per 100,000 population.
1	**Cardinal Santos Medical Center** (Historical average case per OR per day)	235	2.49	8	19.92	909	7272	235000	2.3500	3094.47	LOW VOLUME	With the existing 8 operating rooms, the surgery volume of the sample facilty has a range of 3094 to 4970 both of which is still in Low Volume.
2	**Cardinal Santos Medical Center** (Simulated "surge" of case per OR per day)	235	4.00	8	32.00	1460	11680	235000	2.3500	4970.21	LOW VOLUME	

#	IMPROVED CASE	Number of Beds	Case per OR per DAY	# or ORs	Case of all OR per day	Room Demand	Annual Surgery Case per Year	Annual Patients per Year	Factor	SV (actual)	Volume Result	REMARKS
		Based on public data	Based on interview	Based on existing floor plan	Case per day x number of ORs	(Annual case volume/ number of ORs)	Room Demand x number of ORs	Based on interview/ statistical data	(Annual Patients per Year / 100,000 population)	Annual surgery case per year / Population Factor		**Hypothesis:** To determine the optimal number of ORs, it must relate to the Surgical Volume factor of 5000 cases per 100,000 population.
1	**Cardinal Santos Medical Center** (Historical average case per OR per day)	235	2.49	10	24.90	908.9	9089	235000	2.3500	3867.66	LOW VOLUME	The addition of 2 more OR has raised the surgery volume with a range of 3867 to 6212 surgery volume per 100,000 population. Reaching the optimal Mid-level volume.
2	**Cardinal Santos Medical Center** (Simulated "surge" of case per OR per day)	235	**4.00**	10	40.00	1460	14600	235000	2.3500	**6212.77**	**MID-LEVEL VOLUME**	

Source: From the Author.

Looking at the table above, it can be observed that in its existing facility, CSMC has a computed surgery volume of 3094.47 per 100,000 populations. Simulating a "surge" of cases of at least 4 case per OR per day, the actual surgery volume will become 4,970.21 per 100,000 populations.

Because the Improved has two (2) more ORs, the actual surgery volume with the same existing case per OR per day (2.49) improved case has 3,867.66 per 100,000 population surgery volume, and then during a "surge" improved case achieved the Mid-Level Volume at 6,212.77 per 100,000 population surgery volume. Thus, the researcher can create a range from 2.49 to 4.00 cases per OR per day.

Base Case has an actual SV range of 3,094 to 4,970 per 100,000 populations, while Improved Case has an actual SV range of 3,867 to 6,212, improving the surgery volume of the facility overall by reaching Mid-Level Volume.

7.15 Surgical Volume Speculative Results (CSMC Floor Plan)

Table 11. Evaluation Summary (Base Case vs. Improved Case)

Source: From the Author.

Looking at the table above, the Improved Case floor plan proposal for CSMC has more high rated design elements compared to the Base Case, showing evidence of improvement. Only on design elements nos. 8 and 9 does the improved case have a score of 5 points because the facility is bigger, thus average corridor distances is not below average. Nevertheless, the rest of the design elements has met the criteria, reaching 10 points each. Base Case has a total of 76 points while Improved case has a total of 90 points.

VIII. Conclusion and Recommendations

8.1 Conclusion

The following conclusions have been conceived by the researcher in the course of writing this thesis paper:

- Using Modified-Delphi selection process to solicit the design elements with the highest impact in the surgery department and measuring it using floor plan analysis can lead to measurable and quantitative data that can evaluate an existing floor plan and a proposed floor plan of surgery departments in a variety of scales, Levels, or specializations.
- Using Surgical Volume (SV) as implicatory to measure the efficiency of existing or proposed facility design of surgery departments can address variability and can be an effective indicator to measure the performance of surgery departments overall.
- The selection of design elements using the Modified Delphi process is a significant research methodology for healthcare design to establish evidence-based design. Existing surgery departments can be easily evaluated using this methodology as it can generate measurable and quantitative data.
- To achieve a responsive surgery department facility design, the quantitative data using the design elements that came from evidence-based approach and the opinions of the doctors, nurses, and staff, which is classified as "eminence-based" approach, can be used together as basis to evaluate a variety of surgery departments and become an effective basis whether the design is effective or good.

8.2 Recommendations

The following recommendations are prescribed by the researcher to further enhance the study relating to facility design of surgery departments:

- Inputting more sample hospitals to develop the average values further and to validate any existing or proposed designs that could measure up to the Results Summary of design elements.
- From the building science perspective – a research on infection control, which is a whole different thesis, can also affect facility design, although it could have a different research methodology and data gathering strategies altogether.
- For the consensus on the users – a research about perceptions of staff and patients in existing surgery departments might potentially influence the qualitative data of the research. Although this will not lead to an architecture-related thesis, this might be a good thesis for medical-related courses.

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