# EVALUATION OF THE ARCHITECTS' CONCERN OF THE ACCESSIBILITY IN INTENSIVE CARE UNITS REFERRING TO EVIDENCE-BASED DESIGN

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## ABSTRACT

### EVALUATION OF THE ARCHITECTS' CONCERN OF THE ACCESSIBILITY IN INTENSIVE CARE UNITS REFERRING TO EVIDENCE-BASED DESIGN

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Due to the technological and medical improvements and awareness of the patient-centered approach, architectural design interventions of nursing units in healthcare centers are becoming very important to provide a suitable care process. Among various nursing units, the *Intensive Care Unit (ICU)* environment needs to provide constant and quick access to patients in terms of *visibility and physical accessibility*. In this field, there is various evidence beyond the architectural filed such as medical, social, or nursing that clarifies the impacts of the *visual and physical accessibility* features on the *patients' safety* and *staff efficiency* in *ICU*s. These issues force healthcare architects to find *ICU*s' accessibility features by using different sources of knowledge from different disciplines. However, there are difficulties for healthcare architects to gather explicit knowledge in a systematic approach and consider them in *ICU*s' design process. *Evidence-Based Design (EBD)*, as a systematic and scientific approach, provides a way for healthcare architects to gather scientific knowledge through the *Systematic Review (SR)*.

This study aims to evaluate the architects' concern about *visual and physical accessibility* in *ICU*s' design with the help of *EBD*. For achieving this aim, two *ICU*s were observed in Iran and Finland. Then, *SR* was conducted to find *visual and* *physical accessibility* features that impact the *patients' safety* and *staff efficiency* in *ICU*s. After that, ten healthcare architects (from Turkey) were interviewed with fifteen open-ended and close-ended questions. Finally, qualitative data were evaluated by referring to *SR*'s findings. According to the results, there was a gap between design and scientific research in the *ICU*s' design process, and architects did not refer to any scientific research through the design process. It was found that the architects' knowledge about accessibility features was routed in various sources, including design guidelines, medical advisor, designed projects, personal experiences, and firm's demands through *ICU*s' design process. It is concluded that the *EBD* can improve the architects' approach to design a safe and efficient *ICU*s' environment.

Keywords: *Intensive Care Unit (ICU), Visual and Physical Accessibility, Evidence-Based Design (EBD), Systematic Review (SR)*

# ÖZ

## MİMARLARIN YOĞUN BAKIM ÜNİTELERİNDE ERİŞİLEBİLİRLİK KONUSUNDAKİ ENDİŞELERİNİN KANITA DAYALI TASARIMA BAŞVURARAK DEĞERLENDİRİLMESİ

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Teknolojik ve tıbbi gelişmeler ve hasta merkezli yaklaşımın farkındalığı nedeniyle, sağlık merkezlerinde hemşirelik birimlerinin mimari tasarım müdahaleleri uygun bir bakım süreci sağlamak için çok önemli hale gelmektedir. Çeşitli hemşirelik birimleri arasında, *Yoğun Bakım Ünitesi (YBÜ)* ortamı, görünürlük ve fiziksel erişilebilirlik açısından hastalara sürekli ve hızlı erişim sağlamalıdır. Bu alanda, tıbbi, sosyal veya hemşirelik gibi mimari özelliklerin yanı sıra, *görsel ve fiziksel erişilebilirlik* özelliklerinin *YBÜ*'lerinde *hasta güvenliği* ve *personel verimliliği* üzerindeki etkisini açıklığa kavuşturan çeşitli kanıtlar bulunmaktadır. Bu konular, sağlık mimarlarını farklı disiplinlerden farklı bilgi kaynaklarını kullanarak *YBÜ*'lerinin erişilebilirlik özelliklerini bulmaya zorlar. Bununla birlikte, sağlık mimarları için sistematik bir yaklaşımla açık bilgi toplamak ve bunları *YBÜ*'lerinin tasarım sürecinde dikkate almakta zorluklar vardır. Sistematik ve bilimsel bir yaklaşım olan *Kanıta Dayalı Tasarım (KDT)*, sağlık mimarlarına *Sistematik İnceleme (Sİ)* aracılığıyla bilimsel bilgi toplamaları için bir yol sağlar.

Bu çalışmanın amacı, mimarların *YBÜ*'lerinin tasarımında *görsel ve fiziksel erişilebilirlik* konusundaki endişelerini *KDT* ile değerlendirmektir. Bu hedefe ulaşmak için Iran ve Finlandiya'da iki *YBÜ* gözlendi. Ardından, verimliliğini etkileyen *görsel ve fiziksel erişilebilirlik* özelliklerini bulmak için *Sİ* yapıldı. Daha sonra, on sağlık mimarı (Türkiye'den) on beş açık uçlu ve kapalı uçlu soru ile görüşüldü. Son olarak, nitel veriler *Sİ*'nin bulgularına atıfta bulunularak değerlendirildi. Elde edilen sonuçlara göre, *YBÜ*'lerinin tasarım sürecinde tasarım ve bilimsel araştırma arasında bir boşluk vardı ve mimarlar tasarım sürecinde herhangi bir bilimsel araştırmaya atıfta bulunmadılar. Mimarların erişilebilirlik özellikleri hakkındaki bilgisinin, tasarım yönetmelikler, tıbbi danışman, tasarlanan projeler, kişisel deneyimler ve firmanın talepleri de dahil olmak üzere çeşitli kaynaklara yönlendirildiği bulunmuştur. Kanıta dayalı tasarımın, mimarların güvenli ve verimli bir *YBÜ* ortamı tasarlama yaklaşımını geliştirebileceği sonucuna varılmıştır.

Anahtar Kelimeler: *Yoğun Bakım Ünitesi (YBÜ), Görsel ve Fiziksel Erişilebilirlik, Kanıta Dayalı Tasarım (KDT), Sistematik İnceleme (Sİ)*

To my lovely mother and to the memory of my dear father

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**TABLE OF CONTENTS**

# LIST OF TABLES

TABLES

## LIST OF FIGURES

FIGURES

## LIST OF ABBREVIATIONS

ABBREVIATIONS

ICU: Intensive Care Unit

CCU: Critical Care Unit

NICU: Neonatal Intensive Care Unit

PICU: Pediatric Intensive Care Unit

SICU: Surgical Intenisve Care Unit

EBD: Evidence- Based Design

SR: Sytematic Review

TA: Thematic Analysis

OW : Open Ward

SPR: Single- Patint Room

AusHFG: Australasian Health Facility Guidelines

FGI: Facility Guidelines Institute

VA: Veterans Affairs

# CHAPTER 1

# INTRODUCTION: ARCHITECTURAL CHARACTERISTICS OF INTENSIVE CARE UNITS

## 1.1 State of the motivation: Architectural characteristics of *Intensive Care Units (ICUs)*

Healthcare environments have a significant role in delivering care services. Hospitals are essential kinds of healthcare facilities that include various spaces to help the care process of patients. Nursing units are virtual spaces within hospitals that provide specialized care for patients with a particular disease and try to provide safe space for patients and efficient staff space. Hospitals' nursing units can be separated into two categories based on the level of care, including the *Intensive Care Unit (ICU)* and the non-intensive care unit. Some common kinds of *ICU* are neonatal *ICU*, pediatric *ICU*, surgical *ICU*, or medical *ICU*. Some common kinds of non-intensive care units are neonatal units, women and infant health units, pediatric units, or oncology units.[1]

Nursing units' design plays a significant role in providing patients' maximum demands. For instance, there is considerable attention to reduce nurse fatigue, improve *patients' safety*, reduce nosocomial infection, or enhance *staff efficiency* in nursing units (Becker, 2007). Regards to medical and technological improvements, the patient-centered design approach develops to consider patients' demand in the center of the design (Cama, 2009; McCullough, 2010; Verderber, 2010; Witteman

[1] Retrieved June 12, 2020, from https://www.doh.wa.gov/ForPublicHealthandHealthcareProviders/HealthcareProfessionsandFacilities/HealthcareAssociatedInfections/HAIReports/TypesofHospitalUnits

et al., 2015). Providing patient-centered care requires that patients partner in their personal health care decisions to the full extent desired. Patient decision aids facilitate processes of shared decision-making between patients and their clinicians by presenting relevant scientific information in balanced, understandable ways, helping clarify patients' goals, and guiding decision-making processes (Witteman et al., 2015). Generally, patient-centered design, in contrast to the technological improvements, tries to respect the patients' perspectives and demands, prepares them to participate in their care (Frampton et al., 2003; Frampton & Guastello, 2010; Rodriguez et al., 2007; Stichler, 2011).

Among various nursing units, patients of *ICU*[2] need more special demands than other nursing units because it is a special care unit that provides care for critically ill or injured patients. It is staffed by specially trained medical personnel and has equipment that allows for continuous monitoring and life support. Medically, patient care in an *ICU* is also provided by multidisciplinary teams of physicians, nurses, respiratory care technicians, pharmacists, and other allied health professionals who use highly sophisticated equipment and services of the expert support personnel for direct observing and quick accessing to ill patients 24 hours a day (Berthelsen & Cronqvist, 2003; Newcomb, 2011; Rashid, 2006).

Over the decades, *ICU*s have developed as a specialized nursing unit to care for post-surgical patients in hospitals. Regard to observe *ICU* patients visually at all times, Florence Nightingale[3] was the first person that was identified development in *ICU*s'

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[2] *ICU* is divided to three levels based on provided care level involving Level 1(patient does not require organ support), Level 2 (Patients needing single organ support excluding mechanical ventilation), and Level 3 (Patients requiring two or more organ support (or needing mechanical ventilation alone). Retrieved March 3, 2020, from https://www.bmj.com/content/330/7499/s184.3#:~:text=Level%201%E2%80%94Ward%20based%20care,ionotropes%20and%20invasive%20BP%20monitoring.

[3] Florence Nightingale: "Florence Nightingale**,** byname Lady with the Lamp (born May 12, 1820, Florence [Italy]—died August 13, 1910, London, England), British nurse, statistician, and social

design by in her observation of recovery zones in the numerous hospitals (Cronin et al., 2007). Through the Crimean War in the 1850s, she did an innovative movement to create the modern *ICU* by segregating injured soldiers based on their intensity of injuries. She was also one of the first nurses who develop a nursing unit with an open ward plan called Nightingale ward[4]. The constant monitoring of patients by a specific nurse is one of the essential aspects of *ICU* that almost Nightingale considered it by monitoring the more ill soldiers consistently by specific nurses.

Nurses and other staff's behavior are impacted by *ICU*s' physical environments when helping patients, especially in critical situations (Stichler, 2010). If *ICU* is considered a staff workplace, patients could achieve physical and non-physical help whenever and wherever they need to remove the *ICU*'s *visual and physical accessibility* barriers. Accessibility in *ICU*s defines to design easily accessible environments for staff with eliminated barriers that inhibit the *visual accessibility* to patients or health services. In nursing units, visibility function refers to the staff's sightline to patients; in other words, how staff can see the patients (Rashid, 2014). Sightlines have been used mostly to describe each physical environment's spatial structures and their effects on the space function (Rashid et al., 2009; Rashid, 2009; Rashid & Zimring, 2003).

The physical environment of nursing units significantly impacts structuring the *visual and physical accessibility* to patients (Koch & Steen, 2012). Bringing patients and staff visually and physically accessible together is applicable by designing suitable *ICU*s' environment. The nursing units' physical environment constitutes spaces size, shape, configuration, furniture, equipment, and materials (Rashid, 2014). For example, different layouts affect staff movement and visibility inside nursing units (Shpuza & Peponis, 2007). Pati et al. (2009) implied some

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reformer who was the foundational philosopher of modern nursing." Retrieved September 24, 2017, from https://www.britannica.com/biography/Florence-Nightingale

[4] An open ward or Nightingale ward involves a long main corridor with a narrow width that thirty or thirty-two beds are located the premier of the corridor (Hamilton & Shepley, 2010; Haggard & Hosking, 1999; Verderber & Fine, 2000; Verderber, 2010).

difficulties of improperly designed environments in nursing units such as very long corridors, curvilinear corridor, or deep, charting alcoves. Also, units' furnishing is considered a physical design feature resulting in improper *ICU*s' environment. For instance, some studies discussed that using patient rooms doors without glass and utilizing high walls of nurse stations decrease the staff's *visual and physical accessibility* within *ICU*s (Rashid, 2006).

Generally, the continuing effort to improve the quality of patient care in *ICU*s, coupled with the breadth of medical progress and its attendant technological development, contributes to the dynamics of *ICU*s' evolving environment in hospitals. Todays, COVID-19 [5] enhances the *ICU*'s importance and essential effects of its environment on peoples' life. The ongoing coronavirus disease 2019 (COVID-2019) pandemic has swept worldwide, posing a significant pressure on critical care resources due to many patients needing critical care (Shang at al., 2020). This disease has challenged healthcare facilities and placed immense burdens on medical staff globally (Peng et al., 2020). With an increase in the number of newly confirmed cases and the disease's rapid progression into a critically ill state, *ICU*s were encountered with a shortage of beds, specialist personnel, or a shortage of space (Peng et al., 2020). Almost, some scientific researches were conducted that approved the importnace of *ICU* environmnet on *patients' safety* and *staff effcincy* in *ICU*s throughout the COVID-19 pandemic.

Following the *ICU*'s importance, several studies also mentioned that *ICU*'s physical environment could considerably impact the *patients' safety* and *staff efficiency* (Aalto et al., 2017; Hughes, 2008; McCullough, 2010; Rashid, 2006; Rashid 2009). According to Rashid (2006), the architectural characteristics

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[5] "Coronavirus Disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is highly contagious. In recognition of the global threat it poses, on March 11, 2020, the World Health Organization (WHO) declared COVID-19 to be a pandemic" (Peng et al., 2020, p.1).

of *ICU* can directly affect the care provided to the patient such as the type and orientation of the bed, the type and location of handwashing sinks, and toilets, windows and views out of them, the location of gas and air outlets, the artificial and natural lighting conditions, the furniture, or the visibility of a patient in the room from nursing stations. Another study examined the *ICU*'s family spaces and the impacts on patients' privacy (Fridh et al., 2007). Philbin & Evans (2006) also recommended standards for the NICU's acoustic environment to design the quiet hospital nurseries. Natural or ambient light in *ICU*s also was investigated by Smonig et al. (2019) and Verceles et al. (2013) to explain the relations of light and critical care outcomes.

Among mentioned architectural issues in *ICU*, *visual and physical accessibility* is essential for providing *patients' safety* and *staff efficiency*. As mentioned earlier, the significance of *visual and physical accessibility* to patients was seen in the work of Florence Nightingale. She designed an open ward to observe and approach to patients. She emphasized the physical and visual proximity to patients in an open ward. *Visual and physical accessibility* features in *ICU* can provide accessible and observable spaces for staff without unnecessary obstructions that inhibit the patient's care process.

Through the late 20th century, developing the hospitals in terms of medical technologies impacted the patients' monitoring and physical access. Consequently, staff and patient necessities have also started to change in nursing units of hospitals, particularly in *ICU*s. In this situation, healthcare architects have begun to consider the patients' and nurses' requirements in designing *ICU* more than other nursing units. The new design movement was developed by changing an open ward to a decentralized unit model to offer *visual and physical accessibility* to patients (Ritchey & Pati, 2008). Supplying better *visual and physical accessibility* as an essential issue in all kinds of nursing units, especially *ICU*, can be significantly affected by design (Apple, 2014; Calleja & Forrest, 2011; Harvey & Pati, 2012; Lu & Zimring, 2012; Welch, 2012).

High visibility allows nurses to quickly interfere with patients in the critical situation that considerably impacts *patients' safety* and *staff efficiency* in the *ICU*. (Apple, 2014; Harvey & Pati, 2012; Pati et al., 2014; Pati et al., 2016) *Visual and physical accessibility* provides the ability of the patients' observation continuously or immediate approachability to patients. Relations among the *ICU* spaces allow constant observation and immediate staff access to patients due to facilitating the detection of status changes and enhancing therapeutic actions. Among the architectural spaces, relations between nurse space and patients' space are core components to supply *visual and physical accessibility* in *ICU*s (Newell & Jordan 2015). Architects can provide a physical environment that allows constant observation and immediate staff access to patients to enhance patient safety and staff efficiency (AIA Academy of Architecture for Health, & Facilities Guidelines Institute, 2001; Schmalenberg & Kramer, 2007).

*Visual and physical accessibility* to patients enhances *staff efficiency* in decreasing time utilization and walking distance (Hamilton, 2010; Lawson, 2013; Rashid et al., 2016). For example, if medication or supply rooms are not easily accessible, nursing staff may need to walk more and spend more time walking in *ICU* (Rashid et al., 2016). Thus, a unit with a better physical environment design may help reduce staff walking, allow for better time utilization, and make staff more satisfied. Furthermore, patient safety may not occur or may be negatively affected by outcomes if patients are not easily visible in *ICU*s (Rashid et al., 2016). *Visual and physical accessibility* to patients also enhances *patients' safety* by constant observation of patients and quick interference in a critical situation. For instance, Rashid (2014) reported that single rooms are better than multi-rooms to provide *patients' safety*. Observing a patient's head by nurses is an essential architectural consideration that improves *patients' safety*. A single patient room provides a window between the observation station and the patient room to control patients (Rashid, 2014).

Various research findings show that the *visual and physical accessibilities* to patients strongly depend on the architectural characteristics of *ICU*s (Aalto et al., 2017; Hughes, 2008; McCullough, 2010; Rashid, 2006; Rashid, 2009) and investigated the impacts of *visual and physical accessibility* features on *patients' safety* and *staff efficiency*. Using the research findings and applying them in the decision- making process could provide *patients' safety* and *staff efficiency* in *ICU*s (Ulrich et al., 2004; Ulrich et al., 2008). For instance, Joseph (2006) stated that the nursing units' large size might enhance nurses' walking distance to the patient room.

Some studies also discussed that the small size of the nursing units decreases walking distance and provides better sightlines to patients (Ritchey & Pati, 2008; Trzpuc, 2010; Valentin et al., 2011). Additionally, the units' layout directly interrelates with the staff movements and accessibility to patients (Koch & Steen, 2012; Shpuza & Peponis, 2008). Rashid (2007) and McCullough (2010) stated that a single room model provides efficient interactions by decreasing walking distance and increasing visual access to patients without unnecessary architectural barriers among staff and patients. Leaf et al. (2010) also discussed the relationship between patients' mortality and *ICU*'s design and stated that severely ill patients might experience higher mortality rates when assigned to *ICU* rooms that are poorly visualized by nursing staff and physicians. Almost, designing the nurse station with high walls or patient rooms with blurred doors can diminish the *ICU*'s *visual and physical accessibility* (Stark, 2004).

According to the growing body of scientific research, *ICU*s environments need more consideration to provide *visual and physical accessibility* features. Mentioned studies recommended design solutions to provide *patients' safety* and *staff efficiency* in *ICU*s that architects could employ them in their design process.

## 1.2 Problem definition on *ICU'*s design

Hospital environments play a significant role in delivering care services and can impact on the patients' outcomes. In recent decades, following the medical and technological improvements, hospitals have been faced with fundamental changes in their environments, such as nursing units. Inappropriate design solutions can impact nursing units in creating inefficient and unsafe environments. Due to the developments of the patient-centered approach, patients and staff demands are being significant to design a safe and efficient environment in nursing units, especially ICUs. According to Groat & Wang (2013) and Lang (1987), design in the architectural field is a repetitive process that translates gathered data into design solutions appropriately (Groat & Wang, 2013; Lang, 1987). As mentioned earlier, various researches show the impacts of the visual and physical accessibility features on patients' safety and staff efficiency in ICUs. In this way, to provide a safe and efficient ICU environment, architects attempt to employ and manage the various data sources through their design process. According to Cama (2009), the design process includes programming or decision making, schematic design, design development, and construction documents (Cama, 2009). It is intrinsically a knowledge-based activity with a high degree of complexity and interaction between tacit6 and explicit knowledge7 (Groat & Wang, 2013; Heylighen & Neuckermans, 2000; Lang, 1987). The architects consolidate their ideas or redefine them to gain a suitable design solution (Dursun, 2007; Hogg, 2013; Zeisel, 1984). Many researchers agree that the design process is searching for the best fitting solution for the given design problem, which satisfies the client's needs, environmental expectations, and architectural standards.

According to Lang (1987), the design principles used throughout the design fields are based mostly on the individual professional's insights and personal experiences

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[6] Tacit knowledge:
"knowledge that you do not get from being taught, or from books, etc. but get from personal experience". Retrieved June 18, 2020, from https://dictionary.cambridge.org/dictionary/english/tacit-knowledge

[7] Explicit knowledge:
"knowledge that can be expressed in words, numbers, and symbols and stored in books, computers that can be articulated and easily communicated between individuals and organizations".
Retrieved June 18, 2020, from https://dictionary.cambridge.org/dictionary/english/explicit-knowledge?q=Explicit+knowledge

rather than on a well-formulated and systematic body of shared knowledge based on the systematic research or the cumulative experience of practitioners. Dickinson & Marsden (2009) and Zisko-Aksamija (2008) also stated that architects' knowledge is grounded on the information relative to the client, the context of the client, project, and building site, trends, products, and materials. Although using some norms and standards in the design process is necessary but, it is not enough. They could lead to improper results in the design and would limit creativity. (Mahmoodi, 2001)

According to the mentioned studies, one of the most common challenges in the design field is the gap between research and design (Bechtel, 1972; Becker, 2007; Kasali 2013; Reizenstein, 1975; Seidel, 1982; Sommer, 1997; Zeisel, 1975, 2006). The subjectivity of project information and the amount of tacit knowledge in the design process are challenges for architects to make reliable decisions through the design process. In the healthcare design filed, especially in ICU design, the transmission between tacit and explicit knowledge is inevitable and essential. Using scientific research from a variable domain of disciplines rather than a design field can enhance the quality of the ICUs' environment.

Architects need to determine scientific research to create high-quality environments (Chong et al., 2010). In contrast the growing body of scientific research, architects generally used their individuals' experiences, ideas, values, believes, and interpretations without offering any definitive source of knowledge (Becker, 2007; Cama, 2010; Groat & Wang, 2013; Hamilton, 2017, 2018, 2019; Hogg, 2013; Kasali 2013; Kim 2011; Tetreault & Passini, 2003; Whitemyer, 2010; Zisko-Aksamija, 2008). Kasali (2013) implied that architects scarcely use scientific research through their design process. He emphasized that healthcare architects generally employed precedents, anecdotes, and in-house experiments through their design process.

Recently, the *Evidence-based design*[8] *(EBD)* approach can promote the quality of decisions making process by providing the best available scientific research in various domains of knowledge in the healthcare design field. For the first time, the *EBD* approach was explained by Hamilton as “the conscientious, explicit and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project” (Stichler & Hamilton, 2008, p.3). The conceptual model of *EBD* proposed the making decisions’ process by integrating “credible research evidence,” “practitioner design expertise,” and “client or population needs, preferences, and resources,” in the context of the project in order to meet project goals (Peavey & Vander Wyst, 2017).

This is an essential distinguishable point of *EBD* from research-informed design (RID) restricted to employing just published scientific research in the design process (Peavey & Vander Wyst, 2017). *EBD* has adapted clues from Evidence-Based Medicine (EBM)[9] practice that highlights the significance of integrating the best research outcomes within clinical care rather than conventional resources of knowledge, such as unsystematic medical skills, experts' ideas, and intuition (Chong et al., 2010; Satterfield et al., 2009). In this study, the *EBD* approach used a theoretical framework to clarify this approach's importance in the design field.

*Systematic Review (SR)*[10] as a method of *EBD* is a reliable approach to creating, evaluating, gathering, and synthesizing various scientific research from other research fields beyond architectural design based on the specified criteria (Hamilton, 2011; Urra Medina & Barría Pailaquilén, 2010). By *SR*, architects can use credible research evidence from the unfamiliar domains of knowledge such as social science, nursing, or medicine, to stimulate the different innovative concepts for designers (Hamilton & Watkins, 2009).

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[8] See chapter three: Evidence- based design approach
[9] See chapter three: Evidence- based design approach
[10] See chapter three: Evidence- based design approach

According to the literature reviews, there is no *SR* about the *ICU*s' *visual and physical accessibility* features. In this way, the *ICU*'s accessibility features were reviewed systematically for the first time. Findings of *SR* employed to evaluate the architects' concern about the *visual and physical accessibility* features in the *ICU* design process.

### 1.3 Purpose of the study and research questions

Firstly, this study aimed to understand the *visual and physical accessibility* features in *ICU*s and its impacts on the patients and staff. Secondly, it aimed to clarify the *EBD* approach's importance to improve *patients' safety* and *staff efficiency* in *ICU*s. Thirdly, it aimed to evaluate healthcare architects' opinions and experiences in *ICU*'s design process by referring to the *EBD* approach.

According to these aims, this study answered three main research questions as follow:

1. What are the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*s?
2. How does the *EBD* approach help architects disclose the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*s?
3. What are the architects' opinions and experiences about the *visual and physical accessibility* features in *ICU*s, and how architects could achieve their knowledge in the *ICU*'s design process?

### 1.4 Significance of the study

According to the importance of using explicit knowledge in design, this study's essential contribution is to employ credible research evidence in the decision-making process by healthcare designers, researchers, and clients to achieve a safe and efficient *ICU* environment. There are some difficulties for architects, such as accessibility to scientific research sources and time limitations, to gather them through the design process.

Thus, this study informs architects or researchers about the *SR* process and its employment in the healthcare design filed to manage the scientific evidence. *SR* suggests ways to incorporate credible research evidence into the design process. This study can also be beneficial in architecture's educational field to inform students with *EBD* approach, interpret the evidence, and employ them in the healthcare design process. Additionally, scientific knowledge derived from a *systematic review* of the *ICU*'s *visual and physical accessibility* features added new knowledge. Also, healthcare architects could be considered this knowledge to design a safe and efficient environment in *ICU*s.

## 1.5 Methodology of the research

The methodology of the study was constituted of the three essential parts. In the first part, the researcher observed *ICU* in Iran and Finland to understand *visual and physical accessibility* features in *ICU*s. Observational data were gathered through fieldnotes with visual data like the floor plan and interior views of *ICU*s. Observational data were employed as a data source in the interview section of the methodology.

Secondly, the researcher used *SR* to gather credible research evidence about *ICU*s' *visual and physical accessibility* features. The findings of the *SR* were applied as a source in the interview section of the methodology. Finally, the empirical part of this study was conducted by a semi-structured interview to understand the healthcare architects' opinions about the *visual and physical accessibility* features in *ICU*s.

Before conducting a semi-structured interview, a pilot study was conducted between two healthcare architects to test the interview questions' appropriateness. Based on ethical issues, the interview guide's approval was obtained from the human subjects ethics committee at Middle East Technical University (METU) on Augustus 08, 2018, before conducting interviews (Appendix C: Approval of the interview guide). Qualitative data were gathered using the fifteen questions in the five sections with ten healthcare architects in Turkey- Ankara. Finally, the gather qualitative data were analyzed by deductive Thematic Analysis (TA).

### 1.6 Structure of the dissertation

The current study is structured into five chapters. Chapter two provides a literature review on the architectural characteristics of *ICU*s in three subsections. It firstly explains the historical background of the *ICU*. The second subsection describes the architectural characteristics of the *ICU*. The third sub-section presents the examples of *ICU*s from the 1960s up to the present. Chapter three introduces the *EBD* approach as the theoretical framework of this study included three subsections. Firstly, the researcher describes the *EBD* approach and its implication in the design field. Secondly, the meaning of evidence is defined in the *EBD*. In the third part, the researcher describes *SR* and its process.

Chapter four focuses on the methodology to answer the three research questions. This chapter includes observation of *ICU*s to understand *visual and physical accessibility* features in *ICU*s in Iran & Finland, a *systematic review* of the *visual and physical accessibility* features in *ICU*s to increase *patients' safety* and *staff efficiency*, and semi-structured interview to understand the healthcare architects' experiences about the *visual and physical accessibility* features in *ICU*s.

The findings are discussed to evaluate the architects' concern about *ICU*s' accessibility features in chapter five. Finally, the last chapter provides a conclusion, limitations, and suggestions for future research.

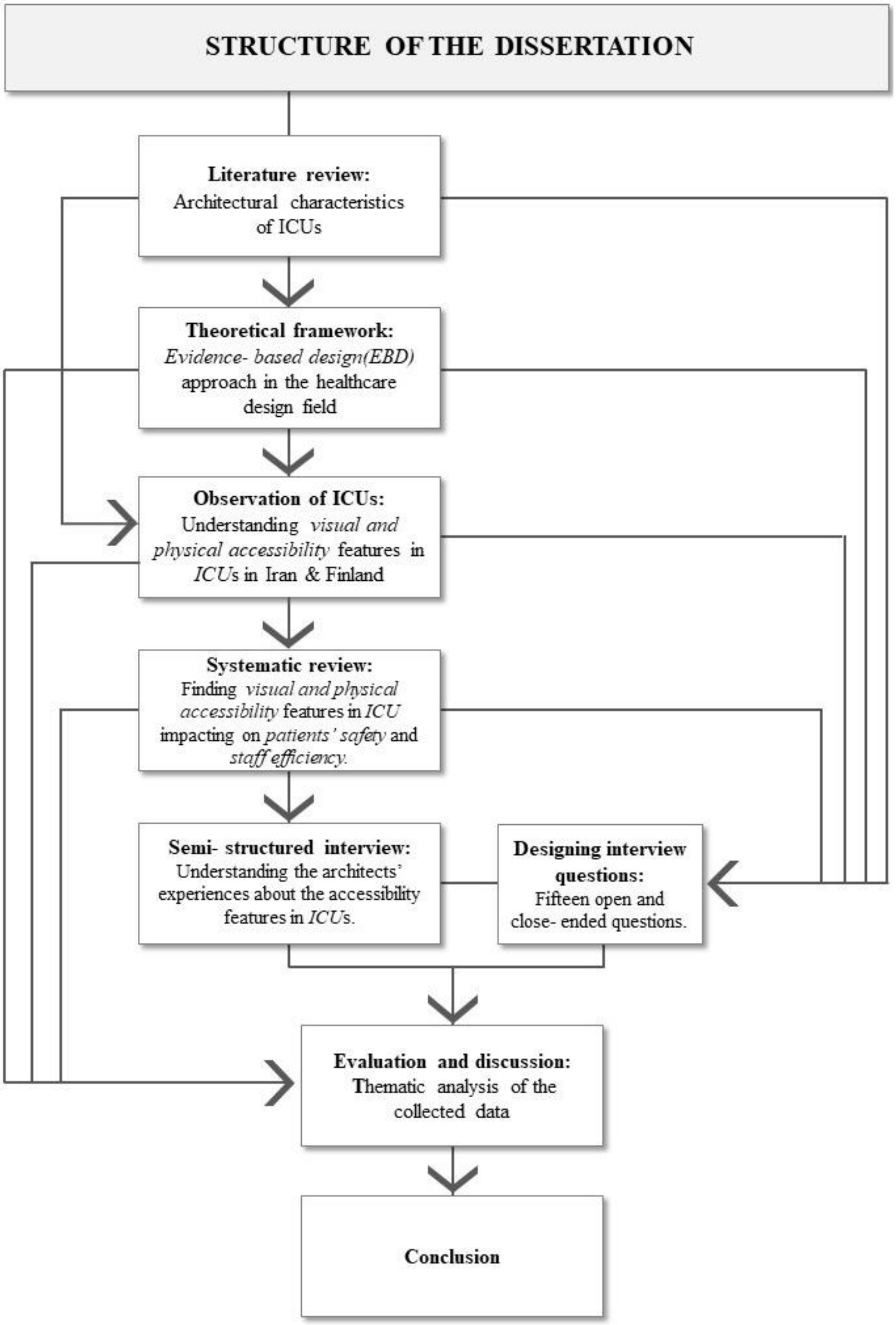



Figure 1.1. Structure of the dissertation (By the researcher)

# CHAPTER 2

## LITERATURE REVIEW LITERATURE REVIEW: ARCHITECTURAL CHARACTERISTICS OF THE INTENSIVE CARE UNITS

As mentioned in chapter one, the *ICU*s*'* physical design can significantly affect *patients' safety* and *staff efficiency*. Among various architectural features, *visibility and physical accessibility* are essential features that provide a safe and efficient environment for patients and staff in *ICU*s. For this reason, this literature review is structured in three main parts with regards to understanding the accessibility features in *ICU*s. Firstly. The historical background of *ICU*s described the technological and medical changes over the decades. The second part of the literature review explained the architectural characteristics of *ICU*s in three main themes: layouts of *ICU*, architectural spaces of *ICU*s, and other architectural characteristics. Finally, the third part of this review presented the examples of *ICU*s from the 1960s to the present by illustrating the selected *ICU*s*'* architectural characteristics.

### 2.1 Historical background of *ICU*

Through the decades, physical access and direct observation of patients always are essential architectural factors in *ICU*s' design. The researcher described the history of *ICU*'s design in two main parts: *ICU*'s design from the mid-19th century to the late 20th century and from the late 20th century up to present (Figure 2.1).

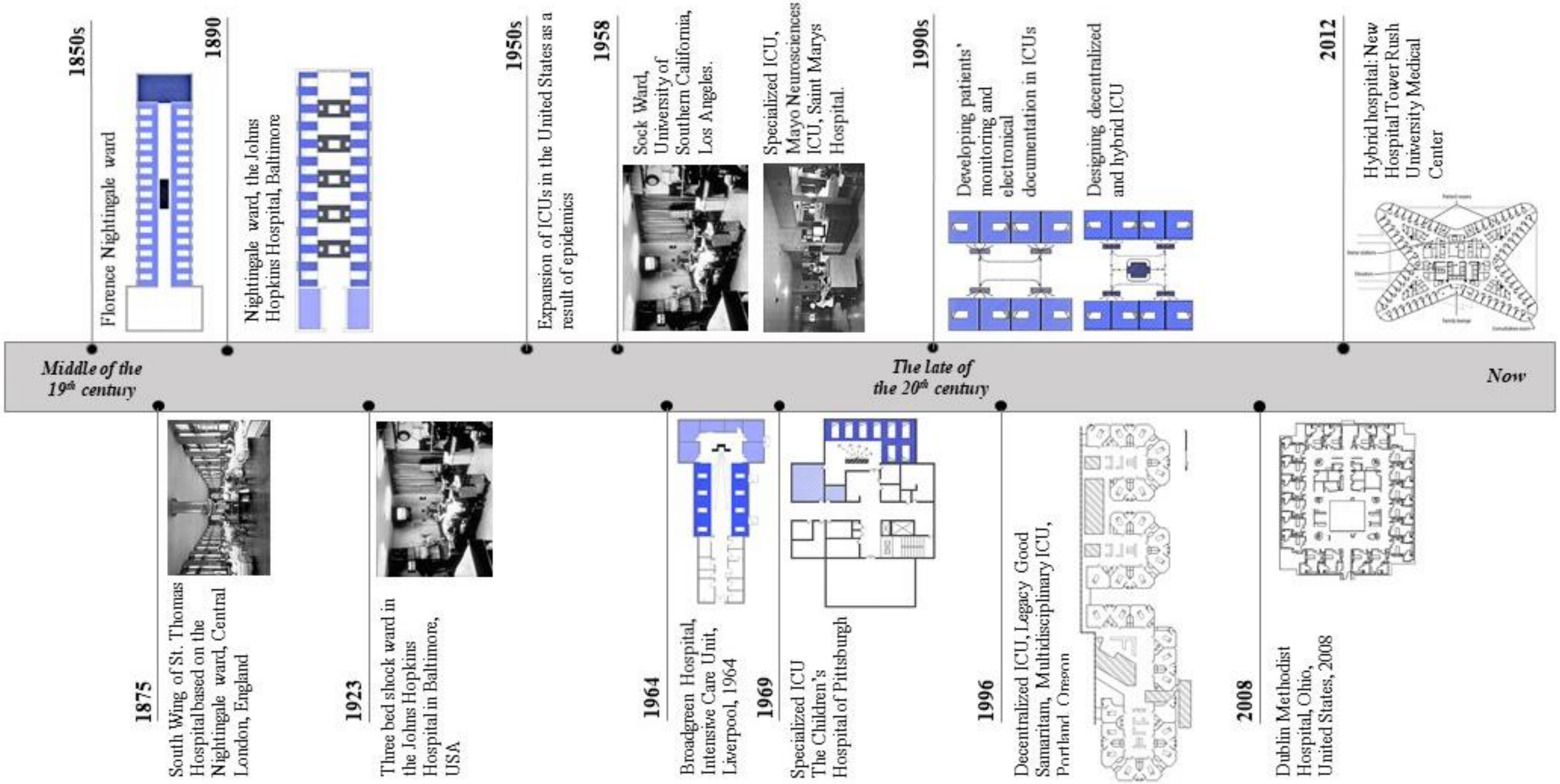



Figure 2.1. Historical background of *ICU*'s design (By the researcher)

### 2.1.1 From the mid- 19th century to the late 20th century

Over the decades, *ICU*s have developed as a specialized nursing unit to care for post-surgical patients in hospitals. Regard to observe *ICU* patients visually at all times, Florence Nightingale[11] was the first person that was identified development in *ICU*s' design by in her observation of recovery zones in the numerous hospitals (Cronin et al., 2007). Through the Crimean War in the 1850s, she did an innovative movement to create the modern *ICU* by segregating injured soldiers based on their intensity of injuries. She was also one of the first nurses who develop a nursing unit with an open ward plan called Nightingale ward. Architecturally, an open ward or Nightingale ward involves a long main corridor with a narrow width that thirty or thirty-two beds are located the premier of the corridor (Hamilton & Shepley, 2010; Haggard & Hosking, 1999; Verderber & Fine, 2000; Verderber, 2010). As you see in Figure 2.2, the nurse station is also placed at the end of the corridor in this ward. The constant monitoring of patients by a specific nurse is one of the important aspects of *ICU* that almost Nightingale considered it by monitoring the more ill soldiers consistently by specific nurses.

[11] Florence Nightingale: **"**Florence Nightingale**,** byname Lady with the Lamp (born May 12, 1820, Florence [Italy]—died August 13, 1910, London, England), British nurse, statistician, and social reformer who was the foundational philosopher of modern nursing." Retrieved September 24, 2017, from https://www.britannica.com/biography/Florence-Nightingale

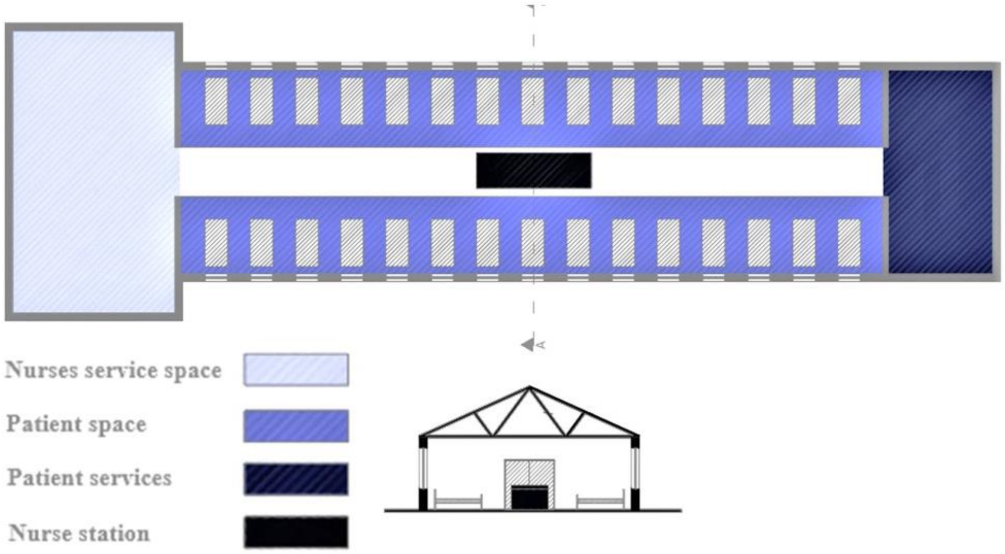



Figure 2.2. Floor plan of the Nightingale ward, the 1850s (Verderber & Fine, 2000)

In the mid- 19th century, Nightingale's plan was applied by many architects as a standard model of nursing units' model in many hospitals (Bobrow & Thomas, 2000; Ristagno & Weil, 2009; Hamilton & Shepley, 2010; IOM, 2004; ; Nightingale & McDonald, 2012; Verderber & Fine, 2000). One of the examples of Nightingale ward in South Wing of St. Thomas Hospital was designed in 1875 (Figure 2.3).

Figure 2.3. South wing of St. Thomas Hospital, 1875, Central London, England [12]

[12] Retrieved December 3, 2019, from https://tr.pinterest.com/pin/463659724107806673/?lp=true

In the late 19th century, the nursing unit design developed in terms of construction and building technologies. According to Bobrow and Thomas (2000), improved technologies permitted to construct complicated plan layouts. For instance, with the help of construction developments, Johns Hopkins hospital applied various types of nursing units' layouts at the same time, such as octagonal, circular, and square floor plan in 1890 (Figures 2.4; 2.5).

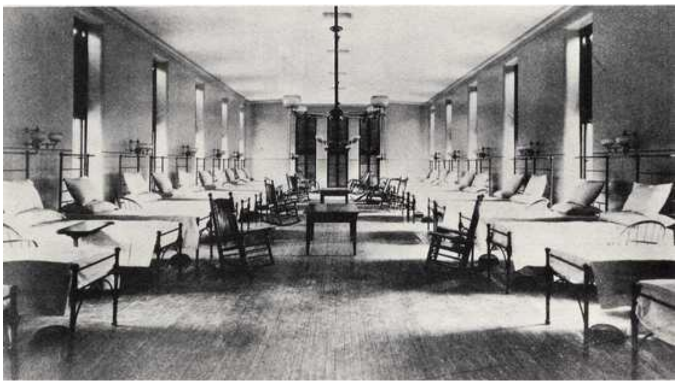


Figure 2.4. Nightingale ward, the Johns Hopkins Hospital, Baltimore, circa 1890 (Verderber, 2010, p. 66)

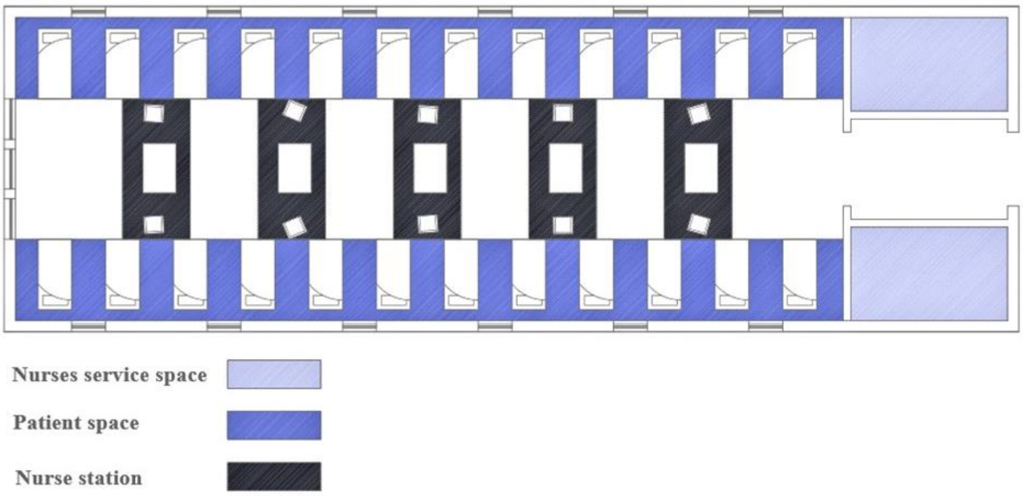



Figure 2.5. Floor plan of Nightingale ward, the Johns Hopkins Hospital, Baltimore, circa 1890 (Verderber, 2010)

As a result of the numerous illnesses spread throughout the First World War, lack of nurses in the hospitals caused that all post-surgical patients were gathered in the specified space called recovery or isolated patients' rooms (Bone et al., 1993). These rooms almost called shock wards to revive wounded soldiers after the surgical operation (Verderber & Fine, 2000). The design concept of the Shock wards was to provide specific care units for each sickness. As the Nightingale open ward, shock rooms also inspired nurses to work in teamwork and communicate with patients permanently to give them necessary services in less time and carefully observe them (Hamm, 2011; Marberry,1995; Weil & Shoemaker, 2004). In 1923, a three-bed nursing unit of post-operative neurosurgical ills was designed as a shock ward at the Johns Hopkins Hospital in Baltimore (Hamilton & Shepley, 2010).

Many of the procedures in *ICU*s were developed throughout the Second World War, to provide efficient resuscitation for the large numbers of severely wounded soldiers (Cronin et al., 2007). Consequently, the modern design ides of *ICU* have expanded from the polio disease in Copenhagen in 1952 (Cronin et al., 2007). According to Bone et al. (1993), many hospitals began to use shock wards as an *ICU*. As seen in Figure 2.6, the nursing unit with four beds started to work as an *ICU* at the University of Southern California in 1958.

Figure 2.6. Sock Ward, University of Southern California, Los Angeles, 1958 (Byan-Brown CW, 1991, p. 6)

As seen in Figure 2.7 and Figure 2.8, the *ICU* of the Broadgreen hospital is another example designed in 1964 in Liverpool that Patients' beds were divided by curtains for providing more privacy in critical situations (Reynolds & Tansey, 2011).

Figure 2.7. Broadgreen Hospital, *ICU*, Liverpool, 1964 (Reynolds & Tansey, 2011, p.28)

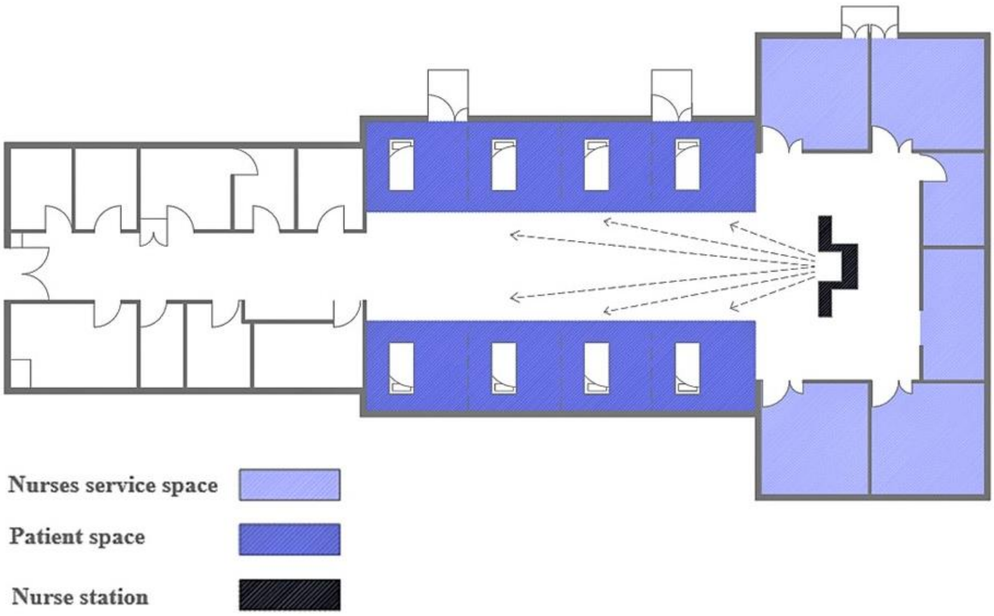



Figure 2.8. Floor plan of *ICU,* Broadgreen Hospital, Liverpool, 1964 (Reynolds & Tansey, 2011, p.28)

After the Second World War, the latest model of *ICU* started to change the floor plan with the evolution of mechanical systems and the patients' monitoring systems, especially over the United States (Bone et al., 1993; Villar et al., 2001). *ICU* had appeared as a specific and fundamental unit in many healthcare facilities such as the Neurosciences *ICU* of Saint Marys' hospital (Figure 2.9).

Figure 2.9. Mayo Neurosciences *ICU*, Saint Marys Hospital, 1958 (Wijdicks et al., 2011, p. 905; Wijdicks, 2012, p. 7; McElheny et al., 2015, p.19-31)

The pediatric *ICU*s (PICUs) of Pittsburgh (CHP) is one of the first PICUs in the United States (Figure 2.10).

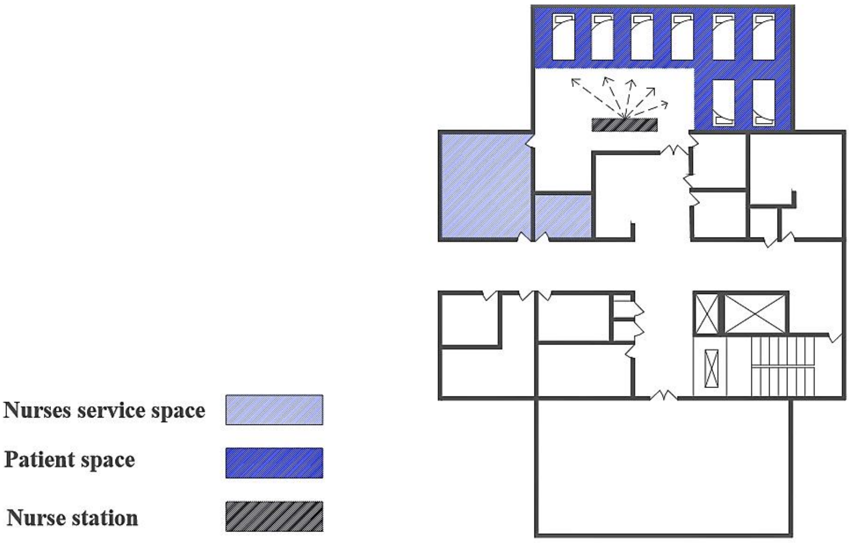



Figure 2.10. Floor Plan of PICU, the Children’s Hospital of Pittsburgh, 1969 (Ozcan, 2006, p. 15)

Until the late 20th century, *ICU* was mostly designed based on the centralization of the unit that involved the centralized station in providing charting and monitoring space for staff (Figure 2.11) (Hamilton & Shepley, 2010; Valentin et al., 2011).

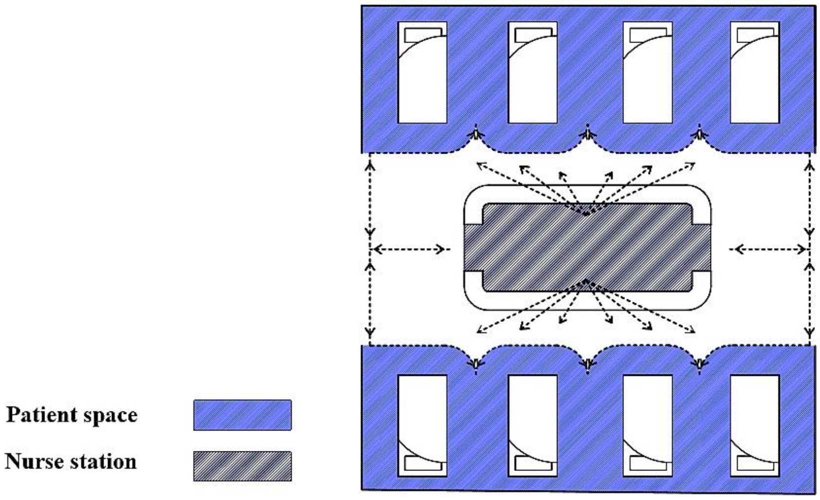



Figure 2.11. Floor plan of the centralized *ICU* (Hamilton & Shepley, 2010)

Many studies show the advantages and disadvantages of centralized *ICU* not only for patients but also for staff. For example, Becker (2007) stated that the nurse station's place could maximize or minimize nurses' walking distance or their observation to patients in a centralized *ICU*. Another study emphasized positioning the nurse station centrally as a beneficial design factor to diminish the nurses' walking distance in *ICU*s (USDVA, 2011). This study also showed that a central nurse station could be placed close to the *ICU*'s entrance to provide suitable control of the patients' access as well as the main teamwork area for staff (USDVA, 2011).

### 2.1.2 From the late 20th century up to the present

Through the late 20th century, developing the hospitals in terms of medical technologies impacted the patients' monitoring and accessing ways. Consequently, staff and patient necessities have also started to change in nursing units of hospitals, particularly in *ICU*s. In this situation, healthcare architects have begun to consider the patients' and nurses' requirements in designing *ICU* more than other nursing units. One of the design movements that began to employ in the design process of *ICU* by healthcare architects is a patient-centered design.

While the centralized unit model was a popular design idea for many decades, the patient-centered design provides the new design movement toward a decentralized or hybrid unit model that offers direct and clear *visual and physical accessibility* to patients (Ritchey & Pati, 2008).

Thus, patient-centered design encourages healthcare architects to use decentralized *ICU* for safer and more efficient *ICU*'s environment by minimizing nurses' walking distances and increasing the spending time of nurses with patients (Bunker-Hellmich, Morelli, & O'Neill, 2010; Hamilton & Shepley, 2010; Knaus et al., 1983; Zborowsky, Rashid, 2014; Verderber & Fine, 2000). In contrast with the centralized unit model, a decentralized unit model suggests several decentralized nurse stations inside *ICU*s that help to observe one or two patients' beds separately (Figures 2.12; 2.13; 2.14) (Hamilton & Shepley, 2010; Pati, 2015; Ritchey & Pati, 2008; Schweitzer et al., 2004).

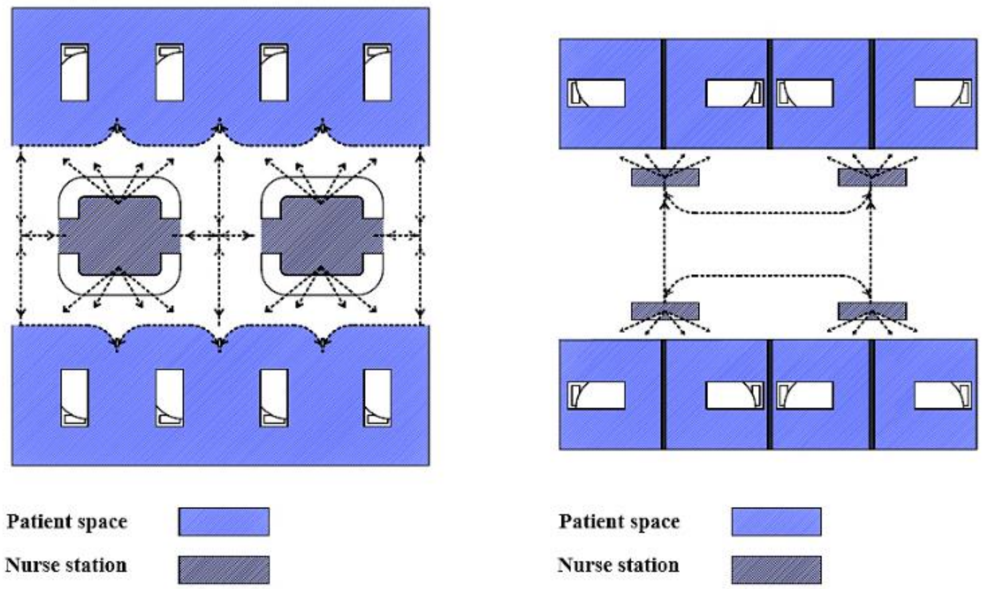



Figure 2.12. Floor plan of a decentralized *ICU* (Hamilton & Shepley, 2010, p. 17)

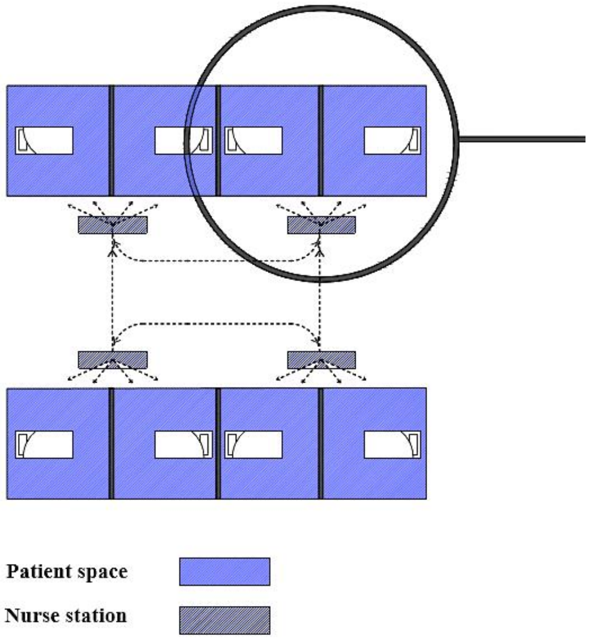



Figure 2.13. Patient rooms of the decentralized *ICU* (Hamilton & Shepley, 2010, p. 17)

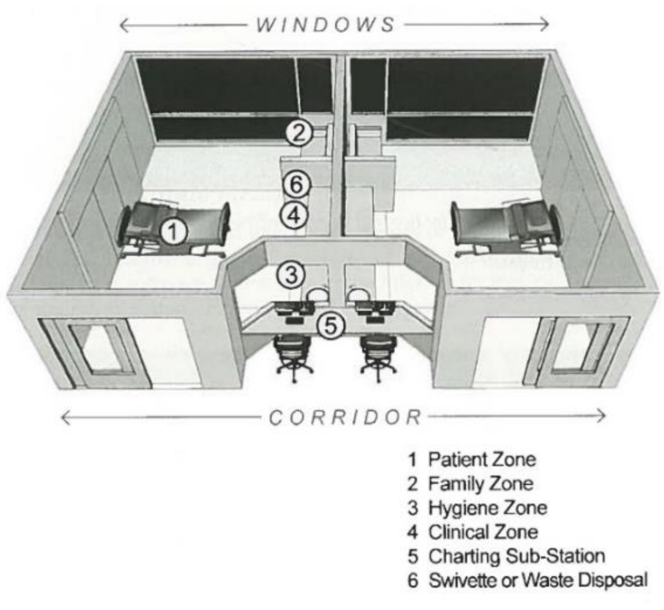



Figure 2.14. Decentralized *ICU* (Hamilton & Shepley, 2010, p. 17)

In a decentralized unit model, healthcare architects have placed the nurses and patients' spaces close together for better visual access (Hamilton & Shepley, 2010; Knaus et al., 1983; Rashid, 2014). Nurses' observation stations should be located on the outside of the two patients' room. Hamilton & Shepley (2010) imply the positioning ways of the patients in a decentralized unit model. One of the suitable ways is to place the patients' head or patients' face on the opposite side of the observation station. Another way suggests a vison to the side of the patient's head by placing patients' beds back on the same wall of two-room in front of the nurses' observation station.

Additionally, some healthcare architectural guidelines suggest choosing a decentralized model of *ICU* to provide *visual accessibility* to the patient's bed (AusHFG, 2016; FGI, 2014). According to FGI (2014), in a decentralized *ICU*, to observe or monitor patients directly by nurses, observation, or charting stations generally use between rooms or appropriate place for observing patients. Dublin Methodist hospital[13], as an example of a decentralized *ICU*, involves nurses' stations, disseminated supply areas, same-handed patients' rooms, and family space inside the patient room (Figure 2.15). With the help of decentralized stations, it aims to place nurses besides the patients to access them easily.

[13] Retrieved September 25, 2017, from https://www.ohiohealth.com/locations/hospitals/dublin-methodist-hospital

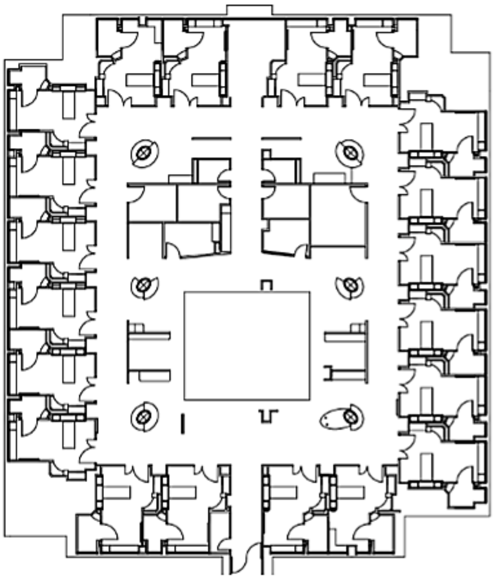


Figure 2.15. Decentralized *ICU*, Dublin Methodist Hospital, Ohio, United States, 2008 (Cai,2013)

Another new design movement is a hybrid unit model with a mixture of the centralized and decentralized unit model in *ICU*s (Hamilton & Shepley, 2010). It contains one decentralized station beside the patient rooms and one mini centralized station beside the central part of the unit (Figure 2.16).

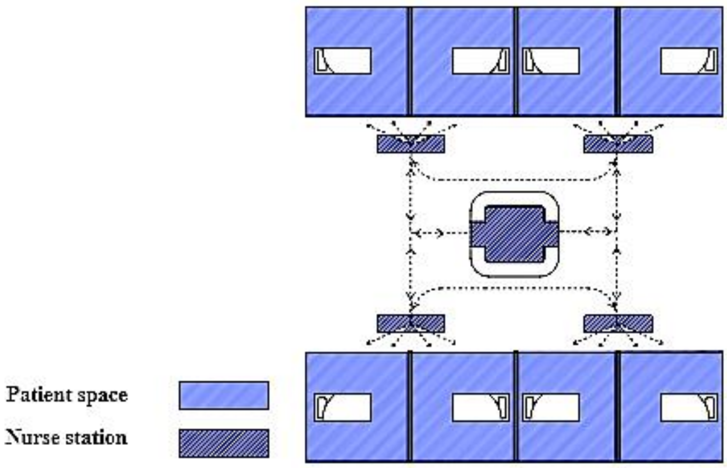



Figure 2.16. Floor plan of the hybrid *ICU* (Hamilton & Shepley, 2010, p. 17)

As you can see in Figure 2.17, the Rush university medical center's Critical Care Unit (CCU) is designed based on a hybrid unit model. This CCU suggests one centralized station as well as the decentralized stations with 61 single-patient rooms.

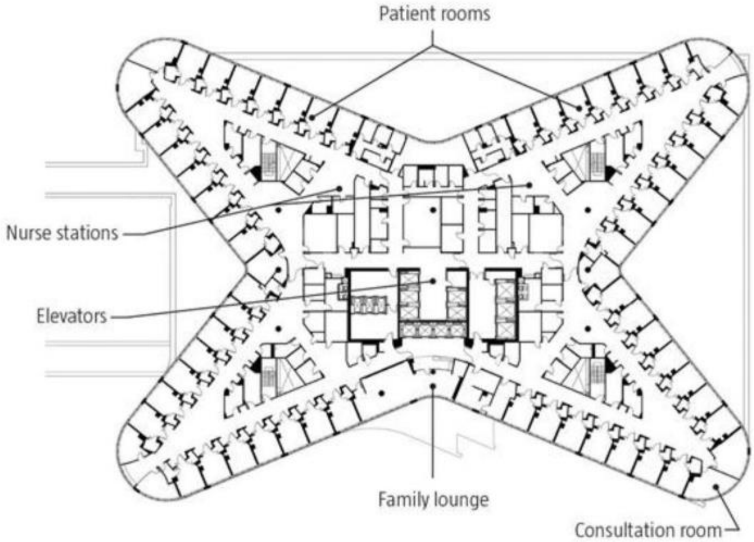



Figure 2.17. New Hospital Tower Rush University Medical Center, Hybrid CCU, Chicago , IL , United States, 2012 [14]

As seen above figure, decentralized and hybrid unit models try to enhance *patients' safety* and *staff efficiency* by using two design solutions. Firstly, walking distance of nurses could minimize significantly by designing decentralized stations and supplementary support areas (Bunker-Hellmich, 2010; Hamilton & Shepley, 2010; Gurascio-Howard & Malloch, 2007; IOM, 2004; Malkin, 2008; Newcomb, 2010; Rashid, 2014; Trzpuc, 2010; Zimring et al., 2004). After that, direct observation and close monitoring of patients could provide by designing nurse stations inside or outside the rooms with a glazed wall or window between the observation's desk and

[14] Retrieved June 12, 2018, from http://aasarchitecture.com/2013/10/rush-university-medical-center-by-perkinswill.html and http://www.architectmagazine.com/project-gallery/rush-university-medical-center

patient room (Figure 2.18) (Hamm, 2011; Hendrich et al., 2009; Trzpuc, 2010; Zimring et al., 2004; Rashid, 2009).

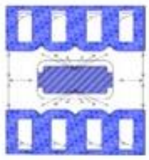
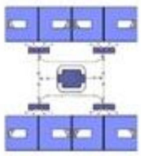
For instance, the *ICU* of the Saratoga hospital is renovated based on a decentralized model of *ICU* with 19 single rooms. As seen in the below figure, each room is equipped by windows between patient and nurses' zone with the ability to fade from transparency to opaque.[15]

Figure 2.18. The Saratoga hospital, Decentralized *ICU*, Saratoga Springs, NY, 2015 [5]

Additionally, in decentralized and hybrid *ICU*s, nurses may gradually perceive the separation feeling from other staff, which could be one of their disadvantages. Social isolation of nurses from other staff is the significant design challenge that is resulted in the organizing way of observation stations in decentralized and hybrid *ICU*s (Hamilton & Shepley, 2010; Zhang et al., 2015). However, high *visual and physical accessibility* to patients in decentralized and hybrid *ICU*s generally improve *patients' safety* and *staff efficiency*.

[15] Retrieved December 03, 2019, from https://aowassoc.com/saratoga-hospital-surgical-pavilion-and-intensive-care-unit-addition-renovations/

Table 2.1 Architectural characteristics of centralized and decentralized *ICU* (By the researcher)

| DATE | ICU'S DESIGN MODEL | CHARACTERISTICS |
|---|---|---|
| **From the mid- 19th century to the late 20th century** | Centralized ICU  | - Increasing the visual accessibility to patients.<br>- Decreasing the physical accessibility to patients.<br>- Increasing the level of noise.<br>- Decreasing privacy of patients. |
| **From the late 20th century up to present** | Decentralized ICU  | - Increasing the visual and physical accessibility to patients.<br>- Decreasing the level of noise.<br>- Decreasing the social interaction of staff. |
| | Hybrid ICU  | |

## 2.2 Architectural characteristics of *ICU*s

Regarding the significance of direct observation and physical access to patients, design encounters an important evolutionary point in the unit designs model from centralized to decentralized units after the late 20th century. However, without considering the *ICU*s' design model, they generally have specific architectural characteristics that will be described in detail as follows:

### 2.2.1 Layouts of *ICU*s

The layout is one of the significant architectural characteristics of *ICU*s that specifies organizations of spaces and connections between different spaces inside the unit (Rashid, 2014). After technological developments, healthcare designers found the chance to expand units' layout in various geometrical models with the help of advanced construction and building methods (Bobrow & Thomas, 2000; Trzpuc, 2010). however, architects started to design *ICU* such as any other nursing units in many kinds of layouts. It is necessary to emphasize that the kinds of *ICU* layout and relationships between various spaces inside them could help patients' *visual and physical accessibility* (Bobrow & Thomas, 2000; Shepley, 2002; Sturdavant, 1960; Trites et al., 1970; Trzpuc, 2010). There are seven kinds of units' layout specified in hospitals that could be applied in *ICU* design (Cai, 2013; James & Tatton-Brown, 1986).

- **Single corridor layout:** It generally consists of some multiple patient room areas on a small scale and some individual room for 30-36 patients (Cai, 2013; James & Tatton-Brown, 1986). Patient rooms are located on one hand of the main corridor to achieve daylight (Cai, 2013; James & Tatton-Brown, 1986). Oppositely, nurses' spaces are located on the other hand of the corridor. Almost, for observing patients suitably and minimizing nurses' walking distance, the main nurse station places in the central part of the unit (Figure 2.19) (Cai, 2013; James & Tatton-Brown, 1986).

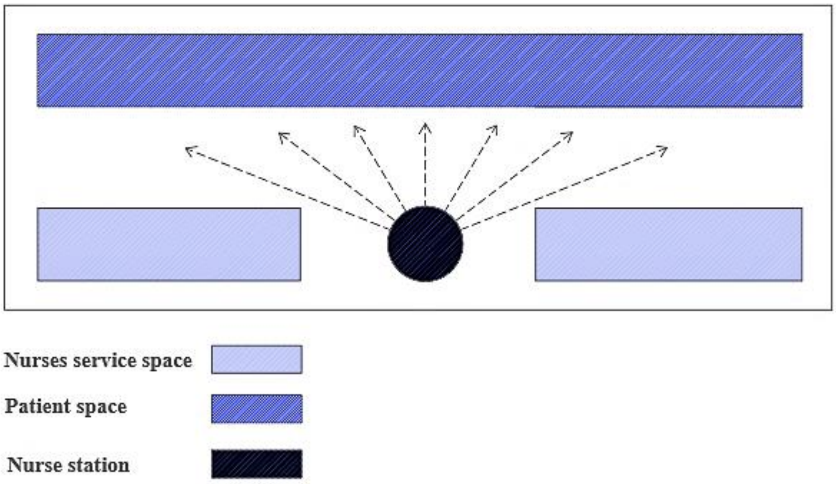



Figure 2.19. Floor plan of the single corridor layout (By the researcher)

In St. Thomas hospital, the east wing of the hospital was designed based on the single corridor layout in 1960 (Cai, 2013). As shown in Figure 2.20, it was designed in T form with two patient and staff wings that staff wing is attached to the patient wing perpendicularly (Cai, 2013). Patient space is designed based on the open unit model for four patients and individual rooms for patients with critical situations. The nurse station is also placed at the joint between the patients and the staff's wing. Some other facilities, such as restrooms and bathrooms, are placed at two end parts of the patients' wing (Cai, 2013).

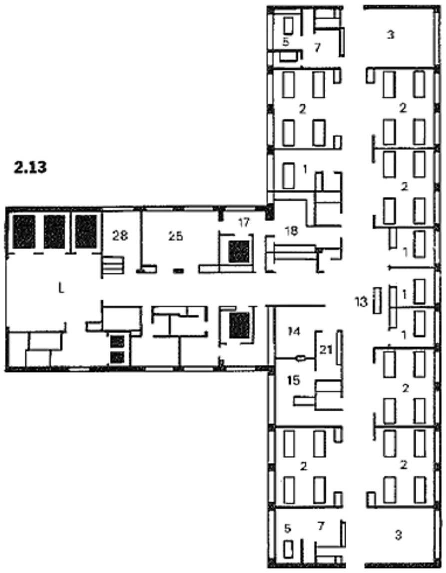



Figure 2.20. East wing, St. Thomas, UK, 1960 (Cai, 2013)

- **Duplex layout:** The duplex or nuffield layout is split into one large unit and two small units for twenty patients. Each small unit consists of a nurse station with one common support space that is used with together (Cai, 2013; James & Tatton-Brown, 1986). This layout could be practical in multiple-bed units to minimize nurses' walking distance (Figure 2. 21) (Cai, 2013; James & Tatton-Brown, 1986).

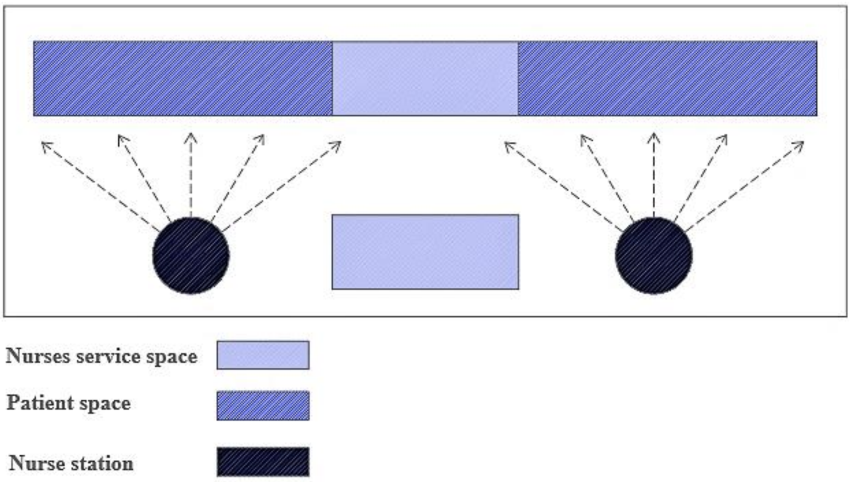



Figure 2.21. Floor plan of the Duplex layout (Nuffield) (By the researcher)

For instance, the nursing unit of the Larkfield hospital is split into two equal patient spaces (Cai, 2013). Each patient space has a separate nurse station, but support space is shared between two spaces (Cai, 2013). According to Figure 2.22, each patient space generally involves sixteen beds that it compromises four isolation beds and three four-multi bedrooms.

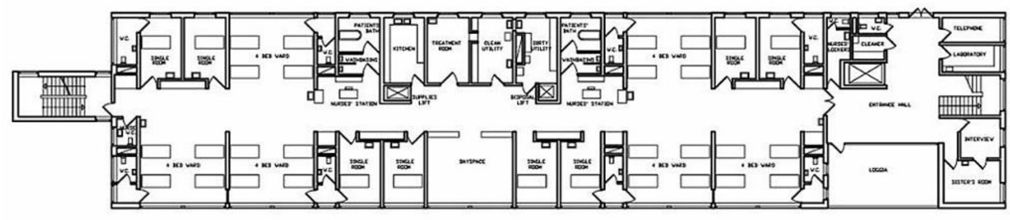


Figure 2.22. Larkfield Hospital, UK, 1960 (Cai, 2013)

- **Racetrack layout:** Racetrack or double corridor layout aims to suit more patients inside a unit without enhancing the nurses' walking distance (Cai, 2013; James & Tatton-Brown, 1986). This layout is one of the common unit layouts because of *staff efficiency* and compacted plan form (Cai, 2013; James & Tatton-Brown, 1986). Additionally, staff and support spaces are suited between the two main corridors, as shown in Figure 2.23 (Cai, 2013; James & Tatton-Brown, 1986).

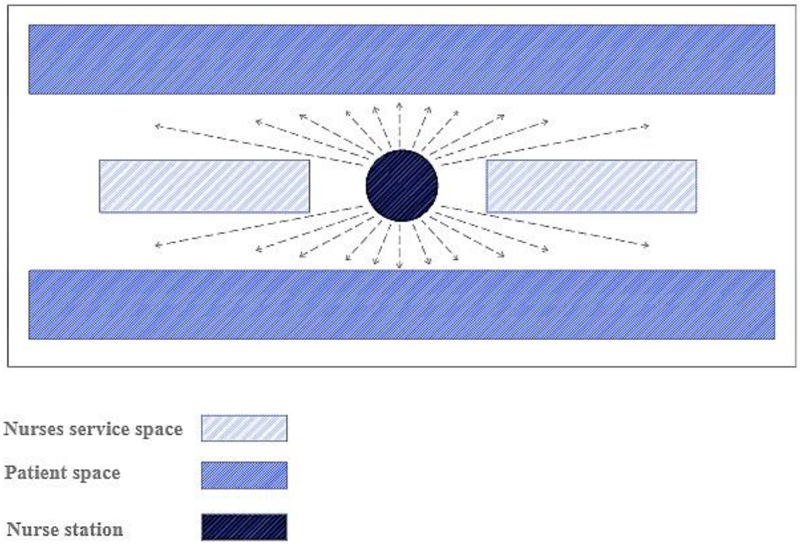



Figure 2.23. Floor plan of the Racetrack layout (By the researcher)

In the Saddleback Memorial Medical Center, total patient rooms were arranged at the surrounding of the racetrack layout (Hamilton & Shepley, 2010). This unit has two nurse stations that support the equal number of patients' rooms. As shown in Figure 2.24, the support and service spaces are located at the center of the unit in the middle of the corridors (Hamilton & Shepley, 2010).

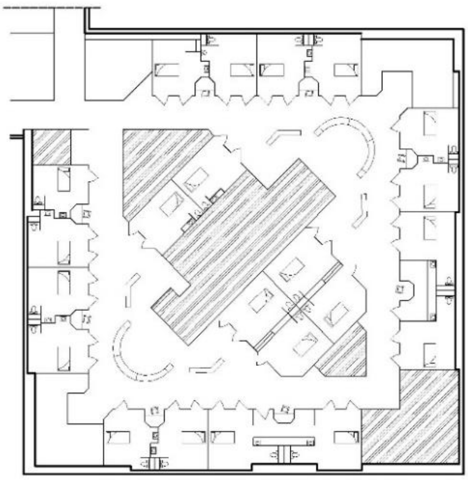


Figure 2.24. The Saddleback Memorial Medical Center, CA, USA, 1988 (Hamilton & Shepley, 2010, p. 24)

- **Courtyard layout:** This layout is a kind of racetrack layout that consists of a ventilation patio in the central part of the unit (Cai, 2013; James & Tatton-Brown, 1986). As shown in Figure 2.25, the service zones are positioned surrounding the patio inserted in the core of the layout. Because of the more distance between patient rooms and the central nurse station in the courtyard layout, designers apply some substations close to the patients' zones (Cai, 2013; James & Tatton-Brown, 1986). The high depth of a plan substantially enhances the nurses' walking length and relinquishes the proper visibility of patients (Cai, 2013; James & Tatton-Brown, 1986). In contrast, it commonly supplies high privacy for patients and ideal daylight inside the unit (Cai, 2013; James & Tatton-Brown, 1986).

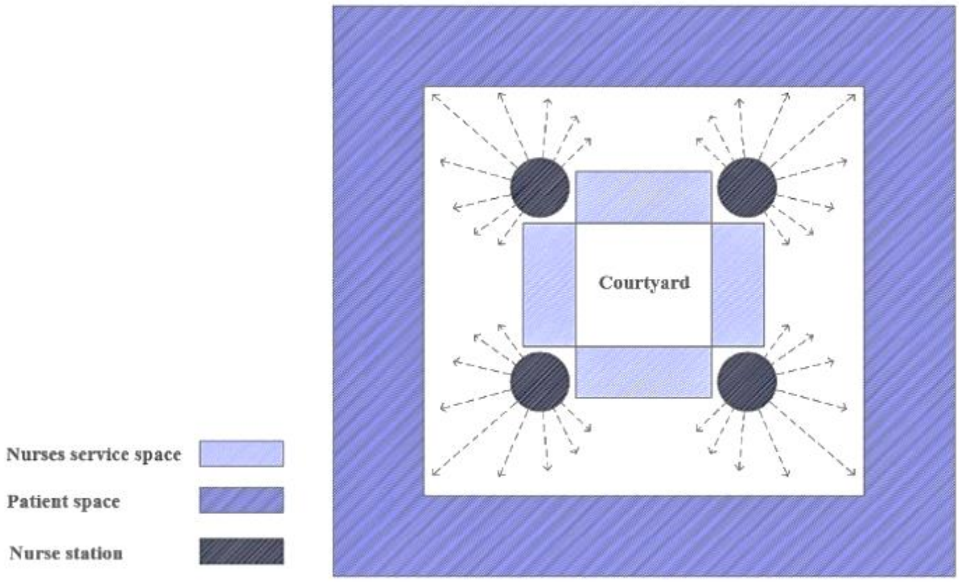



Figure 2.25. Floor plan of the Courtyard layout (By the researcher)

Figure 2.26, as an example of a courtyard layout designed in the Vivantes Clinical Center, shows that patient spaces are organized surrounding the exterior wall. In contrast, staff spaces are organized surrounding the inner wall of the patio (Verderber, 2010).

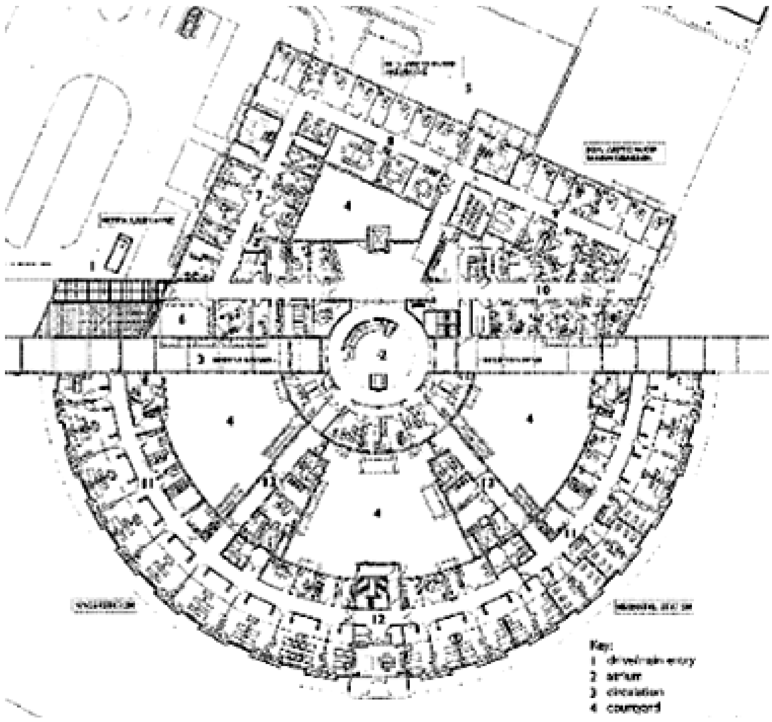



Figure 2.26. Vivantes Clinical Center, Berlin, Germany (Verderber, 2010, p. 207)

- **Cluster layout:** The nursing unit's design has gradually moved to cluster patients in small subunits and place a service area in the central part of the unit to utilize by all small subunits (Cai, 2013; James & Tatton-Brown, 1986). With the help of cluster or cruciform layout, unit clusters in four subunits that nurse station and service space place at the central zone of the unit (Cai, 2013; James & Tatton-Brown, 1986). This layout supplies appropriate patients' observation from the nurse station and minimizes the nurses' walking length to patients significantly (Figure 2.27) (Cai, 2013; James & Tatton-Brown, 1986).

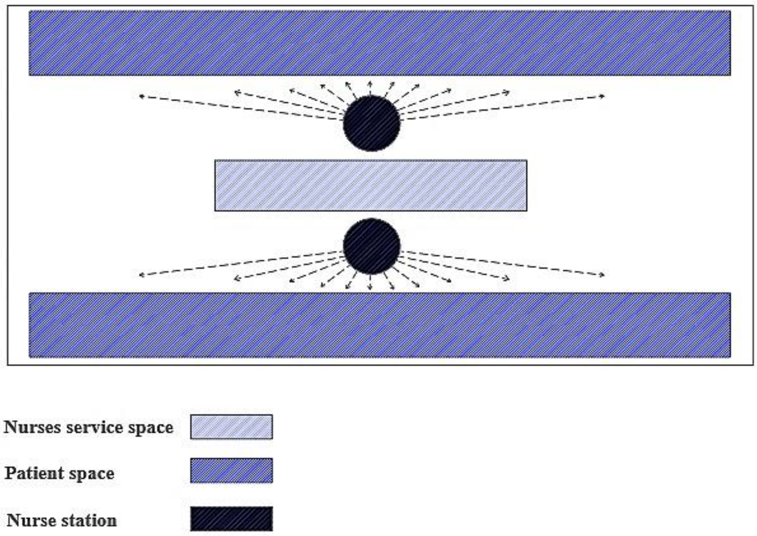


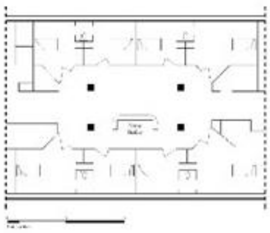
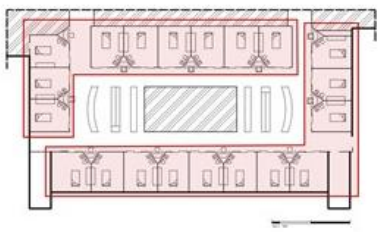

Figure 2.27. Floor plan of the cluster layout (By the researcher)

As shown in the below Figure 2.28, the nursing unit in Hasbro Children's hospital is an explicit model of the cluster layout. This unit contains three patients' pods or subunits that each pod includes ten patients with one small nurse station (Cai, 2013). The central service zone is located in the core of the unit (Cai, 2013).

Figure 2.28. The Hasbro Children's hospital, Rhode Island, US, 1994 (Cai, 2013, p.20)

The clustered layout is directly related to the unit's size, determined by the number of patients' beds. The *ICU*s' size must be proper for patients' persistent observation by specified nurses (Rashid, 2014). He also stated that the size of *ICU*s must be appropriate not only for controlling patients but also for understanding all activities in *ICU*s. Additionally, the *ICU*'s size must also provide a minimum walking length for nurses (Rashid, 2014). The small *ICU*s could be a solution to allow less walking distance, but it may not allow having spaces such as a suitably sized family room or staff rooms (Rashid, 2014). There are architectural guidelines about the size of *ICU*s that have specified ideal *ICU*s' size by describing the patient's bed number inside the unit. Australasian Health Facility Guidelines (2016) imply that the ideal *ICU*'s size is between 10 and 16 beds that supply enough space for teamwork and various activities among nurses and other staff. In addition to architectural guidelines, Rashid (2014) implies the ideal *ICU*s' size, with at least 8 to 12 patients' beds in each unit to the high ability of patients' observation. Large *ICU*s should be clusterd into subunits with 6 to 8 patients' beds (Rashid, 2014). In this way, *staff efficiency* could enhance through providing support zone for each subunit and decreasing the travel distance of staff. For instance, *ICU*s with 24 patients' beds could be clustered into three subunits pods with eight patients' beds to have optimal *visual and physical accessibility* between support and patient zone (Rashid, 2014).

Table 2.2 The size of *ICU*s (AusHFG, 2016; Hamilton & Watkins, 2008; Rashid, 2014)

| Unit size | Bed numbers in ICU | Example |
|---|---|---|
| **Small unit** | Designing maximum 8-12 patients' beds. |  The Grace hospital, 1960s, Detroit, Michigan. (Kaltsas, 1979) |
| **Large unit** | Designing sub- stations of 8-12 patients' beds. |  Harris Methodist Fort Worth Hospital, 2003, Fort Worth, Texas, USA. (Hamilton & Shepley, 2010) |

- **Radial layout:** The central nurse station that is surrounded by rooms is the substantial characteristic of the radial unit. With the help of a radial layout, designers can present a 360-degree view of each patient from the nurses' station (Figures 2.29; 2.30) (Seo et al., 2011; Yi & Seo, 2012). The unusual model of rooms in this unit is declared as a weak point of the radial unit because of the challenges in the facilities' organization.

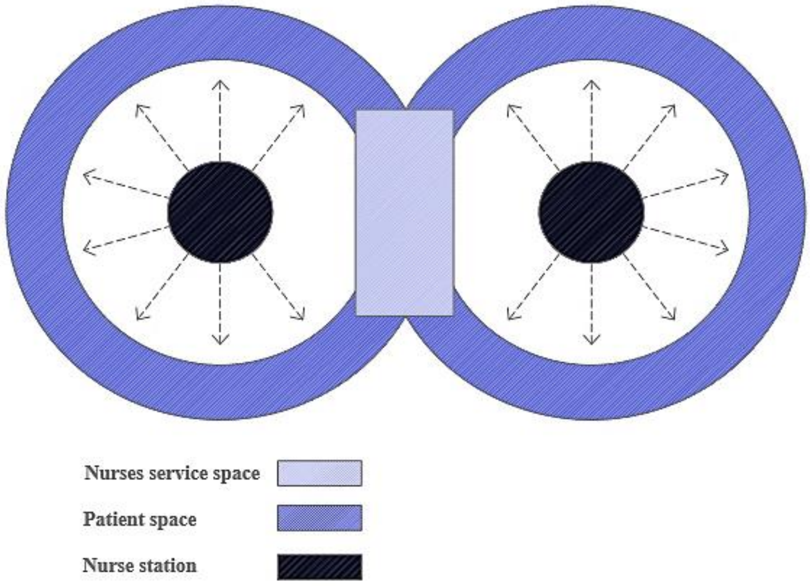



Figure 2.29. Floor plan of the radial layout (By the researcher)

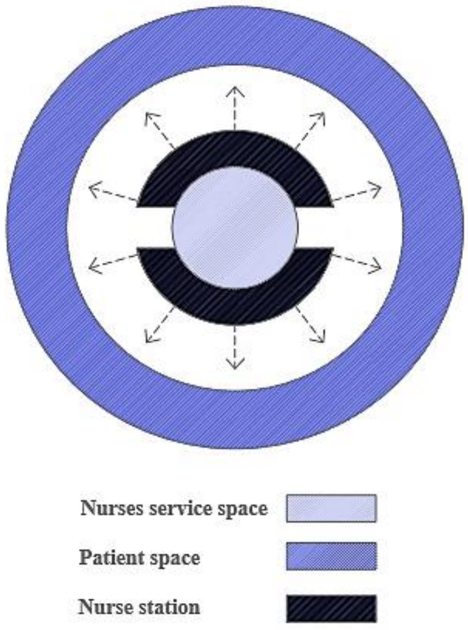



Figure 2.30. Floor plan of the radial layout (By the researcher)

The Brigham and Women's hospital is a glaring example of the radial unit structured in three radial patients' pods with a support zone located on the core of the unit. As shown in Figure 2.31, the central nurse station, surrounded by patients' rooms, supplies the highest *visual and physical accessibility* in each patient's pod. [6]

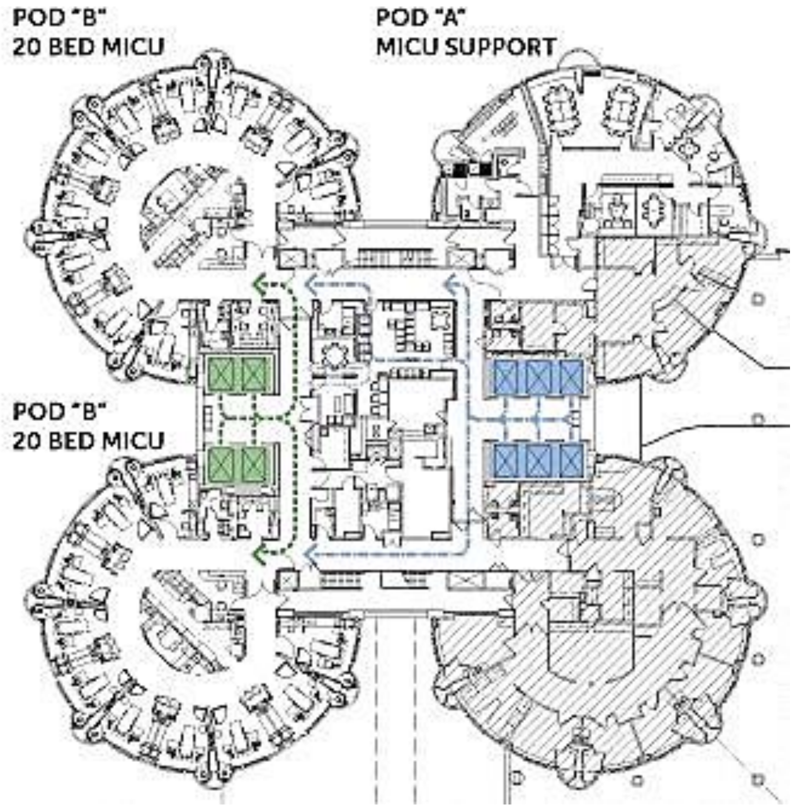



Figure 2.31. Brigham and Women's hospital (Renovation project), Boston, MA, USA[16]

- **Triangle layout:** One of the answers to minimize the nurses' walking length is a triangular layout by placing staff and support zones at the core of the unit (Cai, 2013;

[16] Retrieved February 23, 2018, from http://www.payette.com/project/intensive-care-unit/

James & Tatton-Brown, 1986). It also shares similar challenges with layouts in a radial shape, such as flexibility in facilities' arrangements (Figure 2.32).

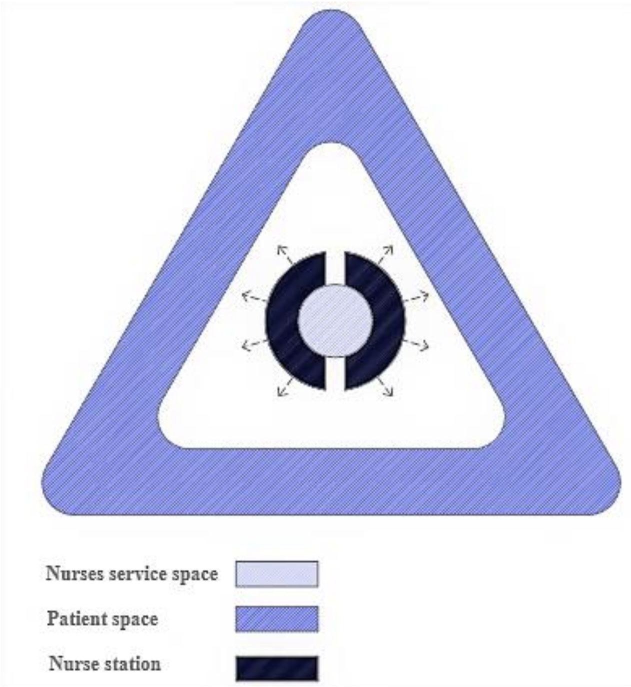



Figure 2.32. Floor plan of the triangle layout (By the researcher)

As seen in Figure 2.33, in the *ICU* of Emory hospital, the patients' rooms are organized on three edges of the triangular layout with two nurse stations and support zone located in the central part of the layout (Cai, 2013). Nurses mostly use the triangular corridor between the patient and staff zones to perform various care activities in this layout (Cai, 2013).

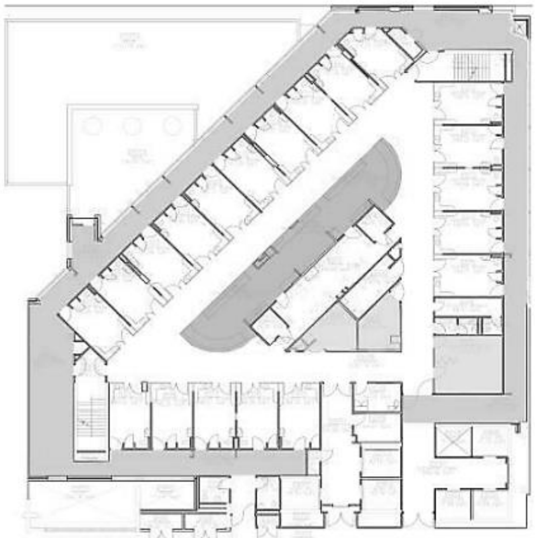
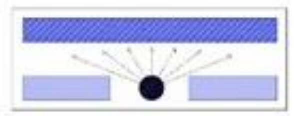
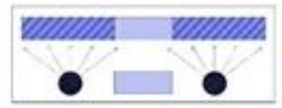
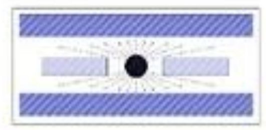
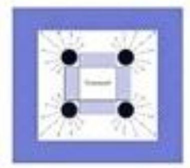
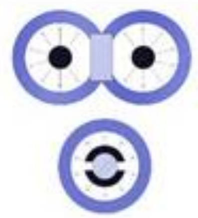


Figure 2.33. The 5E *ICU* of the Emory, Atlanta, GA (Cai, 2013, p. 23)

According to the mentioned literature, the layouts' advantages and disadvantages were summarized as seen in Table 2.3. Single corridor layout increases the *visual and physical accessibility* to patients by locating patient rooms on one side of the corridor and a nurse station in the unit's middle. The duplex layout splits into two sections with a separate nurse station and a support space between two parts. It decreases the *physical accessibility* to patients and could be suitable for designing multiple-bed wards. The racetrack or Double corridor layout locates the nurse station and staff support spaces between the two corridors. In this way, it increases the *visual and physical accessibility* to patients. The courtyard layout places the service areas around the courtyard and uses decentralized nurse stations to provide care for patients' sub-groups. It increases the width of the floor plan and decreases the *physical accessibility* to patients. Cluster or cruciform layout groups patients into sub-units with sub- nurse stations in the middle of each subunit and shares service space among different sub-units. This layout increases the *visual and physical accessibility* to patients. Radial layout involves the nurses' station in the center surrounded by patient rooms with a single circular hallway between them. It increases the *visual and physical accessibility* to patients. It has an inflexibility for future expansions. This layout also involves difficulties in arranging equipment and furniture because of the irregular shape of the unit. The triangular layout places the nurse station and staff support space in the middle of the triangle and increases the *visual and physical accessibility* to patients. It also has an inflexibility for future expansions.

Table 2.3 Advatanges and dısadvanatges of *ICUs*' layouts (By the researcher)

| LAYOUT | DESCRIPTION | ADVANTAGES & DISADVANTAGES | SCHEMATIC MODEL |
|---|---|---|---|
| **Single corridor layout** | - Composing of several smaller multiple bed ward or some single- patient rooms.<br>- Locating patient rooms on one side of the corridor.<br>- Placing staff service areas on the other side of the corridor.<br>- Placing a nurse station in the middle of the unit. | - Increasing the physical accessibility to patients.<br>- Decreasing the social interaction between staff. |  |
| **Duplex layout** | - Splitting into two sections.<br>- Having separate nurse station in each part.<br>- Sharing support space between two parts. | - Decreasing the physical accessibility to patients.<br>- Being suitable for designing multiple-bed wards. |  |
| **Racetrack or Double corridor layout** | - Locating the nurse station and staff support spaces between the two corridors. | - Increasing the physical accessibility to patients.<br>- Fitting more patients without increasing the nurses' walking distance. |  |
| **Courtyard layout** | - Including a courtyard for ventilation in the middle of the unit.<br>- Locating the service areas around the courtyard.<br>- Using de-centralized nurse stations to provide care for sub-groups of patients. | - Providing natural light and ventilation in the unit.<br>- Increasing the privacy of patients.<br>- Increasing the width of the floor plan.<br>- Decreasing the physical accessibility to patients. |  |
| **Cluster or cruciform layout** | - Grouping patients into sub-units with sub- nurse stations in the middle of each subunit.<br>- Sharing service space among different sub-units. | - Increasing the visual and physical accessibility to patients. |  |
| **Radial layout** | - Involving the nurses' station in the center surrounded by patient rooms with a single circular hallway between them. | - Increasing the visual and physical accessibility to patients.<br>- Having difficulties in arranging equipment and furniture because of the irregular shape of the unit.<br>- Having an inflexibility for future expansions. |  |
| **Triangular layout** | - Placing nurse station and staff support space in the middle of the triangle formed by three connecting corridors with access to patient rooms. | - Increasing the physical accessibility to patients.<br>- having an inflexibility for future expansions |  |

### 2.2.2 Architectural spaces of *ICU*s

Generally, *ICU*s involve two main spaces included patient space (involving hygiene or family area) and staff space (involving support or service area) that relations between two spaces could impact the *visual and physical accessibility* to patients. In this part, the patient and staff spaces were described by explaining their architectural characteristics that can impact the *patients' safety* and *staff efficiency* in *ICU*s.

**a. Patient space**

Patient space is described as an essential space of *ICU*s involved patients' beds and medical systems (Rashid, 2014). Patients may be housed in individual rooms or multi rooms. As mentioned earlier, from the mid-19th century to the late 20th century, *ICU* was generally designed based on the multi-room. In a multi-room, as an open ward model, patients' space is not separated from other spaces, and all the patients are places inside a large zone.

For example, *ICU* at Broadgreen hospital was planned as a multi-room with eight beds inside the rectangular layout. Each patient's area is approximately 15 $m^2$ with the particular medical systems inside it (Figure 2.34). Although multi-room *ICU* with the centralized station provides vast visual access to patients, but has a low level of *staff efficiency*.

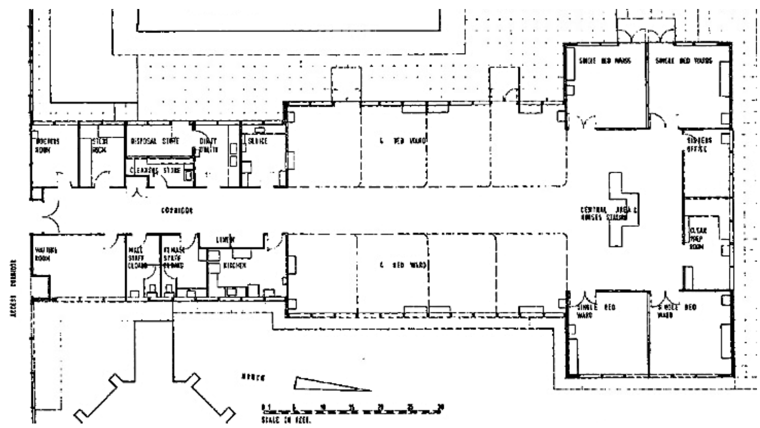


Figure 2.34. The Broadgreen hospital, *ICU*, 1964 (Reynolds & Tansey, 2011)

After the late 20th century, by technological and medical improvements, *ICU*’s spaces started to change in terms of the unit’s size and the furnishing ways of the medical systems. For instance, Marshall et al. (2017) implied that *ICU*’s bed requires easy physical access from all patients’ sides to permit effective care interventions. Thereby, patients’ space should be designed to situate beds in the desired position as large as possible (Marshall et al., 2017). The individual room model is a practical solution to supply enough space for a bed so that it is visible from a central station (Marshall et al., 2017).

Hence, to provide enough patient space and close monitoring of patients, *ICU*'s multi- rooms were gradually getting to change to a single room model (Chaudhury et al., 2006; Verderber & Fine, 2000). The room size is one of the essential parameters that should be considered based on the patients' and staff's demands (Rashid, 2014). All of the patient rooms should locate the patient bed, medical equipment, and other requisite amenities inside it properly (Rashid, 2014). Architectural guidelines almost explain the size of the patient room and illustrate equipment dimensions in detail. FGI (2019) demonstrates that the area of the single room should be at least 18.58 $m^2$. Alongside the international architectural guidelines, Turkish architectural guidelines almost define at least 19.63 $m^2$ space areas for a single room (Figure 2.35).

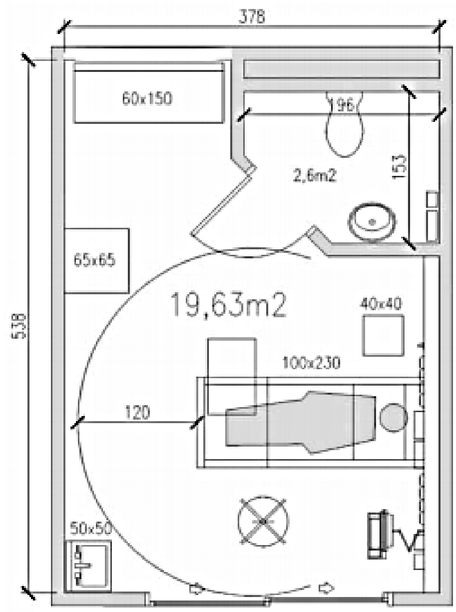



Figure 2.35. Floor plan of a single room, Cardiology, *ICU* (Bakanlığı, 2010, p 83)

As shown in Figure 2.36, the *ICU* of the Sharp Grossmont hospital is one of the single room *ICU*s built-in 2006 (Hamilton & Shepley, 2010). This *ICU* constitutes of 24 single beds with three decentralized nurse stations and central support space.

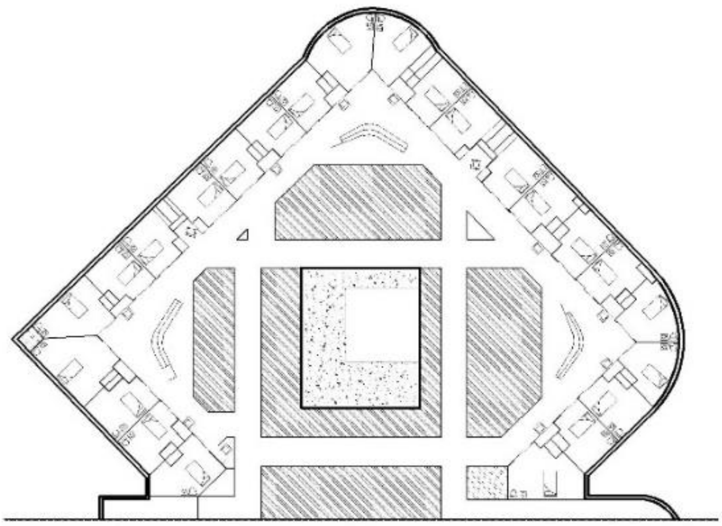


Figure 2.36. The Sharp Grossmont hospital, *ICU,* 2006, CA, USA (Hamilton & Shepley, 2010)

As discussed in various research and architectural guidelines, changing patients' space from multi-room to single rooms also dramatically impacts the *patients' safety* and *staff efficiency* (Apple, 2014; Boardman & Forbes, 2011; Chaudhury & Valente, 2005; Pati et al., 2009). For instance, because of the high burden of work in the NICU, its design model affects the length of access time to patients by nurses. (Shepley, 2002) In another study, it is reported that single rooms are better than multi-rooms to provide *patients' safety* (Rashid, 2014). Observing a patient's head by nurses is an essential architectural consideration that improves *patients' safety* by applying a transparent wall in an observation station of a single patient room located between two patient rooms (Rashid, 2014).

Almost, patient-centered design attempts to consider the significant role of the patients' family in improving the *patients' safety*. In this manner, designers prefer to design a supportive and convenient space for patients' families in hospitals to enhance *patients' safety*. Family space could be designed within the patient room for allowing patients' families to access staff quickly and easily (Rashid, 2006). As seen in Figure 2.37, family space is located inside the patient room, with 10.68 $m^2$ areas divided from patient space by a transparent partition (Hamilton & Shepley, 2010).

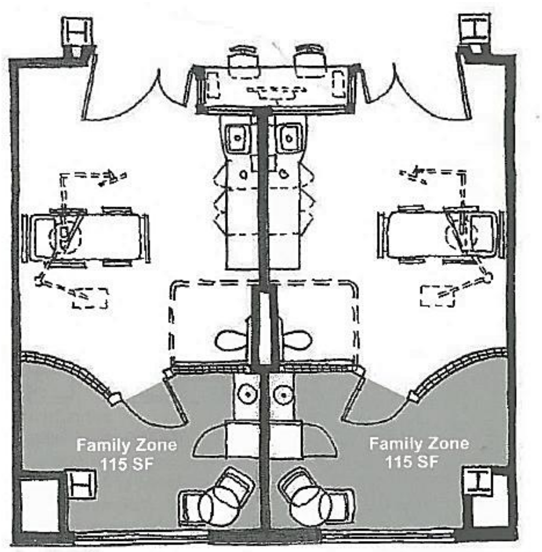



Figure 2.37. The Emory University hospital, Neurosciences *ICU* (Hamilton & Shepley, 2010, p. 27)

Another architectural characteristic of the single bedroom is the restroom's location that can influence the patients' beds and an observation station (Hamilton & Shepley, 2010). Pati et al. (2009) also emphasized that nurses' observation of the patient's head is an essential parameter that designers should consider in designing a restroom within the patients' room. As shown in Figure 2.38, six models of the SPR presented concerning the restroom location inside the room.


Figure 2.38. Location of the restroom in *ICU* (Pati et al., 2009)

Thus, moving toward a single room design could be a practical design solution to enhance the accessibility to patients in *ICU* (Bonuel & Cesario, 2013; Friesen et al., 2008; Smith et al., 2009). A single room is could almost be presented in two architectural models: Same- handed room (standardization room) and mirrored room (Bunker-Hellmich, 2010; Stichler & McCulllough, 2012). As state by Stichler and McCulllough (2012), same-handed rooms are structured in a uniform layout that supply intuitional navigation for staff in each room (Figure 2.39). In other means, this model could enhance *patients' safety* and *staff efficiency* in *ICU* because staff can navigate inside the room easily and determine medical amenities quickly. Almost, in this model, staff make fewer medical errors by putting medical equipment in the right places.

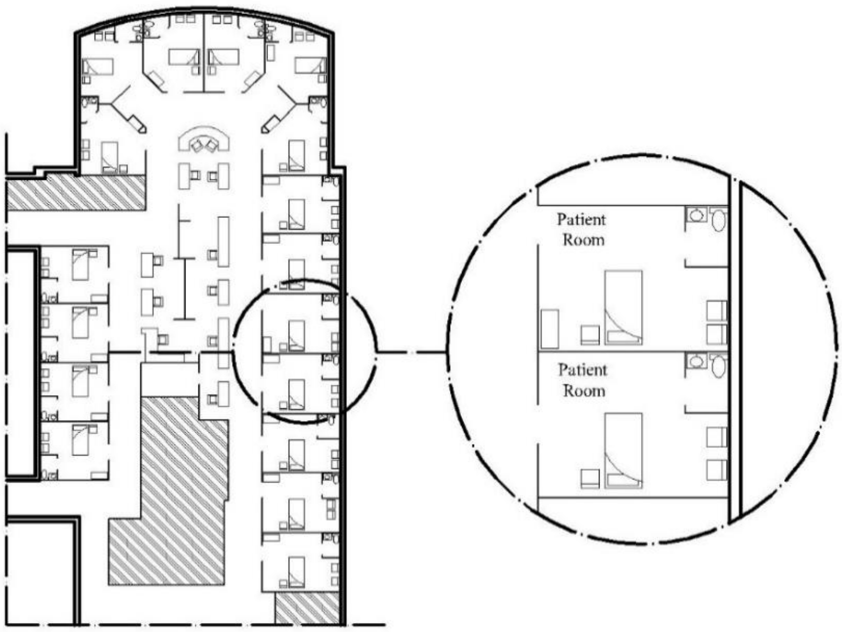



Figure 2.39. Floor plan of the same- handed room, South Florida Baptist, *ICU*, 2006 [17]

[17] http://www.tbo.com/plant-city/south-florida-baptist-expects-to-open-state-of-the-art-icu-in-april-20151016/

In a mirrored-room model, furnishing ways are entirely different from same-handed rooms that provide fewer costs. For instance, the headwall system of a room is shared with the headwall system beside the room. In this model, staff care mistakes can enhance by arranging amenities in a reversed shape inside each room (Healthcare, 2011; Watkins et al., 2011). An example of a mirrored-room *ICU* is Cleveland Clinic, which comprises 24 mirrored single rooms with a racetrack layout (Figure 2.40).

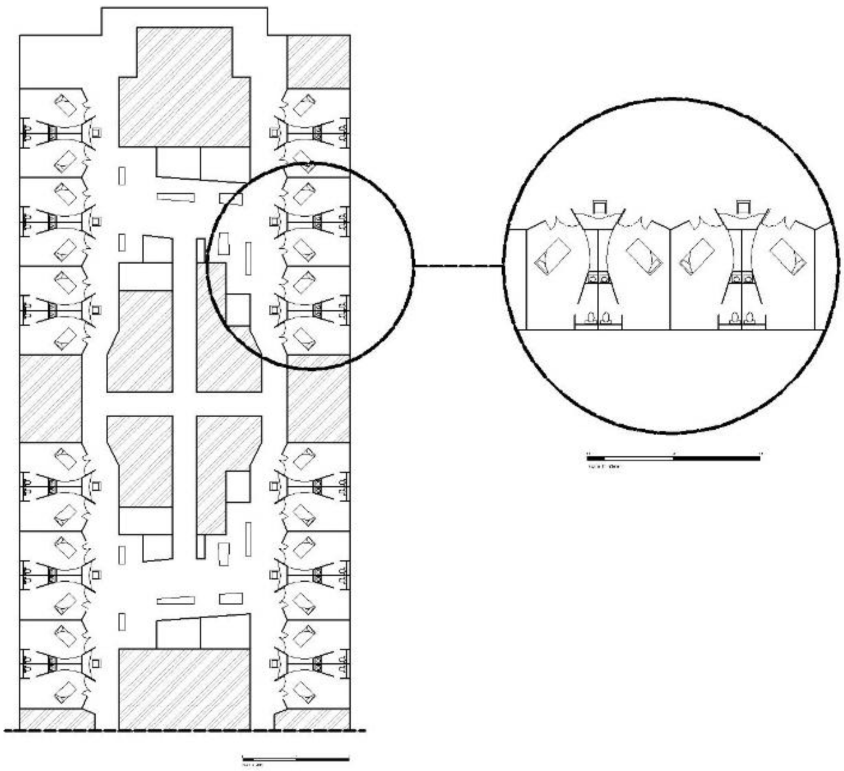


Figure 2.40. Cleveland Clinic, Abu Dhabi, UAE, 2013 [18]

As a whole, multi bedrooms generally enhance the social interaction between staff and enhance patients' *visual accessibility* by providing open space for patients.

[18] Retrieved 27, September 2018 from, https://www.archdaily.com/292167/in-progress-cleveland-clinic-abu-dhabi-hdr-architecture

However, it decreases the *physical accessibility* by providing long walking distance to patients. It also enhances the infection, excessive noise, and privacy because of placing all patients within a shared space within the unit. On the other hand, both models of the SPR improve the *visual and physical accessibility* to patients by providing the observation station close to the patient rooms. This patient room model enhances patients' privacy by separating the patient space from the other spaces of the unit. It also decreases the infection of patients by providing an isolated space for patients inside the unit. The level of noise also decreases by removing the excessive noise in SPR. This model also allows the patient's family to stay beside the patients in *ICU* by considering the family space inside the patient room. One of the disadvantages of SPR is to decrease the social interaction of staff. This model places staff in the isolated space from the central nurse station and decreases nurses' social interactions.

Table 2.4 The patient room model in *ICU* (By the researcher)

<table>
<tr><th colspan="2">Patient room model</th><th>Advantage/s</th><th>Disadvantage/s</th></tr>
<tr><td colspan="2">Multi- bed room</td><td>- Increasing the social interaction of staff.</td><td>- Decreasing visual and physical accessibility to patients.<br>- Decreasing privacy of patients.<br>- Increasing an infection.<br>- Increasing an excessive noise.</td></tr>
<tr><td rowspan="2">Single-patient room</td><td>a. Same- handed patient room (Standardization room)</td><td rowspan="2">- Providing high visual and physical accessibility to patients.<br>- Providing the privacy of patients.<br>- Decreasing an infection.<br>- Decreasing excessive noise.<br>- Providing family space inside the room.</td><td rowspan="2">- Decreasing the social interaction of staff.</td></tr>
<tr><td>b. Mirrored-patient room</td></tr>
</table>

**b. Staff space**

Staff space in *ICU* is identified as space for staff teamwork that mainly determines as a nurse station (Hamilton & Shepley, 2010; Rashid, 2006; Rashid, 2014). This space includes monitoring, documenting, and supporting spaces (Hamilton & Shepley, 2010; Rashid, 2006; Rashid, 2014). As mentioned by Hamilton & Shepley (2010), staff working space should be structured to elevate patients' care process by suggesting proper workspaces for staff functions. It is preferable to place the staff zone adjacent to the patient zone by keeping privacy between staff and patient zones (AusHFG, 2016). In this manner, the nurse station, as the central part of the staff zone, must have a direct and continuous view toward the patient's bed in *ICU* (AusHFG, 2016; Bakanlığı, 2010; FGI, 2014). Staff space generally contains a centralized station or substation or observation station that each of them defines as follows (Rashid, 2006; Rashid, 2014).

- **Centralized station:** The centralized station is the staff workspace that generally locates in the core part of the unit. It usually constitutes of spaces such as patients' monitoring part, medical recording part, and documenting part (Rashid, 2006; Rashid, 2014). The below figure shows the centralized station in the circular layout of the Methodist hospital. As you can see, nurse station houses in the central part of the unit with excellent visual access to patients.

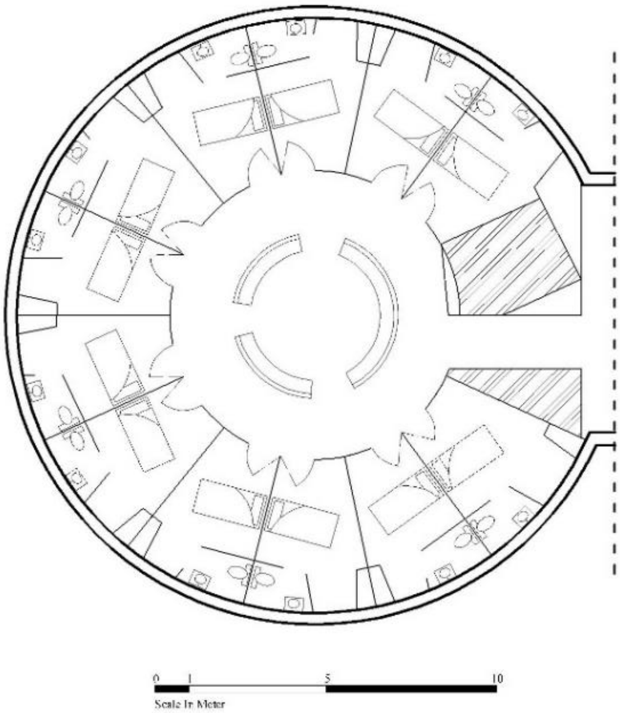



Figure 2.41. The Methodist hospital, Centralized station, Rochester, Minnesota, the 1960s

- **Substations:** Substations are a kind of staff workspace located close to the patients' hobs in the unit. These stations involve activities such as charting, accessing, and recording the patients' care. They may involve deposit spaces for medical supplies or handwashing amenities based on the units' attributes (Rashid, 2006; Rashid, 2014). Designing this station has improved from the late twenties century by changing the open ward to decentralized unit model to approach the better *visual and physical accessibility* to patients. *ICU* of the Saddleback Memorial hospital is a decentralized *ICU* divided into two patient spaces with two decentralized stations (Figure 2.42). Each decentralized station supports eight patient rooms.

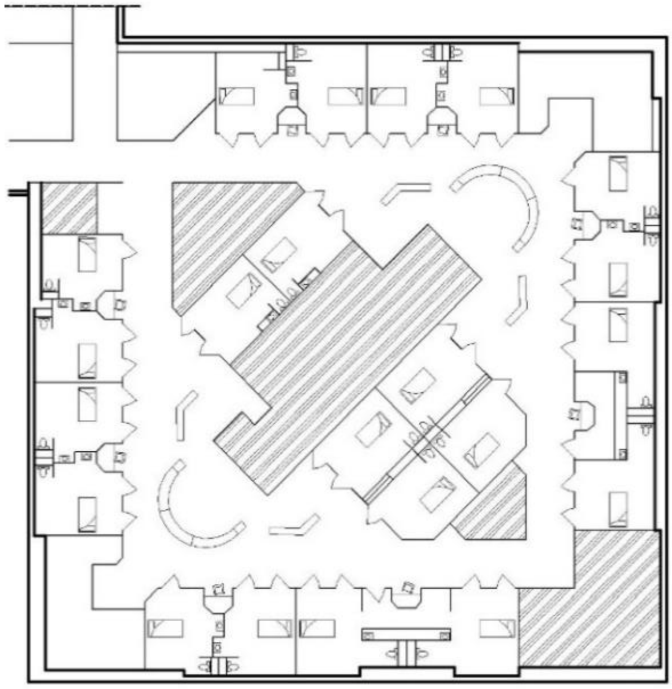


Figure 2.42. Decentralized nurse station, Saddleback Memorial Hospital, Laguna Hills, CA, 1988 (Hamilton & Shepley, 2010)

- **Observation stations:** Observation stations as a staff space often supply spaces for social interactions, staff teamwork, patients' monitoring, and patients care to chart (Rashid, 2014; Rashid, 2016). These stations are commonly arranged outside the patient rooms (Rashid, 2006; Rashid, 2014). Observation stations are more practical than substations in *ICU* because of their proximity to the patient rooms (Rashid, 2006; Rashid, 2014). In the *ICU* of Memorial Sloan-Kettering hospital, the observation stations are arranged outside the patients' rooms for close and constant access to patients (Figure 2.43).

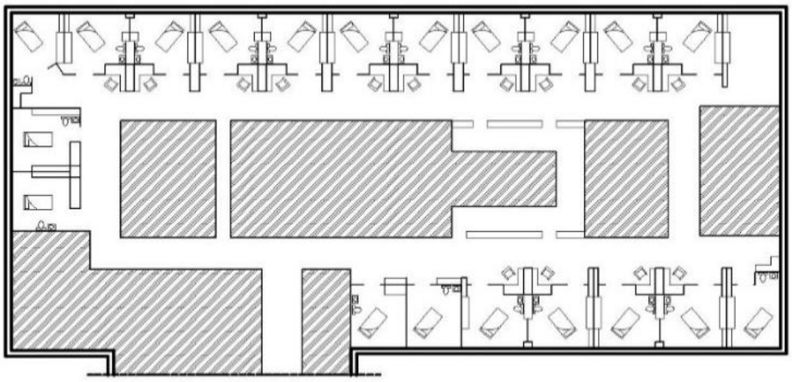


Figure 2.43. Memorial Sloan-Kettering hospital, *ICU*, New York, 2009 (Hamilton & Shepley, 2010)

### 2.2.3 Other architectural chaacteristics

Other architectural characteristics that could impact *visual and physical accessibility* in the *ICU* are categorized into two main subjects included life support systems and material.

**a. Life support system:** Some various systems are used called life support systems to assist the *ICU*s' patients in vital situations (Rashid, 2014). Mentioned systems are presented in five different kinds: headwall, power column, pendant mounted overhead, and bridge system (Rashid, 2014). The type of life support system can affect the interior design of the room and supply different ways to access the patients' beds and amenities within the room (Rashid, 2014). In this manner, life support systems would be chosen based on their characteristics described in the following parts.

***Headwall system:*** The headwall system installed on the wall in the back of the patient's head compromises medical gasses and electrical sockets (Figure 2.44). This system is always arranged in a fixed position without access to the patients' head from behind. Therefore, it does not allow to have flexibility in the beds' position within the room (Hamilton & Shepley, 2010).

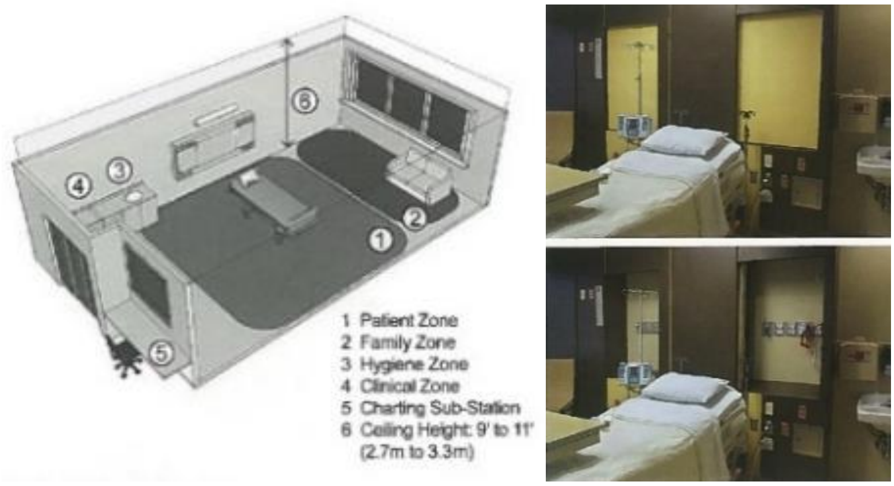



Figure 2.44. The Easter Maine medical center, Headwall system (Hamilton & Shepley, 2010, p. 106)

***Power column system:*** The power column also constitutes of vacuum, medical gases, and medical equipment (Figure 2.45). All equipment is installed on the column fixed on the ceiling and floor of the room (Hamilton & Shepley, 2010). This system allows us to carry installed utilities from above to the level of patients' using (Hamilton & Shepley, 2010). Permitting to access the patient's head from the back of the bed and the capability to position the patients' beds in various locations are the main ideas of the power column in *ICU*s (Hamilton & Shepley, 2010).

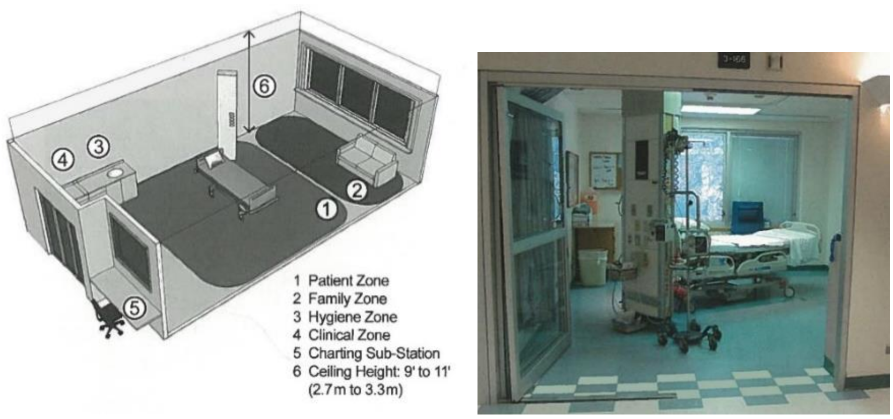



Figure 2.45. The Swedish Medical Center, Power column system, Colorado (Hamilton & Shepley, 2010, p. 109)

***Pendant mounted system:*** The pendant mounted system is the most flexible life support system in *ICU*s and allows a wide variation in a bed position. As shown in the below figures, all electrical equipment, monitors, and gases are arranged on pendants that are hanged from the room's ceiling or wall because of the capability of circular turning in this system.

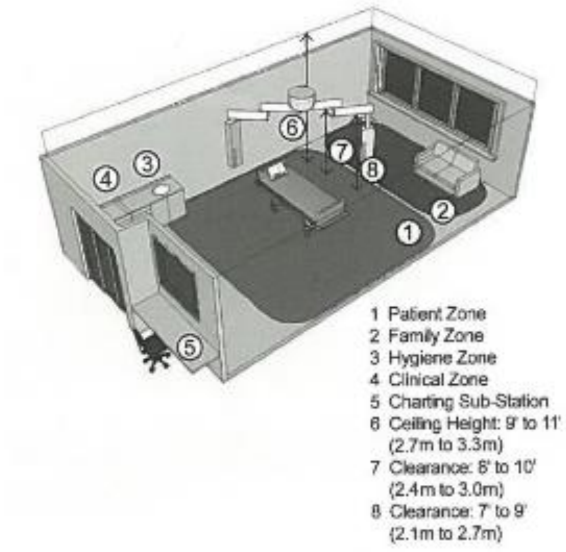



Figure 2.46. Ceiling mounted pendant life support system (Hamilton & Shepley, 2010, p. 112, p.113)

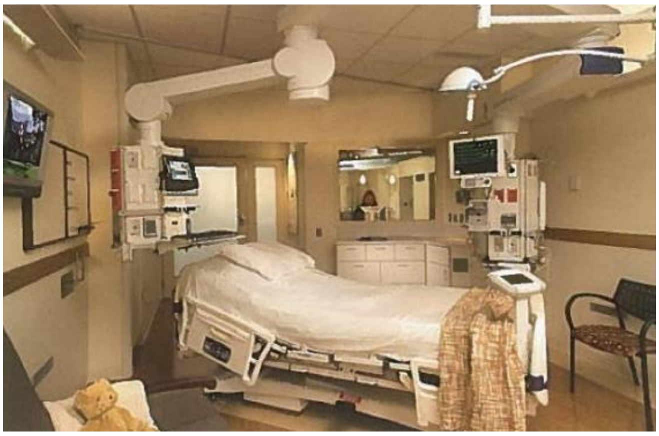


Figure 2.47. The Mercy Medical Center, Ceiling mounted pendant life support system, Cedar Rapids, IO (Hamilton & Shepley, 2010, p. 112, p.113)

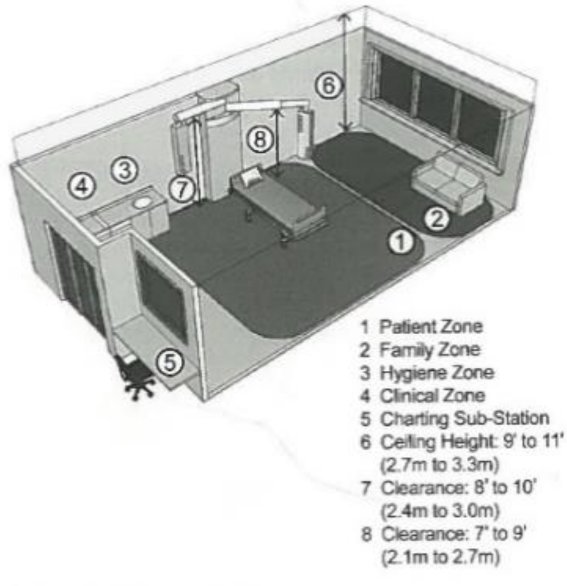



Figure 2.48. Wall- mounted pendant life support system, PA, USA (Hamilton & Shepley, 2010, p. 114)

Figure 2.49. The Lancaster general hospital, Wall- mounted pendant life support system, PA, USA (Hamilton & Shepley, 2010, p. 114)

***Bridge system:*** This system can extend on the head of the patient’s bed by attaching to the room’s floor or hang from the room’s ceiling (Figures 2.50; 2.51; 2.52). It allows *physical accessibility* to the patients' bed from all sides. However, this system provides difficulties related to the height of the crossbar.

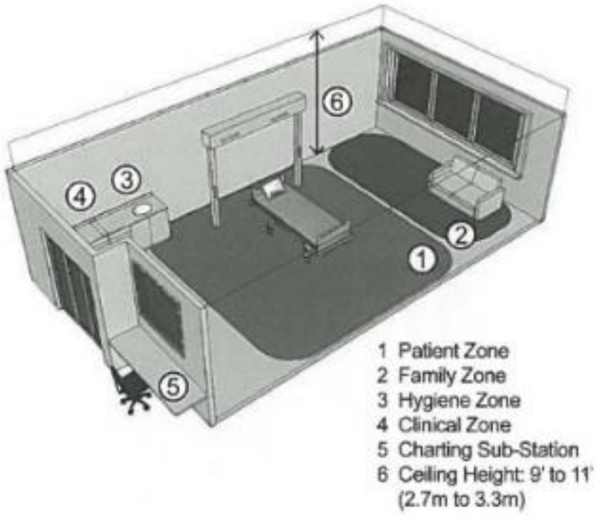



Figure 2.50. Bridge life support system, Attaching to the room's floor (Hamilton & Shepley, 2010, p. 115,116)

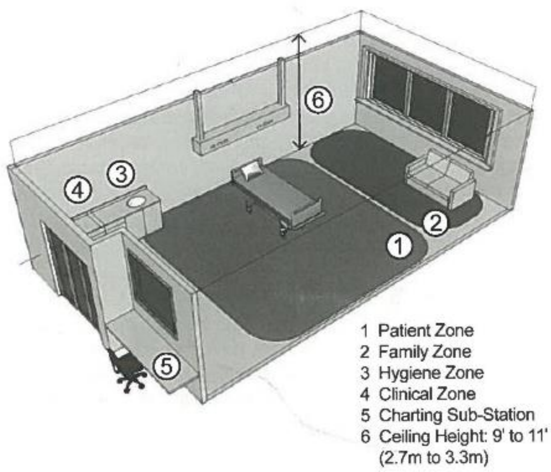



Figure 2.51. Bridge life support system, Hanging from the room's ceiling (Hamilton & Shepley, 2010, p. 115,116)

Figure 2.52. The Groningen Academic Medical Center, Bridge system, Netherlands (Hamilton & Shepley, 2010, p. 116)

As seen in the below table, the advantages and disadvantages of each system are summarized as follows. The headwall system is a kind of system rarely used in high-acuity intensive care settings where the technology may be needed at a moment's notice. It fixes the medical gases, vacuum, and electrical outlets behind the patient's head. This system also provides low ability to reach the patient's head from behind and low flexibility in the bed positions. The power column system allows access to the head of the patient from behind the bed. It places the bed in a variety of locations arrayed around the column's position. In this way, this system needs a large room size. The pendant mounted system brings utilities from the ceiling or wall to connections on the mounting system's suspended armature. The Bridge system provides physical access to the patients'patients' bed from all sides. It also involves the difficulties related to the height of the crossbar.

Table 2.5 Characteristics of the life support systems (By the researcher)

| Life Support Systems | Description | Advantages and disadvantages | Schematic diagram |
|---|---|---|---|
| **Headwall System** | - Mounting the medical gases, vacuum, and electrical outlets behind the patient's head. | - Rarely used in high- acuity intensive care settings where the technology may be needed at a moment's notice<br>- Low ability to reach the patient's head from behind.<br>- Low flexibility in the bed positions. |  |
| **Power Column System** | - Mounting the equipment on the column fixed at the floor and ceiling that brings utilities from above the ceiling down to the level where they may be effectively used for the patient. | - Allowing access to the head of the patient from behind the bed.<br>- Positioning the bed in a variety of locations arrayed around the column's position.<br>- Requiring larger room size. |   |
| **Pendant Mounted System** | - Bringing utilities from the ceiling or wall to connections on the suspended armature by the mounted system. | - Allowing a wide variation in bed positioning. |   |
| **Bridge System** | - Spanning the head of the bed and anchoring to the floor or suspended from the ceiling. | - Accessing to the patients' bed from all sides.<br>- Providing difficulties related to the height of the crossbar. |   |

**b. Materials**

According to the architectural guidelines, some architectural elements of the patient room, such as doors, should be designed with transparent materials to provide *visual and physical accessibility* to patients (Figure 2.53) (AusHFG, 2016; Bakanlığı, 2010) Hadi & Zimring (2016) analyzed *ICU*s to understand the relations between design features of layout and visibility parameters. They stated that big windows and glass breakaway doors provide excellent visibility to patients in *ICU*s. Using blurry materials in *ICU*s impedes *visual and physical accessibility* to patients. for instance. In this way, *ICU* designers prefer to use transparent material such as breakaway glass doors. Glass doors can be closed for privacy, noise reduction, and infection control purposes while maintaining maximum visibility of patients and monitors (Hamilton & Shepley, 2010; Rashid, 2006; Rashid, 2014). Keys & Stichler (2018) also investigated the design features in *ICU*s to enhance safety, and they found glass breakaway doors improves the visibility to patients. Additionally, designers emphasized to use the transparent wall between the observation station and the patient rooms in SPR to provide *visual and physical accessibility* to patients (Hamilton & Shepley, 2010; Rashid, 2006).


Figure 2.53. Glazed door in *ICU*s. [19]

[19] Retrieved July 07, 2019, from https://www.alleghenydoor.com/doors/healthcare-specialty-doors/

It could be significantly beneficial to design the glass door of rooms with a slight angle o decrease reflections of glass doors. In The Littleton Adventist hospital, patint room doors were designed in a transparant material. As seen in Figure 2.54, to minimize the reflection of doors, the corrifodr of the unit was designed with a slighet angle.

Figure 2.54. The Littleton Adventist hospital, Littletom, CO (Hamilton & Shepley, 2010, p. 146)

## 2.3 Case studies of *ICU*s from the 1960s up to present

According to the literature review, ICUs' environments improve in terms of architectural characteristics to provide visual and physical accessibility to patients. Patients of *ICU*s always need constant observation and quick interference all day. Providing visual and physical accessibility to patients could enhance patients' safety and staff efficiency in *ICU*s. As mentioned in this chapter, nurse and patient space and relations between them are essential to provide the visual and physical accessibility to patients in ICUs. This part of the study aimed to illustrate some designed ICUs' architectural characteristics in nurse and patient spaces throughout the decades.

Presented ICUs were selected from various data sources like scientific researches, thesis, websites, or online magazines. Each ICU was illustrated by clarifying the hospital's name, kind of ICU, the number of patient beds, floor plan, patient space, nurse space, and support space and retrieved sources as follows:

As seen in Table 2.55, four case studies of the 1960s were presented that all of them were designed based on an open ward with an average of 8-10 beds separated by curtains. Mentioned ICUs included a central nurse station that was located beside or in the center of the unit. Almost, support spaces were located close to the nurse station. For example, the Broadgreen hospital was designed based on an open ward with eight beds and a central nurse station.

In the 1970s, three case studies were described that were designed in two different unit layout. In this decade, ICUs were gradually changed from an open ward to a single patient room design. One of these case studies is Saint Raphael’s hospital with 14 single-patient rooms, a central nurse station, and seven observation nurse stations for 14 patients (Table 2.56).

As shown in Table 2.57, more space was dedicated to patients' rooms developing the single room design model in the 1980s. Subsequently, the size of the ICUs started to increase. In this way, ICUs were divided into subunits with 8-12 single rooms. Each subunit involves a nurse station in the central part with observation stations and support areas beside the patient rooms. For instance, CCU of the Saddleback memorial hospital was designed with 22 single-patient rooms in two subunits with 11 patient rooms and four observation stations in each subunit.

In the 1990s, 2000s, and 2010s, *ICU*s were generally designed based on a single patient room model, including subunits and observation stations. Regarding the presented case studies in mentioned decades, *ICU*s were designed in large size divided into the nursing pods with 6-8 patients’ rooms. For instance, the *ICU* of Cleveland Clinic was designed with 24 patient rooms in four nursing pods with six single-patient rooms that each pod has a central nurse station and three observation stations to control patients (Tables 2.58; 2.59; 2.60).

Table 2.6 Examples of *ICU*s in1960s (By the researche)

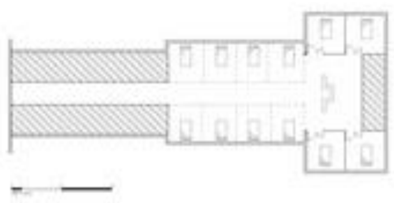
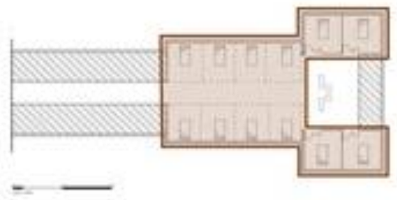
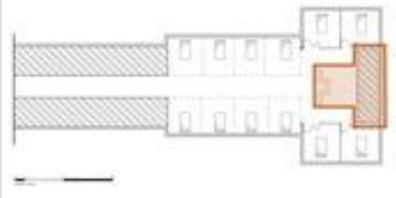
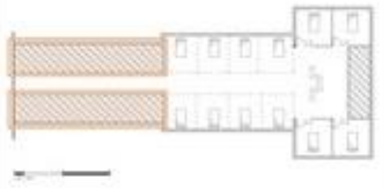
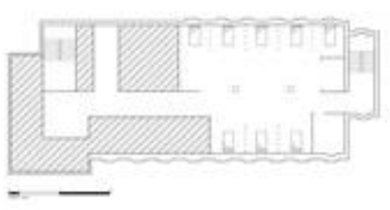
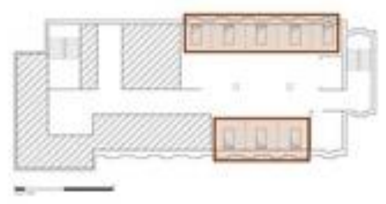
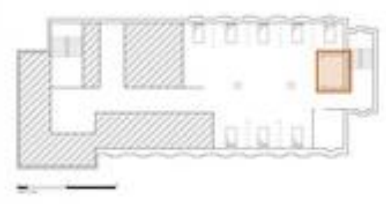
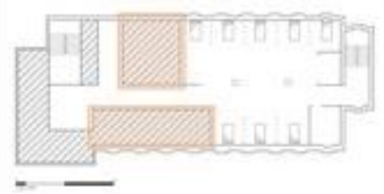
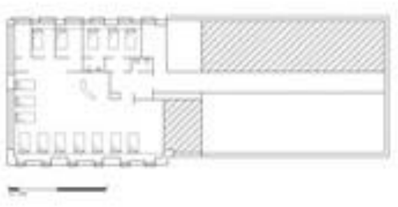
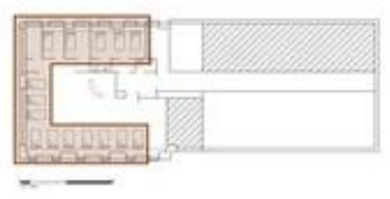
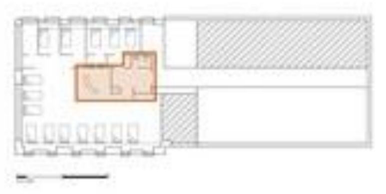
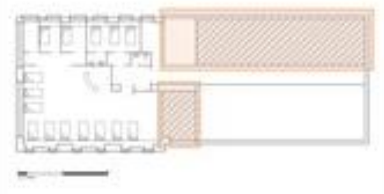
| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| **1960s** | **Broadgreen Hospital, Liverpool, England.**<br>(Reynolds & Tansey, 2011) | ICU with 8 patient beds. |  |  |  |  |
| | **The University of Maryland' s Center Institute. Baltimore, Maryland.**<br>(Kaltsas, 1979) | ICU with 8 patient beds & two isolation rooms. |  |  |  |  |
| | **The Montreal General hospital Montreal, Quebec.**<br>(Kaltsas, 1979) | ICU with 10 patient beds, two isolation rooms & One septic room. |  |  |  |  |
| | **Reddy Memorial Hospital Montreal, Quebec.**<br>(Kaltsas, 1979) | ICU with 6 patient beds & 2 isolation rooms. |  |  |  |  |

Table 2.7 Examples of *ICUs* in1970s (By the researcher)

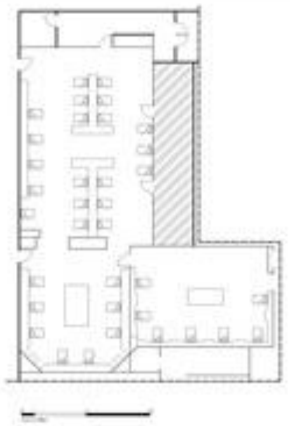
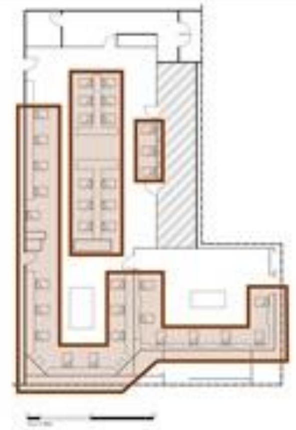
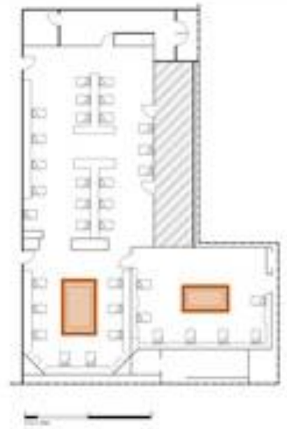
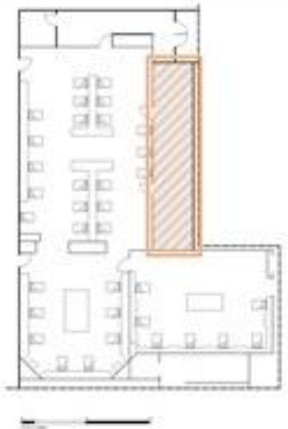
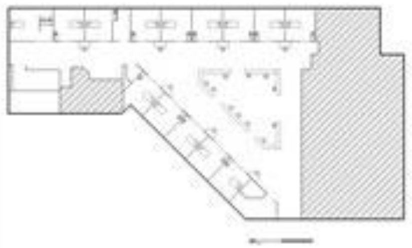
| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| 1970s | **Sanford Children's Hospital, Sioux Falls, SD, USA.**<br>Retrieved October 03, 2019, from https://www.nature.com/articles/7211838#f1 | CNICU with 35 patient beds. |  |  |  |  |
| | **St. Joseph Regional Health Center, Bryan, TX.**<br>(Quan,2006) | ICU with 6 patient beds & 8 single rooms. |  |  |  |  |
| | **Hospital of Saint Raphael New Haven, CT, USA.**<br>Retrieved October 03, 2019, from http://www.kuegleras sociates.com/about/icu-project/ | SICU with 14 single rooms. |  |  |  |  |

Table 2.8 Examples of *ICUs* in1980s (By the researcher)

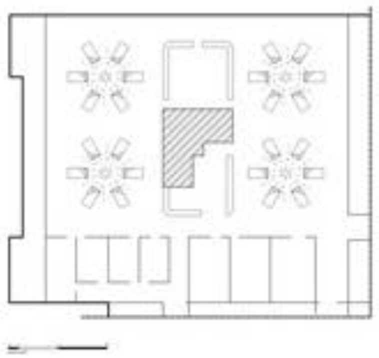
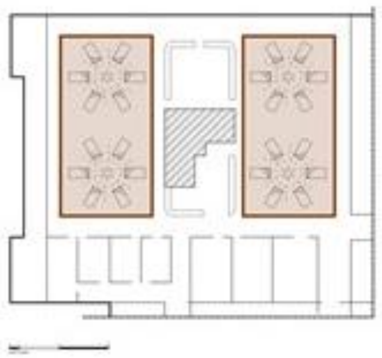
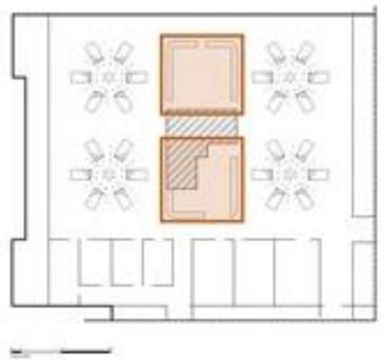
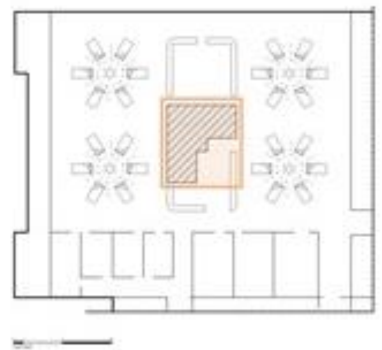
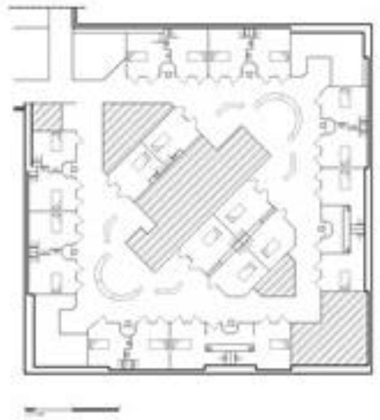
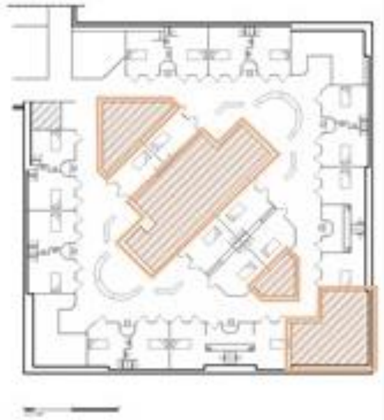
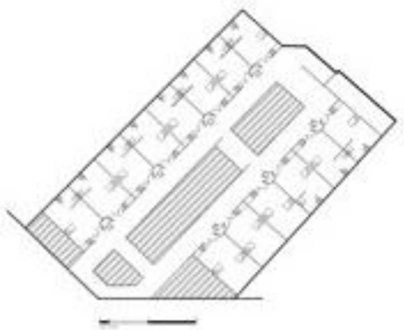
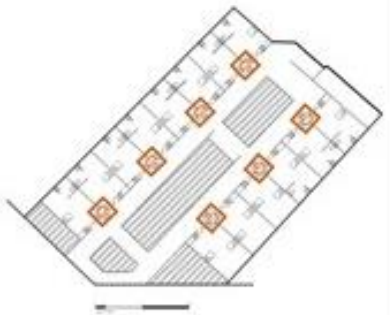
| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| 1980s | **Kobe City General Hospital, Kobe City, Japan.**<br><br>Retrieved December 09, 2019, from http://www.lifestudies.org/braindeadperson02.html | ICU with 24 patient beds. |  |  |  |  |
| | **Saddleback Memorial hospital, Laguna Hills, CA.**<br><br>(Hamilton & Shepley, 2010) | CCU with 22 single rooms. |  |  |  |  |
| | **Sanford Hospital in Fargo, ND.**<br><br>Retrieved November16, 2018, from https://www.craigcompanies.org/12-20/#12-20-page http://collision-detection.blogspot.com.tr/2012/07/sanford-fargo-medical-center.html | NICU with 14 single rooms. |  |  |  |  |

Table 2.9 Examples of *ICU*s in1990s (By the researcher

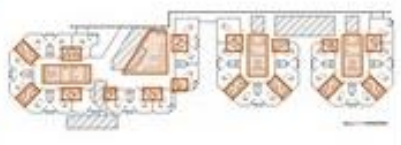
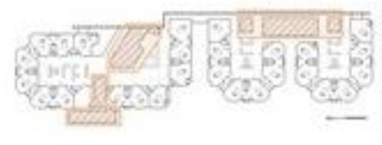
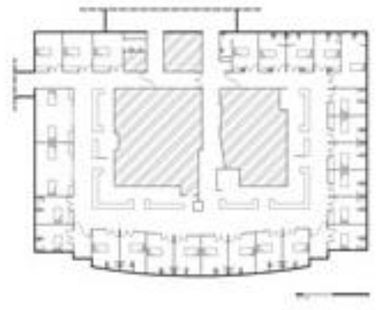
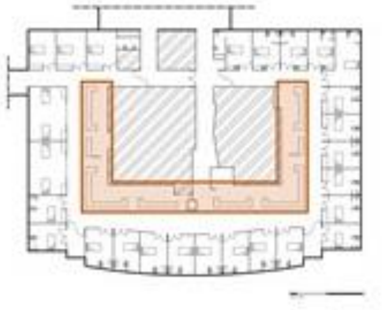
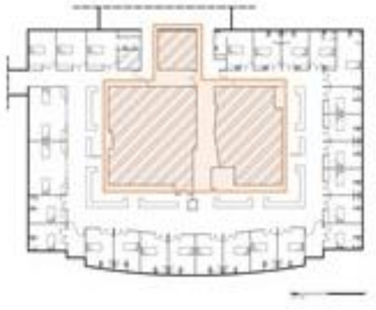
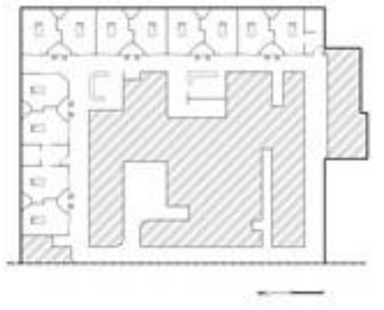
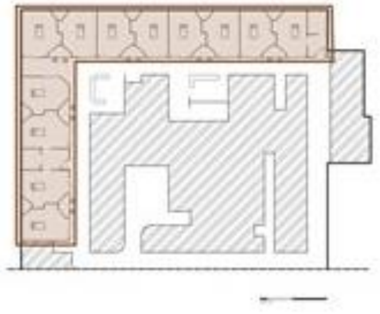
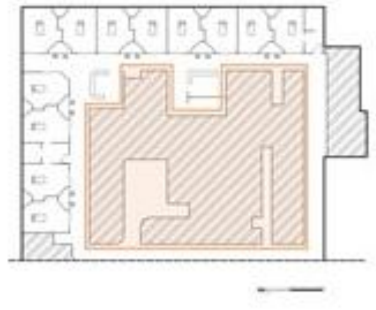
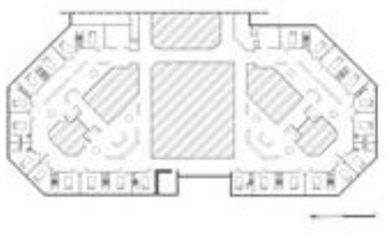
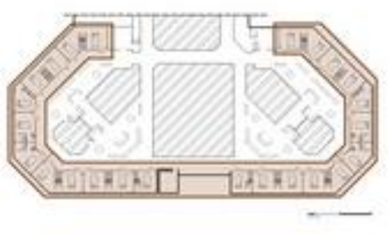
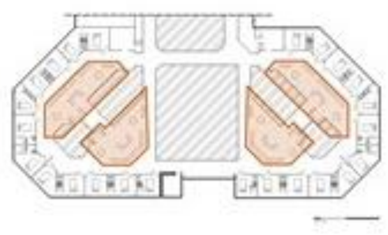
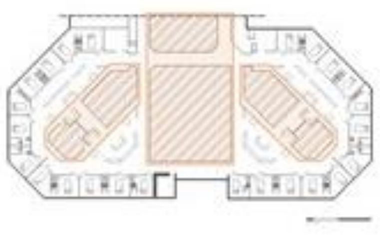
| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| **1990s** | **Legacy Good Samaritan Hospital, Portland, Oregon, USA.** (Hamilton & Shepley, 2010) | ICU with 28 single rooms. |  |  |  |  |
| | **Little Company of Mary Hospital, Illinois, USA.** (Hamilton & Shepley, 2010) | ICU with 24 single rooms & two twin rooms. |  |  |  |  |
| | **Southeast Missouri Hospital, Cape Girardeau, Missouri.** (Hamilton & Shepley, 2010) | CSICU with 12 single rooms. |  |  |  |  |
| | **Swedish Medical Center, Denver, Colorado.** (Hamilton & Shepley, 2010) | Multidisciplinary CCU with 32 single rooms. |  |  |  |  |

Table 2.10 Examples of *ICU*s in 2000s (By the researcher)

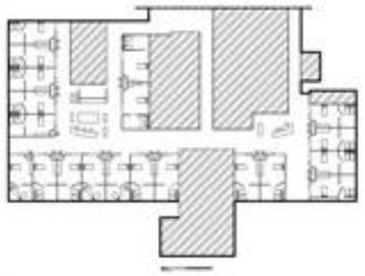
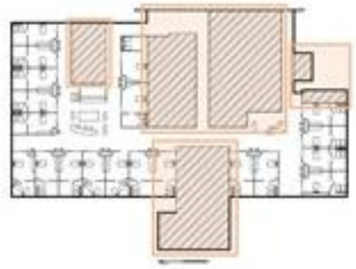
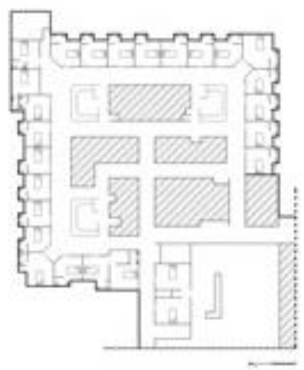
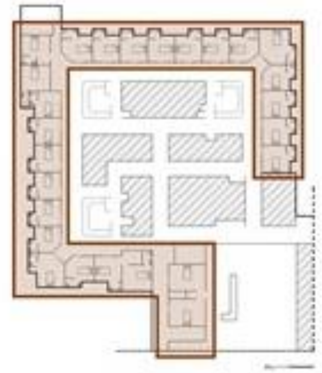
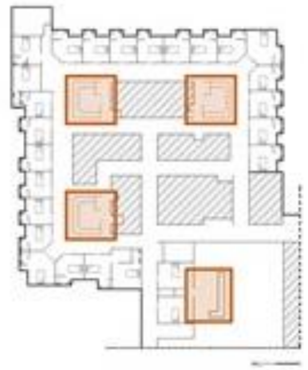
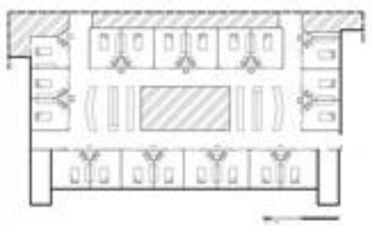
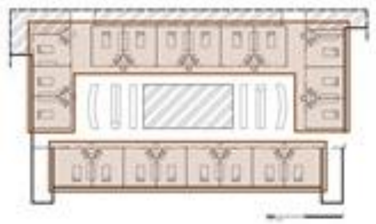
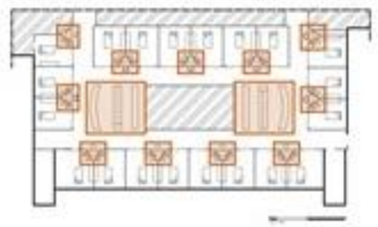
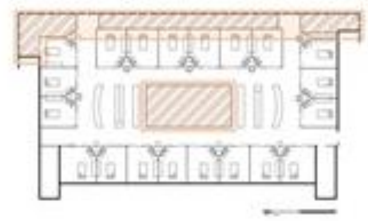
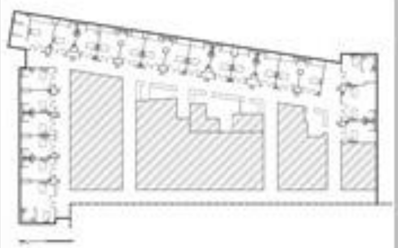
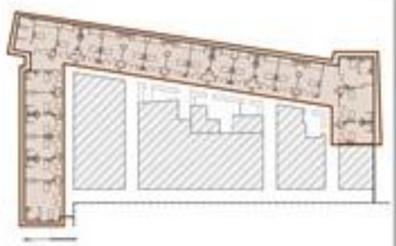
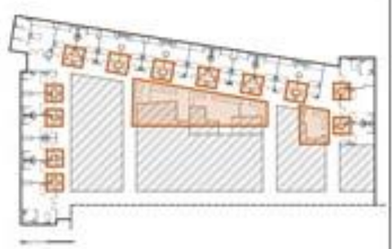
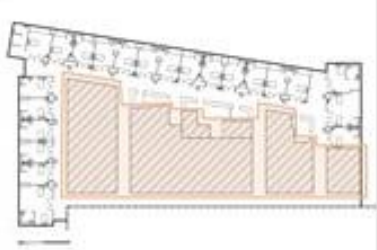
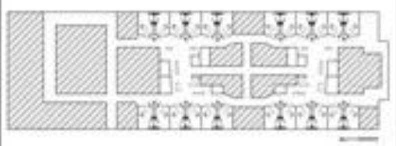
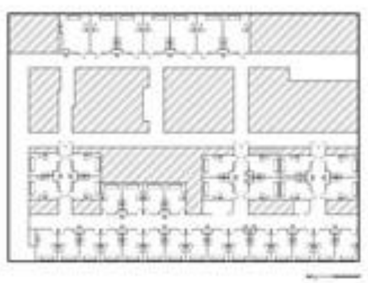
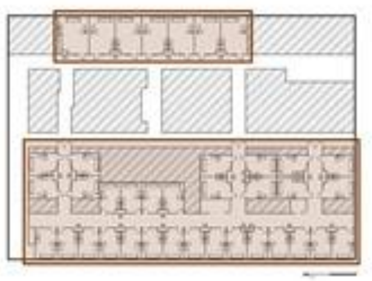
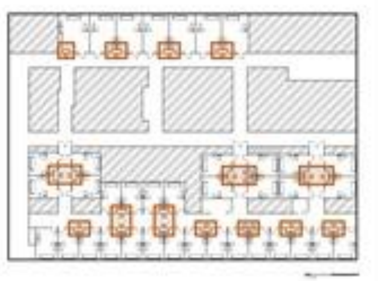
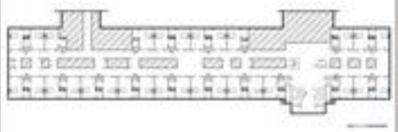
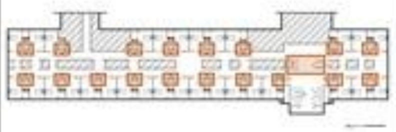
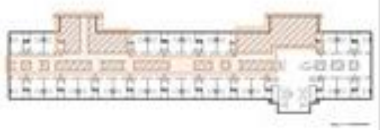
| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| **2000s** | **Emory Hospital, Atlanta, Georgia, USA.**<br>(Yi & Seo, 2012) | ICU with 20 single rooms. |  |  |  |  |
| | **Harborview Medical Center in Seattle, WA , USA.**<br>(Hamilton & Shepley, 2010) | ICU & CCU with 24 single rooms & two isolation rooms. |  |  |  |  |
| | **Harris Methodist Fort Worth Hospital, Fort Worth, Texas, USA.**<br>(Hamilton & Shepley, 2010) | Multidisciplinary ICU with 20 single rooms. |  |  |  |  |
| | **Parker Adventist Hospital, CO , USA.**<br>Retrieved December 09, 2019, from https://www.rtaarchitects.com/tagged/parker-adventist-hospital | CCU with 16 single rooms. |  |  |  |  |

Table 2.11 Examples of *ICU*s in 2010s (By the researcher)

| HOSPITAL | | NUMBER OF BEDS | FLOOR PLAN | PATINET SPACE | NURSE SPACE | SUPPORT SPACE |
|---|---|---|---|---|---|---|
| **2010s** | **Childrens Hospital Los Angeles, California.**<br>Retrieved March 19, 2018 from, https://www.zgf.com/project/chla-pavilion/ | PICU with 20 Single rooms & two twin rooms. |  |  |  |  |
| | **Cleveland Clinic, Abu Dhabi, UAE.**<br>Retrieved 27, September 2018 from, https://www.archdaily.com/292167/in-progress-cleveland-clinic-abu-dhabi-hdr-architecture | ICU with 24 single rooms. |  |  |  |  |
| | **Randall Children´s Hospital, Portland, Orego.**<br>Retrieved April 11, 2018, from https://www.zgf.com/project/legacy-health-randall-childrens-hospital/ | PICU with 24 single rooms. |  |  |  |  |
| | **The Christ Hospital, Cincinnati, Ohio.**<br>Retrieved Augustus 25, 2018, from https://www.archdaily.com/783542/the-christ-hospital-joint-and-spine-center-som/56e13aa4e58eceeacf000026-the-christ-hospital-joint-and-spine-center-som-floor-plan | MICU with 30 single rooms. |  |  |  |  |

## 2.4 Summary

As seen in the below figure, the literature review was presented in three main parts with considering the *visual and physical accessibility* features as follows:

- Describing *ICU*s' historical background from the late 20th century up to the present.
- Describing architectural characteristics of *ICU*s including layout, architectural spaces, and other characteristics.
- Illustrating architectural characteristics of some designed *ICU*s through the decades.

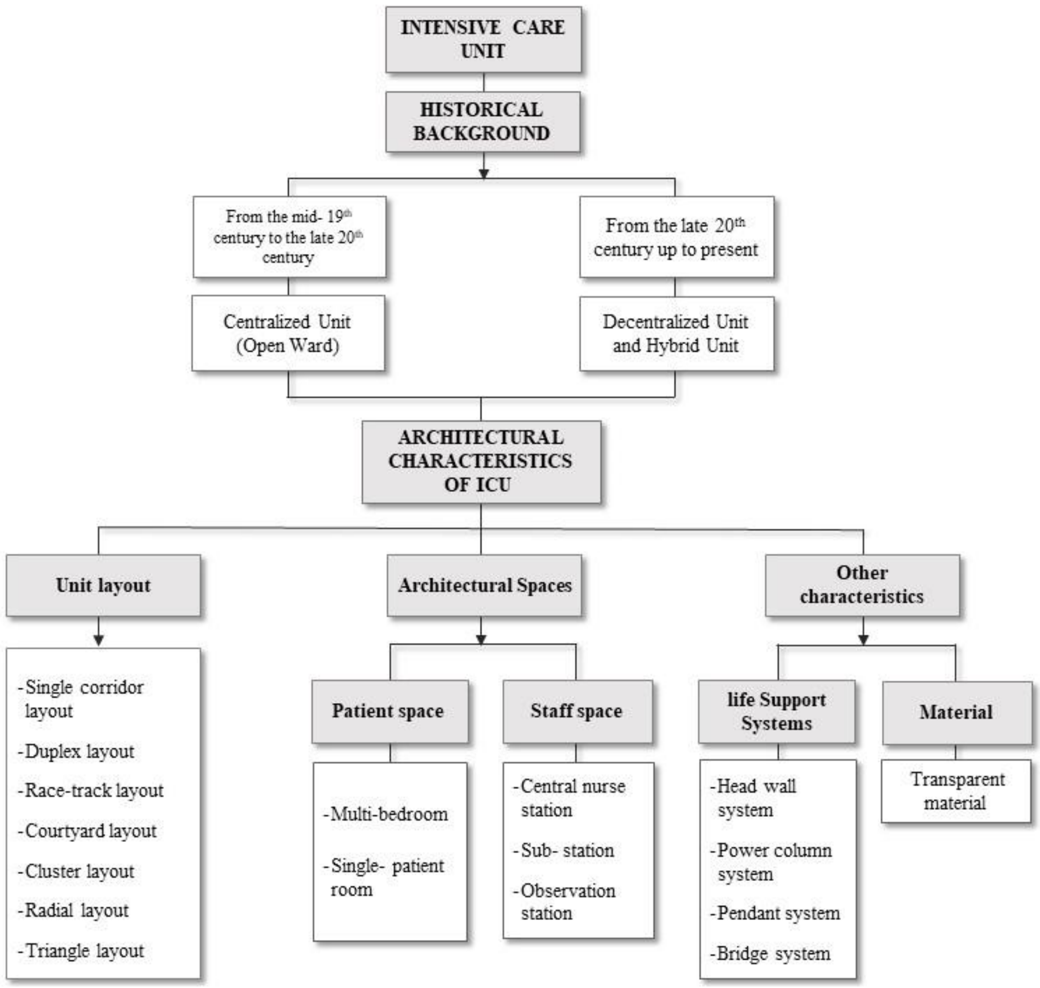



Figure 2.55. Summary of the literature review (By the researcher)

Firstly, the historical background of *ICU*s' design was explained before and after the late 20th century. The late 20th was the revolutionary point of *ICU*s' design changing from centralized to decentralized design. The primary purpose of this change was to provide a safe and efficient environment. This part described the characteristics of both centralized and decentralized design models regarding *visual and physical accessibility* to patients.

Secondly, architectural characteristics of *ICU*s were described in three main themes as follows:

- Layout: Seven kinds of layout were explained by referring to the *visual and physical accessibility* features of each layout. Moreover, advantages and disadvantages of layouts were described as seen in Table 2.3.
- Architectural spaces: Architectural spaces were explained in terms of patient and staff space. Patient spaces were divided into a single room and multi-bedroom in *ICU*s. The single room also was presented in two design models, including the same-handed and mirrored patient room. Staff space was explained as a central nurse station, substation, and observation station in *ICU*s. The advantages and disadvantages of each space were presented with referring to *visual and physical accessibility*.
- Other characteristics: The other characteristics were described in terms of life support systems and material in *ICU*s. As shown in Table 2.5, life support systems' advantages and disadvantages were summarized by referring to *visual and physical accessibility* in *ICU*s.

In the last part of the literature review, some designed *ICU*s were selected to illustrate their architectural characteristics in nurse and patient spaces throughout the decades.

As a whole, this literature review mentioned the body of studies about architectural characteristics of *ICU*s by referring to the *visual and physical accessibility* features. These studies' findings implied the various impacts of the architectural design of *ICU* on the *patients' safety* and *staff efficiency* in *ICU*s. As seen in this chapter, there is a growing body of scientific researches beyond the architectural domain about the

*ICU*s' enviornmnet. Employing finidngs of the mentioned studies in the *ICU*s' design process could be beneficial to provide a safe and efficient environment for users. In this way, according to the complicated *ICU* environment, architects could employ scientific research findings to make reliable decisions through the design process. In recent years, *EBD* as a methodology in the design filed stimulates architects to collect various scientific knowledge and apply them to their design process. In the next chapter, the *EBD* approach was described as a theoretical framework of this study in detail.

# CHAPTER 3

# THEORETICAL FRAMEWORK: EVIDENCE- BASED DESIGN APPROACH

The *ICU*s environment is essential because of patients' critical situation and complicated medical and technological instruments. According to the literature, architects use various data sources such as personal experience and best practice in their design process. They scarcely use scientific researches from various disciplines such as nursing, psychology, or sociology. In this way, the *evidence-based design (EBD)* approach suggests employing the best credible research evidence in the design process.

In this chapter, the researcher defined *EBD* approach as a framework of this study to evaluate the architects' knowledge in the *ICU*s' design process. Implementing *EBD* as a new approach in the design filed presents a process to use the best available evidence through the design process. Firstly, *EBD* was defined in the design process and clarified the meaning of credible research evidence. After that, a *Systematic Review (SR)* was described as a method of *EBD* to gather credible evidence in the design filed. This chapter's importance is mainly to provide a scientific context to evaluate architects' knowledge in *ICU*s*'* design process.

## 3.1 *Evidence- Based Design (EBD)*

For the first time, *EBD* approach was explained by Hamilton as "the conscientious, explicit and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project" (Stichler & Hamilton, 2008, p.3). As seen in Figure 3.1, the conceptual model of *EBD* proposed the making decisions' process by integrating "credible research evidence," "practitioner design expertise," and "client or population needs, preferences, and resources," in the context of the project, in order to meet project goals (Peavey & Vander Wyst, 2017). This is an essential distinguishable point of *EBD* from research-informed design (RID) [20] restricted to employ just published scientific researches in the design process (Peavey & Vander Wyst, 2017).

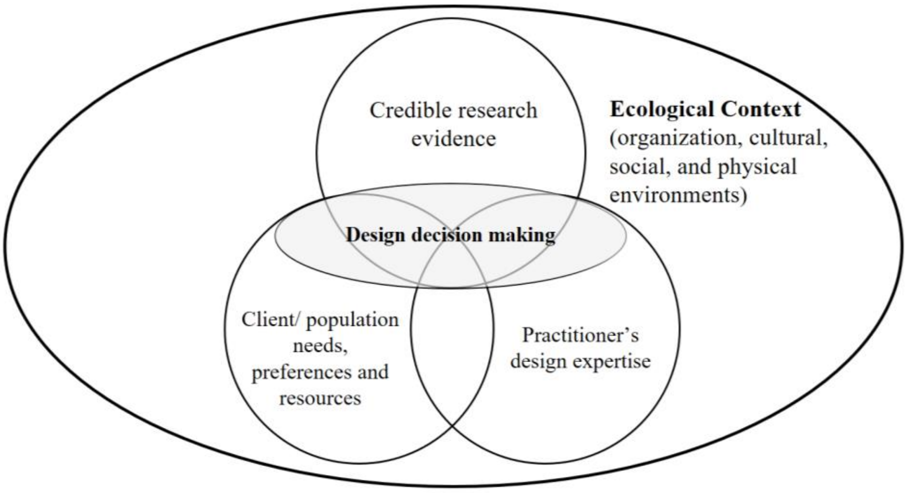



Figure 3.1. Conceptual model of *EBD*. (Peavey & Vander Wyst, 2017, p.152)

*EBD* has adapted clues from Evidence-Based Medicine (EBM) approach that highlights the significance of integrating the best research outcomes within clinical care rather than conventional resources of knowledge, such as unsystematic medical skills, experts' ideas, and intuition (Chong et al., 2010; Satterfield et al., 2009). EBM is a clinical practice method that accommodated an Evidence-Based Practice (EBP) concept to make clinical decisions better by focusing on the utilization of reliable evidence (Fagan, 2017). EBP is any practice that depends on scientific evidence to lead and make decisions (Li et al., 2019). Practices that do not

[20] "Research-informed design is limited in its application since as the name implies, it uses only published research to inform the design process" (Stichler, 2016, p.8).

depend on any evidence can depend on tradition, intuition, or other unverified methods (Li et al., 2019).

*EBD* is generated from the Nightingale's environmental theory [21] and extended with Ulrich's (1984) research that revealed the effects of a view of a window on patient rehabilitation. One healthcare design project based on *EBD* is the "Pebble Project" as an international project that accommodates a different group of advanced healthcare settings and experts (Hamilton &Watkins, 2009; Ulrich et al., 2008; Zensius, 2008). In this project, architects have committed to employing an *EBD* procedure for producing healing spaces that develop care quality, safety, and functional efficiency (Hamilton &Watkins, 2009; Ulrich et al., 2008; Zensius, 2008).

The purpose of *EBD* is generally to contribute systematic process and positive outcomes to develop *patients' safety*, and *staff efficiency* (Becker & Parsons, 2007; Hamilton &Watkins, 2009; Pati, 2011; Peavey & Vander Wyst, 2017; Ulrich et al., 2008; Zimring & Bosch, 2008). Using evidence should not decrease the practitioner's role in the decision-making process (Hamilton, 2018). *EBD* employs the best evidence from research and practice in eight steps, including:[22]

- "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 the implementation of design and construction.
- Measure post-occupancy performance results."

[21] Environmental theory of Florence Nightingale describes that nursing is *the act of employing the patients' environment to help them in their rehabilitation* (Nightingale, 1863).
[22] Retrieved Dec 24, 2019, from https://www.healthdesign.org/certification-outreach/edac/about

Architects and researchers can cooperate on each of the mentioned steps, such as searching relevant evidence, interpreting relevant evidence, and post-occupancy evaluation[23] steps (Nasar, 2007; Peavey & Vander Wyst, 2017). This cooperation creates evidence-based data for contributing to generate suitable design solutions in the design process (Nasar, 2007; Peavey & Vander Wyst, 2017; Zborowsky & Bunker-Hellmich, 2010).

According to this process, the essential value of *EBD* procedure is transparency in a process that indicates the step by step decision-making process and finally shares the outcomes of design (Chong et al., 2010) and using scientific researches in the design process to make designers ensure about the reliability of their decisions (Becker & Parsons, 2007).

### 3.2 Evidence in *Evidence- Based Design (EBD)*

Both tacit and explicit knowledge could be used in the design process, and architects can make decisions based on personal and shared knowledge (Hamilton, 2017; Hamilton, 2019). In this way, Hamilton (2019) stated, "Evidence, intuition, and experiment are thus all relevant to design decision-making that must all work together in a balanced way for the designer, creating the strongest potential for project success" (p.71). However, architects often make design decisions based on tacit knowledge, such as intuition and personal experience (Hamilton, 2017; Hamilton, 2019).

Knowledge drawn from scientific findings includes credible facts and support for robust theories (Hamilton, 2019). In *EBD*, the "credible research evidence" is relatively more rigorous than other kinds of evidence because it is conducted using

[23] "Post- occupancy evaluation is the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time" (Preiser et al., 2015, p 3).

scientific methodologies without reflecting individual thoughts and priorities (Becker & Parsons, 2007). "Credible research evidence" as explicit knowledge could affect the quality of healthcare environment that is grouped from formal academic studies to private institutional studies, expert experience, and unofficial best-practice standards (Becker & Parsons, 2007). It is needed to determine evident standards for what creates "credible evidence" and the approaches for its formation and implementation (Chong et al., 2010).

Some researchers suggested a categorization for the levels of evidence in *EBD*. As seen in Table 3.1, Peavey & Vander Wyst (2017) combined categorizations suggested by Stichler (2010), Pati (2011), and Stetler (2002) and offered the framework with eight-level of evidence. According to this framework, evidence was categorized from a meta-analysis and *SR* as the most reliable evidence to experience designers or healthcare providers as weakest evidenc.

"Meta-analysis is a quantitative, formal, epidemiological study design used to systematically assess previous research studies to derive conclusions about that body of research. Outcomes from a meta-analysis may include a more precise estimate of the effect of treatment or risk factor for disease, or other outcomes, than any individual study contributing to the pooled analysis" (Haidich, 2010, p.29). Almost, a *systematic review* is utilized to access and apply various credible research evidence to *EBD*'s design process. The researcher describes *SR* and its implication in the following part in detail.

Table 3.1 levels and strength of evidence for healthcare design (Peavey & Vander Wyst, 2017, p.146)

| Level of evidence | Description |
|---|---|
| **Level 1 (Strongest)** | Meta- analysis and systematic reviews of randomized controlled trials or experimental studies |
| **Level 2** | Single experimental study (randomized, controlled) |
| **Level 3** | Single quasi- experimental study (e.g., nonrandomized, concurrent, or historical controls) |
| **Level 4** | Systematic, interpretive, or integrative review of multiple studies of observational or qualitative research |
| **Level 5** | Single nonexperimental study, correlational, descriptive, mixed methods, and qualitative research |
| **Level 6** | Published evaluation data (e.g., facility evaluation, mock-ups) that were systematically collected and were verifiable |
| **Level 7** | Consensus opinion of authorities(e.g., a nationally known guideline group with strong peer review) |
| **Level 8 (Weakest)** | Opinions of recognized experts, case studies |

## 3.3 *Systematic Review (SR)*

One of the rigorous steps of *EBD* includes finding credible research evidence. A *SR* is a reliable approach to creating, evaluating, gathering, and synthesizing various scientific research from other research fields beyond architectural design based on the specified criteria (Hamilton, 2011; Urra Medina & Barría Pailaquilén, 2010). By *SR*, architects can use credible research evidence from the unfamiliar domains of knowledge such as social science, nursing, or medicine, to stimulate the different innovative concepts for designers (Hamilton & Watkins, 2009). *SR* also tries to decrease prejudice and arbitrary errors in combining studies' findings with some strategies (Higgins et al., 2019; Urra Medina & Barría Pailaquilén, 2010). These strategies involve using an evident searching process traced by explicit and reproducible identical inclusion and exclusion criteria in the selection of studies for the review and rigorous assessment of research methodologies of achieved studies

(Becker, 2007; Foster, 2013; Higgins et al., 2019; Rosenbaum, 2011; Urra Medina & Barría Pailaquilén, 2010).

Identifying scientific research relevant to the research questions is a fundamental component of *SR* (Becker, 2007; Higgins et al., 2019). To show the importance of *SR* in *EBD*, Foster (2013) implied the main differences between *SR* and narrative review. As shown in Table 3.2, a narrative review regards a broad research subject rather than a specific research subject. It has an overall look at a general subject without having strong evidence for the effectiveness of specific interventions. It has also been criticized because of a lack of an explicit searching process, rigorous definitions, and standardized process.

Table 3.2 The differences between the systematic review and the narrative review (Foster, 2013)

| PROCESS/STEP | NARRATIVE REVIEW | SYSTEMATIC REVIEW |
|---|---|---|
| 1. Research question | Usually not explicitly stated or goal is general, to summarize a topic | Specific research question |
| 2. Search for studies | Usually not reported | Comprehensive and methods reported |
| 3. Selection of studies | Criteria not provided, process often biased | Selection process is reported |
| 4. Evaluation of quality and coding | Quality is not assessed, all studies are not treated the same | All studies are treated the same, including assessment of quality |
| 5. Synthesis | Qualitative and non-systematic | Systematic |

In *SR*, researchers can employ scientific researches that were not published called grey literature. Grey literature can involve academic papers such as theses, reports, or conference papers (Higgins et al., 2019; Paez, 2017). Using grey literature may diminish publication bias, increase reviews' comprehensiveness, and timeliness (Higgins et al., 2019; Paez, 2017).

According to Higgins et al., (2019), the *SR* process involves defining the research question, presenting "PRISMA" diagram, extracting data, and summarizing findings that will be defined as follows:

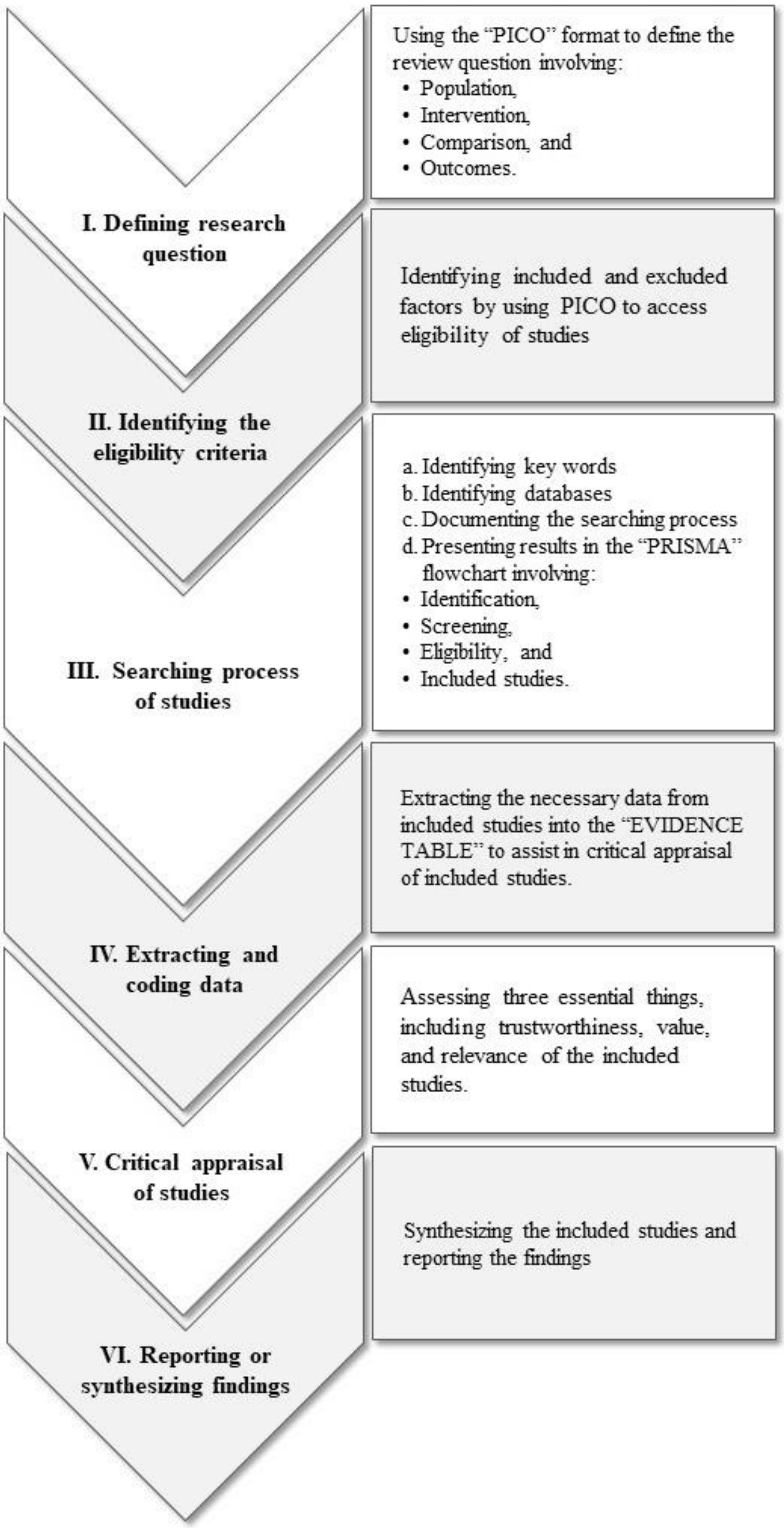



Figure 3.2. Systematic review process (Higgins et al., 2019)

### I. Defining review question

Defining the review question is the significant stage in conducting *SR* that makes the review process more useful (Higgins et al., 2019). The question should be defined explicitly in one general question or some specific questions (Higgins et al., 2019). In this step, the question of research, inclusion, and exclusion criteria, and the review scope should be defined very precisely. A "PICO" format involving "Population," "Intervention," "Comparison," and "Outcomes" is used to frame the *SR* research question. The research question and review become more precise and evident by "PICO" (Brown & Ecoff, 2011; Foster, 2013; Higgins et al., 2019). In other words, defining the review question sets the inclusion and exclusion criteria and the eligibility factors of review (Foster, 2013; Gough et al., 2012). In this way, after specifying the *SR* question, included and ex22cluded review factors should be explained in detail to choose the exact studies for saving time (Higgins et al., 2019).

### II. Eligibility criteria of stuides

Specifying the exclusion criteria constitutes the scope of *SR*. These criteria help with being persistent with screening findings and usually several essential issues that might be hard to integrate into the searching process, or if they were involved, they might exclude some useful findings.

### III. Searching process of studies

The searching process aims to be comprehensive enough to improve an extensive list of related studies (Higgins et al., 2019). It starts with Identifying key words and synioumumns od key words to achive the related stuides in the searching process. After that, data bases specifies to search stuides with emp;loy specified key words and suynumumns. To documant search results, reference Management Systems can be used such as EndNote or Mendeley (Higgins et al., 2019). Reference Management Systems help download searching results from each database, check for duplications, and save reviewer comments (Higgins et al., 2019).

Finally, the Diagram of "PRISMA" [24] is used to show the process of the utilization of criteria about inclusion and exclusion factors in *SR* (Higgins et al., 2019). It depicts the flow of data through the four different steps and outlines the number of identified, included, and excluded results and the exclusions' reasons (Higgins et al., 2019). As seen in Figure 3.3, the process of searching includes:

**Identification:** Firstly, the keywords should be clarified to start the searching process. Boolean operators such as "AND" and "OR" could be used to integrate keywords to narrow or broaden the achieved results. Almost the electronic databases for searching should be clarified. To meet the review's validity, two reviewers should conduct the whole procedure of data extraction separately. For finding more results, hand searching of journals could be utilized by reviewers.

**Screening:** In the first screening process, to minimize bias in the searching process, at least two reviewers conduct a titles and abstracts' screening relying on the "PICO" question and specified excluded and inclusion criteria **(**Higgins et al., 2019).

**Eligibility:** After the first-step screening, a profound assessment of full-text is screened for the second time, relying on the eligibility criteria (Higgins et al., 2019). Eligibility criteria are the pre-specification of included and exclude factors of review, and it is one of the characteristics that recognize an *SR* from other reviews (Higgins et al., 2019). The "PICO" question usually translates into the eligibility criteria (Higgins et al., 2019). The same set of eligibility criteria could be applied to screen titles, abstracts, and full-text studies.[25]

**Included stuides:** The final step is to report the included studies by using the "PRISMA" diagram (Higgins et al., 2019). As seen in the below figure, PRISMA illustrates the all searching process by showing the number of resulted studies in each step, including identification, screening, eligibility, and included studies in the systematic review.

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[24] Retrieved August 06, 2019, from http://prisma-statement.org/PRISMAStatement/FlowDiagram

[25] Retrieved December 16, 2019, from https://www.environmentalevidence.org/guidelines/section-6

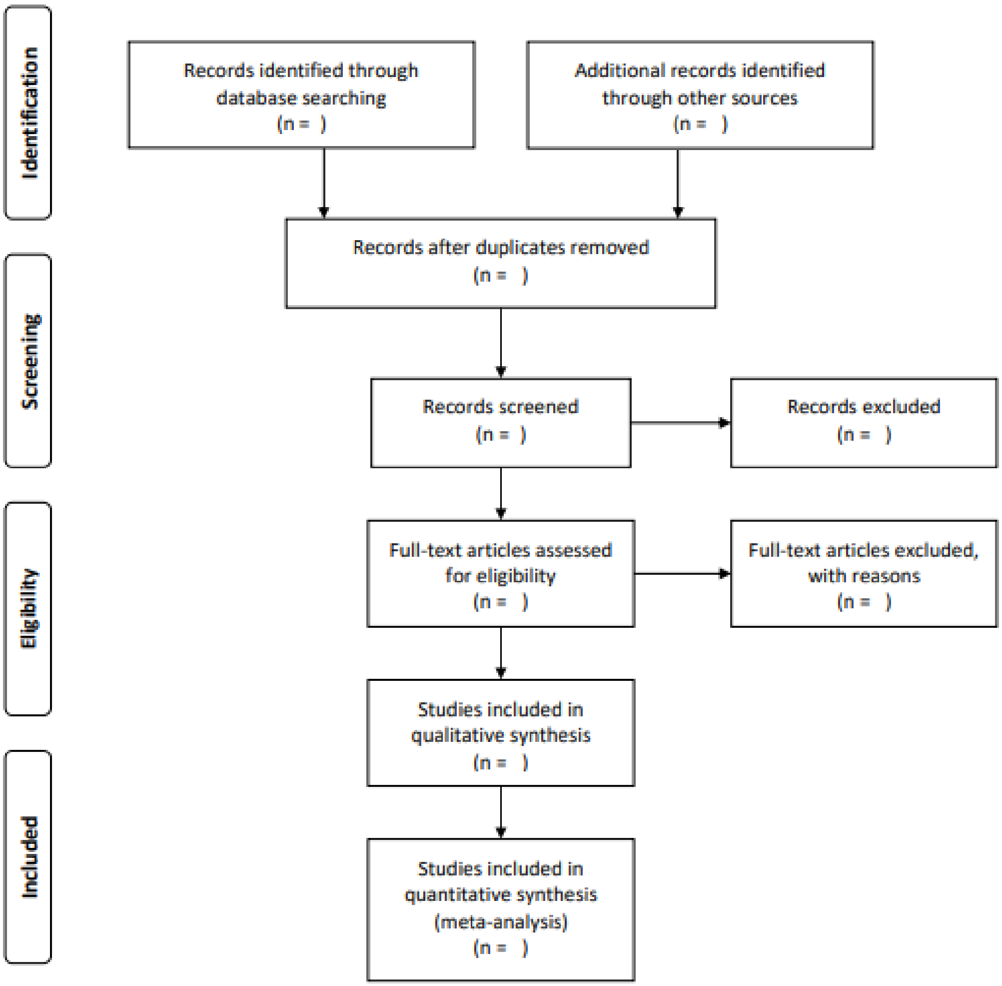


Figure 3.3. Diagram of "PRISMA" [5]

## IV. Extracting and coding data

Extracting and coding data are a procedure of reading studies and systematically coding each study's properties into a specific table named "evidence tables." (Higgins et al., 2019). Extracting data could be done by hand, or by special programs such as Microsoft Word (Higgins et al., 2019). The Cochrane Handbook suggests a list including "methods, participants, interventions, outcomes, results, and miscellaneous." For instance, the below table shows another kind of extraction from that is constituted of five items involving "author, population, study design, design intervention, and findings." Extracting the necessary data from included studies into the “EVIDENCE TABLE” to assist in the critical appraisal of included studies in the following part of the study.

Table 3.3 Data extraction form (Foster, 2013, p.145)

| Author/ year | Population | Study design | Design intervention | Findings |
|---|---|---|---|---|
| | | | | |

### V. Critical appraisal of studies

Critical appraisal is the process of looking at studies to assess trustworthiness, relevance, and value (Stichler, 2015). Most architects are not trained as researchers, and they do not know how to appraise and evaluate the quality of available evidence (Chong et al., 2010). Architects rarely have education about research methodologies and are also ambiguous about the evidence meanings (Chong et al., 2010). It is often challenging to assess research quality without awareness of research methods (Hamilton, 2003; Rosenbaum, 2011; Zborowsky & Bunker-Hellmich, 2010).

Critical appraisal checklists supply a framework to interpret and determine the reliability of the studies. Generally, there are various frameworks such as Joanna Briggs Institute (JBI) [26], Critical Appraisal Skills Programme (CASP) [27], or Johns Hopkins Research Evidence Appraisal Tool. The mentioned frameworks are generally used in EBM because the health studies are rigorous, and their appraisal process also needs a rigorous process.The appraisal of *EBD* evidence may be less rigorous than evidence of health care (Stichler, 2010a, 2010b). For this reason, Stichler (2015) presented the “literature appraisal tool” for using in *EBD* approach was adapted from “Johns Hopkins Nursing Evidence-Based Practice Model and

[26] https://joannabriggs.org/critical-appraisal-tools
[27] https://casp-uk.net/casp-tools-checklists/

Guidelines" (Table 3.4). The mentioned tool involves some parts to interpret and determine the reliability of the studies included citation, type of study, location, key concepts, framework, study design, sample, data sources type, statistical test used, findings, recommendations, strengths, weaknesses, level of evidence, quality of evidence.

Table 3.4 Literature appraisal tool[28] (Stichler, 2015)

| **Literature Appraisal Tool** | |
|---|---|
| **Citation** | Author (s): |
| | Title: |
| | Journal, Year, Volume, Issue Pages: |
| **Type of Study** | ☐Systematic Review of Literature<br>☐Quantitative ☐ Qualitative<br>☐Mixed Methods ☐ Case Study<br>☐Other ---------- |
| **Location/Setting** | ☐United states ☐ Others ------------------ |
| **Key concepts/ Variables/ Design Features** | |
| **Framework/ Theory** | |
| **Study Design** | ☐Meta- analysis ☐Systematic ROL ☐Experimental<br>☐Quasi- experimental (comparison) ☐Correlational<br>☐Descriptive<br>☐Expert Opinion ☐Vender recommendation |
| **Sample** | Size Sampling Method Sample Characteristics |
| **Data Sources Type** | ☐Self- developed Survey ☐Self- report ☐Observational<br>☐Organizational Data ☐Clinical data ☐ Other |
| **Statistical Tests Used** | ☐Percentage of Change ☐Frequencies ☐Statistical Tests |
| **Findings** | |
| **Recommendations** | |
| **Strengths** | |
| **Weaknesses** | |
| **Level of Evidence** | ☐Level 1 ☐Level 2 ☐Level 3 ☐Level 4 ☐Level 5 |
| **Quality of Evidence** | ☐High ☐Good ☐ Low |

The last two parts of mentined form included the evidence level and evidence quality to appraise the healthcare design field's evidence. According to Stichler (2010), there are six levels for appraising the evidence as follow:

- Level 1 (The strongest): Systematic reviews of multiple Randomized Controlled Trials [29] (RCT) or nonrandomized studies; meta-analysis 30 of multiple experimental or quasi experimental studies; meta- synthesis of multiple qualitative studies leading to an integrative interpretation.
- Level 2: Well- designed experimental (randomized) and quasi- experimental (nonrandomized) studies with consistent results compared to other, similar studies.
- Level 3: Observational studies, well designed qualitative or systematic reviews of observational or qualitative studies, or RCT or quasi- experimental studies with inconsistent results compared to other, similar studies.
- Level 4: Professional standards or guidelines with studies to support recommendations.
- Level 5: Opinions of recognized reports, case studies
- Level 6 (The weakest): Recommendations from manufactures or consultants who have a financial interest or bias.

Almost the evidence quality provides a tool to determine the evidence strength (Stichler, 2015). To access the quality of evidence, the researcher must weigh the quantity (e.g., number of studies, sample size), quality (e.g., rigor), appropriateness (e.g., applicability to context), and the feasibility (e.g., degree of difficulty of successful implementation) of the evidence (Pati, 2011; Stichler 2010a; Peavey &

[29] Randomized Controlled Trial (RCT): "A study in which a number of similar people are randomly assigned to 2 (or more) groups to test a specific drug, treatment or other intervention. One group (the experimental group) has the intervention being tested, the other (the comparison or control group) has an alternative intervention, a dummy intervention (placebo) or no intervention at all. The groups are followed up to see how effective the experimental intervention was. Outcomes are measured at specific times and any difference in response between the groups is assessed statistically. This method is also used to reduce bias". Retrieved July 3, 2020, from https://www.nice.org.uk/glossary?letter=r

[30] Meta- analysis: "A meta-analysis is a statistical analysis that combines the results of multiple scientific studies. Meta-analysis can be performed when there are multiple scientific studies addressing the same question, with each individual study reporting measurements that are expected to have some degree of error."

Vander Wyst, 2017) In this way, (Stichler, 2015) implied to the three levels of evidence quality included high, good, and low quality. High-quality evidence (A rating) has an extensive review of the literature with recommendations based on studies with consistent results, adequate sample sizes, appropriate research designs and controls, and definitive conclusions based on the results of the studies supported by the findings in the synthesis of the literature. Good quality evidence (B rating) has a fairly comprehensive literature review that includes research articles and opinion articles, sufficient sample sizes, reasonably consistent results, and relatively definitive conclusions based on the data and the literature review. Low Quality or Flawed evidence (C rating) has an insufficient sample size, little evidence, or evidence with inconsistent results drawn from a limited literature search, and inconclusive results.

**VI. Reporting or synthesizing findings**

There exists various kind of methods to synthesize the evidence in *SR* (Foster, 2013). Synthesis involves the comparison, integration, and summary of the studies included in the *SR*. The kind of synthesis is generally chosen based on the research question (Dixon-Woods et al., 2005). There are three types of synthesis: framework, thematic, and mixed methods synthesis (Foster, 2013; Gough et al., 2012). Framework synthesis is one way to identify the model of a particular phenomenon in the *SR* (Foster, 2013; Gough et al., 2012). In framework synthesis, investigating a research question and the theoretical or empirical background of studies that form studies' frameworks could extract new data from studies (Brunton et al., 2020). Another approach is the thematic synthesis that synthesizes studies' findings to determine the studies' categories by reviewing them to investigate data in qualitative studies (Foster, 2013; Gough et al., 2012; Thomas & Harden, 2008). Mixed methods as a robust approach of synthesizing integrate outcomes of all forms of studies such as qualitative and quantitative research to employ all kinds of studies (Dixon-Woods et al., 2005; Foster, 2013; Gough et al., 2012). This approach could have significant consequences by employing various evidence in different methodologies (Dixon-Woods et al., 2005).

### 3.4 Summary

According to the mentioned literature, architects' knowledge is generally based on consensus knowledge (for instance, the best practice) and experience-based knowledge (for instance, prior experiences) in the design process. *EBD*, as a new trend in the design practice, suggests using reliable evidence in terms of scientific researches to make reliable design decisions. Regarding the mentioned literature, the critical characteristics of *SR* are defined as the following:

- A clearly stated set of objectives with predefined eligibility criteria for studies;
- An explicit, reproducible methodology;
- A systematic search that attempts to identify all studies that would meet the eligibility criteria;
- An assessment of the validity of the findings of the included studies, for example, through the assessment of the risk of bias; and
- A systematic presentation, and synthesis, of the characteristics and findings of the included studies. (Higgins & Green, 2011)

In this way, the researcher used *EBD* as a theoretical framework to provide a safe and efficient *ICU* environment. *EBD* allows architects to assess the reliable evidence to hypothesize and produce design solutions for implementing in their project. The architects integrate scientific knowledge throughout each step of *EBD* to better design solutions and outcomes. *SR* was used as an *EBD* method to find relevant scientific research in various knowledge domains to evaluate the architects' concern in this field. Designers rarely employ the *EBD* approach in their design process and remain more theoretically. Considering the current state of "credible research evidence" in the architectural design procedure, the employing *SR* is like giving the architects direction on how to involve and benefit more with scientific researches as an essential part of their design procedure.

As mentioned in chapter two, there is various credible research evidence about the *ICU* design and impacts of architectural characteristics on *patients' safety* and *staff efficiency* in the unit. However, there is not any *SR* in this field of design. In the next chapter, the *SR* was employed as the first and significant step of the *EBD* approach to disclosing *ICU*s' accessibility features. Almost *SR* findings were utilized to evaluate the healthcare architects' concern about the accessibility features in *ICU*s.

# CHAPTER 4

## METHODOLOGY: INVESTIGATING OF HEALTHCARE ARCHITECTS' DESIGN PROCESS IN INTENSIVE CARE UNIT

As mentioned in previous chapters, architects encounter various evidence beyond architectural filed such as medical, nursing, or psychological through the *ICU*s*'* design process. They need to make decisions based on the best available evidence to provide more safe and efficient *ICU*s environments. Gathering various evidence and using them in the decision- making process could enhance *patients' safety* and *staff efficiency* in *ICU*s. This study purposed to gather data for evaluating healthcare architects' concerns in the *ICU* design process regarding credible research evidence. In this way, this chapter described the research methods, materials, process, and validity of methods in detail. Firstly, two open ward *ICU*s located in Iran and Finland were observed to closely comprehend the *ICU*s' environment, understand the *visual and physical accessibility* features within observed *ICU*s, and employ the fieldnotes as the supplementary data to design the interview questions. Secondly, the *SR* employed to disclose the *visual and physical accessibility* feature in *ICU*s. Finally, the researcher used an interview methodology to understand the healthcare architects' experiences about *ICU*s' accessibility features.

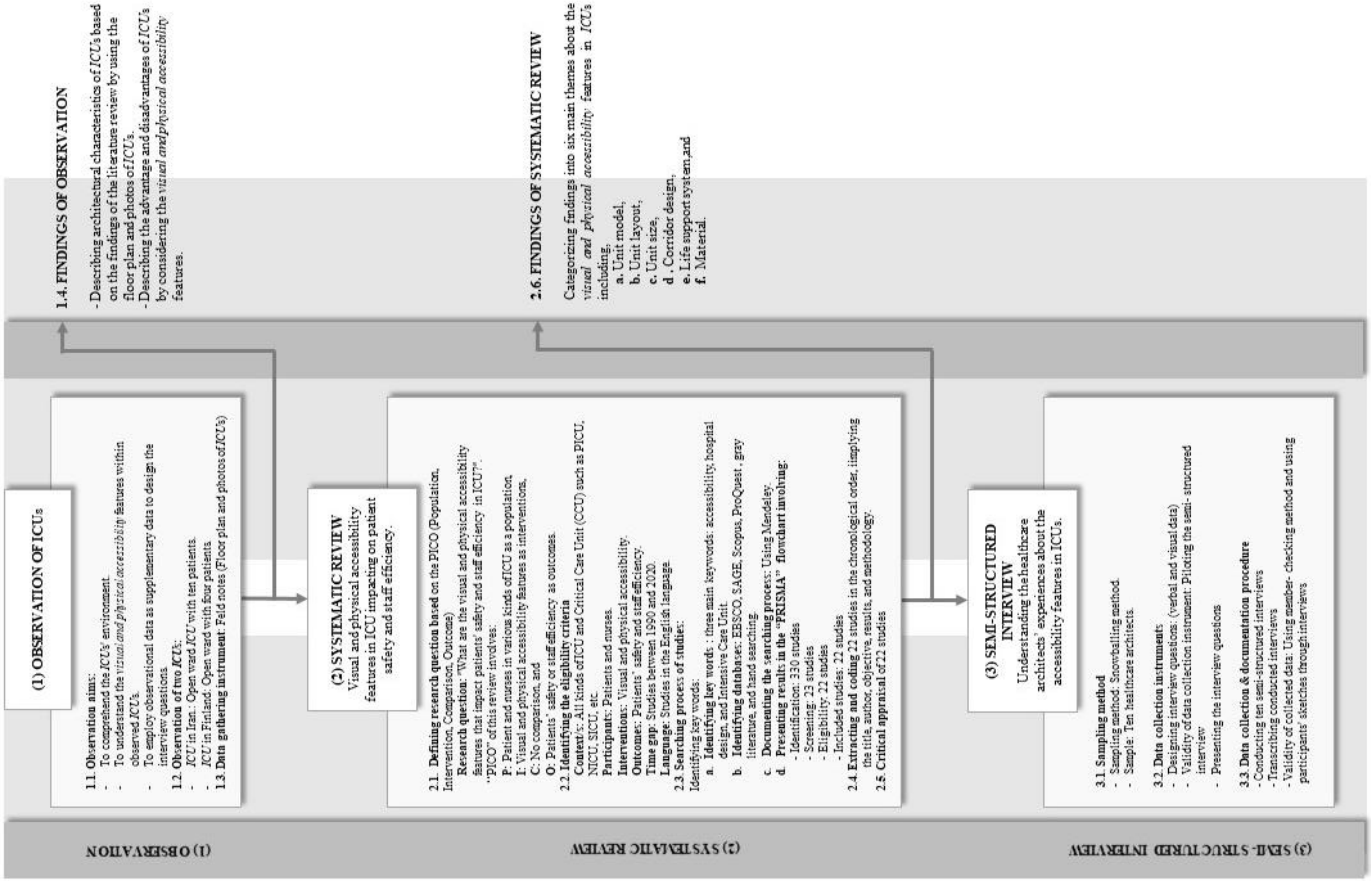


Figure 4.1. Methodology of the study (By the researcher)

## 4.1 Observation of *ICU*s: Iran and Finland

This part of the methodology aimed to clarify the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*s by collecting observational data from two different *ICU*s located in two different countries Iran and Finland. One of the selected *ICU*s is located in Shahid Madany Hospital as the main cardiovascular surgery center, in Iran, Tabriz. Another *ICU* is located in the Seinäjoki Central Hospital, Finland, Seinäjoki, and is the first *EBD* project in Finland. Filed notes were employed by the researcher to gather observational data in selected *ICU*s. Field notes generally use to gather the behaviors, actions, and other issues, enabling us to save what the researcher observes (Brown, 2013; Charmaz & Mitchell, 2001; Schwandt, 2014; Wolfinger, 2002).

In the presented observations, the fieldnote used to describes the *ICU*'s architectural characteristics and *visual and physical accessibility* features of each *ICU* by utilizing the floor plan and interior views of *ICU*s. Each *ICU*'s floor plan and interior views were analyzed to explain *ICU*s' architectural characteristics based on the presented themes in chapter two. These themes were included unit design model (centralized, decentralized, or hybrid unit), unit layout, architectural spaces (patient space, staff space), and other architectural characteristics (life support systems and material) of *ICU*. Finally, all reported data were summarized by mentioning the advantages and disadvantages of each *ICU* in terms of *visual and physical accessibility* to patients. Additionally, reported data was used as supplementary data to design the semi-structured interview questions in the following part of the study.

### 4.1.1 Intensive Care Unit in Iran: *ICU*(1)

The first *ICU* was observed in the Shahid Madany Hospital, located in Tabriz, Iran. Shahid Madany Hospital, Center of cardiovascular surgery specialty, was established in 1969. During current years, Shahid Madany Hospital, the biggest and best-equipped Center of Cardiovascular surgery specialty in the North West of the country, provided different services in inpatient treatment and training and education of medical students in heart surgery in the specialty level. This center has a significant role in health promotion and is the center of excellence in research, education, and treatment. *ICU* of this hospital was also founded in 1969 on the second floor of the hospital near the hospital's surgical unit. This *ICU* was observed on December 11, 2018. through the observation, fieldnote, floor plan, and interior views of the *ICU* were saved through the observation. The observational data of this unit was documented as the *ICU*(1) to report and evaluate its' architectural characteristics as follow:

***Layout of ICU*(1)**:

*ICU* (1) was designed based on the open ward with approximately 225 $m^2$ and a wide corridor in the unit's middle. As shown in Figure 4.2, patients were placed around the *ICU*'s two walls. It involved ten patients' beds in two groups of five patients beside together within the unit. This open ward involved two main nurse stations located on the two sides of the unit that each nurse station should control and observe the five patients all day. It was also designed in the rectangular shape with minimum corners in the floor plan.

As mentioned in chapter two, the layout is one of *ICU*s' significant architectural characteristics that specify organizations of spaces and connections between different spaces inside the unit. The open ward of *ICU* (1) was design based on the cluster layout in two small sub-units with place a service or support area in the central part of the unit to utilize by all small subunits. In the following part, the architectural spaces of *ICU* (1) included patient and nurse sand support space, were described to clarify the *visual and physical accessibility* features.

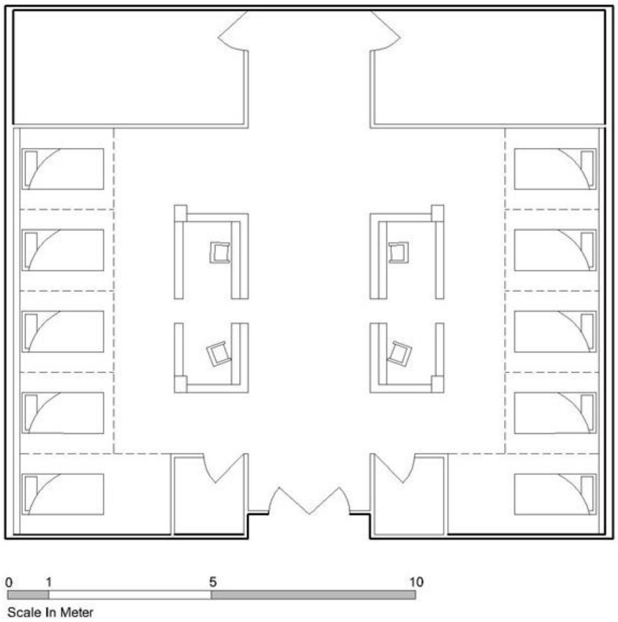


Figure 4.2. Floor plan of *ICU* (1) (By the researcher)

As mentioned in chapter two, *ICU*s involve two main spaces included patient and staff space, that the relations between mentioned spaces could impact the *visual and physical accessibility* to patients. In this way, the architectural spaces of *ICU* (1) were explained by clarifying its architectural characteristics that can impact the *patients' safety* and *staff efficiency.*

***Patient space:***

Patient space of *ICU* (1) was designed based on the multi-bedroom involved ten patients' beds with technological and medical systems. . Each sub-unit involved five patients with one nurse station in providing *visual and physical accessibility* to patients. Space for each patient was approximately 6 $m^2$, with the particular medical systems located beside each patient bed. As mentioned in chapter two, patients bed requires easy physical access from all patients' sides to permit effective care interventions. Patients' space should be designed to situate beds in the desired position as large as possible. As shown in the below figure, the layout of *ICU*

(1) provided a small area for each patient, approximately 6 $m^2$, which decreases patients' *physical accessibility*.

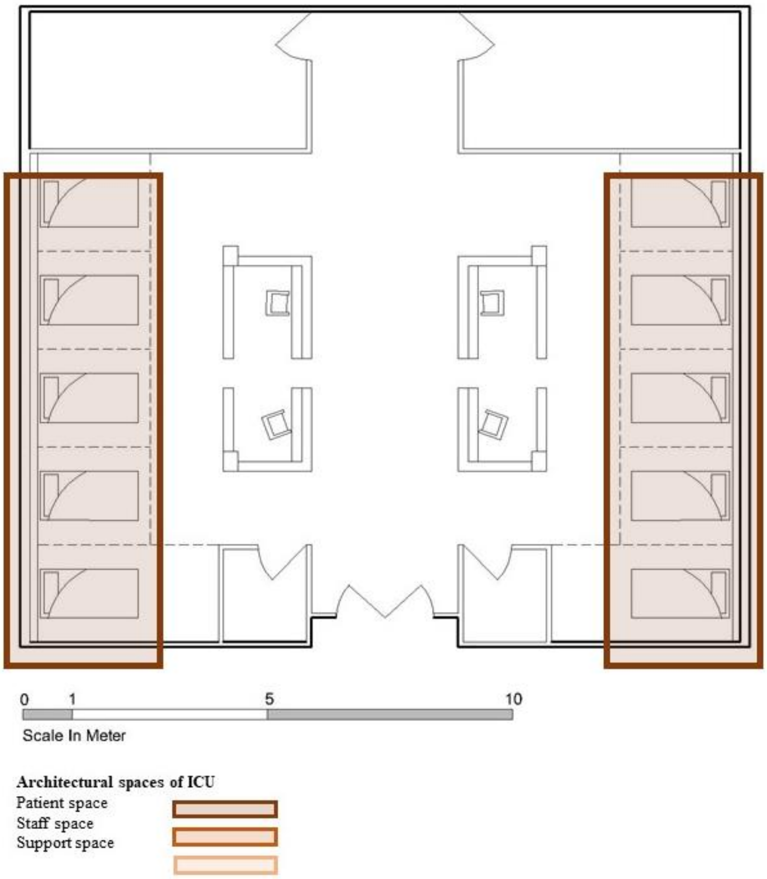


Figure 4.3. Patient space of *ICU* (1) (By the researcher)

***Staff space:***

As mentioned in chapter two, staff space provides working space for staff, especially for nurses in *ICU*. It is preferable to place the staff space adjacent to the patient space by keeping privacy between them. As the central part of the staff space, the nurse station should have a direct and continuous view of the *ICU*'s bed. Staff space of *ICU* (1) involves two sub-stations close to the patients' hobs in the unit, including charting, accessing, recording the patients' care, monitoring space, documenting space, and supporting spaces. As mentioned in chapter two, staff space should be structured to provide *visual and physical accessibility* to patients by suggesting proper workspaces for staff. In *ICU* (1), each nurse station was designed to constant control and quick access to five patients in each sub-unit. The nurse station's size is one of the essential factors that impact staff satisfaction within the *ICU*. As shown in Figure 4.4, each nurse station was designed in the rectangular shape approximately 8m$^2$ included documenting and monitoring spaces for nurses with high *visual and physical accessibility* to patients.

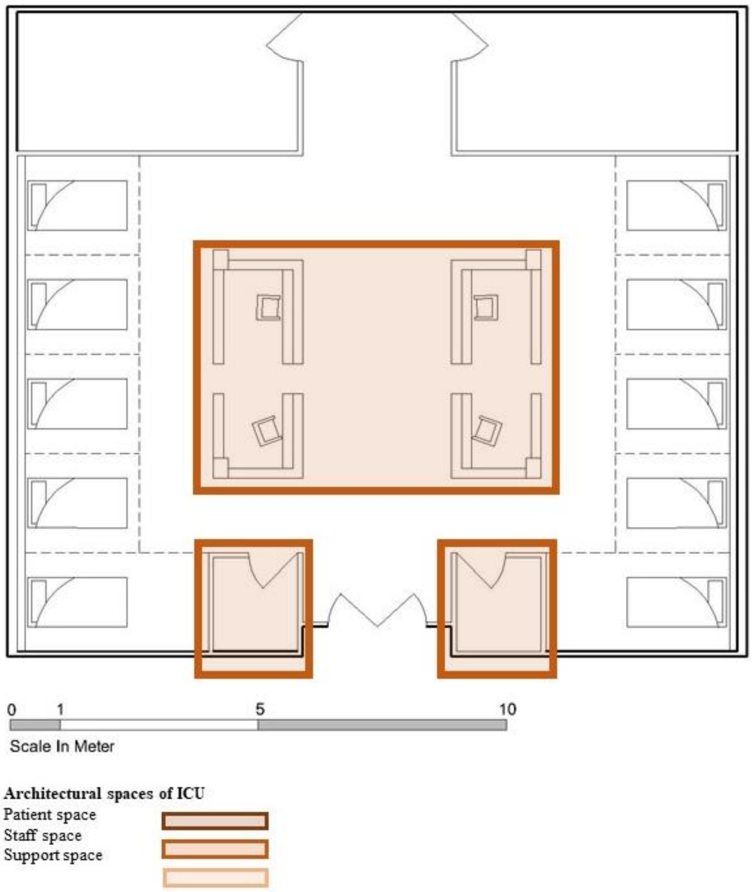


Figure 4.4. Staff space of *ICU* (1) (By the researcher)

***Support space:***

Support space provides a zone to provide medical and technical services for patient care. As shown in Figure 4.5, two separate support spaces were provided for each subunit with five patients within *ICU*(1). Each support space was located near the patient space and nurse station of each subunit. As mentioned in chapter two, *staff efficiency* could enhance by providing a support zone for each subunit and decreasing staff's travel distance. In the *ICU*(1), nurses could easily access support space because of the short distance between support and patient space. In this way, nurses could quickly provide care services for patients in *ICU*(1).

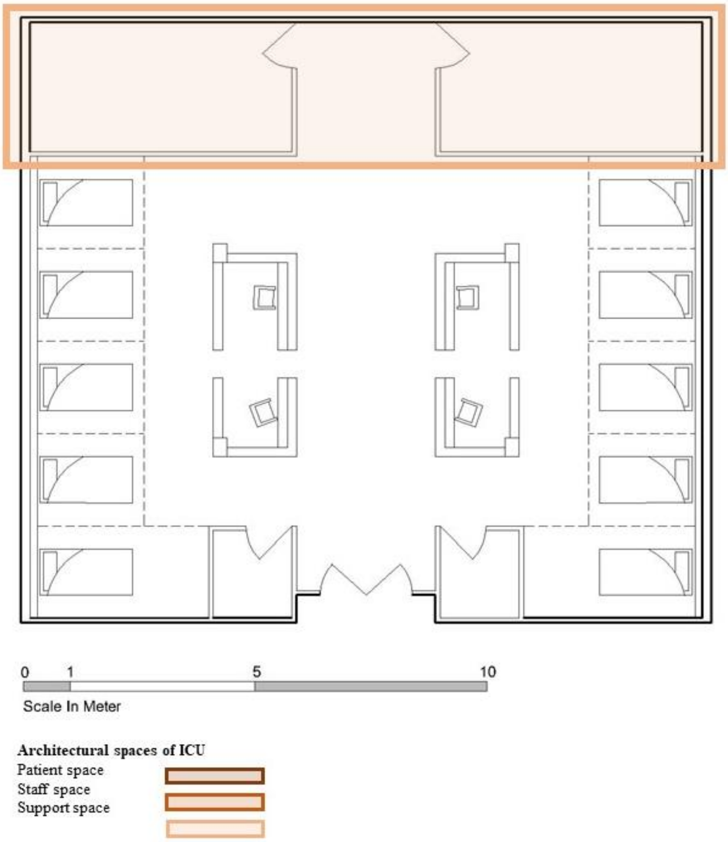


Figure 4.5. Support space of *ICU* (1) (By the researcher)

Following the gathering observational data in *ICU* (1), two interior views were saved to evaluate patients' *visual and physical accessibility* features. In this unit, these visual data helped describe the architectural characteristics and evaluate patients' accessibility features.

- ***View A of ICU* (1)*:***

As shown in Figure 4.6, *ICU* (1) was designed based on multi- bedrooms with a wide corridor in the middle of the unit. There was a filtered space in the unit's entrance to change the clothes before entering the *ICU* (1). There are two doctor's offices and two restrooms for staff beside the entrance door of the *ICU*. The main corridor divided the unit into two subunits, with five patients located the premier of the main corridor. As mentioned in chapter two, there is a relation between a corridor width and accessibility to *ICU*s patients. Wider corridors provide better opportunities for *visual accessibility* to patients. As seen in Figure 4.6, *ICU*(1) involves the broad corridor in the middle of the unit that provides high *visual and physical accessibility* to patients.

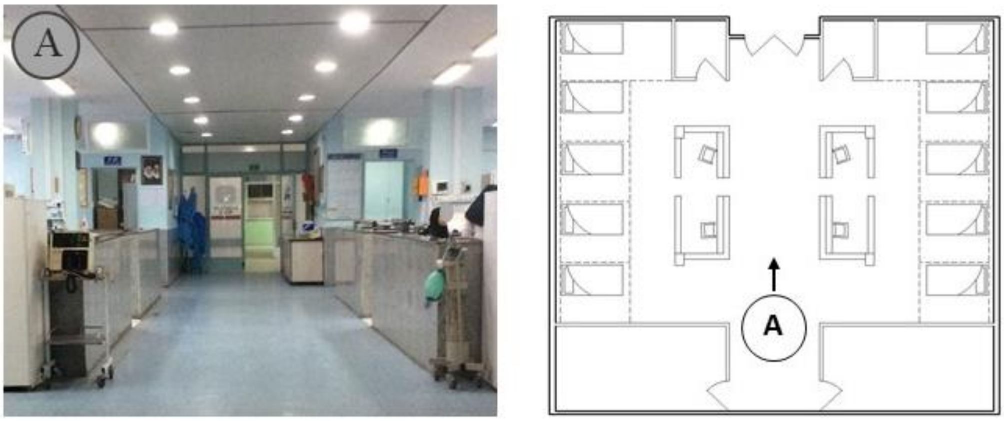


Figure 4.6. View A of *ICU* (1) (By the researcher)

- ***View B of ICU* (1)**:

This view showed the sub-unit of *ICU* (1) included a multi-bedrooms model and a nurse station in front of the patients' beds. The sub-unit of *ICU* (1) involves five patients' beds separated from the curtains between patients. The curtain between patients provides the private space them in the *ICU*. These curtains decreased *visual accessibility* to patients, and nurses could not observe patients from a nurse statin. In *ICU*s, patients' heads should be continuously observed from the nurse station. The headwall systems were also fixed behind the patients' beds that decrease the *physical accessibility* to patients' heads in this unit.

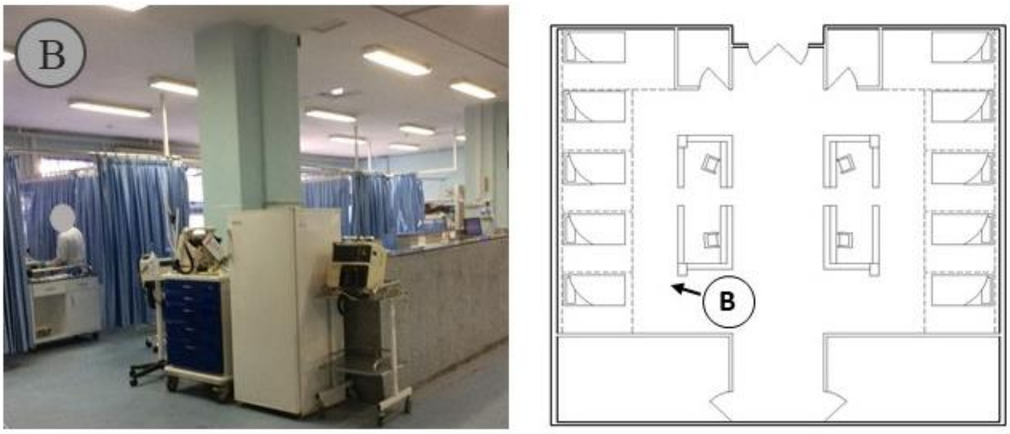


Figure 4.7. View B of *ICU* (1) (By the researcher)

As a whole, the *ICU*'s advantages and disadvantages were summarized regarding the mentioned architectural characteristics in the last part. The purpose of open wards units is to provide high accessibility to patients in *ICU*s. As stated in chapter two, the large *ICU*s' large size should be grouped into subunits with 6 to 8 patients' beds to provide high *visual and physical accessibility* to patients. This *ICU* was design based on an open ward in two sub-units with five patients. In *ICU*s, relationships between various spaces could help patients' *visual and physical accessibility*. Sub-units of *ICU* (1) provide high *visual and physical accessibility* to five patients by locating a nurse station near the patient space. In other words, the cluster layout of *ICU* (1) supplies appropriate patients' observation from the nurse station and minimizes the nurses' walking length to patients significantly. Thus, nurses could interfere with patients quickly and observe them continuously all day.

One of the disadvantages of multi-bedroom is to provide limited space for each patient inside uint. As mentioned in chapter two, the patient space area in SPR is at least 18.58 $m^2$. According to the technological and medical services in *ICU*s, patients need more space to achieve *visual and physical accessibility* by staff. However, the patient space of *ICU*(1) is approximately 7$m^2$, with limited *physical accessibility* to the patient's head. As mentioned earlier, using curtains between patients is a disadvantage of *ICU*(1) because of decreasing the patients' *visual accessibility*. As mentioned in chapter two, using transparent materials in *ICU*s enhances patients' constant observation, such as windows or transparent walls between patients.

Patient beds' position of *ICU*(1) provided limited *physical accessibility* to patients due to using the headwall system. As mentioned in chapter two, the headwall system is always arranged in a fixed position without access to the patients' head from behind. In this way, the headwall system did not allow flexibility in the beds' position within *ICU*(1). Additionally, the cluster layout of *ICU*(1)with a wide corridor in the mid of the unit is an advantage to provide high *visual and physical accessibility* to patients. It provides enough space to easily carry patients' beds and quick access to the various *ICU*(1).

Table 4.1 Advantages and disavantages of *ICU* (1) (By the researcher)

<table>
<tr><th colspan="5">ICU (1)</th></tr>
<tr><th colspan="3">Architectural characteristics</th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td colspan="2">Layout</td><td>Cluster layout</td><td>Providing high accessibility to patients by placing a nurse station close to the patients' bed</td><td>-----------------------</td></tr>
<tr><td rowspan="2">Architectural space</td><td>Patient space</td><td>Two sub- units with five patients</td><td>Providing enough space for accessibility to patients</td><td>Providing small area for each patient</td></tr>
<tr><td>Staff space</td><td>Two nurse stations</td><td>Providing high accessibility to patients by placing nurse station near the patients' bed</td><td>Providing small area for nurses</td></tr>
<tr><td rowspan="2">Other characteristics</td><td>Life support system</td><td>Headwall system</td><td>Providing low cost system</td><td>Decreasing physical accessibility to patients/ providing low flexibility in bed position</td></tr>
<tr><td>Materials</td><td>Using curtains between patients</td><td>Providing privacy for patients</td><td>Decreasing the visual accessibility to patients</td></tr>
</table>

### 4.1.2 Intensive Care Unit in Finland: *ICU*(2)

The second *ICU* was observed in Seinäjoki Central Hospital, established in Seinäjoki, Finland, in 1977. *ICU* of this hospital was also founded in 1977, located on the second floor of the hospital. This *ICU* with 24 SPR is the first *EBD* project in Finland that was renovated in 2018 by the *EBD* approach to enhance *patients' safety* and *staff efficiency*. This *ICU* was observed before the renovation on April 03, 2017, and fieldnote, floor plan, and *ICU* interior view were saved. Observational data was documented as the *ICU*(2) to report and evaluate its architectural characteristics and accessibly features as follow:

***Layout of ICU*(2)**:

As shown in Figure 4.8, *ICU* (2) was designed based on the open ward with a main straight corridor approximately 264 m$^2$. This unit is involved four patient beds located beside the wall and the primary nurse station located in the central part of the unit to control and observe all patients. It was designed in the single corridor layout that patients are located on one hand of the main corridor, and nurses' spaces are located on the other hand of the corridor. This kind of *ICU* layout provides high observation to patients and minimizes nurses' walking distance. In the following part, architectural spaces included patient, nurse, and support spaces, which were described to clarify the *ICU*'s *visual and physical accessibility* features**.**

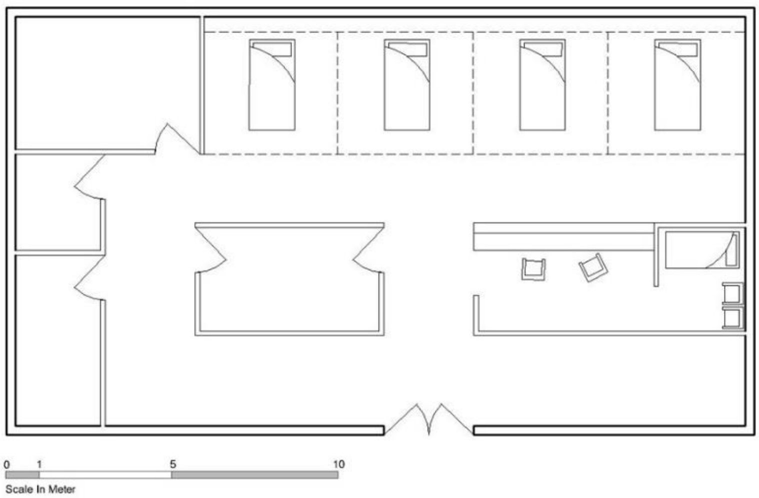


Figure 4.8. Floor plan of *ICU* (2) (By the researcher)

As mentioned earlier, *ICU*s involve two main spaces included patient space and staff space that relations between two spaces could impact the *visual and physical accessibility* to patients. In this way, the architectural spaces of *ICU*(2**)** were explained by clarifying its architectural characteristics that can impact the *patients' safety* and *staff efficiency*.

***Patient space:***

The patient space of *ICU* (2) was designed based on the multi-bedroom with four patients' beds and medical systems located inside the open space without separating from other interior spaces. Space for each patient was approximately 25m$^2$, with the particular medical systems located beside each patient bed. As mentioned earlier, patients' bed requires easy physical access from all sides to provide adequate care. In this unit, there is enough space for *physical accessibility* to patients. As shown in the below figure, this unit provided a large area for each patient, approximately 25m$^2$, which provides high *physical accessibility*.

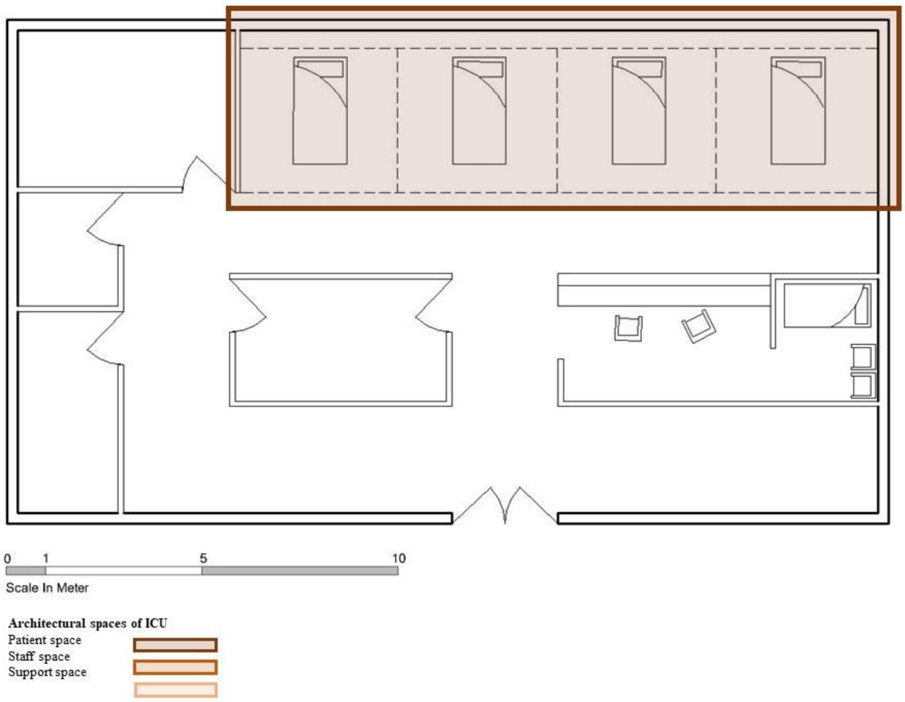


Figure 4.9. Patinet sapce of *ICU* (2) (By the researcher)

***Staff space:***

As mentioned earlier, as the central part of the staff space, the nurse station should have a direct and continuous view of the *ICU*'s bed. Staff space in *ICU* (2) was involved in a nurse station that included charting, accessing, recording the patients' care, monitoring space, documenting space, and supporting spaces. In this *ICU*, a nurse station was designed near the patient space to control and observe four patients. The nurse station was designed in the rectangular shape approximately 24 $m^2$ included documenting and monitoring spaces and a restroom for nurses besides the nurse station approximately 8 $m^2$. Generally, *ICU* (2) provided enough space for nurses within the nurse station to document and monitor patients. Also, a nurse station has a transparent wall to observe and control patients. Almost four small nurse desks are located beside each bed to observe and control the patients.


Figure 4.10. Staff space of *ICU* (2) (By the researcher)

***Support space:***

As shown in Figure 4.11, support spaces were provided for patients and nurses located beside the *ICU*'s patient spaces and nurse station. The distance between the support space and nurse station is short, and a nurse could quickly access care services. It could enhance *staff efficiency* in *ICU* (2). However, the support space's location could enhance *staff efficiency* by decreasing the travel distance of the staff. Moreover, it also enhances the *patients' safety* by minimizing the interference time to patients in critical situations. In this way, nurses in *ICU*(2) could provide convenient care services for patients.

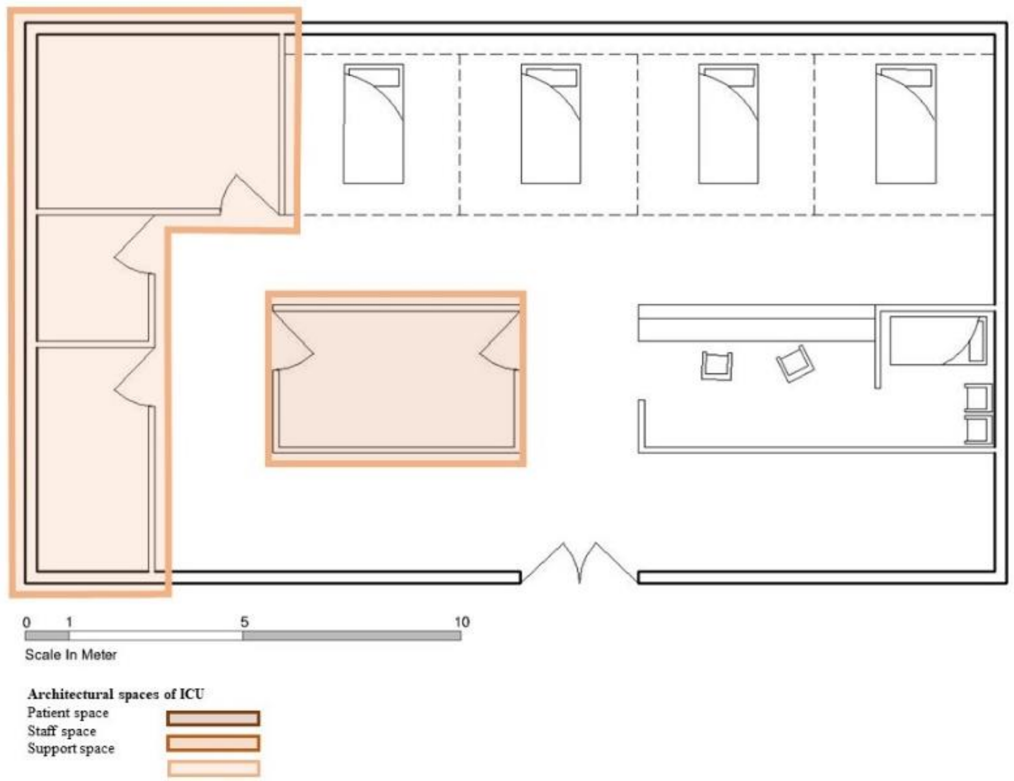


Figure 4.11. Support space of *ICU* (2) (By the researcher)

Following the gathering observational data in *ICU* (2), an interior view was saved to evaluate patients' *visual and physical accessibility* features. In this unit, these visual data helped describe the architectural characteristics and evaluate patients' accessibility features.

- ***View A of ICU* (2)**:

As seen in Figure 4.12, an essential view of the *ICU* was saved through the observation. *ICU*(2) was designed based on multi- bedrooms with a single corridor. As mentioned earlier, there is a relation between a corridor width and accessibility to patients in *ICU*s. In this *ICU*, the corridor provides high *physical and visual accessibility* to patients. Also, *ICU*(2) placed five patients besides the wall that curtains separated patients from beside patients. Utilizing curtains between patients could decrease the *visual accessibility* to patients from the nurse station. Almost the headwall system was fixed behind the patients' head that decreases the flexibility of beds' position within the unit. As mentioned earlier, the small nurse desks are located beside the patient beds included the computer for monitoring patients and a chair for sitting the nurse beside the patient bed.

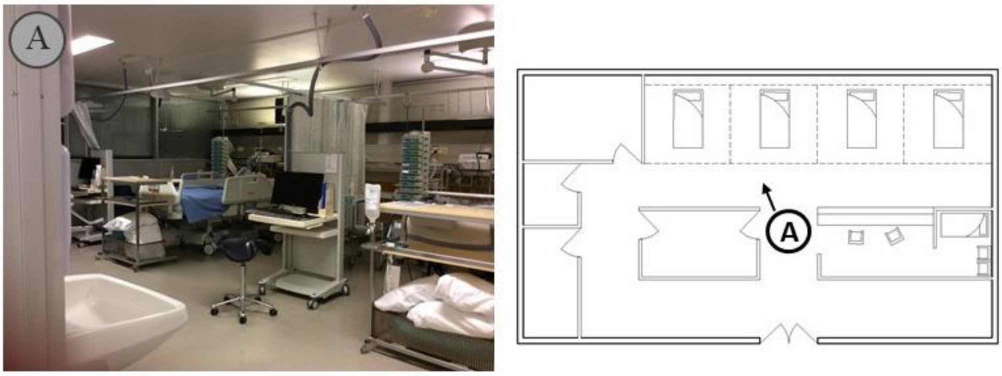


Figure 4.12. View A of *ICU* (2) (By the researcher)

However, the *ICU*'s advantages and disadvantages were summarized regarding the mentioned architectural characteristics. The purpose of open wards units is to provide high accessibility to patients. *ICU*(2) was designed based on a multi-bedroom with four patients in the single corridor layout. This *ICU*, with a wide corridor, provides high accessibility to patients. *ICU*(2) provides a suitable relationship between patient and nurse space by placing the nurse station close to the patient space and locating small nurs desks beside the patient's bed. In other means, the single corridor layout of *ICU*(2) provides appropriate patients' observation from the nurse station and minimizes the nurses' walking distance to patients significantly.

Thus, nurses could interfere with patients quickly and observe them continuously all day.

According to the technological and medical services in *ICU*s, patients need more space to achieve *visual and physical accessibility* by staff. One of the advantages of *ICU* (2) is to provide enough space for each patient, approximately 24 $m^2$. Also, using transparent materials in *ICU*s enhances patients' constant observation, such as windows or transparent walls between patients. Using curtains between patients in this *ICU* could be a disadvantage that could decrease patients' *visual accessibility*.

Table 4.2 Advantages and disavantages of *ICU* (2) (By the researcher)

| **ICU (2)** | | | | |
|---|---|---|---|---|
| **Architectural characteristics** | | | **Advantages** | **Disadvantages** |
| **Layout** | | The single corridor layout | Providing high visual and physical accessibility to patients | ----------------------- |
| **Architectural space** | **Patient space** | Involving multi-bedrooms for five patients | Providing enough space for accessibility to patients | ----------------------- |
| | **Staff space** | One nurse station & four small nurse desks | Providing high accessibility to patients by placing nurse station near the patients' bed | ----------------------- |
| **Other characteristics** | **Life support system** | Headwall system | Providing low cost system | Providing low flexibility in bed position |
| | **Materials** | Using curtains between patients | Providing privacy for patients | Decreasing the visual accessibility to patients |

In summary, two *ICU*s located in Ian and Finland were observed, and fieldnote of observations was reported as discussed in the previous part. As regards to findings, one of the essential contributions of observations was to clarify the *visual and physical accessibility* to patients in two kinds of *ICU*s with a different layout. Also, findings of observation evaluated to disclose the advantages and disadvantages of each *ICU* to provide the *visual and physical accessibility* to patients. Another vital contribution of observations was employing the fieldnotes as the supplementary data to design the interview questions in the following part of the methodology.

## 4.2 *Systematic Review*: The *visual and physical accessibility* features in *ICU*s to increase *patients' safety* and *staff efficiency*

This part of the study aimed to show how the *EBD* approach helps architects disclose the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*s. As mentioned in chapter one, over the medical and technical improvements, care facilities and technologies have improved and occupied more space in *ICU*s. Designing settings can impact users' behavior in different ways (Wakefield & Blodgett, 1996). Among different features within *ICU*s, the *visual and physical accessibility* between patients and staff is the essential factor for supplying an environment that increases caring quality and assists patients to be safe (Frampton & Guastello, 2010; France et al., 2005; Stichler, 2011). Patients and staff require well-organized *ICU*s*'* environments without barriers to their interactions and constant patient control (Stichler, 2010). In this way, instant access and observing patients are significant demands in the *ICU*s (Becker, 2007; Trzpuc, 2010). Accessibility means the state of being able to see and access physically to patients. *Visual accessibility* relates to the patients' line of sight; in other words, how they could be seen by staff (Peponis, Ross, & Rashid, 1997; Rashid & Zimring, 2003; Rashid et al., 2009; Rashid, 2009).

Considering of the patients and staff demands in the design process of *ICU* is commonly a critical reason to enhance *the patients' safety* and *staff efficiency* (Cama, 2009; Devlin & Arneill, 2003; Dijkstra et al., 2006; Frampton & Guastello, 2010; Lawson, 2010; McCullough, 2010; Stichler, 2011; Verderber, 2010; Ullán et al., 2012). As mentioned in chapter one, there is various credible research evidence related to the accessibility features in *ICU* in various domains of disciplines rather than architecture. As mentioned in chapter three, *SR* is precisely a kind of research with scheduled methods and processes to search and extract the most literature related to research subject regarding specified inclusion and exclusion criteria. *SR* of *visual and physical accessibility* features in *ICU*s can help architects to design a safe and efficient *ICU*s environment. In this part, the researcher gathered available credible research evidence about the *visual and physical accessibility* features in *ICU*s by *SR*.

*SR* integrates the findings of primary studies by utilizing approaches to decrease prejudice and accidental errors. These approaches involve the comprehensive search of all related literature and reproducible criteria in the selection of literature. As seen in Figure 4.13, the researcher employed four essential steps to conduct this *SR*.

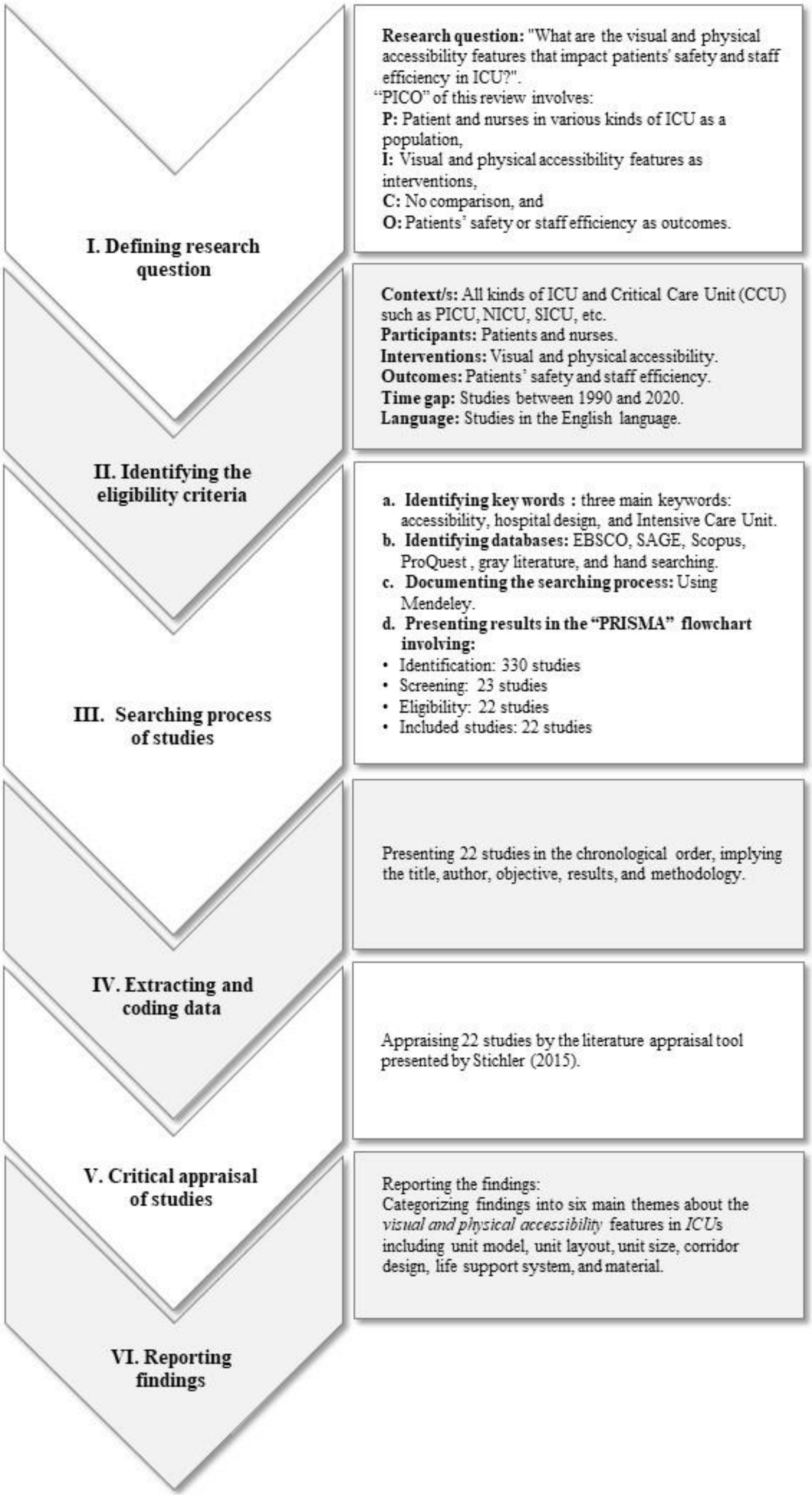


Figure 4.13. Systematic review process (By the researcher)

### 4.2.1 Defining review question

Defining the review question is the significant stage in conducting *SR* that makes the review process more useful. As mentioned in chapter three, resarch question wit reagrding the aim of the review explained in this study. To investigating and enclosign the accessibility features in review, we have to clarify the question very precisely. As mentioned in chapter three, the *SR* qustion was design based on the PICO [31] as follows:

Table 4.3 Parameters of "PICO" (By the researcher)

| Population (P) | Intervention (I) | Comparison (C) | Outcome (O) |
|---|---|---|---|
| Patient and nurses in various kinds of ICU | Visual accessibility & Physical accessibility | No comparison | Patient's safety and staff efficiency |

Population (P): This *SR* aimed to find the *visual and physical accessibility* features in *ICU*s. These features generally impact the users in *ICU*s, especially patients and nurses. In this way, patients and nurses were selected as a population parameter of the research question in this *SR*.

Intervention (I): The *SR* aimed to disclose the accessibility features that impact patients and nurses in *ICU*s. For this reason, *visual and physical accessibility* was defined as the intervention parameter in the research question.

Comparison (C): According to the *SR'*s aim, there is not any comparison in this *SR*. Thus, the comparison parameter did not consider in the definition of the research question.

Outcomes (O): *Patients' safety* and *staff efficiency* were considered as outcomes in the definition of the research question. As mentioned earlier, accessibility features in *ICU* could impact on the *patients' safety* and *staff efficiency*.

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[31] See chapter three, part (3.3)

Acoridng to described PICO parameters, the question of this systematic review was defined as follows: "What are the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*?". After defining the review quetion, the following part was clarified the criteria to improve the eligibility of the *SR*.

### 4.2.2 Identifying the eligibility criteria

According to the *SR* question, the researcher specified included and excluded factors and used them in the eligibility accessing process. One of the eligibility factors in the current *SR* was the context of the studies. Concerning the *SR* question, all kinds of *ICU* and Critical Care Unit (CCU) such as PICU, NICU, and SICU were included in the current *SR*. Almost, the patients and nurses of *ICU*s were included as participants in *SR*. The interventions and outcomes were also considered as eligibility criteria. In this way, *ICU*s' v*isual and physical accessibility* features were considered an intervention in *ICU* to provide the *Patients' safety* and *staff efficiency*. Almost the searching date of studies was specified between 1984 and 2020. All studies in the English language were included in the current *SR*.

### 4.2.3 Searching process of studies

The searching process involved four fundamental stages that each step defined in detail as follows:

**a. Identifying Key words**

Regarding included and excluded factors, a searching process of the *SR* was conducted by the researcher and one reviewer in two main steps. Firstly, we clarified keywords to start the searching process. For this reason, groups of keywords were defined and tried several times to find the relevant studies related to the *visual and physical accessibility* features in *ICU*s. Finally, we finalized a combination of the three main keywords: accessibility, hospital design, and *Intensive Care Unit*.

As shown in Figure 4.14, each main keyword was involved in some synonym words. We achieved the mentioned synonym word from the *ICU*'s accessibility definition and keywords of relevant studies to *ICUs*' accessibility features. We considered accessibility to be the main keyword with seven synonyms included access, *physical accessibility*, visibility, visual access, circulation, communication, and physical communication. Also, hospital design was considered the main keyword with four synonyms: healthcare architecture, hospital design, healthcare facility design, and healthcare facility architecture. Additionally, the *intensive care unit* was considered the main keyword with three synonyms: critical care unit, critical care, intensive care, *ICU*, and CCU.

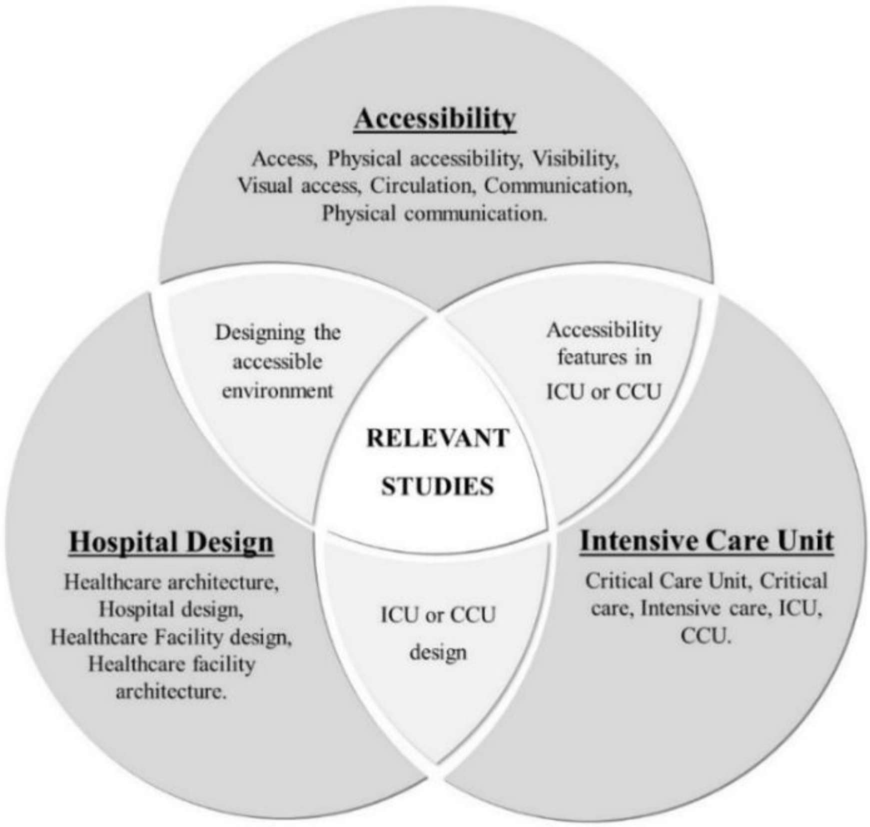


Figure 4.14. Keywords of the searching process (By the researcher)

To narrow or broaden the achieved results, we utilized Boolean operators of "AND" among the three keywords and Boolean operators of "OR" among synonyms keywords to integrate keywords. Figure 4.15 shows three main groups of keywords that were specified related to accessibility, hospital design, and intensive care unit.

Each group of keywords was included in synonym words combined with “OR” to broaden the search results. For instance, the six synonym words of intensive care units were combined  CCU, *ICU*, intensive care unit, critical care unit, critical care, and intensive care with “OR” to extend the relevant findings in this filed.

("CCU" OR "ICU" OR "intensive care unit" OR "critical care unit" OR “critical care” OR “intensive care”)

**AND**

(“accessibility” OR "physical accessibility" OR "visibility" OR "physical communication" OR "communication" OR "visual access" OR "physical access" OR “access” OR “visuality” OR “visible” OR “circulation” OR “accessible”)

**AND**

("healthcare design" OR "healthcare architecture" OR "healthcare design" OR "hospital design" OR "healthcare facility design" OR “healthcare facility architecture”)

Figure 4.15. Integrations of the keywords (By the researcher)

**b. Identifying data basses**

Secondly, we specified databases to search the literature, involving "EBSCO," "SAGE," "Scopus," and "ProQuest." As shown in the below tables, the advanced search option was used to add inclusion or exclusion requirements and restrict each database's results. We considered studies, including *systematic review*, quantitative studies, qualitative studies, mixed-method studies, and gray literature [32] like theses,

[32] “Gray literature can include academic papers, including theses and dissertations, research and committee reports, government reports, conference papers, and ongoing research, among others. It may provide data not found within commercially published literature, providing an important forum

conference proceedings, and reports. Hand searching also was used to find other relevant scientific researches.

**c. Documenting the seraching results**

In this stage, we employed the "Mendeley" as a Reference Manager Software to manage and save the extracted studies in the searching process. As mentioned earlier, four databases included "EBSCO," "SAGE," "Scopus," and "ProQuest" were used to search the relevant studies in current *SR*. The advance search was used in the searching part of each database to find the studies. The searching details of each database were shown in the table by specifying the database's name, access date, the advanced search of keywords, keywords, number of results.

The searching process's detail of SAGE was shown in the below table accessed on Augustus 30, 2020. The advanced search was chosen to start the searching process. In the database's advanced search, we specified keywords and the searching sources of keywords such as abstract, title, or anywhere. In this way, the *intensive care unit*'s synonym keywords were searched in the abstract parts of studies to narrow the achieved results. Also, synonym keywords of accessibility and hospital design were searched in the anywhere of results to find more relevant studies in this *SR*. A combination of specified keywords in the SAGE database was shown in the below table. As a result, 34 studies were found in this database.

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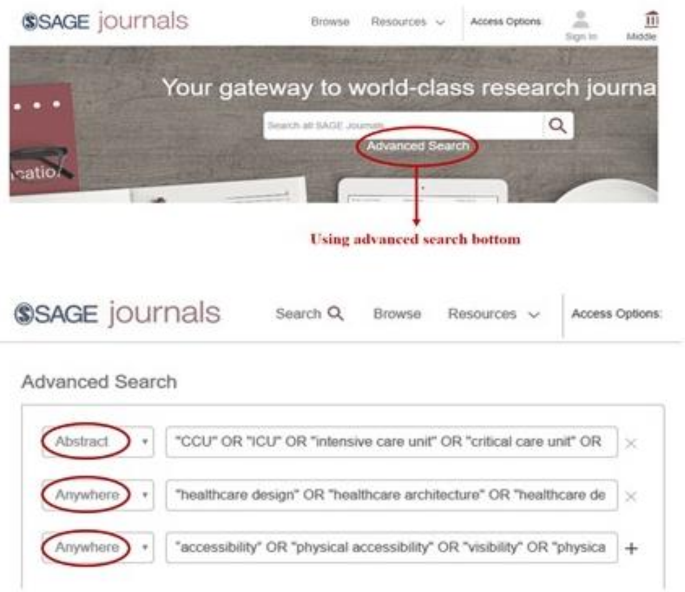
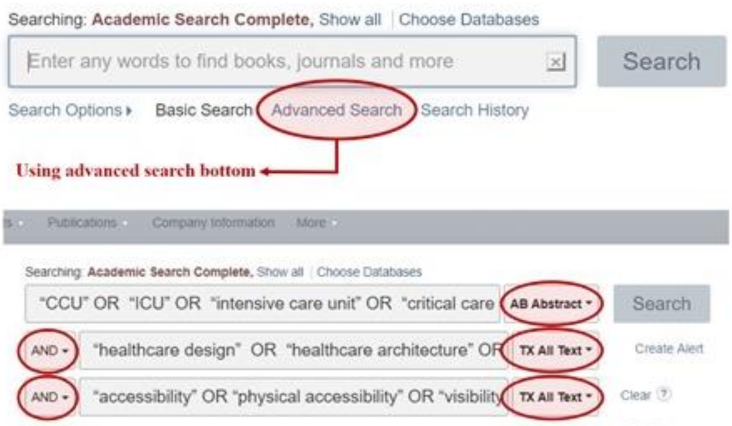
for disseminating studies with null or negative results that might not otherwise be disseminated" (Paez, 2017).

Table 4.4 Combinations of the specified keywords in “SAGE” (By the researcher)

<table>
<tr><td>Database</td><td>SAGE</td></tr>
<tr><td>Accessed date</td><td>30/08/2020</td></tr>
<tr><td>Advanced search</td><td>
</td></tr>
<tr><td>Key words</td><td>for [[Abstract "ccu"] OR [Abstract "icu"] OR [Abstract "intensive care unit"] OR [Abstract "critical care unit"] OR [Abstract "critical care"] OR [Abstract "intensive care"]] AND [[All "healthcare design"] OR [All "healthcare architecture"] OR [All "healthcare design"] OR [All "hospital design"] OR [All "healthcare facility design"] OR [All "healthcare facility architecture"]] AND [[All "accessibility"] OR [All "physical accessibility"] OR [All "visibility"] OR [All "physical communication"] OR [All "communication"] OR [All "visual access"] OR [All "physical access"] OR [All "access"] OR [All "visuality"] OR [All "visible"] OR [All "circulation"] OR [All "accessible"]]</td></tr>
<tr><td>Number of results</td><td>34 studies</td></tr>
</table>

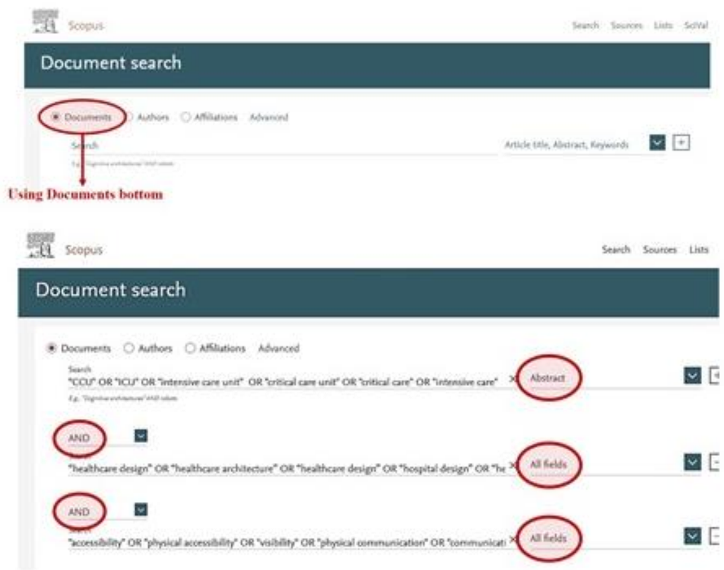
The searching process's detail of EBSCO was shown in the below table accessed on Augustus 30, 2020. The advanced search was chosen to start the searching process. In the database's advanced search, we specified keywords and the searching sources of keywords such as abstract, title, or anywhere. In this way, the *intensive care unit*'s synonym keywords were searched in the abstract parts of studies to narrow the achieved results. Also, synonym keywords of accessibility and hospital design were searched in the full text of results to find more relevant studies in this *SR*. A combination of specified keywords in the EBSCO database was shown in the below table. As a result, 78 studies were found in this database.

Table 4.5 Combinations of the specified keywords in “EBSCO” (By the researcher)

| | |
|---|---|
| **Database** | EBSCO |
| **Accessed date** | 30/08/2020 |
| **Advanced search** |  |
| **Key words** | AB ( "CCU" OR "ICU" OR "intensive care unit" OR "critical care unit" OR “critical care” OR “intensive care” ) AND TX ( "healthcare design" OR "healthcare architecture" OR "healthcare design" OR "hospital design" OR "healthcare facility design" OR “healthcare facility architecture” ) AND TX ( “accessibility” OR "physical accessibility" OR "visibility" OR "physical communication" OR "communication" OR "visual access" OR "physical access" OR “access” OR “visuality” OR “visible” OR “circulation” OR “accessible” ) |
| **Number of results** | 78 studies |

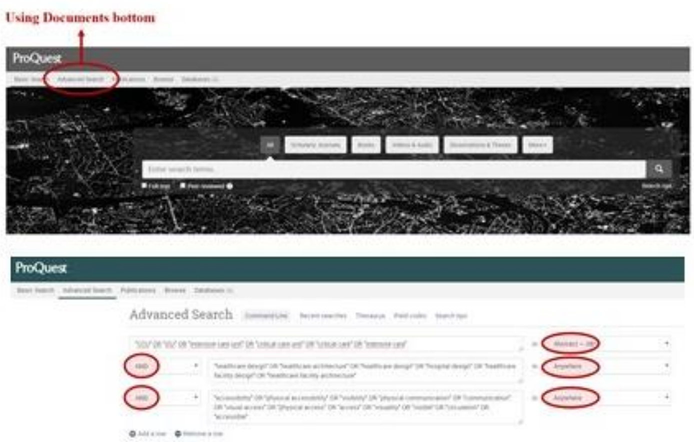
Also, the searching process's detail of Scopus was shown in the below table accessed on Augustus 30, 2020. The advanced search was chosen to start the searching process. In the database's advanced search, we specified keywords and the searching sources of keywords such as abstract, title, or anywhere. In this way, the *intensive care unit*'s synonym keywords were searched in the abstract parts of studies to narrow the achieved results. Also, synonym keywords of accessibility and hospital design were searched in all fields of results to find more relevant studies in this *SR*. A combination of specified keywords in the Scopus database was shown in the below table. As a result, 189 studies were found in this database.

Table 4.6 Combinations of the specified keywords in "Scopus" (By the researcher)

| | |
|---|---|
| **Database** | Scopus |
| **Accessed date** | 30/08/2020 |
| **Advanced search** |   |
| **Key words** | ( ABS ( "CCU" OR "ICU" OR "intensive care unit" OR "critical care unit" OR "critical care" OR "intensive care" ) AND ALL ( "healthcare design" OR "healthcare architecture" OR "healthcare design" OR "hospital design" OR "healthcare facility design" OR "healthcare facility architecture" ) AND ALL ( "accessibility" OR "physical accessibility" OR "visibility" OR "physical communication" OR "communication" OR "visual access" OR "physical access" OR "access" OR "visuality" OR "visible" OR "circulation" OR "accessible" ) ) AND PUBYEAR > 1983 AND PUBYEAR < 2020 AND ( LIMIT-TO ( LANGUAGE , "English" ) ) |
| **Number of results** | 189 studies |

Finally, the searching process's detail of ProQuest was shown in the below table accessed on Augustus 30, 2020. The advanced search was chosen to start the searching process. In the database's advanced search, we specified keywords and the searching sources of keywords such as abstract, title, or anywhere. In this way, the *intensive care unit*'s synonym keywords were searched in the abstract parts of studies to narrow the achieved results. Also, synonym keywords of accessibility and hospital design were searched in anywhere of results to find more relevant studies in this *SR*. A combination of specified keywords in the ProQuest database was shown in the below table. As a result, 70 studies were found in this database.

Table 4.7 Combinations of the specified keywords in "ProQuest" (By the researcher)

| | |
|---|---|
| **Database** | ProQuest |
| **Accessed date** | 30/08/2020 |
| **Advanced search** |   |
| **Key words** | ab("CCU" OR "ICU" OR "intensive care unit" OR "critical care unit" OR "critical care" OR "intensive care") AND ("healthcare design" OR "healthcare architecture" OR "healthcare design" OR "hospital design" OR "healthcare facility design" OR "healthcare facility architecture") AND ("accessibility" OR "physical accessibility" OR "visibility" OR "physical communication" OR "communication" OR "visual access" OR "physical access" OR "access" OR "visuality" OR "visible" OR "circulation" OR "accessible") |
| **Number of results** | 70 studies |

**d. Presenting results in the "PRISMA" flowchart**

Finally, results were presented in the "PRISMA"[33] to depict the flow of data through the four different steps and outline the number of identified, included, and excluded results (Figure 4.16).

**Identification:** In this step, we identified 340 studies by electronic searching and imported them into the Mendeley. Bibliography and references of identified studies manually were reviewed for further sources. As a result, we found three studies and imported them into Mendeley. After duplicating achieved studies in the Mendeley, 330 studies resulted in this step. As mentioned earlier, the searching details of SAGE, EBSCO, Scopus, and ProQuest were shown in detail, such as the accessed date, the combinations of keywords, and the number of results.

**Screening:** After identification step, we screened titles and abstracts of extracted studies with regards to the eligibility criteria and research question (PICO). Then, we discussed our disagreements about the resulted studies through the first-screening process to meet an agreement. After the discussion, we excluded 305 studies and reported 23 studies as a result of this step.

**Eligibility:** Then, we screened full texts of achieved 23 studies for the second time based on the eligibility criteria and PICO as employed in the first- screening process. One of studies was excluded in this process.

**Included studies:** Finally, 22 studies were reported in the PRISMA flowchart as included studies.

[33] Retrieved August 06, 2019, from, http://prisma-statement.org/PRISMAStatement/FlowDiagram

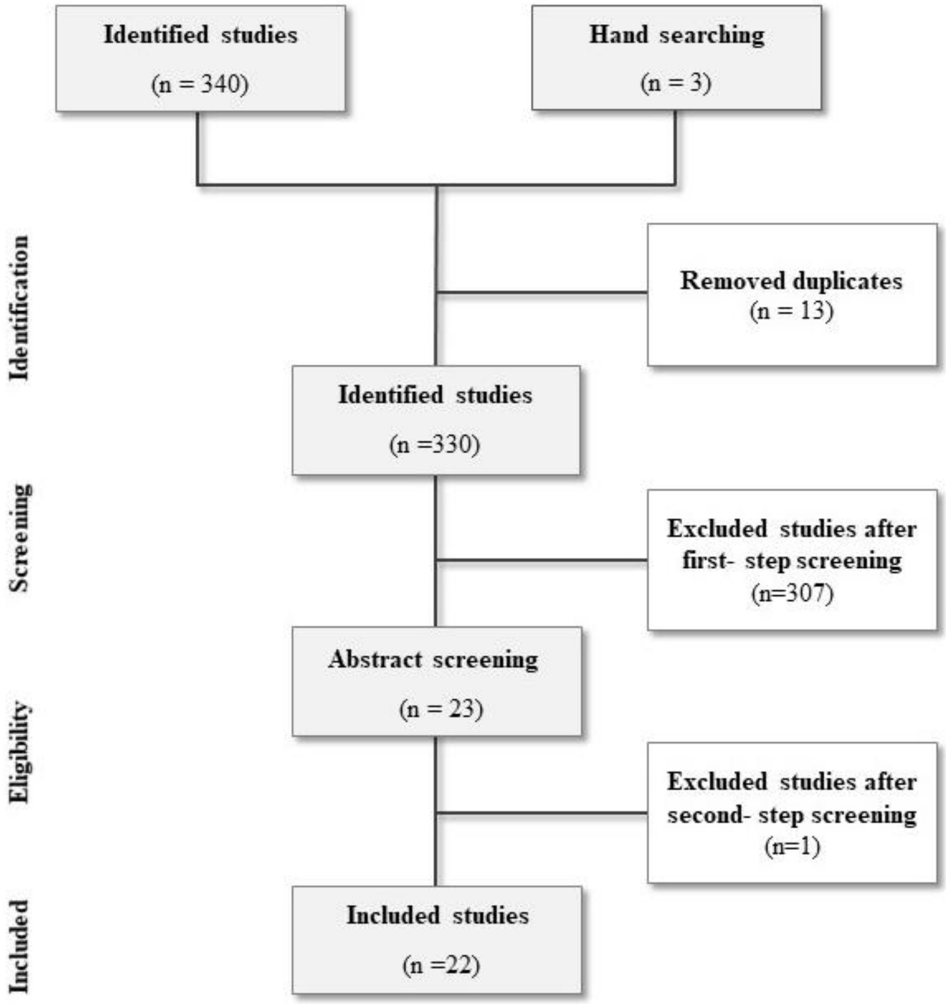



Figure 4.16. PRISMA flowchart of the systematic review (By the researcher)

### 4.2.4 Extracting data

As shown in the below tables, the researcher presented descriptive characteristics of 22 studies in chronological order, including the title, author, objective, results, and methodology. This table assisted in assessing the validity of the included studies in the following part of *SR*.

Table 4.8 Extracted data (By the researcher)

| PAPER NO | STUDY | AUTHOR/ DATE | RESEARCH OBJECTIVE/S | RESULTS | METHOD |
|---|---|---|---|---|---|
| 1 | A Decade of Adult Intensive Care Unit Design A Study of the Physical Design Features of the Best-Practice Examples. | Rashid, M./ 2006 | - Identifying important physical design features of some of the best practice example ICUs in the United States.<br>- Explaining the general patterns and the advantages and disadvantages of these design features. | Patient safety & Staff efficiency | Report |
| 2 | Room for improvement: nurses' perceptions of providing care in a single room newborn intensive care setting. | Walsh, W. F., McCullough, K. L., & White, R. D./ 2006 | Presenting data from a quality improvement effort, aimed at a post-hoc evaluation of the nurses' perceptions of the impact of single-room patient NICU design on caregiving, safety, and communication. | Patient safety | Qualitative study |
| 3 | Influence of nursing unit layout on staff communication and interaction patterns. | Dutta, R./ 2008 | Comparing three configurations of nursing unit—radial, single-corridor, and double-corridor—and examining their effects on nursing staff behavior and nurses' subjective feelings in a 570-bed hospital building. | Patient safety & Staff efficiency | Quantitative study (Thesis) |
| 4 | The Design of Adult Acute Care Units in U.S. Hospitals. | Catrambone, C., Johnson, M. E., Mion, L. C., & Minnick, A. F/ 2009 | Describing the current state of design characteristics determined to be desirable by the Agency for Health Research and Quality (AHRQ) in U.S. adult medical, surgical, and intensive care units (ICUs). | Patient safety & Staff efficiency | Quantitative study |
| 5 | Design for Critical Care: Impact of the ICU. | Hamilton, K/ 2010 | Reporting impact of the ICU. | Patient safety | Report |
| 6 | Relationship Between ICU Design and Mortality. | Leaf, D. E., Homel, P., & Factor, P. H./ 2010 | Determining whether patient visibility correlates with mortality and/or various secondary clinical outcomes. | Patient safety | Quantitative study |
| 7 | The Role of Design in Communication, Interaction and Teamwork. | Harale, K/ 2010 | Examining the relationship between physical design and communication in healthcare delivery. | Patient safety | Quantitative study (Thesis) |
| 8 | Critical Communication: Observing How ICU Environments Impact Nurse Communication. | Newcomb, E. M. D./ 2011 | Understanding of how the physical design of Intensive Care Unit (ICU) environments may be improved to enhance nursing communication, and in turn, the quality and safety of patient outcomes. | Patient safety & Staff efficiency | Qualitative study (Thesis) |

Table 4.9 Extracted data (By the researcher)

| PAPER NO | STUDY | AUTHOR/ DATE | RESEARCH OBJECTIVE/S | RESULT | METHOD |
|---|---|---|---|---|---|
| 9 | Impact of Hospital Unit Design for Patient-Centered Care on Nurses' Behavior | Seo, H. B., Choi, Y. S., & Zimring, C. /2011 | Comparing large and small units to find the effect of unit design on nurses' walking distance and trip patterns when they walk to obtain patient medications. | Staff efficiency | Quantitative study |
| 10 | Can intensive care staff see their patients? An improved visibility analysis methodology. | Lu, Y., & Zimring, C./ 2012 | Studying the spatial properties of environments to which habitual users are attuned. First, we propose a refinement to the standard analysis of visual fields. The refined visibility analysis, named targeted visibility here, focuses on preselected targets and asks how many of them are visible from each occupiable location. In our case, the targets are patient beds in the unit. Second, with the help of new visibility analysis, we want to understand how intensive-care staff tune their behavior based on the visibility pattern in the setting. | Patient safety & Staff efficiency | Quantitative study |
| 11 | Recommended standards for newborn ICU design, eighth edition | White, R. D., Smith, J. A., & Shepley, M. M./ 2013 | Recommending Standards for Newborn ICU Design. | Patient safety & Staff efficiency | Report |
| 12 | A Comparative Evaluation of Swedish Intensive Care Patient Rooms. | Apple, M/ 2014 | Investigating the effects of design decisions made in the three selected ICU projects, providing timely design feedback in light of the increasing demand for ICU beds and the transition to single-bed rooms. | Staff efficiency | Qualitative study |
| 13 | Creating spaces in intensive care for safe communication: a video reflexive ethnographic study. | Hor, S. Y., Iedema, R., & Manias, E./ 2014 | Reporting on an interventionist video reflexive ethnographic (VRE) study that explored how clinicians used the built environment to achieve safe communication in an intensive care unit (ICU) in a metropolitan Sydney hospital. | Patient safety | Qualitative study |
| 14 | Evidence-based design in an intensive care unit: End-user perceptions. | Ferri, M., Zygun, D. A., Harrison, A., & Stelfox, H. T. / 2015 | Describing end-user impressions and experiences in a new intensive care unit built using evidence-based design. | Patient safety & staff efficiency | Qualitative study |
| 15 | Nurses' Interaction in Two Midwest Single-Patient Room Designed Neonatal Intensive Care Units. | Boyle, A./ 2015 | Understanding nurses' interactions with one another in two small-sized single-patient room (SPR) designed neonatal intensive care units (NICU). | Patient safety | Qualitative study (Thesis) |

Table 4.10 Extracted data (By the researcher)

| PAPER NO | STUDY | AUTHOR/ DATE | RESEARCH OBJECTIVE/S | RESULT | METHOD |
|---|---|---|---|---|---|
| 16 | Design to Improve Visibility: Impact of Corridor Width and Unit Shape. | Hadi, K., & Zimring, C/ 2016 | Analyzing 10 intensive care units (ICUs) to understand the associations between design features of space layout and nurse-to-patient visibility parameters. | Patient safety & Staff efficiency | Quantitative study |
| 17 | Physical and Visual Accessibilities in Intensive Care Units A Comparative Study of Open-Plan and Racetrack Units. | Rashid, M., Khan, N., & Jones, B./ 2016 | Comparing physical and visual accessibilities and their associations with staff perception and interaction behaviors in 2 intensive care units (ICUs) with open-plan and racetrack layouts. | Patient safety | Quantitative study |
| 18 | Is ICU Safety Threatened by the Straight Corridor? | Hamilton, D. K. / 2017 | Reporting one experienced critical care nurse that patients could be harmed because nurses can't see or hear each other's need for help. | Patient safety | Report |
| 19 | Navigating the Patient Room: Critical Care Nurses' Interaction with the Designed Physical Environment. | Hamilton, D. K./ 2017 | Exploring and understand the way critical care nurses navigate within the patient room and interact with its features. | Patient safety & Staff efficiency | Qualitative study (Thesis) |
| 20 | Evaluating Nurses' Perception of Patient Safety Design Features in Intensive Care Units. | Islam, F., & Rashid, M./ 2018 | Exploring the relationships of nurses' perceptions of ICU designs and specific patient safety scales. | Patient safety | Quantitative study |
| 21 | Safety and Security Concerns of Nurses Working in the Intensive Care Unit. | Keys, Y., & Stichler, J. F/ 2018 | Exploring nurses' perceptions of their own safety and security in the ICU environment. Understanding nurses' perceptions of design features that would enhance their feelings of safety and security for themselves and their patients. | Patient safety | Qualitative study |
| 22 | Neonatal Nurses' Work in a Single Family Room NICU | Doede, M./ 2019 | Understanding how single-family room layout impacts nurses work. | Patient safety & Staff efficiency | Qualitative study (Thesis) |

### 4.2.5 Critical appraisal of the studies

After extracting data, we critically appraised twenty-two studies based on the literature appraisal tool (Stichler, 2015) implied in chapter three. Almost the evidence level and evidence quality were appraised based on the evidence level and evidence quality presented by Stichler (2010). As a whole, all of them achieved studies that were considered as evidence in the current *SR* to disclose the accessibility features in *ICU*s. Most of them were conducted by qualitative methodologies (such as observation and interview methods) and quantitative methodologies (such as survey, questionnaire, and observation methods). Regarding the aim of studies, nine studies examined accessibility features in *ICU*s, ten studies evaluated the effects of *ICU*s' design on users, and three studies identified the physical design features of *ICU*s.

#### 4.2.6 Findings of systematic review

Finally, the researcher reported a comprehensive overview of the findings. Due to inadequate numerical data and heterogeneity of gathered studies, a meta-analysis [34] was not conducted in the current *SR*. For this purpose, the discussion and findings parts of the included studies were reviewed by researchers, and the texts related to the *visual and physical features* were extracted. Extracted texts were presented in the tables involving paper number, page number, architectural feature, and related text.

As seen in the below table, the extracted findings of studies were summarized. Firstly, the study's number was mentioned, and the page number of extracted data as specified in the next part. The architectural feature was related to the *ICU*'s accessibility features, considering the relevant study's extracted data. Finally, the extracted data related to the accessibility features were mentioned in the table. For instance, pod or cluster layout was extracted from the paper (1) as the *ICU*'s accessibility feature. As stated in paper (1), "designers use multiple pods in an attempt to improve patient-staff visibility and to take services closer to patients. The spatial, social, and behavioral implications of a multiple-pod *ICU* layout are yet to be studied, but some observations follow." In this way, all of the extracted findings

[34] See chapter three

from twenty-two studies were presented in tables to categorize the accessibility features in themes and sub-themes.

Table 4.11 Example of extracted texts (By the researcher)

| SYSTEMATIC REVIEW FINDINGS | | | |
|---|---|---|---|
| **Paper Number** | **Page Number** | **Architectural Feature** | **Related Text** |
| **1** | 286 | Racetrack layout | "Designers prefer the racetrack type layout because it maximizes the perimeter wall of a unit. As a result, more patient rooms can have natural light and outdoor views. Arguably, this type of layout also reduces the nurse's walking distance, an issue that needs further investigation. In addition, a racetrack type layout with beds around a central service core seems to be a very logical pattern to achieve a workable visual module where nurses and patients are able to see each other." |
| | 286 | Pod or cluster layout | "Of course, in most best-practice ICUs, designers use multiple pods in an attempt to improve patient-staff visibility and to take services closer to patients. The spatial, social, and behavioral implications of a multiple-pod ICU layout are yet to be studied, but some observations follow." |
| | 292 | Headwall system | "Traditionally, these devices have been clustered on a vertical surface at the head end of the patient bed, known as the headwall (Fig 8). Headwalls require patient beds to be put against the wall, thereby restricting movement and access to the patient's head." |
| | 294 | Power column system | "The power column requires very little space, and allows 360◦ degree access to the patient." |
| | 294 | Ceiling-mounted Boom system | "A more recent trend is to have a ceiling-mounted, articulating arm with all gas and electrical outlets and monitors, known as a "boom". As the patient care space gets larger and the desire for flexibility within the space increases, the ceiling boom offers the desired flexibility to caregivers by allowing support services to be placed at a variety of locations around the patient. However, booms are very costly." |
| | 295 | Glass door of rooms | "ICU designers prefer breakaway glass doors, as they can be closed for privacy, noise reduction, and infection control purposes while maintaining maximum visibility of patients and monitors." |
| **2** | 269 | Pod or cluster layout | "In an ideal NICU design both the visibility and contact between the nursing and medical teams could be improved by placing the nursing station and the physician work area adjacent to the patient rooms. A potential configuration would be a pinwheel design with 10 to 12 rooms around the periphery of a physician nurse work area." |
| **3** | 59 | Transparent wall between a room and a corridor | "The alcove work stations that were designed to allow the nurse to perform charting activities without disturbing the patient while keeping an eye on him or her through a window outside the patient rooms were also among the areas that had few interactions." |
| | 66 | Decentralized unit | "Decentralized pods maximizes visual access, but slight other goals and benefits." |

As mentioned in the last part, the researcher reviewed all the findings of gathered studies to extract the *ICU*'s *visual and physical accessibility* features. After that, the gathered findings related to the accessibility features were grouped in the categories to present as themes and sub-themes. Almost categorizing the studies' findings was conducted by considering *ICU*s' architectural characteristics referred to in chapter two. As seen in the below figure, findings were categorized into six main themes about the *visual and physical accessibility* features in *ICU*s included unit model, unit layout, unit size, corridor design, life support system, and material.

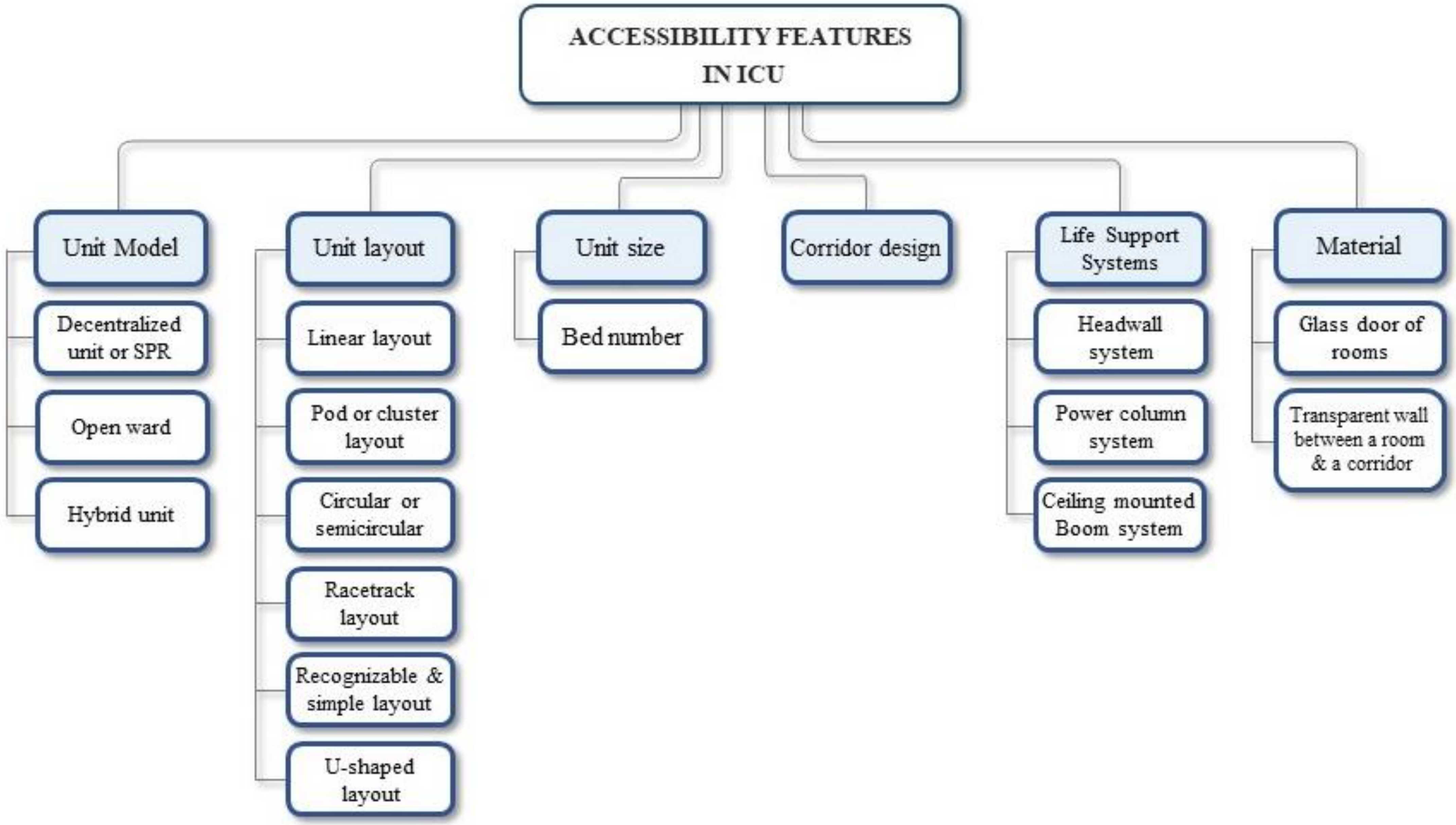



Figure 4.17. The accessibility features in *ICU*s (By the researcher)

According to the presented framework of the accessibility features in *ICU*s, the researcher explained each theme and sub-theme by referring to some direct quotations from studies as follows:

**a. Unit model**

The unit model was reported as an accessibility feature in *ICU*s with three main sub-themes involving an open ward, a decentralized unit, and a hybrid unit.

**Open ward:** This unit model places a nurse station in the center or beside the unit with multi- bedrooms. One of the studies explained the positive effects of an open ward in terms of the *visual and physical accessibly* to patients in comparison with a racetrack layout and stated,

> the open-plan *ICU* provides better physical and visual accessibilities than the racetrack *ICU*, as we have found before, it makes sense that the number of clinicians who know the locations of their peers is higher in the open-plan *ICU* than racetrack *ICU* (Rashid et al., 2016, p.325).

On the other hand, some studies implied the negative effect of an open ward in *ICU*. Hor et al.  (2014) stated that the unit's openness could be a risk factor for *patients' safety*. This openness could provide the interruptions and distractions that impeded nurses' concentration and caused mistakes and frustration.

**Decentralized unit or SPR:** According to the findings, many studies discussed the advantages and disadvantages of a decentralized unit in *ICU*s. For instance, Hamilton et al. (2018) implied, "The concept of decentralized unit design is intended to improve *patients' safety* by the proximity of outside of two rooms the nurse to the patient" (p.7). The decentralized unit involves charting alcoves to enhance the visibility of a pair of rooms and accessibility to the patient (Boyle, 2015; Dutta, 2008; Hamilton, 2017; Hamilton et al., 2018).

On the other hand, Doede (2019) explained the disadvantage of single- room design in NICU and stated, "While single-family room NICUs provide definite advantages over open bay layouts for infants, families, and nurses, their impact on nurses' work is complex and connected to overall gains in privacy and losses in visibility and proximity" (p.117).

**Hybrid unit**: The researcher found two studies in this review that were implied to hybrid *ICU* that is a mixture of the centralized and decentralized unit model in *ICU*s. One of the studies depicted the benefit of a hybrid unit to provide a flexible work environment for nurses in *ICU*s and explained,

> the mix between central and de-centralized nurse stations allowed nurses to select a space that worked best for their needs or tasks that nurses need to accomplish. The two types of nurse stations facilitated both individual and group work occurring simultaneously and offered nurses the kind of work environment flexibility that is required in *ICU*s (Newcomb, 2011, p. 95).

Almost, another study explained the positive impacts of a sliding door between two rooms in a hybrid unit to provide an efficient observation of patients (Apple, 2014).

**b. Unit layout**

The unit layout that specifies organizations of spaces and connections between different spaces inside units was found as an accessibility feature in *ICU*s. The findings of this review showed that the unit layout could be considered in *ICU*s to provide the *patients' safety* and *staff efficiency*. For instance, Hamilton (2017) stated, "unit designs should support nurses by configurations that minimize travel distance and time to supply and medication rooms" (p. 309). One study explained the importance of a unit layout on *visual and physical accessibility* to patients and stated,

> designing unit layouts that are repeatedly broken down into smaller convex spaces (higher convex fragmentation values) or designing units which have longer distances between their rooms or between their two ends (longer relative grid distances) might result in lower visibility levels across the unit compared to units with lower convex fragmentation values or shorter relative grid distances (Hadi & Zimring, 2016, p.47).

The researcher found some kinds of *ICU*'s layout that authors investigated their impacts on the *patients' safety* and *staff efficiency* in *ICU*, including:

**Recognizable and simple layout:** According to Hamilton (2010), the recognizable and simple layout could provide *physical accessibility* to patients. He stated that a unit layout should be designed in recognizable, simple, and compact shapes. These kinds of unit layout provide equipment and medications close to the staff.

**Linear layou**t: According to the findings of this review, a linear layout is a kind of *ICU* layout that can provide access to the medications, supplies, and equipment in the care process.

**Circular layout:** This layout includes the central nurse station that is surrounded by rooms is the substantial characteristic of the radial unit. Circular or semicircle units provide access to supplies and medications in the care (Hamilton, 2010). One study investigated the perspective of nurses about the *ICU*s' design features and implied, "Circular or "U"- shaped units preferred to enhance visibility" (Keys & Stichler, 2018, p.70).

**U-shaped layout:** Regard the findings of this review; the researcher found one study that examined nurses' or other care providers' perspectives about the design features in *ICU*s. This study asserted that U-shaped units could enhance visual access to patients (Keys & Stichler, 2018).

**Racetrack layout:** Racetrack or double corridor layout that suits more patients inside a unit without enhancing the nurses' walking distance was mentioned as the most common layout among various *ICU* layouts because of the high visibility to patients. According to Leaf et al. (2010), "this design maximizes the perimeter wall of a unit, allowing more rooms to have natural light, and also increases visibility from a central location" (p.1026). Also, Rashid (2006) implied that this layout could reduce the walking distance of nurses by locating the patient beds around the central nurse station.

**Pod or cluster layout:** This layout clusters patients into the small subunits and places a service area in the core of the unit. According to Boyle (2015), “pod/cluster style can be the most effective configuration for the NICU, supporting patient, family and provider needs” (p.67). Rashid (2008) also stated that designers attempt to employ a cluster design to improve visibility to patinates and put services near the patients. On the other hand, the cluster layout enhances walking distance of staff and decreases the teamwork inside *ICU*s (Ferri et al., 2015).

**c. Unit size**

The unit size was determined as an accessibility feature in *ICU*s defined based on the bed number in *ICU*s. Ferri et al. (2015) emphasized that users made positive and negative comments about the unit size. For instance, some mentioned the challenge of large units resulting in greater walking distances between patients and staff.

**Bed number:** Hamilton (2010) explained that large units with more than nine beds could not provide suitable visibility to patients. He suggested that large units should be broken into clusters with seven or eight beds. According to Dutta (2008),

> A "multi hub" approach in which each central station serves a cluster of not more than 6-8 rooms, with that model being replicated for larger units, duplicates some equipment and space; however, it also works on many levels since it reduces walking distances, provides high visual access to patient rooms, and serves as a communication node (p.67).

**d. Corridor design**

According to findings, there is a relation between a corridor width and accessibility to patients in *ICU*s. Hadi & Zimring (2016) stated, "This correlation suggests that wider corridors provide better opportunities for nurse-to-patient visibility" (p.47). Hamilton (2018) also stated that many problems in decentralized units sometimes are related to the corridor width. Almost White et al. (2013) recommended that the corridor's width in an open ward NICU should allow smooth movement of equipment besides the infants.

**e. Life support system**

Life support systems in *ICU*s impact the arrangement of a patient room, unit layout, and nurses' work environment (Islam & Rashid, 2018). In this review, three kinds of these systems were determined as follows:

**Headwall system:** This system generally restricts access and movement to patients' heads by putting patient beds against the wall (Islam & Rashid, 2018).

**Power column system:** Rashid (2006) reported that the design characteristics *ICU*s between 1993 and 2003 and stated that the power column system needs little space and provides 360-degree physical access to the patient.

**Ceiling- mounted boom system:** This system consists of ceiling-mounted arms and monitors mounted from the ceiling. Rashid (2006) explained that this system offers high flexibility to staff in movement and *physical accessibility* to patients by placing services on locations around the patient. As a result, this system needs a larger space of a room.

**f. Material:** According to findings, some elements of the patient room should be designed with transparent materials. Opaque materials may impede *visual accessibility* between patients and staff.

**Glass door of rooms*:*** According to Rashid (2006), "*ICU* designers prefer breakaway glass doors, as they can be closed for privacy, noise reduction, and infection control purposes while maintaining maximum visibility of patients and monitors" (p. 295). Keys & Stichler (2018) investigated the design features in *ICU*s to enhance safety, and they found glass breakaway doors improves the visibility to patients. Hadi & Zimring (2016) analyzed *ICU*s to understand the relations between design features of layout and visibility parameters and stated big windows and glass breakaway doors provide excellent visibility to patients

As a whole, credible research evidence about the accessibility features in *ICU*s was gathered through the rigorous process of *SR*. After appraising the quality and level of evidence, the findings of studies reported in six main themes about the *visual and physical accessibility* features in *ICU*s. The findings of studies were reported descriptively without synthesizing the studies' findings because of the heterogeneity of studies' methodologies. The gathered studies were conducted in different methodologies, such as qualitative and quantitative methodologies. In this way, the findings of studies would be reported descriptively by categorizing the themes and sub-themes.

Almost a systematic review of the study aimed to show how the *EBD* approach helps architects disclose the *visual and physical accessibility* features that impact *patients' safety* and *staff efficiency* in *ICU*s. As mentioned in chapters one and two, there are various research domains rather than an architectural field that shows the impacts of *visual and physical accessibility* features on patients and staff. Using the research findings and applying them in the decision- making process could provide a safe and efficient environment in *ICU*s. By *SR*, credible research evidence was gathered systematically in the rigorous searching process from 1984 to 2020. Gathered twenty-two studies were appraised in terms of level and quality of evidence and reported findings. After reviewing the discussion parts of twenty-two studies, the researcher reported the extracted *visual and physical accessibility* features in *ICU*s. In summary, these features were categorized into six main themes involving unit model, unit layout, unit size, corridor design, life support systems, and material.

These findings contributed to the significant scientific knowledge about the *visual and physical accessibility* features in *ICU*s that architects could employ to make more reliable decisions in the *ICU* design process. This systematic review searched the relevant literature about accessibility features in *ICU* in an explicit, rigorous, and standard process that summary of findings was discussed as follow:

According to findings, the unit model was discovered as a theme divided into three sub-themes: open ward, decentralized model, and hybrid unit. Two evidence mentioned open ward *ICU* in their findings. Hor et al. (2014) investigated *physical and visual accessibilities* and their associations with staff perception and interaction behavior in *ICU*. They described an open ward that provides openness within *ICU* by offering wide corridors or free pillars within the unit. This evidence also emphasized that the open ward facilitates connectedness and contextual awareness for staff and improves patients' *safety*. Another evidence (Rashid et al., 2016) was emphasized in the open ward *ICU* that provides better *physical and visual accessibility* than the racetrack *ICU* to provide patient safety.

Seven studies discussed the decentralized unit model in *ICU*s that affects the *visual and physical accessibility* to patients in *ICU*s. Some studies explained that the decentralized units locate staff close to patient rooms to monitor patients closely by providing an observation station between two patient rooms (Such as Boyle. 2015; Hamilton, 2017). Among findings, one of the studies mentioned to the disadvantages of the decentralized Neonatal *ICU*. Doede (2019) stated that while single-family NICUs provide definite advantages over open ward NICU for infants, families, and nurses, their impact on nurses’ work is complex and connected to overall gains in privacy and losses in visibility and proximity to patients.

Among archived studies, just one study was investigated in the hybrid unit like a modern *ICU*. A hybrid unit suggests two types of nurse stations that can facilitate nurses' individual and group work to enhance *patients' safety* and *staff efficiency*. Newcomb (2011) mentioned the physical design of *ICU* may be improved to enhance nursing communication and showed that the mix between centralized and decentralized nurse stations allows nurses to select the best space to work within a hybrid unit. Another study emphasized using the interior windows in various locations to provide visual access to patients within the patient rooms and between the rooms and the corridor in hybrid units (Apple, 2012). However, a hybrid unit generally needs more investigation about the advantage and disadvantages in *ICU*s.

The unit layout of *ICU*s was extracted from the studies' findings in the six types layout, including linear layout, pod layout, racetrack, simple layout, recognizable and simple layout, and U-shaped layout. As mentioned in studies, the linear layout provides access to the various supplies, equipment, and medications needed to deliver care in *the ICU* and enhance *patients' safety* (For example, Hamilton, 2010). One of the studies mentioned that the deepness of linear units in a decentralized model would be significant because linear units with limited visibility of nurses and enhance the safety risk of patients (Hamilton, 2017).

Related to the pod or cluster layout, some of the studies supported this layout's effectiveness in NICU because of placing the nursing station and the physician work area adjacent to the patient rooms to enhance the infant's safety (Boyle, 2015; Walsh et al. 2006). Findings showed that a potential and ideal layout in NICU would be a pod layout with clustering the rooms in 10 to 12 beds around the nurse's work area's periphery. Studies emphasized that pod layout provides both the visibility and contact between the nursing and medical teams that could be improved by placing the nursing station and the physician work area adjacent to the patient rooms.

Circular layout almost impacts *visual and physical accessibility* by providing a more significant opportunity to view every patient, and it can be preferred by designers to enhance patient safety in *ICU*s (Catrambone et al., 2009; Keys & Stichler, 2018). A racetrack layout also reduced the nurse's walking distance in *ICU*s enhance *visual accessibility* to patients by placing beds around a central nurse station and service core (Rashid, 2006; Leaf et al. 2010). As a whole, the unit layout was suggested in the recognizable layout such as simple, compact geometries with a high ratio of the external perimeter is important in *ICU* design to provide *visual and physical accessibility* to patients and access all the various supplies, equipment and medications needed in the delivery of care.

Unit size is another accessibility feature in *ICU* that was extracted from findings of studies defined based on the bed number within *ICU*. In large units, each central station should serve a cluster of not more than 6-8 rooms to reduce walking distances, provides high *visual and physical accessibility* access to patient rooms. An *ICU* larger than 8–9 beds is challenging to design with high quality of observation from a central nurse station. If larger numbers of beds are required in

*ICU*, designers should break them into pods or clusters of 7 or 8 beds, group together to form a larger unit under a central nurse station (Hamilton, 2010; Keys & Stichler, 2018).

According to the findings, corridor design also impacts *visual and physical accessibility* to patients in *ICU*. For instance, the corridor's width in an open ward should allow for easy movement of all equipment. In a decentralized *ICU*, the corridor's width should allow for two patients' simultaneous passage from the corridor, and broader corridors provide better *visual access* opportunities (Hadi, & Zimring, 2016).

Findings also reported life support systems as accessibility features in the *ICU* that dictate a patient room arrangement and layout and affect a nurses' work area. Findings reported three kinds of life support systems, including headwall, power column, ceiling-mounted boom. Headwall systems generally require patient beds to be put against the wall, restricting movement and access to the patient's head. The power column system has an advantage in high flexibility and the ability to position the bed in various locations arrayed around the column's position. The most appealing feature of the power column system is direct, continuous, unrestricted access to the critical care patient's head. Additionally, the ceiling-mounted boom offers the desired flexibility to caregivers by allowing support services to be placed at various locations around the patient.

Material as an accessibility feature was presented in two subjects, included a glass door of rooms and a transparent wall between a room and a corridor. Findings showed that designers prefer foldaway or breakaway glass doors to maintain maximum visibility to patients and monitors in *ICU*s (Keys & Stichler, 2018). In the decentralized *ICU*, the alcove workstations allow the nurse to perform charting activities without disturbing the patient while keeping an eye on them through a window outside the patient rooms.

According to the mentioned literature, the most crucial *SR* method was employed to provide credible research evidence about *ICU*'s *visual and physical* *accessibility* features. Firstly, as described in chapter five, these findings were used as a source for defining codes to analyze the gathered qualitative data thematically. Secondly, they were employed to evaluate the architects' concern about the mentioned features in *ICU* design in the following part of the discussion. In this way, *SR* was clarified that how *EBD* can help architects design a safe and efficient environment in *ICU*s.

## 4.3 Semi-structured interview: Understanding the healthcare architects' experiences about the accessibility features in *ICU*s

This part of the study aimed to understand architects' opinions and experiences about the *visual and physical accessibility* features in *ICU*s and sources of architects' knowledge in the *ICU*'s design process. According to these aims, the researcher chose a qualitative research method to understand architects' experiences and opinions in this filed. This kind of research method is beneficial to investigate and understand people's views and experiences in greater depth (Anyan, 2013; Fielding, 2012; Haq, 2015; Tong et al., 2012). In qualitative research, the data can be gathered through archival documents analysis, ethnography, focus group discussions, or unstructured interviews.

Among qualitative data collection methods, an interview was chosen as the most popular source of data collection. The interview method is based on discussing and talking, focusing on an interviewer asking questions and interviewees' answers (Kvale, 1997). It is a powerful and flexible means to obtain people's experiences and opinions about a particular subject (Kvale, 1997; Sekaran, 2003; Turner, 2010; Wilkinson & Birmingham, 2003; Yin, 2003). Compared with other data gathering tools, interviews register more accurate data relying on the research purposes and questions by feeling and seeing interviewees' gestures (Haq, 2015).

There are three kinds of interviews, including structured, unstructured, and semi-structured interviews. The structured interview usually aims to acquire information about specific facts with a designed order of questions (DiCicco-Bloom & Crabtree, 2006; Yin, 2003). In opposite the structured interview, the unstructured interview is not based on the designed order of questions (Sekaran, 2003). However, there is a specific topic in the interviewer's mind to achieve throughout the interview (Sekaran, 2003).

The semi-structured interview synthesizes the structured and unstructured interviews that ask for facts and views from interviewees (DiCicco-Bloom & Crabtree, 2006; Yin, 2003). In this kind of interview, the interviewer can peruse the order of questions throughout the interview with the freedom to modify the order, time, and wordings assigned to questions in each interview (Alshenqeeti, 2014; Collingridge & Gantt, 2008; Haq, 2015; McTat & Leffler, 2017; Polkinghorne, 2005; Rubin & Rubin, 2011). Thus, the semi-structured interview was employed to understand healthcare architects' opinions and experiences about the *ICU*'s *accessibility features* as follows:

### 4.3.1 Sampling method

An interview should standardize its procedures and criteria for the participants' election to eliminate the impacts of various variables and generalize the results (Berg & Lune, 2004; Polkinghorne, 2005). The participants should be elected regarding the questions of research and theoretical/conceptual framework of the study (Berg & Lune, 2004; Crabtree, 2006; DiCicco-Bloom & Sargeant, 2012). The selected participants must be capable of informing the main perspectives and aspects of the study's phenomenon (Berg & Lune, 2004; DiCicco-Bloom & Crabtree, 2006; Sargeant, 2012). The researcher selected participants among architects that had experience in the *ICU*s' design field by snowballing sampling method. Snowballing is adjusted when potential participants are not enough for gathering data or when it is necessary to gather more relevant data (Haq, 2015; Berg & Lune, 2004; DiCicco-Bloom & Crabtree, 2006; Sargeant, 2012).

Finding healthcare architects was a difficult task. With the snowballing sampling method, the researcher selected healthcare architects as interview participants from Turkey, Ankara (Table 4.12). The researcher attempted to contact with the introduced architects through an email (Appendix A: Participant recruitment email). In this email, participants were informed that the researcher would be in contact with an email or phone to verify the interview's scheduled time, date, and location.

Almost, the number of participants was determined in the current interview. There are no regulations for sample size in the interview (Patton, 2001). Saturation is a tool to finalize the sample size in qualitative research to ensure the participants' sufficiency of the information (Gibbins, Bhatia, Forbes, & Reid, 2014). Researchers consider a data saturation where there is enough data to repeat the study (Kwong et al., 2014; Nelson, 2017). In the current interview, the researcher achieved data saturation with ten participants when their opinions and experiences did not bring any new data about accessibility features in *ICU*.

Table 4.12 Participants of the semi-structured interview (By the researcher)

| Interview number | Date of interview | Old | Level of education | Experience | Time |
|---|---|---|---|---|---|
| 1 | 09/08/2018 | 28 | M.S Architecture | 4 years | 34 minutes |
| 2 | 09/10/2018 | 25 | B.A Architecture | 3 years | 32 minutes |
| 3 | 09/10/2018 | 29 | B.A Architecture | 5 years | 39 minutes |
| 4 | 09/10/2018 | 33 | B.A Architecture | 8 years | 40 minutes |
| 5 | 09/10/2018 | 32 | B.A Architecture | 7 years | 34 minutes |
| 6 | 09/10/2018 | 38 | B.A Architecture | 8 years | 32 minutes |
| 7 | 09/14/2018 | 46 | M.S Architecture | 20 years | 34 minutes |
| 8 | 09/14/2018 | 75 | B.A Architecture | 15 years | 31 minutes |
| 9 | 09/18/2018 | 33 | M.S Architecture | 10 years | 38 minutes |
| 10 | 09/20/2018 | 37 | B.A Architecture | 12 years | 40 minutes |

### 4.3.2 Data collection instruments

Based on the purpose of the current interview, the researcher decided to gather verbal data with a combination of the visual data[35]. The combination of the visual and verbal data can facilitate a better understanding of research subjects by promoting new ideas and relations between insights (Comi et al., 2014; Denzin & Lincoln, 1994; Pain, 2012). Verbal data may not be adequate to express complex or abstract insights of participants to provide a chance to discover unspoken feelings and thoughts of participants (Bischof et al., 2011; Glegg, 2019; Pain, 2012). In this way, visual data can enhance researcher and participant understanding by suggesting an influential association between them (Weber & Mitchell, 1995). Also, it can help to examine the verbal data or discussions (Weber & Mitchell, 1995).

To understand architects' opinions about accessibility features in *ICU*, verbal data was gathered using open-ended and close-ended questions. Open-ended questions produce insights into the experiences, and beliefs of the participants (Fielding, 2012; Green et al., 2012; Ridder et al., 2014). Close- ended questions supply limited insight and opinions with yes or no answers (Fielding, 2012; Ridder et al., 2014). On the other hand, visual data was gathered by using participants' drawings throughout interviews.

**I. Designing interview questions**

As mentioned earlier, current interview aimed to understand architects' opinions and experiences about the *visual and physical accessibility* features in *ICU*s and sources of architects' knowledge in the *ICU*'s design process. Questions were logically structured in a deductive procedure that is started with open-ended questions and after were restricted the participants' responses by closed-ended questions. To enhance the interview methodology's reliability and validity, the researcher

[35] There are many ways to collect visual data, such as maps, diagrams, matrices, photographs, collages, and drawings. (Banks, 2008; Davison, McLean, & Warren, 2015; Glegg, 2019)

considered the wording of interview questions by avoiding complex terms in questions and did not guide or confuse the participants' responses by asking more than one question at the same time.

As seen in Figure 4.18, the interview questions were designed based on some data sources, including literature review findings, the theoretical framework of the study, fieldnotes of the observations, and the findings of the *SR*.

| Section | Aim of section | Data sources of the interview questions | |
|---|---|---|---|
| 1 | General information of architects | Personal information of architects | **General questions** ↓ |
| 2 | General information about *ICU* in the hospital | Literature review | |
| 3 | Architects' approach about architectural features of *ICU* | Literature review and fieldnotes | **Open- ended questions** ↓ |
| 4 | Architects' approach about *accessibility features* in *ICU* | Filednotes and findings of the *systematic review (SR)* | |
| 5 | Architects' approach sources in *ICUs*' design process | Theoritical framework of the study (*EBD* approach) | **Close-ended questions** |

Figure 4.18. Data sources of the interview questions (By the researcher)

In this manner, the researcher designed thirteen questions in five main sections in both Turkish and English language for the pre-test process, and each section was described in detail as follows:

**Section 1:** Firstly, the researcher started the interview with warm-up and straightforward questions that allowed participants to introduce themselves and feel a rapport with the interviewer. Three questions were asked about the architects' personal information, such as age, working experiences, and education level. Close-ended questions were designed to diminish the participants' misunderstanding of questions.

**Section 2:** Following, the researcher designed two primary questions to apprehend a general knowledge of healthcare architects about *ICU*. The literature review findings of the architectural characteristics of *ICU* were employed to design the questions of this section. One of the questions was about the *ICU* definition, and the other one was about the place of *ICU* in hospitals.

**Section 3:** To move toward the interview's purpose, the researcher asked from architects' knowledge about the *ICU'*s design features. Literature review findings and fieldnotes of observation were utilized as a data source to design this section's interview questions. Three open-ended questions were designed related to the healthcare architects' opinions and experiences about *ICU'*s spaces. Questions were started with asking architectural features of *ICU* and moved towards asking the impacts of architectural features on nurse and patients' relationships in the *ICU*. In each question, the researcher also asked participants to give some examples to extract necessary data more efficiently and profoundly.

**Section 4:** This part was involved two questions to elicit more details about architects' information related to the *visual and physical accessibility* in *ICU*. In this way, the fieldnotes and SR findings were employe as a data source to design the questions in this section. Two indirect questions were designed about the features of nurse and patient spaces in *ICU* and their impacts on the patients and staff relations. As mentioned earlier, to enhance the collected data's validity and quality, the researcher asked participants to explain their opinions or experiences through simple sketches.

**Section 5:** In the last part, the researcher designed two key open-ended questions to discover in-depth information about the design sources that impact on designing process in *ICU*s. The theoretical framework of this study (*EBD* approach) was used to design this section's question. These questions were designed by presenting some examples of data sources to decrease the ambiguities of questions for participants. For instance, in the first question, the researcher asked kinds of data sources in the *ICU* design process and gave some examples to participants such as personal experiences and architectural guidelines. Finally, the researcher finished the interview with a close-ended question about using scientific research in the design process.

Table 4.13 Interview questions for pre- testing stage (By the researcher)

| Section | Topic | Aim of section | Question/s |
|---|---|---|---|
| 1 | General information of architects | To achieve architects' personal information and their working experiences. | a) How old are you?<br>○ 25- 34<br>○ 35- 44<br>○ 45- 54 s<br>○ 55- 64<br>○ 65 or older<br><br>b) How many years of experience do you have in healthcare design field?<br><br>c) What is your level of education in architecture? (For example, Bachelor, Master or, Ph.D.) |
| 2 | General knowledge of architects about ICUs | General approach of architects about ICU in the hospital | a) Could you give a definition of ICU?<br><br>b) What do you think about the place of ICU in hospitals? |
| 3 | Architects' knowledge of architectural parameters of ICU | Architects' approach about architectural features of ICU | a) What do you think about architectural spaces of ICU?<br><br>b) In your opinion, what architectural features are important in ICU's architectural spaces? Could you please give some examples?<br><br>c) In your opinion, what architectural features have impacts on patients and nurses' relations in ICU's design? Could you please give some examples? |
| 4 | Architects' knowledge about accessibility features in ICUs' design process | Architects' approach about accessibility features in ICU | a) In your opinion, what is a nurse station/ nurse workplace in ICU? And, what are the properties of the nurse station? (For example, size, shape, location in ICU, type. doors, etc.)? Please indicate them in simple diagrams or sketches.<br><br>a) In your opinion, what is a patient room in ICU? And, what are the properties of the patient room? (For example, size, shape, location in ICU, type, equipment etc.) Please indicate them in simple diagrams or sketches. |
| 5 | Architects' knowledge sources in ICU's design process | Architects' approach sources in ICU's design process | a) What kinds of data sources do you use in the design process of ICU? (For example, personal experiences, architectural guidelines, national and international specifications etc.)<br><br>b) What do you think about the role of national and international guidelines in the design process of ICU? Please give guidelines' names.<br><br>c) Have you ever used scientific research in your decision- making process? Could you please give examples? |

### II. Piloting the semi- structured interview

One way to ensure the validity of the interview is to conduct a pilot interview. A pilot study as a small scale of the major interview is the first essential step to pre-test questions to find potential probe questions (Haq, 2015; Kvale, 2007; Morse & Richards, 2002; Teijlingen & Hundley, 2001; Weiss, 1994). In this way, the researcher conducted initial tests with two participants with the same criteria as the current interview participants (Table 4.15).

Table 4.14 Participants of the pilot interview (By the researcher)

| Number of participant | Date of Interview | Old | Level of Education | Work Experience | Time |
|---|---|---|---|---|---|
| **1** | 1th March, 2018 | 27 | B.S Architecture | 4 years | 36 minutes |
| **2** | 2th March, 2018 | 34 | M.S Architecture | 11 years | 41 minutes |

The researcher contacted two participants by email to identify the date, time, and location of the interview. The researcher conducted both interviews based on the designed interview guide in the Turkish language and recorded interviews with a voice recorder. After finishing the interviews, the researcher listened to recorded interviews and saved transcripts of each interview in the Microsoft word program.

The researcher understood how to ask questions from participants, what questions could be suitable to ask from participants, and how much time was necessary to complete the interview. Based on conducted pilot interviews, the researcher faced with some ambiguous questions, unnecessary questions. Also, some questions presented inadequate information about the investigated subjects. Thus, the researcher applied some modifications in the interview guide as follows:

In the second section, the researcher found (***Qa)*** & ***(Qb)*** very general and ambiguous for participants and changed both. In the third section, the researcher achieved the same information from ***(Qa)*** & ***(Qb)*** and decided to combine both and presented them as one question. Two questions were then added to understand the general knowledge of architects about *ICU* by asking to draw simple sketches. In the fourth section, the researcher inserted two new questions, including ***(Qc)*** & ***(Qd)***, to understand architects' accurate knowledge about the physical relations between patient and nurse's space in *ICU* by drawing simple sketches. In the fifth section, the researcher modified the wording ***(Qc)*** to clarify the question.

Table 4.15 Modifications of the interview questions (By the researcher)

| SECTION | MODIFICATIONS OF THE QUESTIONS | | |
|---|---|---|---|
| | **Old question/s** | **Modification/s** | **New question/s** |
| **2** | ***(Q a)*** Could you give a definition of ICU? | Changing ***(Q a)*** | ***(Q a)*** Could you tell about the very specific issues and roles of ICU in the hospital? |
| | ***(Q b)*** What do you think about the place of ICU in hospitals? | Changing ***(Q b)*** | ***(Q b)*** In your opinion, what kind of physical relations there must be in ICU in the hospital? (For example, relations with other nursing units, location of ICU in hospital, etc.) Please indicate them in simple diagrams or sketches. |
| **3** | ***(Q a)*** What do you think about architectural spaces of ICU?<br>***(Q b)*** In your opinion, what architectural features are important in ICU's architectural spaces? Could you please give some examples? | Combining ***(Q a)*** & ***(Q b)*** | ***(Q a)*** What types of architectural spaces do you specify in ICU? (For example, patient's space, nurse's space etc.) |
| | | Adding two new questions | ***(Q b)*** Could you tell about the general architectural features and equipment of ICU's spaces? (For example, technical and medical equipment, furnishing, etc.) |
| | | | ***(Q c)*** What types of architectural layout do you prefer in ICU's design? (For example, rectangular, circular, etc.) And, why? Please indicate them in simple diagrams or sketches. |
| **4** | | Adding two new questions | ***(Q c)*** To provide physical relations between patient and nurse's space in ICU, what architectural features do you consider in design process? (For example, entrances of spaces, distance of spaces, size of spaces, relations between spaces, etc.) Please indicate them in simple diagrams or sketches. |
| | | | ***(Q d)*** To provide physical relations between patient and nurse's space in ICU, what furnishing / equipment do you consider in design process? (For example, door, window, bed, medical equipment, technical equipment, etc.) Please indicate them in simple diagrams or sketches. |
| **5** | ***Q c)*** Have you ever used scientific research in your decision- making process? Could you please give examples? | Changing ***(Q c)*** | ***(Q c )*** Do you refer scientific researches/ published or unpublished researches in the design process of ICU? If yes, please give examples. |

### III. Presenting the interview questions

After the piloting interview, the researcher presented the new set of interview questions in five main sections. As displayed in Table 4.17, the researcher identified each section's aim, questions, supplementary information about expected answers, and estimated time for each section (Appendix B: Interview guide in the Turkish language).

Table 4.16 Interview questions (By the researcher)

| Aim of section | Question/s | Supplementary information | Time |
|---|---|---|---|
| **Section 1: "General information of architects"** | | | |
| **Aim of section** | **Question/s** | **Supplementary information** | **Time** |
| **To achieve architects' personal information and their working experiences.** | a) How old are you?<br>o 25- 34<br>o 35- 44<br>o 45- 54<br>o 55- 64<br>o 65 or older<br>a) How many years of experience do you have in healthcare design field?<br>b)What is your level of education in architecture? (For example, Bachelor, Master or, Ph.D.) | Answers must be very briefly. | Less than 1 minute |
| **Section 2: "General approach of architects about ICU in the hospital"** | | | |
| **Aim of section** | **Question/s** | **Supplementary information** | **Time** |
| **To find out general approach and opinions of architects about ICU in hospitals.** | a) Could you tell about the very specific issues and roles of ICU in the hospital?<br>b) In your opinion, what kind of physical relations there must be in ICU in the hospital? (For example, relations with other nursing units, location of ICU in hospital, etc.) Please indicate them in simple diagrams or sketches. | Answers must consider ICU as a part of the hospital. | 2 minutes |
| **Section 3: "Architects' approach about architectural features of ICU"** | | | |
| **Aim of section** | Question/s | Supplementary information | Time |
| **To find out architects' approach about ICU's architectural features.** | a) What types of architectural spaces do you specify in ICU? (For example, patient's space, nurse's space etc.)<br>b) Could you tell about the general architectural features and equipment of ICU's spaces? (For example, technical and medical equipment, furnishing, etc.)<br>c) What types of architectural layout do you prefer in ICU's design? (For example ,rectangular, circular, etc.) And, why? Please indicate them in simple diagrams or sketches. | Q a: Answers must include the name of architectural spaces.<br>Q b: Answers describe the general features of ICU' spaces without details (For example, patient space characteristic, nurse space characteristics, etc.) | 15 minutes |
| **Section 4: "Architects' approach about accessibility features in ICU"** | | | |
| **Aim of section** | Question/s | Supplementary information | Time |
| **To find out architects' approach about accessibility features in terms of visual and physical accessibility in ICU.** | a) In your opinion, what is a nurse station/ nurse workplace in ICU? And, what are the properties of the nurse station? (For example, size, shape, location in ICU, type. doors, etc.)? Please indicate them in simple diagrams or sketches.<br>b) In your opinion, what is a patient room in ICU? And, what are the properties of the patient room? (For example, size, shape, location in ICU, type, equipment etc.) Please indicate them in simple diagrams or sketches.<br>c) To provide physical relations between patient and nurse's space in ICU, what architectural features do you consider in design process? (For example, entrances of spaces, distance of spaces, size of spaces, relations between spaces, etc.) Please indicate them in simple diagrams or sketches.<br>d) To provide physical relations between patient and nurse's space in ICU, what furnishing / equipment do you consider in design process? (For example, door, window, bed, medical equipment, technical equipment, etc.) Please indicate them in simple diagrams or sketches. | Q c & Q d: Answers must focus on the importance of the relations between the nurse and patient' space (in terms of accessibility) in ICU. | 15 minutes |
| **Section 5: "Architects' approach sources in ICU's design process"** | | | |
| **Aim of section** | Question/s | Supplementary information | Time |
| **To find out scientific data or guidelines that architects use in ICU's design process.** | a) What kinds of data sources do you use in the design process of ICU? (For example, personal experiences, architectural guidelines, national and international specifications etc.)<br>b) What do you think about the role of national and international guidelines in the design process of ICU? Please give guidelines' names.<br>c) Do you refer scientific researches/ published or unpublished researches in the design process of ICU? If yes, please give examples. | | 10 minutes |

### 4.3.3 Data collection and documentation procedure

The reliability of the interview stands in the consistency of the questions asked of each participant. An interview guide is a tool to provides the reliability of the study if the researcher peruses it throughout the data collection process (Alban-Metcalfe & Alimo-Metcalfe, 2013; Boesch et al., 2013; Dasgupta, 2015; Havenga et al., 2014; Qu & Dumay, 2011; Patton 2015; Sarma, 2015).

Based on ethical issues, approval of the interview guide was obtained from the human subjects ethics committee at Middle East Technical University (METU) on Augustus 08, 2018, before conducting interviews (Appendix C: Approval of the interview guide). In this way, the researcher employed the designed interview guide and asked similar questions. The wording of the questions and the follow-up questions were varied in some places.

Before starting the interview, the researcher asked for each participant to read and sign the consent form. In the consent form, the researcher explained the aim of the current interview and the voluntary nature of participation and their right to refuse to participate in this interview (Appendix D: Consent form). After signing the consent form by each participant, the researcher turned on the audio device to record the interview. Brief and short notes of the participants' responses were taken throughout the interviews. Last, the debriefing form was given to each participant to describe the purposes and hypothesis of the interview (Appendix E: Debriefing form).

After fulfilling each interview, the researcher transcribed recorded interviews into the Microsoft Word and keep it in the specific folders with a specific code. This code was constituted of a combination of the interview number and the date of the interview. For instance, the first interview was coded like I.109082018 by combining an interview number (I.1) and the interview date (09082018) (Appendix F: Example of transcripts of interviews).

The sketches of participants were also attached to each transcript in JPG format. The researcher attempted to enhance the validity of the collected data by employing participants' sketches, controlling data saturation, and using a member checking method as follows:

- Participants' sketches enhanced the validity and reliability of the collected data by applying extra data that were not implied verbally. These sketches also approved the interview discussions and decreased misunderstanding of gathered data.
- Another strategy to confirm the reliability of the collected data is data saturation (Birt et al., 2016; Kwong et al., 2014). Data saturation occurred with ten participants when any new information was obtained from the participants in the current interview.
- A common way to maximize the validity of the interview is member-checking (Holmes & Parker, 2017; Kamball, 2017; Schwaninger et al., 2015). Before analyzing the collected data, the researcher allowed each participant to review and confirm the transcribed interview by sending a request to confirm the content of transcribed data.

This chapter provided qualitative findings to evaluate the healthcare architects' concerns in *the ICU* by referring to evidence-based knowledge. Firstly, the researcher observed two *ICU*s located in Iran and Finland and reported findings as descriptive information employed as supplementary sources to design the semi-structured interview questions. After that, research evidence of*ICU*s' accessibility features were gathered from 1984 to 2020 and reported in six main themes. These themes clarified the *visual and physical accessibility* features in *ICU*s that impact the *patients' safety* and *staff efficiency*. Finally, semi-structured interviews were conducted with healthcare architects to understand their knowledge about *ICU*'s design process. The next chapter described the analysis of gathered data by thematic analysis and evaluated the results by referring to the *SR*'s findings.

# CHAPTER 5

## EVALUATION AND DISCUSSION: THEMATIC ANALYSIS OF THE COLLECTED DATA

After data collection, data analysis is the next step to interpret collected data. In this chapter, the Thematic Analysis (TA) was employed to extract the healthcare architects' opinions and experiences about the *ICU*'s accessibility features. Then, the TA's findings were evaluated and discussed by referring to the *SR's* findings. In this way, one of the robust data analysis techniques is a TA widely employed in qualitative research by summarizing data under the thematic headings (Braun & Clarke, 2006; Dixon-Woods et al., 2005; Guest, 2012; Miles & Huberman, 1994; Wolcott, 1994). By using TA, the researchers can get more essential insights to comprehend concepts within the various size of the dataset (Braun and Clarke, 2006; Dixon-Woods et al., 2005; Vaismoradi et al., 2013). In this way, the researcher started to analyze collected data-parallel with conducting interviews by employing Braun and Clark's process (2006) of TA as follow:

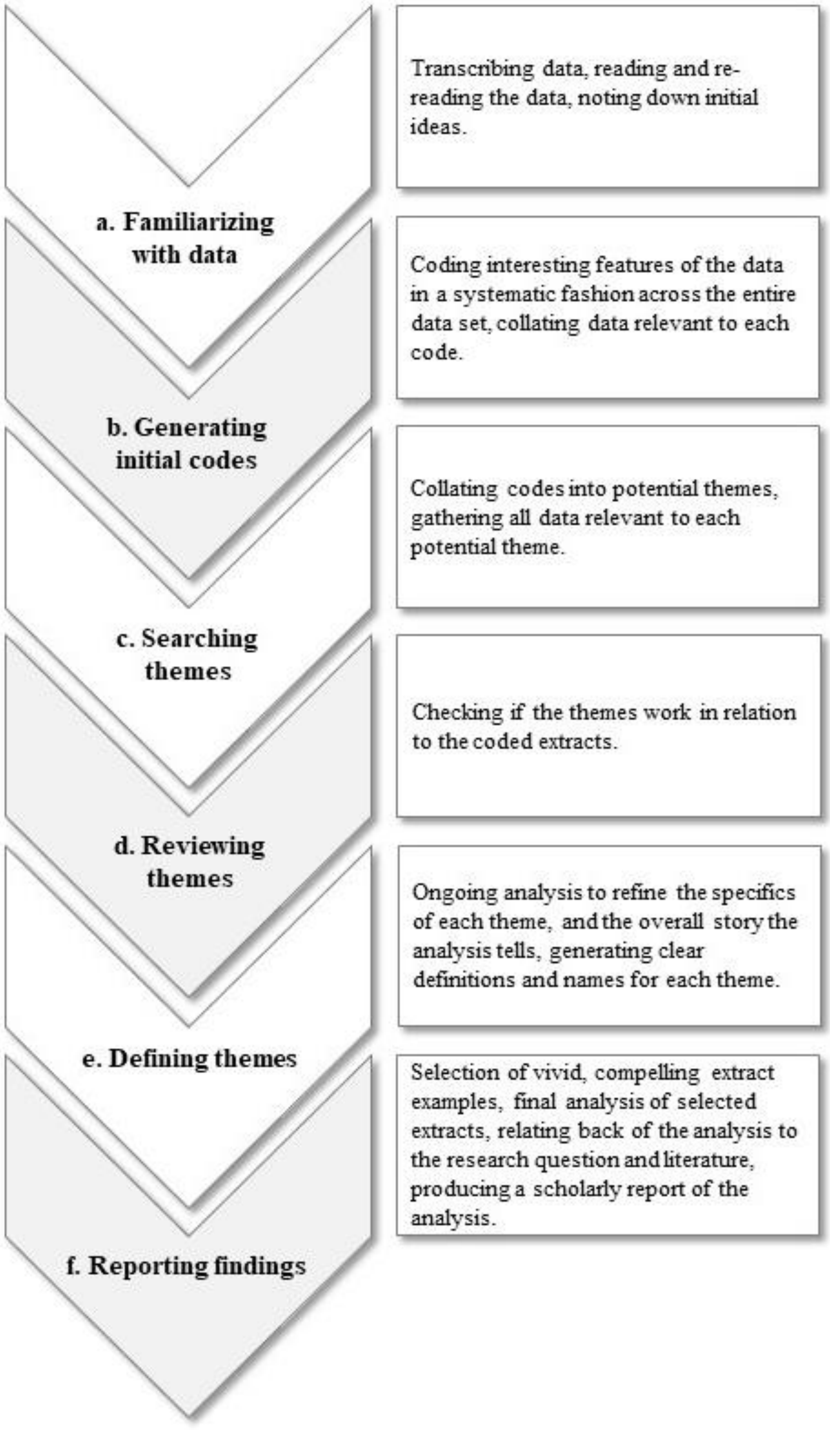



Figure 5.1. Steps of the Thematic Analysis (TA) (Braun & Clarke, 2006, p. 87)

## 5.1 Familiarizing with data

In this step, the researcher read, and reread collected data to provide better contact and greater awareness about the gathered data, determine an explicit understanding of participants' responses. The researcher focused on the interview purpose to evolve the thematic phrases within the participant's statements. At the end of this stage, the researcher achieved a comprehensive insight into the pattern within the gathered data about the *ICU*'s accessibility features and design sources.

## 5.2 Generating initial codes

After reading transcripts and familiarizing them with gathered data, the researcher started to develop initial codes by reducing and summarizing the raw data into meaningful units in an iterative process. The researcher employed a deductive coding approach and prepared codebooks before beginning the initial coding process. The deductive coding approach generally assists in focusing the coding on specific issues important in the research or related to the specific theory (Rowley 2002). For this reason, codebooks were used for starting initial codes. The codebook is essential to analyze qualitative data because it provides a formalized coding (Campbell et al., 2013; Cochrane 2006; Creswell, 2014; Fereday & Muir- Fonteyn et al. 2006). Codebook helps to repeat the coding process by other researchers and tests the reliability of the coding process. The list of codes can be changed during the deductive coding process if some new codes emerge within data (Linneberg & Korsgaard, 2019). In this part, essential sources were employed to prepare the codebook for initial coding.

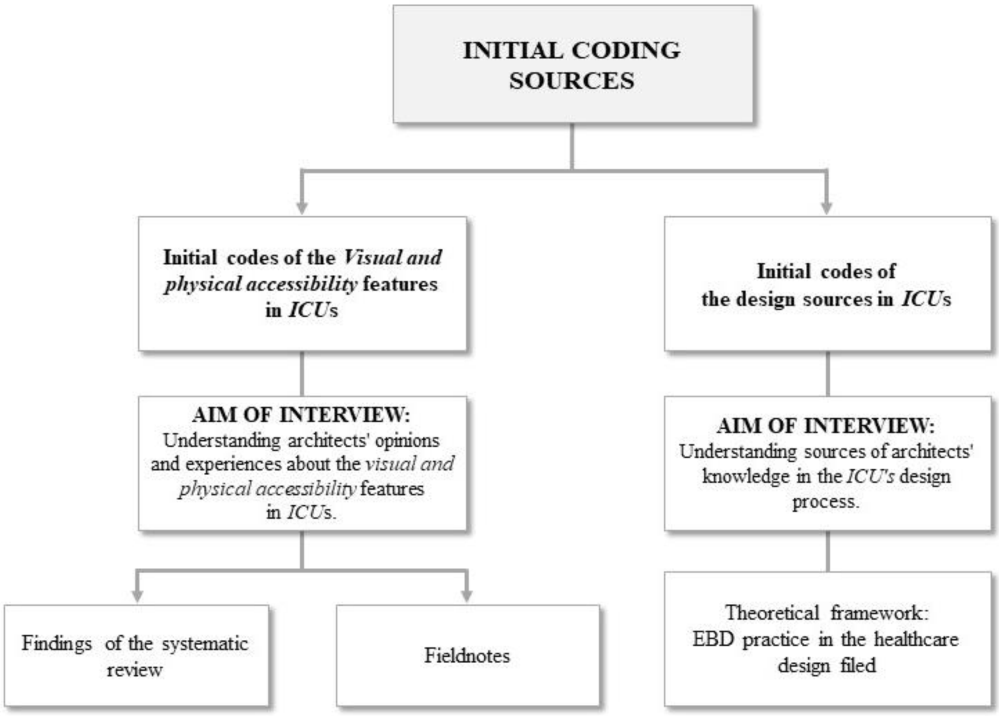



Figure 5.2. Sources of the initial coding (By the researcher)

The codebooks were prepared in two essential subjects involving the accessibility features in *ICU*s and design sources employed in the *ICU*s*'* design process to start the transcripts' deductive coding. As shown in Figure 5.2, three primary sources were used to prepare a codebook of *ICU*s*'* accessibility features, including the interview's aim to understand the architects' opinions about accessibility features in *ICU*, findings of the *SR*'s findings, and fieldnotes. As seen in the below table, defined codes were described by code label, definition, descriptions, and an example quote from participants to avoid ambiguity of specified codes. In this way, ten codes were defined as the *ICU*s' accessibility features involved open ward (OW), single patient room (SPR), simple layout, rectangular layout, number of SPR, number of beds in the OW, bed beside the wall in the SPR, transparent wall between a room and a corridor, transparent wall between patients in the OW, and transparent door.

Table 5.1 Code book related to the accessibility features in *ICU*s (By the researcher)

| Code label | Definition | Description | Example |
|---|---|---|---|
| Open ward (OW) or Arena plan | An open ward or arena plan model is a kind of ICU model involving a central nurse station beside or in the center of the unit. It involves patient beds located around the unit. | In this unit, nurses can observe all patients at the same time. Patients should be separated from beside the patient by a transparent wall or window. | "In my opinion, ICU should be design based on the open ward....this model of ICU is the most healthy design model. These are patient beds, and they should be located in observable place by a nurse" (I.5, p.4, L.72). |
| Single patient room (SPR) | SPR includes single rooms with observation stations between two rooms and the main nurse station to support patients and staff inside the unit. | In this unit, nurses can control patients from observation stations in critical situations. | "...we tried to place all single-patient rooms around the unit, and we designed one nurse station for two patient rooms. Additionally, we designed one main nurse station. It is important that nurses can see all patients" (I.4, P.3, L.68). |
| Simple layout | A simple layout is a kind of a unit designed in the simple shapes with the minimum corners. | Simple layout with minimum corners provides a suitable view to patients. | "Standards want the minimum number of corners because the more corners create more problems for patients observation" (I.2, P.3, L.66). |
| Rectangular layout | Rectangular layout is a kind of the layout in the rectangular shape designed in open ward model or decentralized unit model. | This layout supplies a suitable view to patients with minimum hinders. | "Plan as the rectangular shape could be more appropriate. I think patients' control is easier ...." (I.7, P.5, L.85). |
| Number of SPR | It is the number of single-patient rooms within a decentralized unit. | The size of the unit determines by the number of patient room that impacts on patients' observation and walking distances by nurses. 8-12 patient rooms should be inside the unit. | "This is the ICU with eight patient rooms" (I.5, P.4, L.79). |
| Number of beds in the OW | It defines the number of patient beds in an open ward. | The unit's size is determined by bed number that impacts patients' observation and walking distances by nurses. Maximum 8-12 patients bed is a small unit. | ".... based on the design guidelines and standards, there is one nurse for eight patients in the open ward" (I.6, P.3, L.58). |
| Bed beside the wall in the SPR | It is a kind of bed position inside the single patient room that bed located beside the wall. | In this bed position, a life support system is installed on the wall in the back of the patient's head. Nurses can not physically access to the patients' head from behind. | "...we put the patient bed beside the wall and doctor couldn't access patients just from the behind the patient head" (I.5, P.6, L.124). |
| Transparent wall between a room and a corridor | It is a transparent separator used between observation stations and a corridor in SPR. | In SPR, nurses can see and control patients from observation stations (located outside the room) through a transparent wall or window. | "Nurse should observe patients. So, there should be transparent glass or window between patient room and corridor" (I.2, P.8, L.174). |
| Transparent wall between patients in the OW | It defines as a transparent separator used between patients in an open ward. | In an open ward, nurses can see and control patients from the main nurse station (located beside or the center of an open ward) through a transparent wall or window between patients. | "The most important in an open ward is easy to access and observe patients. For this reason, patient beds are separated by the glass" (I.8, P.6, L.103). |
| Transparent door | A transparent door is used in SPR constructed of glass. | In SPR, nurses can observe and control patients from a transparent or glass door without entering a room. | "...specially in ICU's patient rooms, the door of rooms are designed with glass completely,......to observe the patients" (I.4, P.4, L.77). |

Almost two primary sources were utilized to define a codebook of *ICU*s*'* design sources included the interview's aim to understand architects' knowledge in the *ICU*'s design process and the theoretical framework (*EBD* approach) of this study. As seen in the below table, defined codes were described by code label, definition, descriptions, and an example quote from participants to avoid ambiguity of specified codes. In this way, eleven codes were defined as the *ICU*s' design sources involved design guidelines, Türkiye Sağlık Yapıları Asgari Tasarım Standartları, Facility Guidelines Institute (FGI), Australasian Health Facility Guidelines (AusHFG), Veterans Affairs (VA), fire safety guidelines (Sağlık Bakanlığı Yangın Önleme ve Söndürme Yönergesi), medical advisor, national projects, international projects, personal experience, and firm’s demands.

Table 5.2 Code book related to the design sources (By the researcher)

| Code label | Definition | Description | Example |
|---|---|---|---|
| Design guidelines | Design guidelines are a set of rules, standards, or codes to protect public health, safety, and general welfare related to the construction and occupancy of buildings and structures. | Designers use Turkish and international guidelines or standards as data sources in the design process. | "...international and Turkish guidelines want to design based on this model" (I.6, P.4, L.85). |
| Türkiye Sağlık Yapıları Asgari Tasarım Standartları<br><br>Retrieved 18, January 2019 from, https://sbu.saglik.gov.tr/Ekutuphane/Yayin/414 | These guidelines define a set of minimum design standards in public and private healthcare facilities to increase the service quality in this field. | Heath ministry guidelines (Asgari Tasarım Standartları) are used by designers as a data source in the design process. | "....health ministry wants the rooms to design in the form of a rectangular" (I.4, P.8, L.190). |
| Facility Guidelines Institute (FGI)<br><br>Retrieved 18, January 2019 from, https://fgiguidelines.org/about-fgi/ | FGI is a set of guidelines that develops rules for the planning, design, and construction of hospitals, outpatient facilities, and residential health, care, and support facilities. | FGI is used by designers as a data source in the design process. | "We try to design suitable ICU by using various international guidelines such as FGI, VA, and Australasian guidelines" (I.5, P.8, L.170). |
| Australasian Health Facility Guidelines (AusHFG)<br><br>Retrieved 18, January 2019 from, https://healthfacilityguidelines.com.au/australasian-health-facility-guidelines | AusHFG is a set of guidelines that outlines the specific requirements for the planning and design of an Intensive Care Unit (ICU), including a Paediatric Intensive Care Unit (PICU). | Designers use AusHFG as a data source in the design process. | "We try to design suitable ICU by using various international guidelines such as FGI, VA, and Australasian guidelines" (I.5, P.8, L.170). |
| Veterans Affairs (VA)<br><br>Retrieved 18, January 2019 from, https://www.cfm.va.gov/til/dGuide/dgInpatientNU.pdf | VA is a set of guidelines and supplementary to current technical manuals, building codes, and other VA criteria in planning Healthcare Facilities. | Designers use VA as a data source in the design process. | "We try to design suitable ICU by using various international guidelines such as FGI, VA, and Australasian guidelines" (I.5, P.8, L.170). |
| Fire safety guidelines (Sağlık Bakanlığı Yangın Önleme ve Söndürme Yönergesi)<br><br>Retrieved 18, January 2019 from, https://www.saglik.gov.tr/TR,11257/saglik-bakanligi-yangin-onleme-ve-sondurme-yonergesi.html | It is a set of rules prescribing minimum requirements to prevent fire and explosion hazards arising from storage, handling, or use of dangerous materials, or other specific hazardous conditions. | Designers use the fire safety guidelines as a data source in the design process. | "A lot of guidelines are involved in the design process. for example, fire safety guidelines. In fact, it's not only intensive care guidelines" (I.2, P.8, L.191). |
| Medical advisor | Medical advisor explains the medical and health subjects such as medical systems inside ICU to designers. | A medical advisor, as a data source, helps designers in the decision-making process. | "We do not decide on the level of ICU. Medical advisors or companies usually decide on it" (I.4, P.2, L.51). |
| National projects | National projects are hospital projects designed in Turkey. | National projects are used as data sources in the design process. | "We design new projects looking at the old project in Turkey. Then we apply the new guidelines" (I.2, P.5, L.114). |
| International projects | International projects are a kind of concept or hospital projects prepared or designed in foreign countries. | Designers use international projects as data sources in their design process. | "We sometimes look at an international hospital and international examples" (I.6, P.9, L.177). |
| Personal experience | The personal experience of designers involves their skills, knowledge, or information about design problems. | Designers use their personal experiences as data sources in the design process. | "In ICU, actually, there are such relationships. We draw these based on our experience..." (I.5, P.1, L.24). |
| Firm's demands | They are needs of architectural firms or companies that wants consider in the design process. | Designers consider the architectural firms' or companies' demand as a data source in the design process. | "Usually, we design units according to the firm's demands" (I.6, P.8, L.150). |

After defining the codebooks, initial codes were generated in two primary cycles. The first cycle was included the coding transcripts based on defined codes in accessibility features and design sources in *ICU*. The second cycle was conducted in three steps, including reviewing the initial codes, revising the codebook, and evaluating codes' inter-rater reliability.

Table 5.3 Initial coding steps (By the researcher)

| **Initial coding steps** | |
|---|---|
| First cycle | Coding data based on codebook. |
| Second cycle | I. Reviewing the initial codes<br>II. Revising the codebook<br>III. Evaluating inter- rater reliability of codes. |

**b.a. First cycle of coding**

After defining codes, the researcher started first cycle coding without translating transcripts into the English language to keep the original meaning and feeling of sentences. The researcher also used the English language to code all transcripts because the final reports of this interview would be presented in the English language. Selected parts of the text were just translated into the English language to report the findings. Defined codes related to the accessibility features and design sources in *ICU*s were employed to code ten transcripts of interviews and extract the related text to defined codes.

**b.b. Second cycle coding**

The second cycle of coding was constituted of three steps to achieve the final codes. In this way, the first cycle coding results were reviewed as a second time to access final codes of accessibility features and design sources in *ICU*. The defined codes of the *ICU*'s accessibility feature and design sources did not change after reviewing initial codes. In the third step, the inter-rater reliability of initial codes was evaluated to enhance the qualitative data's reliability. Considering the inter-rater reliability (IRR) is a recognized method of ensuring the study's trustworthiness when multiple researchers are involved with coding in qualitative studies. The researcher employed interrater reliability (IRR) by using an independent coder to verify the concurrence level. The concurrence level is the degree of coding similarity between coders that could be 80% agreement on 95% of the codes (Miles & Huberman as cited in McAlister et al., 2017). For this reason, the formula described in Miles and Huberman (1994) was employed to calculate the concurrence level of coding.

$$\text{reliability} = \frac{\text{number of agreements}}{\text{number of agreements} + \text{disagreements}}$$

Figure 5.3. Inter-rater reliability (IRR) (Miles & Huberman as cited in McAlister et al., 2017)

According to this formula, the number of agreements is the number of codes that two coders agree over the total number of codes in the same coded transcript. The number of disagreements is the number of codes that two coders disagree over the total number of codes in the same coded transcript. In this study, an independent coder coded the most extended transcripts that involved more data (Transcript 3) based on the defined codes of the *ICU*'s accessibility features and the design sources. Two IRR values were determined between each set of two coders:

- The number of times coder 1 (The researcher) agreed with coder 2 (The independent coder) divided by the total number of codes used by coder 1, and

- The number of times coder 2 (The independent coder) agreed with coder 1 (The researcher) divided by the total number of codes used by coder 2.

It was essential to check both ways because these numbers may vary significantly due to the total number of codes applied by each coder. After that, we participated in a discussion session, and negotiating results emerged from the coding process, and 92% of the reliability was achieved. There were no changes in the defined codes of the accessibility features and design sources in *ICU* after the inter-rater- reliability process. In this way, after two primary coding cycles, the ten transcripts' initial codes were presented in the tables included interview codes, page, line, code, and related text. As seen in the below table the initial coding of the interview (2) was presented with identified codes using defined codes of accessibility features and design sources in *ICU*.

Table 5.4 Example of initial coding (By the researcher)

| INITIAL CODING | | | | |
|---|---|---|---|---|
| **Interview Code** | **Page** | **Line** | **Code** | **Related text** |
| I.209102018 | 1 | 16 | Design guidelines | " Yonetmelik aklima geliyor, hep cizim yaptigim icin. Aslinda, konu cok saglik ve tibbi konu oldugu zaman, cok fazla müdahale sansimiz olmuyor." |
| | 1 | 19 | Helath ministry guidelines | "Dolaysiyla, biz saglik bakanligindaki istandartlara gore tasrarim ediyoruz. Genel bir metre kare tablusu oldugu icin, bir tasarim beklenmiyor, ve beklenmemeli." |
| | 3 | 49 | Transparent wall between a room and a corridor | "Hemsire, yogun bakim tek kisilik odasinda, soyle onemli oluyor, hep hastayla gorsel acisindan surekli iletisimde olmasi gerekiyor. O yuzden, genelde sefaf cam kulanmaya calisiyoruz." |
| | 3 | 51 | Design guidelines | "Hemsirenin ozelligi, bikare, cok net bisekilde, hastayi gore biliyor olmasi lazim. O yuzden, tam merkezi konumlarda yapiyoruz. Yonetmeliklere gore yani." |
| | 3 | 64 | Single patient room (SPR) | "Bi kare, tip olarak, bi hastaya, bi yatak odasi dusecek, cunku sonucta, burada hastalar biraz daha kritik durumunda olurlar, hem birbiriyle, hem havayla gecan sorunlar olur." |
| | 3 | 66 | Simple layout | "Onun harcinda dediginiz gibi, mecbur olarak, minimum kose sayisi istiyorlar standartlarda, cunku nekadar fazla kose varsa, o kadar sorun olur hasteleri gormek falan." |
| | 3 | 66 | Design guidelines | "…minimum kose sayisi istiyorlar standartlarda,…" |
| | 3 | 68 | Rectangular layout | "O yuzden, iste yuvarlak yapabileceğimiz icin aslinda, yani bi ameliyathane kadar duzenlemedigimiz icin, mecburi olarak kare biciminde dusunuyoruz. Yani dikdörtgen aslinda, ve iste, cok basit bence, cok sey yapmadan, nasil anlatsam, karmasik hale getirmeden, cunku maximum soyle gozlemleri olabilecek sekilde yapilmali." |
| | 3 | 75 | Rectangular layout | "Bu sekilde, dikdörtgen pilani hastalari goemek icin daha uygun." |
| | 4 | 95 | Single patient room (SPR) | "Yine sey, maximum gozlem, bunun haricinde, suralar, soyle kucuk deskler koyuyoruz. Burada hem hastayla alakali not aliyorlar, hemde kolayca gozlem yapabiliyorlar. Bunlari mumkun oldugunca şeffaf tercih ediyoruz. Hata saglik bakanligi surayin bile seffaf olmasin istiyor. Yani burada eger bi hemsire varsa, diyer oda daki kisiyi gorebilmesi lazim, ama biz bunu, hasta mahremiyet acisindan olmamasini dusunuyoruz." |

### 5.3 Searching themes

In this part, all initial codes were organized in the groups to extract the theme or sub-themes about the accessibility features and design sources in *ICU*s. After that, all defined themes and sub-themes were reviewed for achieving the viability of each theme. In this way, achieved initial codes were categorized to extract the themes and sub-themes related to the accessibility features and design sources in *ICU*s. As seen in the below figures, the process of searching themes and sub-themes was shown from step 1 to step 6.

In step 1, all initial codes of accessibility features in *ICU* were gathered in diagrams to determine a meaningful and consistent pattern. Sources of codes were shown in the table beside each code to specify the number of interview, page, and line of extracted codes. Step 2 started to categorize all similar initial codes in the same group with identical colors. In this way, the single patient room (SPR) and open ward (OW) were grouped in the same category with the same color. A simple layout and rectangular layout were identified in the same group with the same color in the next step. In step 4, the number of SPR and the number of beds in the OW were grouped in the same category with the same color. The bed beside the wall in the SPR was determined as a single code in one category in step 5. Finally, a transparent wall between a room and a corridor, a transparent wall between patients in the OW, and a transparent door were identified as the same category and specified in the same color. (Figure 5.6)

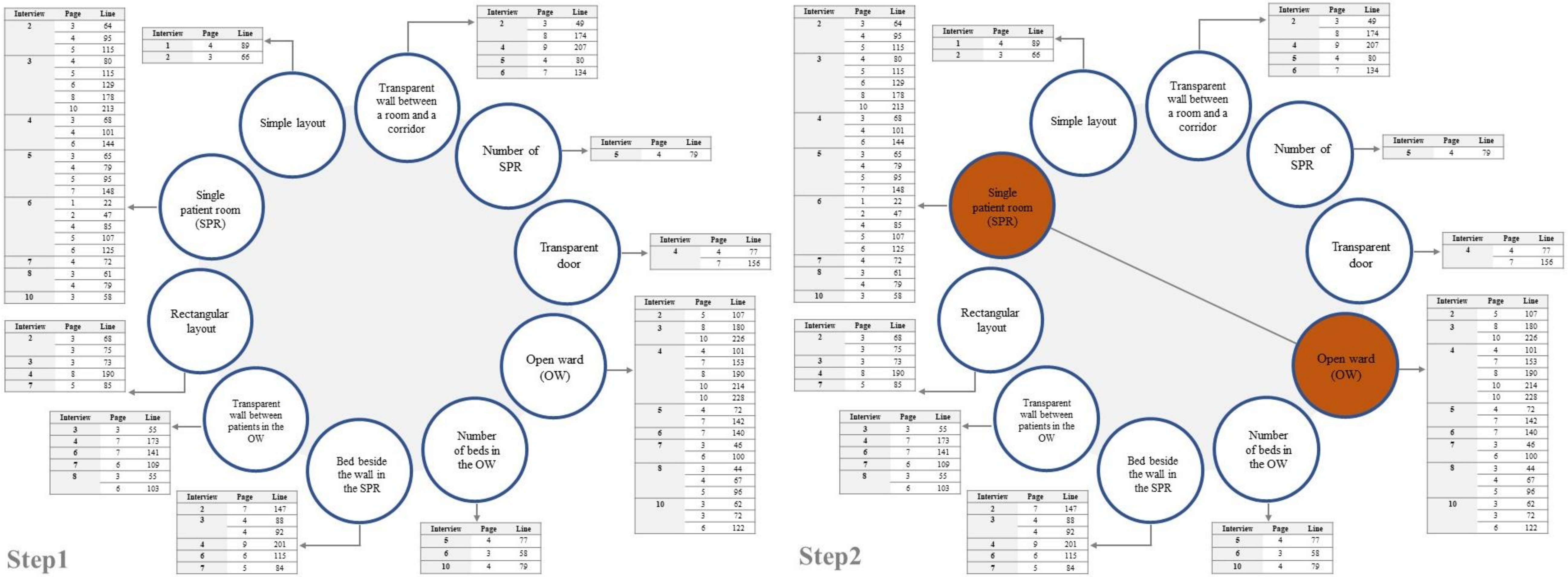



Figure 5.4. Steps of searching themes related to the accessibility features: Steps 1 & 2 (By the researcher)

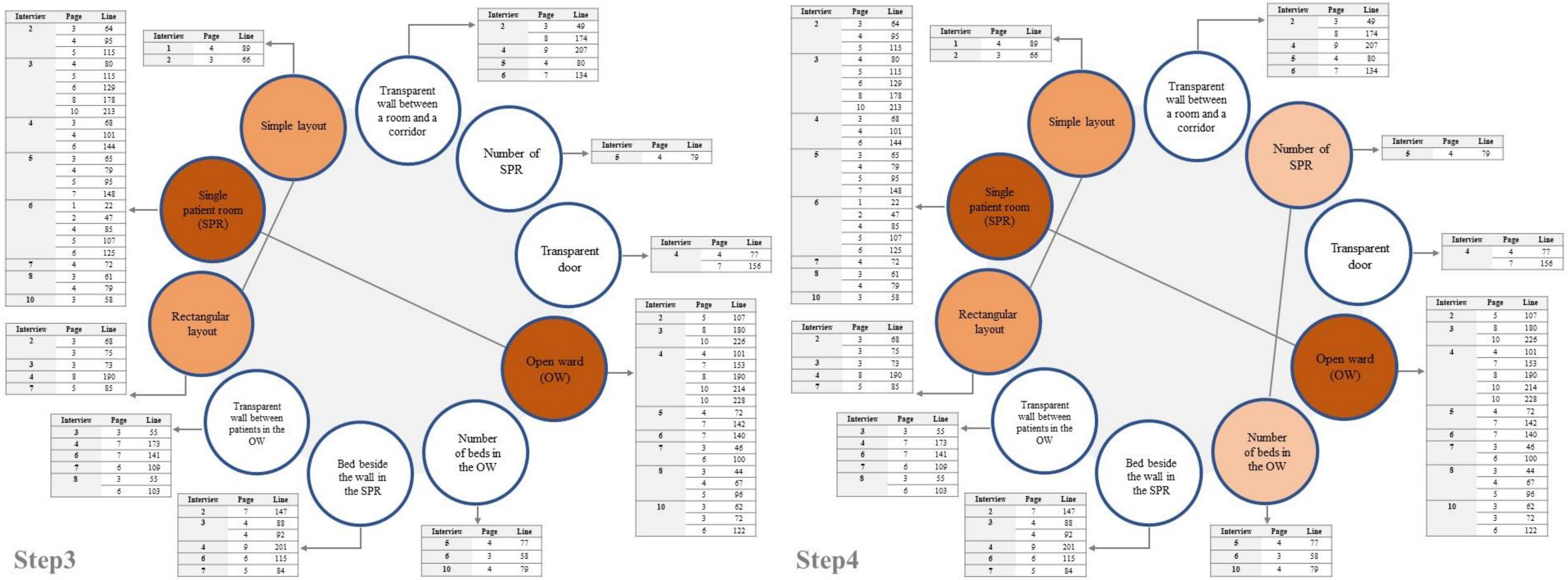



Figure 5.5. Steps of searching themes related to the accessibility features: Steps 3 & 4 (By the researcher)

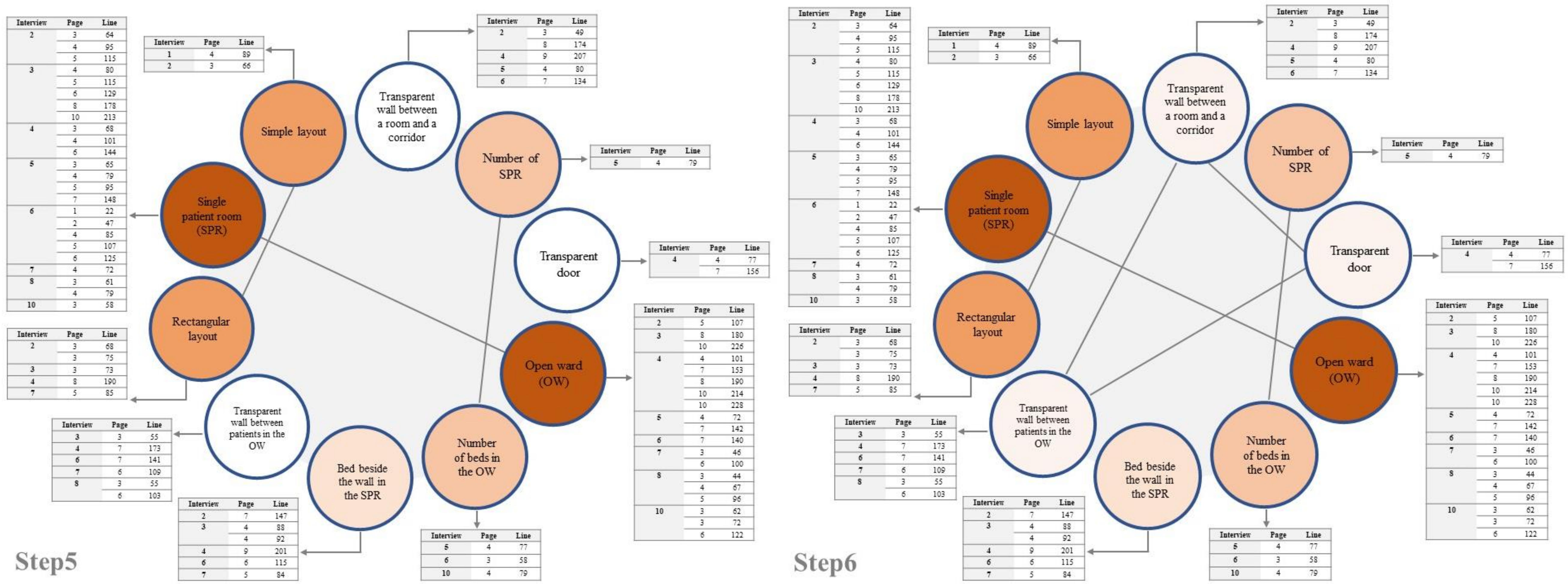



Figure 5.6. Steps of searching themes related to the accessibility features: Steps 5 & 6 (By the researcher)

Similarly, achieved initial codes were categorized to extract the themes and sub-themes related to the design sources in *ICU*s. As seen in the below figures, the process of searching themes and sub-themes was shown from step 1 to step 6.

In step 1, all initial codes of design sources of *ICU* were gathered in a diagram to determine a meaningful and consistent pattern. Sources of codes were shown in the table beside each code to specify the number of interview, page, and line of extracted codes. Step 2 started to categorize all similar initial codes in the same group with identical colors. Design guidelines, Health ministry guidelines, Fire safety guidelines, Australian health facility guidelines, Facility Guidelines Institute (FGI), and Veterans Affairs (VA) were identified in the same group and specified with the same color. The medical advisor was defined as one category in step 3. After that, National projects, international projects were grouped in the same category with the same color. Personal experiences were considered in one category in step 5. Finally, the Firm's demands were determined as one category among the initial codes (Figure 5.9).

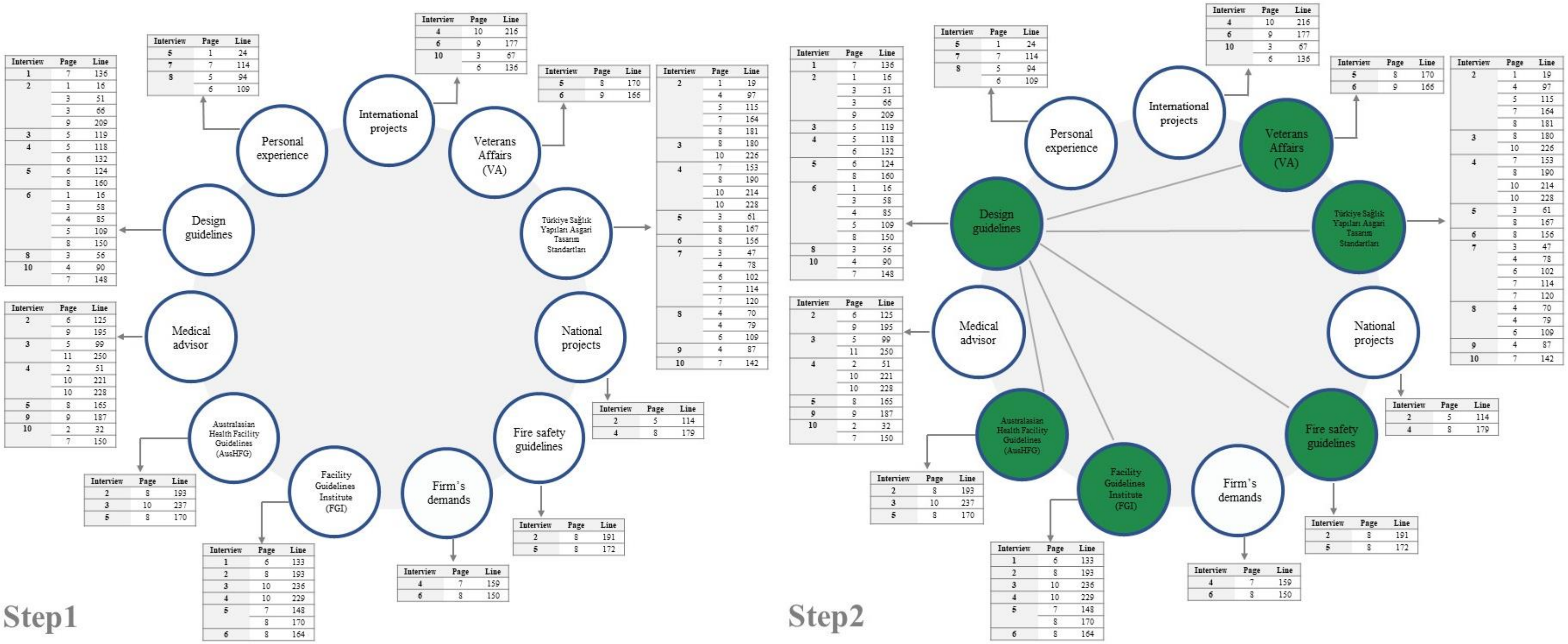



Figure 5.7. Steps of the Searching themes related to the design sources: Steps 1 & 2 (By the researcher)

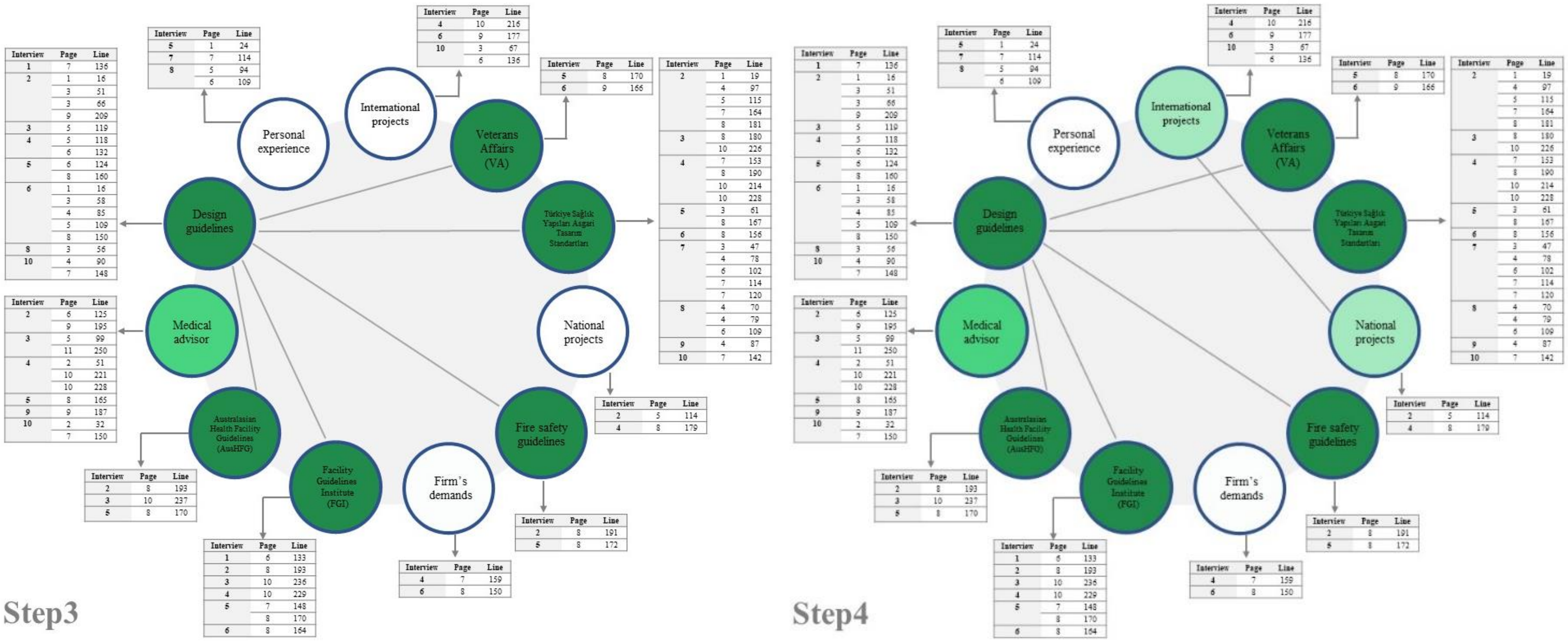



Figure 5.8. Steps of the Searching themes related to the design sources: Steps 3 & 4 (By the researcher)

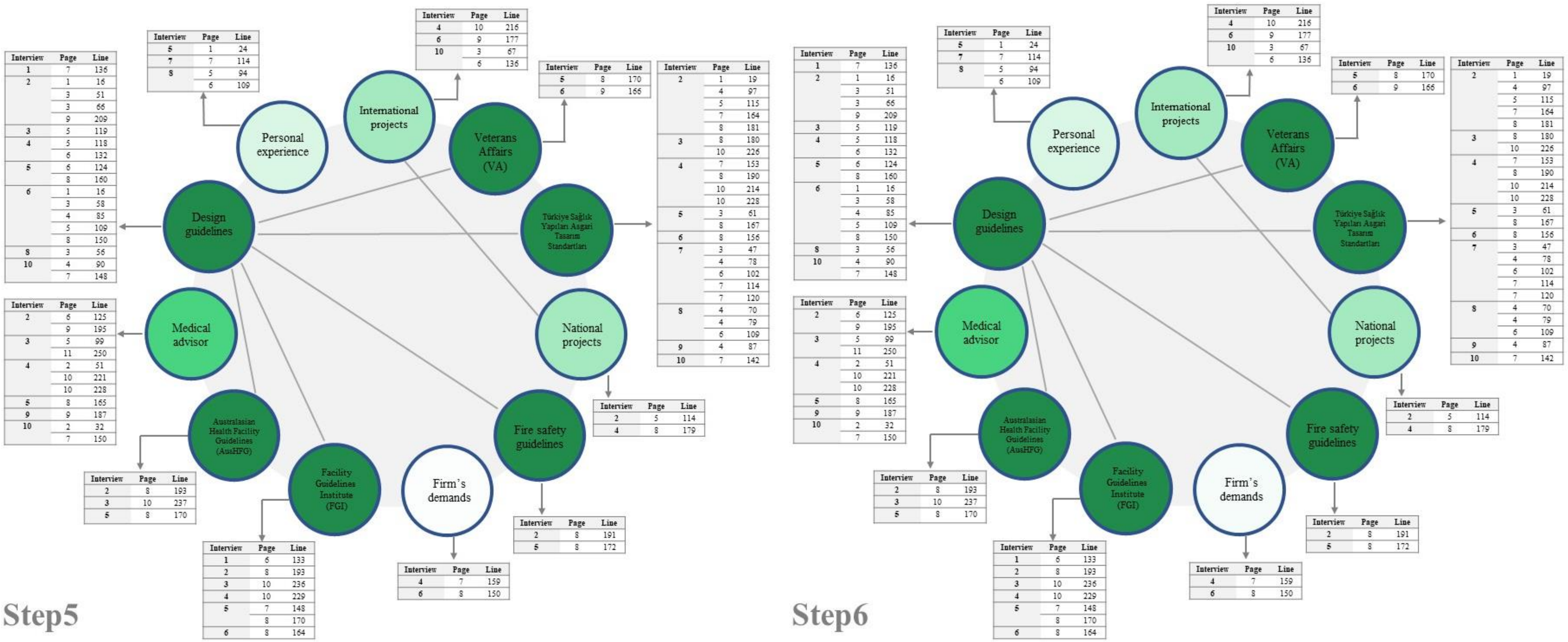



Figure 5.9. Steps of the Searching themes related to the design sources: Steps 5 & 6 (By the researcher)

## 5.4 Reviewing themes

For the ultimate refinements of themes, the researcher reviewed extracted themes regarding the purpose of the interview to remove repeated or unrelated codes. Extracted themes associated with together meaningfully while there were clear and identifiable distinctions among them. The consistency of findings also enhanced the reliability of the analyzing process. The researcher found the similarity between *systematic review* findings and the TA's findings.

## 5.5 Naming themes

Finally, the researcher named and defined extracted themes, including accessibility features in *ICU*s and design sources of *ICU*s. As shown in Figure 5.10, accessibility features in *ICU*s include five main themes: (a) unit model, (b) unit layout, (c) unit size, (d) life support system, and (e) material.

Almost extracted themes related to the design sources identified in five main themes: (a) design guidelines, (b) medical advisor, (c) design projects, (d) personal experiences, and (e) firm's demands (Figure 5.11).

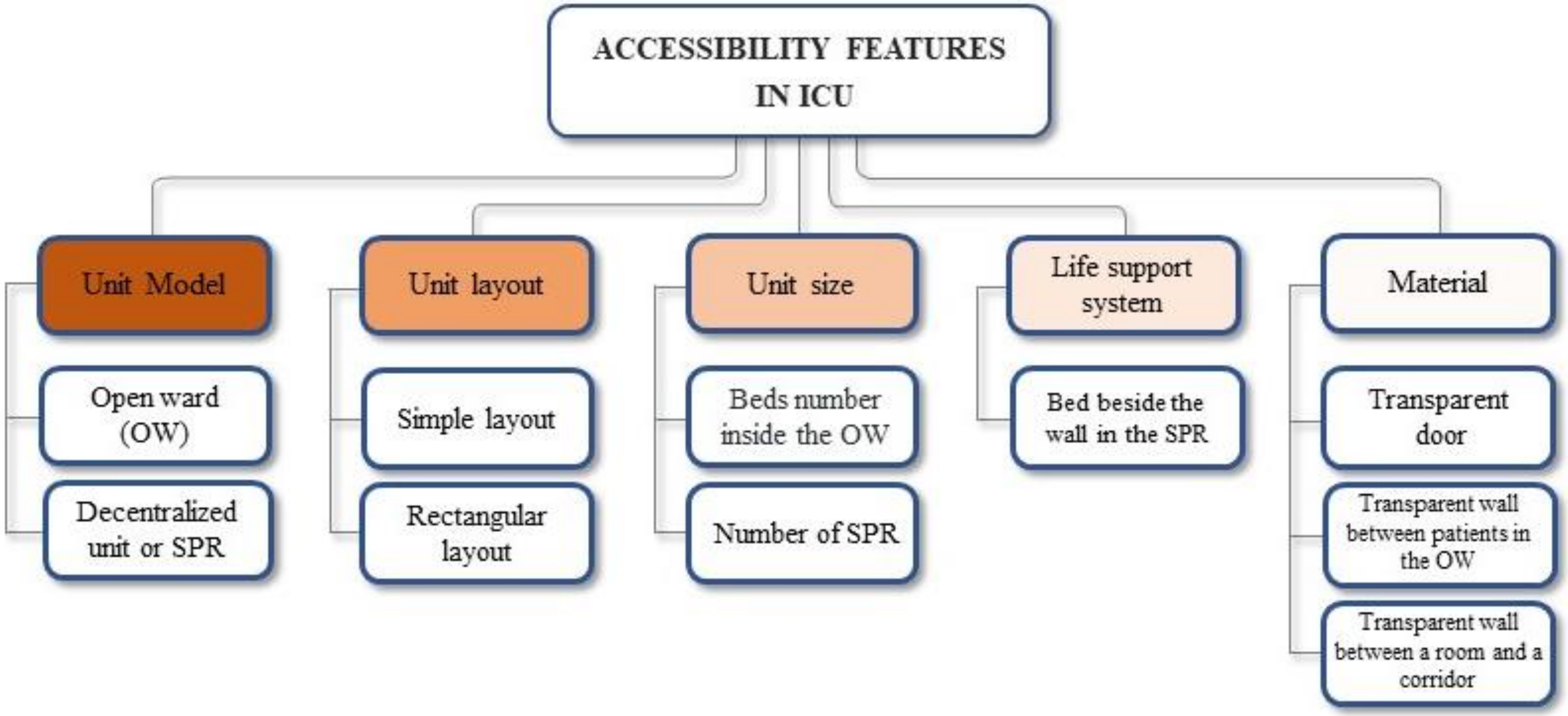



Figure 5.10. Accessibility features in ICUs (By the researcher)

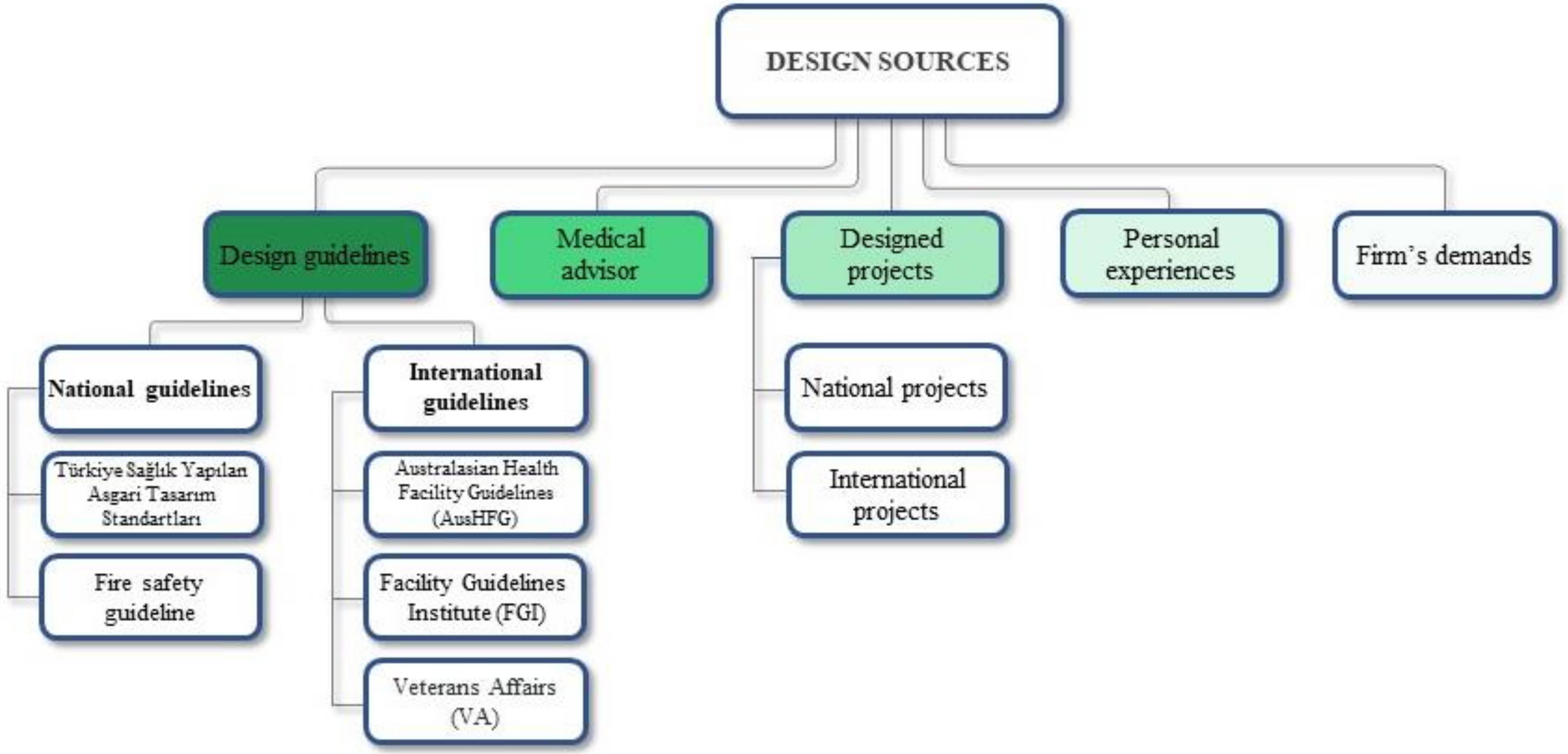



Figure 5.11. Design sources (By the researcher)

The TA's findings were reported to elaborate on the meaning of the extracted themes by describing a label of the theme, the meaning of the theme, and quotations from the transcriptions related to the theme. In this manner, the researcher reported themes in two parts as follows:

**Part 1) Accessibility features in *ICU*s**

***a. Unit model:*** With careful attention to what each participant said in the interviews, the researcher determined the unit model, including open ward and single patient room as the accessibly features in *ICU*s.

- **Open ward:** Eight of ten participants mentioned an open ward throughout interviews that impacted *visual and physical accessibility* in *ICU*s. These participants generally used the word an arena plan in their statements that mentioned to the open ward model. For instance, ***P6*** described that an arena plan is a multi-bedroom *ICU* that provides an overall observation of all patients (Figure 5.12).

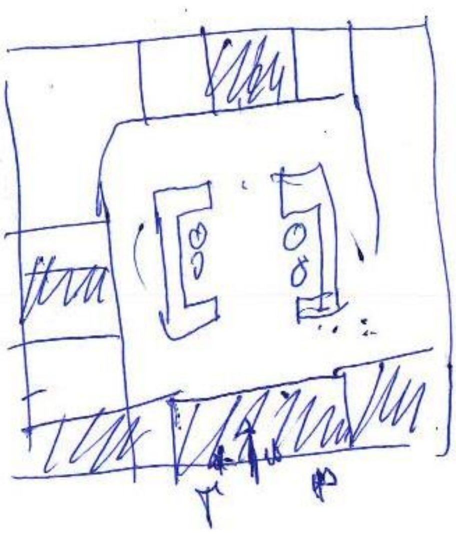


Figure 5.12. Open ward of *ICU* (I.6, p.7)

Another participant mentioned the open ward as an arena plan is a multi-bedroom *ICU* that provides an overall observation of all patients When asked types of architectural layout in *ICU*'s design, ***P5*** shared, "In my opinion, *ICU* should be design based on an arena plan….because it is the most healthy design model. These are patient beds, and they should be located in an observable place by a nurse" (Figure 5.13).

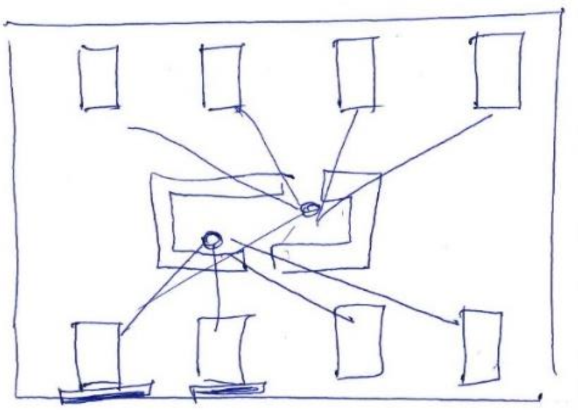


Figure 5.13. Open ward of *ICU* (I.5, p.4)

***P10*** described the necessity of the relations between patients and nurses within *ICU*s. She empathized with the location of the nurse space in an open ward to provide observation to all patients. She said, "…we design nurse station in the central part of the arena plan." Also, ***P7*** discussed the physical relations between patient and nurse's space and said,

> It is very important to take patients under control all the time. So, we design an arena plan that nurses can control the patients very comfortably. And we design the nurse station in the center or beside the unit.

Almost, ***P2*** talked about the location of the nurse station in an open ward. She said that the nurse space could locate beside the open ward to observe and control all patients by nurses (Figure 5.14).

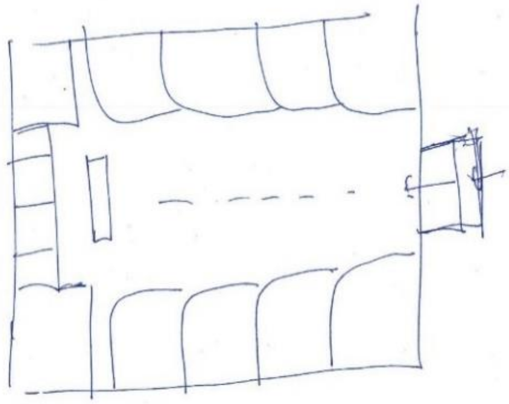


Figure 5.14. Open ward of *ICU* (I.2, p.6)

In an open ward, ***P7*** preferred nurse station in the central part of the unit and shared, "….we can design nurse station beside the ward…and in the central part of unit….but nurse station in the beside of the unit occupies more space within the unit" (Figure 5.15)

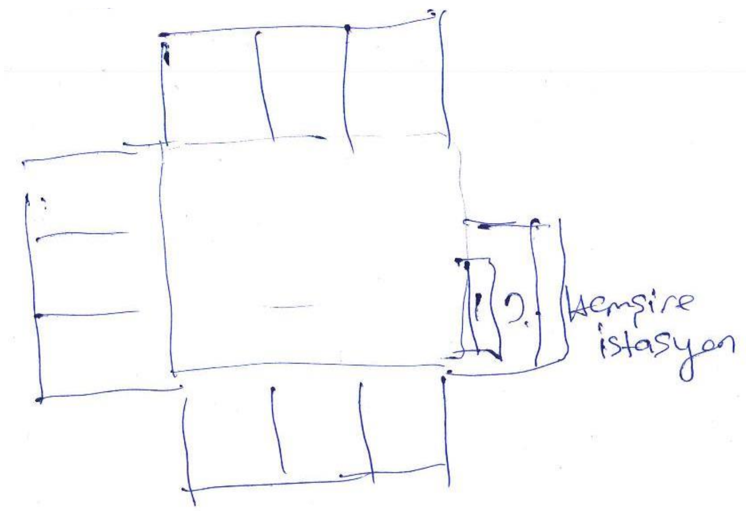



Figure 5.15. Open ward of *ICU* (I.7, p.3)

Some participants also preferred an open ward more than a single patient room to provide physical relations between patient and nurse's space in *ICU*. For instance, ***P5*** said, "…., we always attempt to design nurse station in the central part of the *ICU*…both unit model (open ward and SPR) are suitable for *ICU*…," but he emphasized, "Open ward is certainly more suitable than SPR."

Some participants also emphasized quick interferences with patients in an open ward. ***P8*** explained an arena plan with easy observation and interference with all patients and said, "A nurse can easily see and interfere with all patients in an arena plan." As similar, ***P10*** said that open ward is more practical than a single patient room (SPR) in terms of easy access to patients without wasting time. She implied to the disadvantage of a single patient room and explained, "…there isn't enough staff in Turkey….. in this situation, nurses waste time to enter the single-patient rooms for interfering with patients."

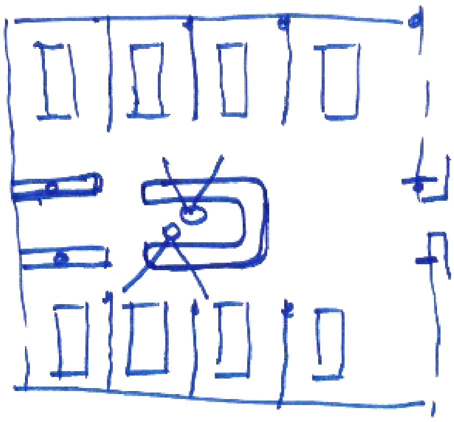


Figure 5.16. Open ward of *ICU* (I.10, p.3)

- **Single patient room (SPR):** SPR is another kind of *ICU* design model with a separate room for each patient. ***P2*** talked about the single patient room and said, "One room should be considered for each patient in *ICU* ….. because of the critical situation of patients in this unit." Eight participants shared their opinions about the relation between SPR and the accessibility to patients in *ICU*s. They emphasized an observation station between two rooms to provide easy access to patients in SPR. ***P6*** described that small nurse station places between two paint rooms to provides maximum visibility to patients from small nurse stations between two patient rooms.

***P10*** believed, "In my opinion, the single rooms are suitable for privacy and convenient access to patients" (Figure 5.17).

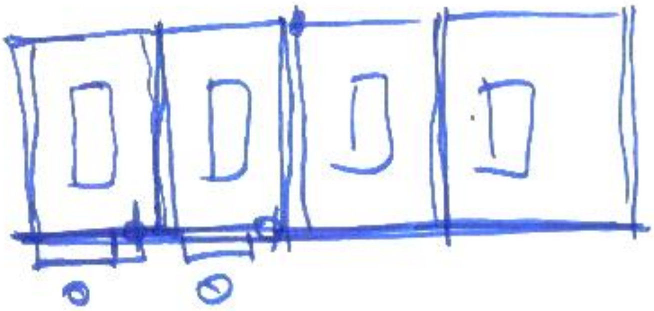


Figure 5.17. Single patient room of *ICU* (I.10, p.4)

Similarly, ***P3*** talked about the observation station between two rooms and drew two kinds of the observation station's patient desk, as seen in the below the figure.

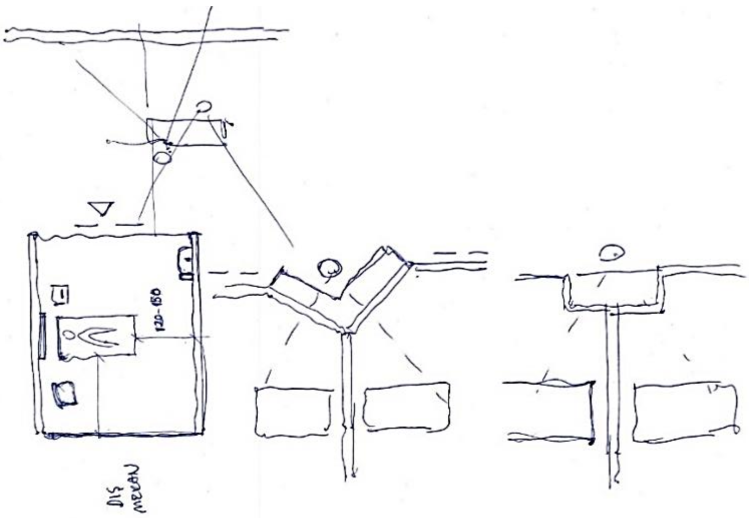


Figure 5.18. Single patient room in *ICU* (I.3, p.9)

Also, participants talked about the impacts of guidelines on their decision- making process. For instance, ***P8*** emphasized to design a single patient room *ICU* based on health ministry standards to control patients suitably. He drew SPR with a nurse station beside the unit and observation stations between two rooms to control and observe patients.

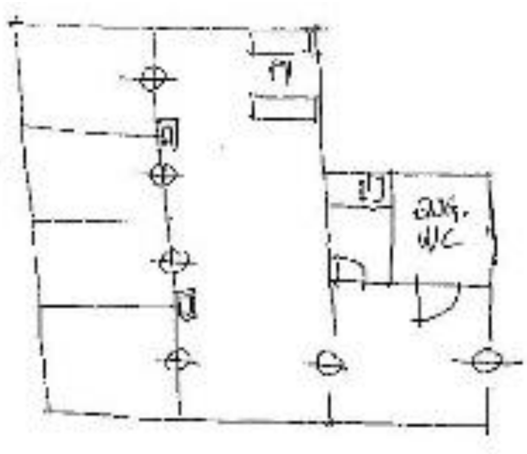


Figure 5.19. Single patient room (I.8, p.3)

Similarly, ***P7*** explained a single patient room designed based on health ministry guidelines with one central nurse station and a small nurse station between two rooms (Figure 5.20). He also mentioned needing more staff in SPR rather than an open ward model.

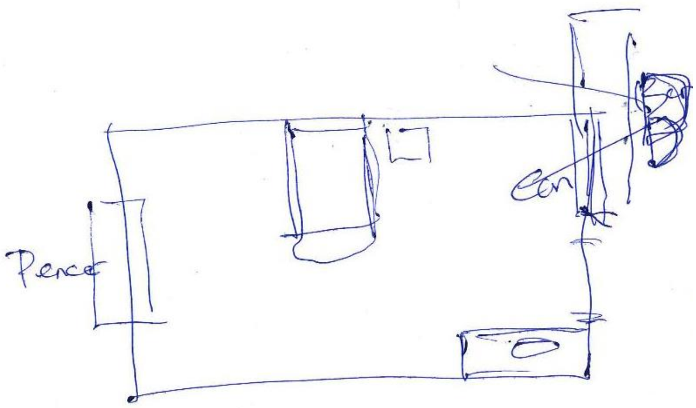


Figure 5.20. Patient room inside *ICU* (I.7, p.7)

***b. Unit layout:*** Participants discussed the unit layout as a theme of accessibility feature involved a simple layout and a rectangular layout. Unit layout specifies organizations of spaces and connections between different spaces inside units.

- **Simple layout:** Two of the ten participants mentioned using a simple layout in *ICU*'s design process. ***P2*** explained her experience of designing the simple layout in the *ICU*. She preferred a simple layout *ICU* with minimum corners and shared, "Standards want the minimum number of corners because more corners create more problems for patients' observation."

- **Rectangular layout:** Four of the ten participants implied on the rectangular layout as a unit layout that provides suitable observation to patients. For instance, ***P2*** shared, "…. the rectangular layout is a suitable layout for observing patients in *ICU*" (Figure 5.21).

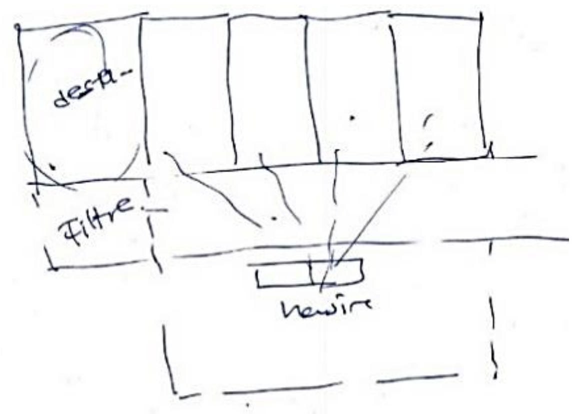



Figure 5.21. Floor plan of *ICU* (I.2, p.4)

***P3*** also referred to the rectangular layout to provide a suitable observation to patients. ***P7*** shared his opinions about rectangular layout and said, "*ICU* in a rectangular shape could be an appropriate *ICU* layout. In my opinion, patients' control and observation is easy in this kind of layout."

Additionally, participants talked about the impacts of the design guidelines on *ICU*s' layout. For instance, ***P4*** said, "…health ministry wants from designers to design the *ICU* in a rectangular shape."

***c. Unit size:*** Participants implied that a unit size was determined as an accessibility feature in *ICU*s defined based on the bed number in *ICU*s with OW and SPR model.

- **Number of beds in the OW:** When the researcher asked about the general architectural features and equipment of *ICU*s, ***P6*** shared, "based on the design guidelines and standards, there is one nurse for eight patients in the open ward."

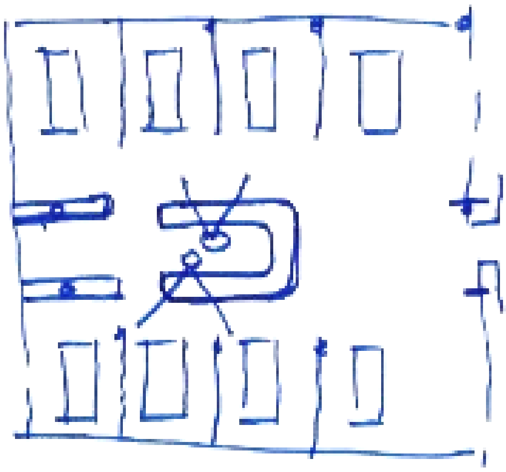


Figure 5.22. Open ward of *ICU* (I.10, p.4)

***P5*** explained OW as an *ICU* design model and drew an open ward with eight patient beds and a nurse station in the center (Figure 5.23).

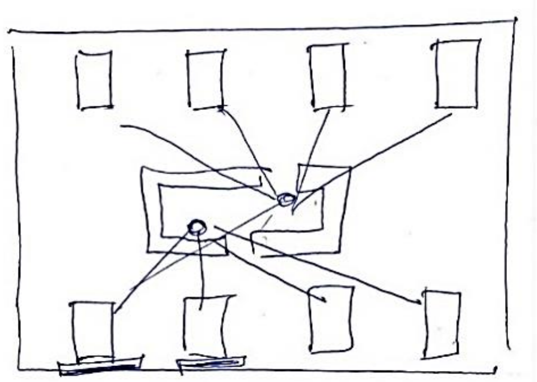


Figure 5.23. Open ward of *ICU* (I.5, p.4)

- **Number of SPR:** One of the participants referred to the bed number in SPR. ***P5*** talked about SPR as a suitable *ICU* design model and drew the *ICU* with eight single-patient rooms and two isolation rooms.

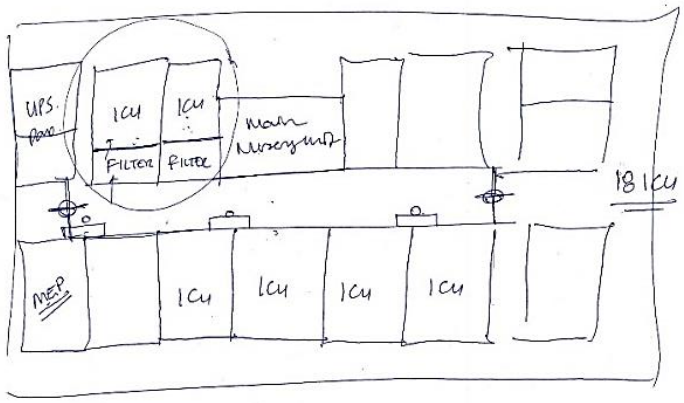



Figure 5.24. Single patient room of *ICU* (I.5, p.5)

***d. Life support system:*** Life support systems impact an arrangement of the patient room, especially on the bed position inside a single room.

- **Bed beside the wall in SPR:** In the current interview, when the researcher asked properties of the patient room, several participants shared their opinions about one kind of a life support system, including the headwall system. They generally designed the patient bed beside the wall in SPR. ***P5*** shared, "We put the patient bed beside the wall, and staff couldn't access patients just from the behind of the patient"  (Figure 5.25).

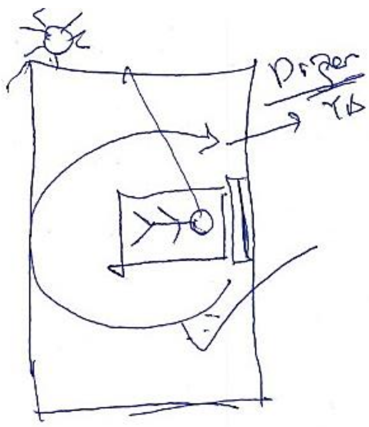


Figure 5.25. Patient's bed position inside *ICU* (I.5, p.7)

Participants such as ***P4*** indirectly mentioned the bed position within SPR. He drew the single patient room and showed a bed beside the wall (Figure 5.26).

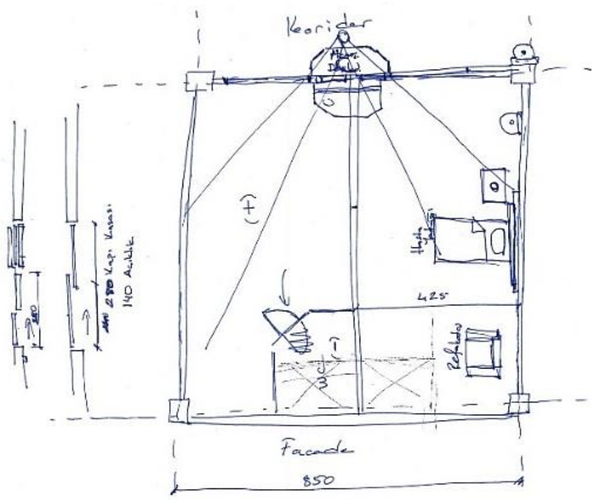



Figure 5.26. Patient’s bed position inside *ICU* (I.4, p.8)

Almost, ***P3*** believed that placing a patient bed beside the wall is suitable than in the middle of SPR. He also explained that in this position, nurses could observe patients from the corridor efficiently.

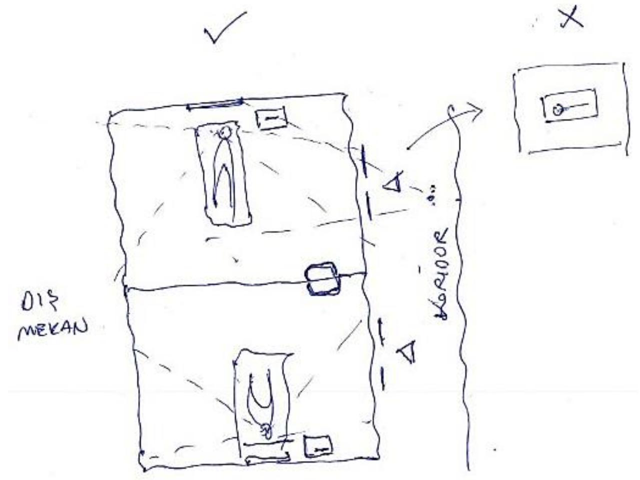



Figure 5.27. Patients’ beds position inside room (I.3, p.4)

Additionally, participants referred to the impacts of guidelines on a bed position in *ICU*. ***P6*** shared that the health ministry just allows putting a patient bed behind the wall within SPR (Figure 5.28).

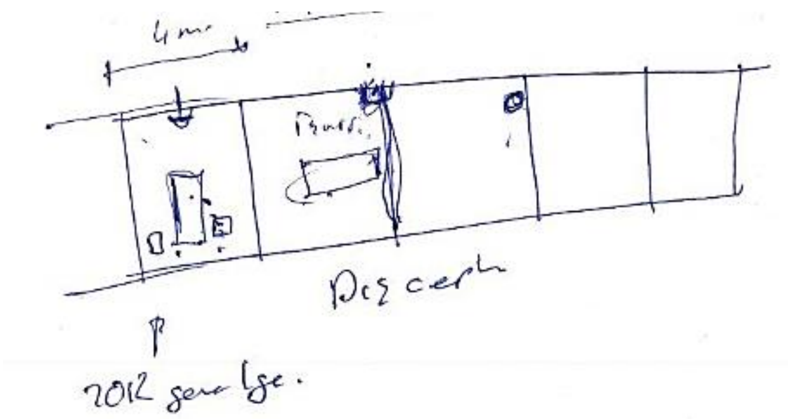


Figure 5.28. Patient room inside *ICU* (I.6, p.6)

***e. Material:*** According to the statements in the current interview, participants recommended using transparent material such as a glass door or transparent wall between patients to produce constant observation to patients.

- **Transparent door:** ***P4*** shared their experience about general architectural features and equipment of *ICU* and said, "…specially in *ICU*'s patient rooms, the door of rooms are designed with glass,…… to observe the patients." ***P6*** mentioned to the design guidelines about *ICU* design and shared, "Our guidelines stated that nurse desks should observe patients directly. For this reason, we design all room doors and the wall between rooms and nurse desk with a glass" (Figure 5.29).

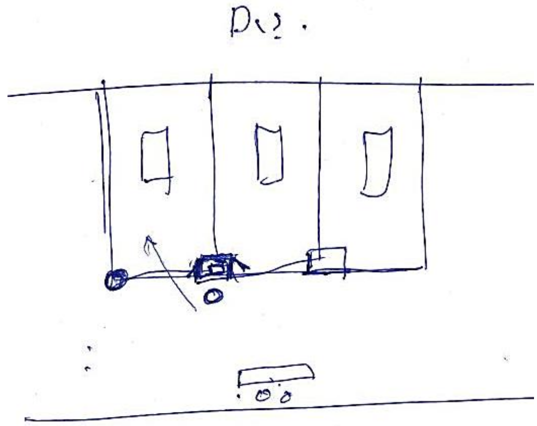


Figure 5.29. Patient room inside *ICU* (I.6, p.7)

- **Transparent wall between patients in the OW:** ***P3*** emphasized the importance of patients' visibility in an open ward and said, "a nurse who observes patients should see patients very clear. In this way, we can use windows or transparent glasses between patients." Other participants such as ***P6***, ***P7***, and ***P8*** also shared their opinions about using the curtain or transparent wall between patients to provide visual access to patients in OW.
- **Transparent wall between a room and a corridor:** Four of the ten participants talked about the transparent wall between a room and a corridor in SPR. For instance, ***P6*** mentioned the glass wall or window between a patient room and an observation station to provide physical relations between patient and nurse's space. Similarly, ***P4*** stated, "the role of nurses is essential in the SPR because they always have to be in constant visual connection with patients. Therefore, we usually try to use transparent glass." He drew an observation station with a window and a glass door to observe patients from the corridor without entering the patient room.

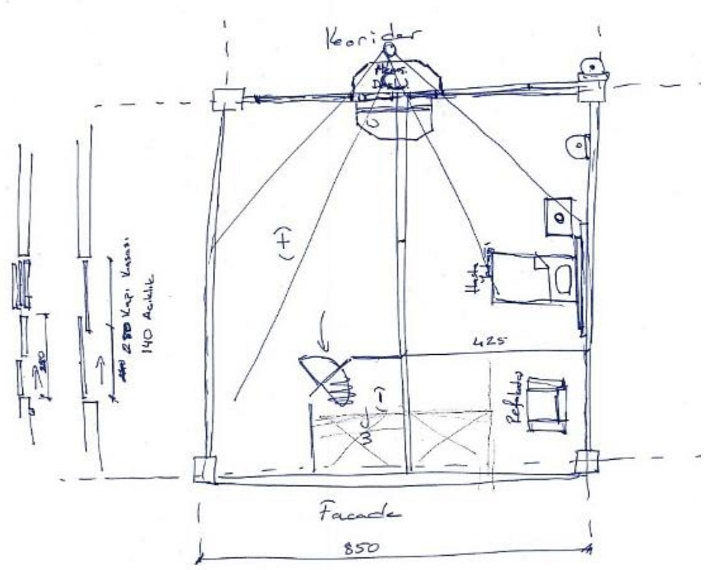



Figure 5.30. Patient room inside *ICU* (I.4, p.9)

***Part 2) Design sources***

The researcher determined five design sources, including design guidelines, medical advisor, designed projects, personal experiences, and firm's demands. Each design source was described as referring to participants' statements as follows:

**a)** ***Design guidelines:*** Among referred design sources, many of participants mentioned using the national and international design guidelines in the *ICU* design process. ***P2*** believed that designers could not intervene more in the *ICU* design because they should consider the guidelines in the design process. ***P4*** talked about the considering guidelines in designing *ICU* spaces, such as the dimension of spaces. Also, ***P6*** discussed the number of patient beds in *ICU* with refining to the guidelines and standards. Additionally, ***P10*** shared, "Guidelines sometimes change in various design subjects, and we have to change our designs based on the new guidelines because designed projects are controlled according to the new guidelines."

As a whole, the researcher determined two kinds of design guidelines involving national and international guidelines.

- **National guidelines:** Participants implied the national guidelines (Turkish design guidelines) as data sources in the *ICU* design process, including:

**Health ministry guidelines** ***(Türkiye Sağlık Yapıları Asgari Tasarım Standartları)***[36]**:** Nine of the ten participants mentioned health ministry guidelines as data sources throughout their interviews. These guidelines define a set of minimum design standards in public and private healthcare facilities to increase the service quality in this field. As described by participants, all designers should consider health ministry guidelines in the *ICU* design process. For instance, ***P2*** *shared*, "We usually design the *ICU* based on SPR with referring to the health ministry guidelines ….". Almost, she stated that designers should use

[36] Retrieved 18, January 2019 from, https://sbu.saglik.gov.tr/Ekutuphane/Yayin/414

the transparent glass or window between a room and a corridor to provide direct observation to patients based on the health ministry guidelines. Similarly, ***P7*** emphasized the importance of the health ministry guidelines and said, "the health ministry wants to locate nurse stations in the middle of the unit."

**Fire safety guidelines (Sağlık Bakanlığı Yangın Önleme ve Söndürme Yönergesi)[37]:** Two of the ten participants mentioned employing the fire safety guidelines in the *ICU* design process. Fire safety guidelines are a set of the rules prescribing minimum requirements to prevent fire and explosion hazards arising from storage, handling, or use of dangerous materials, or other specific hazardous conditions. ***P5*** explained the role of national guidelines such as the fire safety guidelines in the *ICU* design process. ***P2*** also shared, "A lot of guidelines are involved in the *ICU* design process such as the fire safety guidelines."

- **International guidelines:** As national guidelines, participants also mentioned international guidelines as data sources in the *ICU* design process, including:

**Australasian Health Facility Guidelines (AusHFG)[38]:** AusHFG is a set of guidelines that outlines the specific requirements for the planning and design of *ICU*, including a Pediatric Intensive Care Unit (PICU). Three of the ten participants referred to use AusHFG in the *ICU* design process. For instance, ***P2*** shared, "…we don't use just the Turkish design guidelines. We use other regulations such as AusHFG." Almost, ***P5*** stated, "We try to design suitable *ICU* by using various international guidelines such as FGI, VA, and AusHFG."

[37] Retrieved 18, January 2019 from, https://www.saglik.gov.tr/TR,11257/saglik-bakanligi-yangin-onleme-ve-sondurme-yonergesi.html

[38] AusHFG is a set of guidelines that outlines the specific requirements for the planning and design of an Intensive Care Unit (ICU), including a Paediatric Intensive Care Unit (PICU).

**Facility Guidelines Institute (FGI)[39]:** FGI is a set of guidelines that develops rules for the planning, design, and construction of hospitals, outpatient facilities, and residential health, care, and support facilities. As described by the six participants, the FGI was employed as an international guideline in the *ICU* design process. For instance, ***P6*** talked about the international guidelines' role and said FGI is the essential international guideline in the *ICU* design process.

**Veterans Affairs (VA)[40]:** VA is a set of guidelines and supplementary to current technical manuals, building codes, and other VA criteria in planning Healthcare Facilities. Some participants, such as ***P6***, mentioned VA that explains more details about *ICU* design. ***P5 also*** shared, "We try to design suitable *ICU* by using various international guidelines such as FGI, VA, and Australasian guidelines."

**b) Medical advisor:** As discussed by six participants, the medical advisor was determined as a data source in the *ICU* design process. Medical advisor explains the medical and health subjects such as medical systems inside *ICU* to designers. For example, ***P4*** said that designers could not decide on the level of *ICU* in the design process. He stated that medical advisors always decide the *ICU* level and helps designers in similar subjects.

**c) Designed projects:** According to the participants' statements, designers sometimes use national and international projects as data sources in their design process.

- **National projects:** According to ***P2***, designers use past projects to design new projects in Turkey and said, "We design new projects based on the old designed projects." ***P4*** also shared, "We usually use past projects as examples. …., we use old projects and change them based on new design guidelines."

- **International projects:** International projects are a kind of concept or hospital projects prepared or designed in foreign countries. As stated by ***P10***, designers used

[39] Retrieved 18, January 2019 from, https://fgiguidelines.org/about-fgi/
[40] Retrieved 18, January 2019 from, https://www.cfm.va.gov/til/dGuide/dgInpatientNU.pdf

international projects and changed them based on Turkey's design guidelines. ***P6*** also emphasized on using international projects as concept projects. Some participants believed that there are nurses' lacks in Turkey. Thus, international projects designed based on SPR could not be suitable for Turkey because they need more staff in *ICU*.

**d) Personal experience:** Participants discussed using their personal experiences in the *ICU* design process. The personal experience of designers involves their skills, knowledge, or information about design problems. Three participants referred to use their personal information in the *ICU* design process. As described by ***P8***, designers use their skills, for instance, to provide physical relations between patients and nurses' space within *ICU*.

**Firm's demands:** Firm's demands are needs of architectural firms or companies that wants consider in the design process. Some participants talked about the firm's demands and the impacts of them on the design decisions. For instance, ***P6*** stated, "We usually design units based on firm's demands". ***P4*** explained that the firm's demands might change from one project to another one. So, designers should consider the mentioned demands in the *ICU* design process.

As a whole, TA was used to analyze data deductively and findings reported by referring to participants' statements. Mentioned findings were evaluated and discussed by referring to SR's findings in the following part.

## 5.6 Evaluation and discussion

As mentioned in the previous part, semi-structured interviews were conducted with ten healthcare architects selected by the snowballing method to understand architects' opinions and experiences.Qualitative data was gathered in terms of the verbal (using open-ended and close-ended questions) and visual data (using participants' sketches). The qualitative data was analyzed through deductive TA using the defined codes presented in chapter four. After the TA process, architects' opinions about the *ICU*'s accessibility features were disclosed in the five main categories, including unit model, unit layout, unit size, life support systems, and material.

As seen in Figure 5.31, the TA and *SR*'s findings were compared to evaluate the architects' concern about accessibility features in *ICU*s. The pink color specified TA findings, and the *SR*'s findings were specified by orange color as follows:

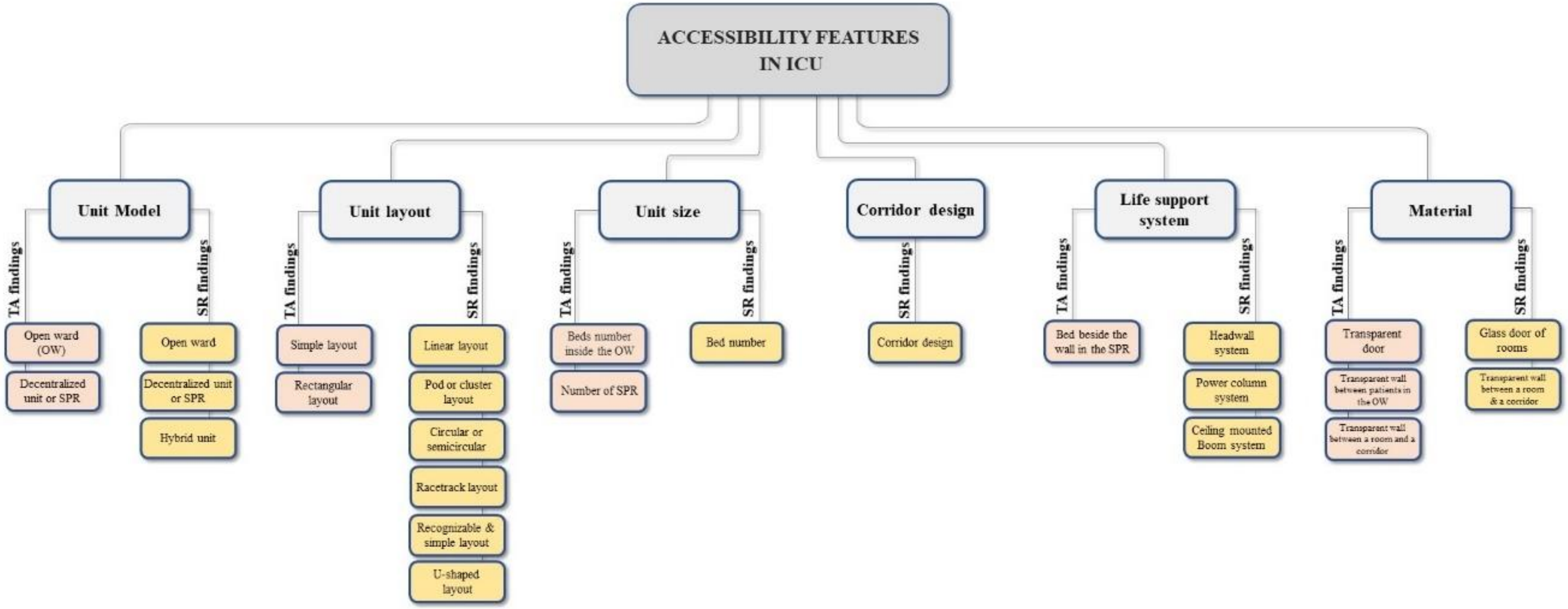



Figure 5.31. Accessibility features in *ICU*s: TA & *SR* findings (By the researcher)

According to the TA findings, two kinds of unit models were determined as *ICU*s' accessibility features. Architects generally implied two kinds of *ICU* design models included the open ward and single-patient room. They mentioned the impacts of each unit model on the observation and access to the patients in *ICU*. Many architects discussed the open ward or multi-bedroom that provides an overall observation to all patients. They said stated that patient beds should be located in an observable place by a nurse. In this way, the open ward plan allows patients to arrange patients' beds in an observable place where nurses can control all patients very comfortably from the central nurse station.

Architects also mentioned providing the relations between patients and nurses in *ICU*s by centralizing the nurse station or placing it beside the open ward unit. Architects preferers an open ward more than a single patient room because of quick interference and access to patients without wasting time in an open ward.

Throughout interviews, architects shared their experiences about SPR and emphasized an observation station between two patient rooms to provide maximum *visual and physical accessibility* to patients in *ICU*s. Meanwhile, architects talked about the impacts of design guidelines on their design decision in *ICU* design, and they underlined the importance of the design guidelines, especially health ministry guidelines. According to their statements, the SPR unit model selects based on design guidelines that involve a central nurse station and an observation station between two rooms.

On the other hand, architects stated the disadvantage of the SPR model in Turkey. This kind of *ICU* model generally needs more staff than an open ward. Because of the lack of nurses in Turkey, architects believed that the SPR model could not be suitable for providing quick access and constant observation to patients in *ICU*s. According to the mentioned importance of design guidelines, architects addressed the limitations of their interference in *the ICU* design process. Regarding *SR* findings, the hybrid model as accessibility features in *ICU*s did not refer by architects throughout interviews. As a whole, architects mainly talked about designing *ICU* based on the SPR model referred to in the design guidelines.

Additionally, architects didn't talk about the other kinds of *ICU*, such as neonatal *ICU*, mentioned in the *SR*'s findings.

Architects talked about the unit layout as accessibility features in *ICU*s that specifies organizations of spaces and connections between different spaces inside units. Architects mentioned simple layout and rectangular layout as suitable layouts to provide quick access and constant observation to patients in *ICU*s. They addressed the design guidelines that emphasize on a simple layout *of ICU* with minimum corners and rectangular shape of *ICU* to provide high visibility to patients. Regards to *SR*, findings referred to more other kinds of *ICU* layout of the *ICU* layout, such as linear, cluster, circular, and racetrack layout that architects did not mention them throughout the interviews. Architects generally emphasized the simplicity in *ICU* layout by considering the design guidelines of *ICU*.

The researcher extracted the unit size as the accessibility feature in *ICU* from architects' sketches. As mentioned earlier, unit size can impact on the patients' observation ad physical access to patients. Some architects mentioned the number of beds throughout explaining the *ICU* design model and showed the bed numbers within the open ward and SPR of *ICU*s in their drawings. They showed the open ward and SPR with eight patients' beds with referring to design guidelines. As mentioned earlier, systematic review findings discussed *ICU*s larger than 8–9 beds that should be broken into pods or clusters of eight beds to provide the *visibility and physical accessibility* to patients. Architects did not talk about the cluster design in *ICU*s and just mentioned to consider the number of beds based on the design guidelines in *ICU*s.

As mentioned in chapter one, life support systems can impact an arrangement of the patient room, especially on the bed position inside the SPR unit and *visual and physical accessibilit*y. Some architects showed the bed position in SPR in their sketches throughout the interviews. For instance, architects showed the patients' bed beside the wall that implied to use the headwall systems in SPR. In the headwall system, the patient bed places beside the wall, and staff couldn't access patients just from the patient's behind. Architects emphasized the importance of the design guidelines through *ICU* design and mentioned that design guidelines suggest this kind of life support system and placing beds beside the wall in SPR.

*SR* findings also mentioned the power column ceiling-mounted systems and impacts on visual and physical access to patients while architects just talked about the headwall system and placed patient beds beside the wall of SPR. *SR* finding discussed the ceiling boom that offers the desired flexibility to caregivers by allowing support services to be placed at various locations around the patient in easy access to them in *ICU*.

Finally, architects discussed the utilized materials in *the ICU*s environment to provide high observation and constant patient control. They generally recommended using transparent material such as a glass door or a transparent wall between patients. Architects emphasized glass doors in SPR and windows between the observation station and corridor in SPR based on the guidelines, especially health ministry guidelines. They also talked about using the windows or transparent glasses between patients in an open ward *ICU* to enhance the patients' control from central nurse stations. Regards to *SR* findings, studies additionally mentioned foldaway or breakaway glass doors that can enhance visibility and quick access to the patient in *ICU*s.

As a whole, architects' knowledge was disclosed about the *visual and physical accessibility* features in *ICU* through fifteen interview questions. According to the mentioned summary and discussion of findings, architects' concerns about accessibility features in *ICU* were evaluated by referring to the *SR* findings. Following to answer the third research question, data sources of architects in the *ICU*'s design process, generally discovered by asking the last part of the interview question. As mentioned in chapter four, design sources of architects were extracted by deductive TA and categorized into five main themes that were involved design guidelines (national and international), medical advisor, designed projects (national and international), personal experiences, and firm's demands.

As mentioned in chapter four, each design source was explained by referring to architects' statements through interviews. Architects mostly mentioned using design guidelines in terms of national and international guidelines through the *ICU* design process. They mentioned using design standards through designing an *ICU* design model, *ICU* layout, bed position in SPR, beds' number, and equipment within SPR and open ward. Architects believed in their limited interferences in the *ICU* design process because they considered design guidelines in their decision- making process.

According to TA findings, two kinds of guidelines employed by architects in *ICU* design included national and international. National guidelines mentioned by architects were included "Türkiye Sağlık Yapıları Asgari Tasarım Standartları" and "Sağlık Bakanlığı Yangın Önleme ve Söndürme Yönergesi." Architects mostly mentioned utilizing "Türkiye Sağlık Yapıları Asgari Tasarım Standartları" is more than another guideline in the *ICU* design process. As mentioned earlier, most architects highlighted some critics about the national design guidelines such SPR design model because of the lack of nurses in Turkey. International guidelines were also referred by architects involved in AusHFG, FGI, and VA. Among the mentioned international guidelines, architects mostly implied using FGI and VA because they provided more details about the *ICU* standards. In addition to the mentioned design guidelines, architects almost implied medical advisors' role as design sources in their decision-making process. Architects stated that medical advisors could help designers make the right decisions related to *ICU*s' medical or health subjects.

Design projects were extracted as other design sources in *ICU*s. Architects explained that designed projects were employed to design new *ICU*s by adding architectural changes based on the national design guidelines. Architects also mentioned using the concept projects designed by foreign firms in Turkey. Architects employed concept projects after changing based on national design guidelines. Meanwhile, architects emphasized to use their personal experiences achieved from previous *ICU*s' projects. Throughout interviews, architects mostly referred to their previous *ICU*s' design experiences and used them to provide high *visual and physical accessibility* to patients in *ICU*s. The firm's demands were also mentioned as a design source by architects in *ICU*s. Architects discussed the different demands of the firms about projects that should be considered through the design process.

# CHAPTER 6

# CONCLUSION

This chapter presented some recommendations and conclusions for this study. This study was conducted to evaluate the architects' concern about *visual and physical accessibility* features in *ICU*s by referring to the *EBD* approach. For this reason, this study aimed to understand the *visual and physical accessibility* features in *ICU*s and its impacts on the patients and staff. Secondly, it aimed to clarify the *importance of the EBD* approach to improve *patients' safety* and *staff efficiency* in *ICU*s. Thirdly, it aimed to evaluate healthcare architects' opinions and experiences in *ICU*'s design process by referring to the *EBD* approach. According to these aims, three main questions were answered using observation, systematic review, and semi-structured interviews.

- What are the *visual and physical accessibility* features that impact patients' safety and staff efficiency in *ICU*s?
- How does the *EBD* approach help architects disclose the visual and physical accessibility features that impact patients' safety and staff efficiency in *ICU*s?
- What are the architects' opinions and experiences about the visual and physical accessibility features in *ICU*s, and how architects could achieve their knowledge in the *ICU*'s design process?

The observation part of the methodology aimed to clarify the visual and physical accessibility features that impact patients' safety and staff efficiency in *ICU*s by collecting observational data from two *ICU*s located in Iran *(ICU1)* and Finland *(ICU2)*. In summary, two *ICU*s were observed, and the fieldnote of observations was reported, as discussed in chapter four. Regarding findings, observational findings clarified the *visual and physical accessibility* to patients in two kinds of *ICU*s with a different layout.

Then, the *SR* method was employed to provide credible research evidence about *ICU*'s *visual and physical accessibility* features. Firstly, as described in chapter four, these findings were used as a source for defining codes to analyze the gathered qualitative data thematically. Secondly, they were employed to evaluate the architects' concern about the mentioned features in *ICU* design in the following part of the discussion. In this way, *SR* was clarified that how *EBD* can help architects design a safe and efficient environment in *ICU*s.

Finally, semi-structured interviews were conducted with ten healthcare architects selected by the snowballing method to understand architects' opinions and experiences.. Qualitative data was gathered in terms of the verbal (using open-ended and close-ended questions) and visual data (using participants' sketches). The qualitative data was analyzed through deductive TA using the defined codes presented in chapter four. After the TA process, architects' opinions about the *ICU*'s accessibility features were disclosed in the five main categories, including unit model, unit layout, unit size, life support systems, and material.

The gathered data were evaluated and discussed in chapter five. Based on this evaluation, the study's findings addressed the gap between the *ICU*'s design and research by revealing architects' knowledge about the *ICU*'s *visual and physical accessibility* features. In comparing *SR*s' findings and TA's findings, architects have limited knowledge about the *ICU*s layout, corridor design, and life support system. Almost, there is a lack of knowledge about the new design trends, such as hybrid design and its potential to provide a flexible and accessible environment in the *ICU*.

Architects generally referred to the various design sources that impact their design decisions. Also, *SR's* findings presented the last scientific research suggesting design solutions to provide *visual and physical accessibili*ty in *ICU*s. The architects did not know some of the accessibility features found in *SR*, such as corridor design, that impact patients' *visual and physical accessibility*. Also, they did not have enough knowledge about the life support system in *ICU*s.

Architects' knowledge about the *ICU*'s accessibility features was extensively generated based on cooperation between the mentioned design sources, including design guidelines, medical advisors, designed projects, personal experiences, and firm's demands. For instance, architects implied that they should design a single patient room based on the health ministry's design guidelines. Among design sources, architects generally mentioned employing the design guidelines and concept projects as data sources to provide a visible and accessible environment in *ICU*s.

It is concluded that *EBD* can improve the architects' approach in the *ICU* design process by clarifying the available research evidence. *EBD* is used in the healthcare field and used in other design fields such as educational design or office design. However, hospital design field, there are various and complicated design problems that *EBD* can help to make decisions based on reliable and credible research evidence. *EBD* could also be beneficial to discover the design problems and solve them in the systematic approach.

According to the evaluation, *SR* as a method of *EBD* employed to discover the accessibility features in *ICU*s and provided explicit and comprehensive knowledge about the specific design fled. In comparison with architects' knowledge, *SR* provides more reliable and explicit knowledge about the accessibility features. In contrast, architects described accessibility features by referring to the design guidelines. Architects did not refer to any scientific research findings as a data source in their decision-making process.

According to results, using *SR* can help architects design more safe and efficient *ICU* environment. Architects can consider credible research evidence to provide *visual and physical accessibility* to patients. In this way, it is beneficial for architects to learn the *EBD* approach through their educations and apply it to their design process. Gathering evidence and appraising gathered evidence could be a rigorous process for architects because this process needs time and experience to search for relevant researches. In this way, the hospital design's interdisciplinary team could also employ a researcher to help in conducting the *SR* and gathering credible research evidence.

As mentioned, there is various evidence about accessibility features in *ICU* in various disciplines rather than architectural domains such as nursing. Thus, *SR* assists in gathering and employing various credible research evidence in the design process. Using the evidence of other disciplines such as nursing or psychology helps architects consider the other parameters that can impact *patients' safety* and *staff efficiency* in *ICU*s.

Based on this study's process, some recommendations arose based on the study's data findings and limitations. In chapter four, the observation of *ICU*s in Ian and Finland was reported in terms of accessibility features to patients. Both observed *ICU*s were designed based on the open ward model with the rectangular shape.

Regarding the ethical limitations of the ICUs, the researcher could not find the opportunity to observe the accessibility features of the *ICU*'s based on SPR design model. It is recommended that observing the SPR can significantly help to achieve valuable data about the visual and physical accessibility features in *ICU*. It will also allow the opportunity to compare the accessibility features of the SPR and the open ward design models to clarify each design model's advantages and disadvantages.

As mentioned earlier, COVID-19 increase the significance of *ICU* environments as a vital role in people life. Through this disease, many researchers conducted various researches about the physical environments of *ICU*s. Some of these researches were conducted related to the infection in *ICU*s' environments and lack of enough spaces for patients and staff in *ICU*s. As a whole, *ICU*s' environment always needs to improve physical environments to provide appropriate care for patients. *EBD* approach could be a beneficial method to design safe and efficient environments for patients and staff.

# REFERENCES


Aalto, L., Aalto, L., Lappalainen, S., Lappalainen, S., Salonen, H., Salonen, H., & Reijula, K. (2017). Usability evaluation (IEQ survey) in hospital buildings. *International Journal of Workplace Health Management*, *10*(3), 265-282.

Apple, M. (2014). A comparative evaluation of Swedish intensive care patient rooms. HERD: Health Environments Research & Design Journal, 7(3), 78-93.

Australasian Health Facility Guidelines (AusHFG). (2016). Australasian health facility guidelines.

Bakanlığı, S. (2010). Türkiye Sağlık Yapıları Asgari Tasarım Standartları 2010 yılı klavuzu, Ankara. Sağlık Bakanlığı yayını.

Becker, F. (2007). Nursing unit design and communication patterns: What is "real" work?. *HERD: Health Environments Research & Design Journal*, *1*(1), 58-62.

Becker, F. D. (2007). Closing the research-design gap. Implications, 5(10), 1-5.

Becker, F., & Parsons, K. S. (2007). Hospital facilities and the role of evidence-based design. *Journal of Facilities Management*, *5*(4), 263-274.

Bitner, M. J. (1992). Servicescapes: The impact of physical surroundings on customers and employees. *The Journal of Marketing*, 57-71.

Boardman, A. E., & Forbes, D. (2011). A benefit-cost analysis of private and semi-private hospital rooms. *Journal of Benefit-Cost Analysis*, *2*(1), 1-27.

Bobrow, M., & Thomas, J. (2000). Inpatient care facilities. *Building Type Basics for Healthcare Facilities, RL Kobus, Editor*, 131-193.

Bone, R. C., McElwee, N. E., Eubanks, D. H., & Gluck, E. H. (1993). Analysis of indications for intensive care unit admission: clinical efficacy assessment project: American College of Physicians. *Chest*, *104*(6), 1806-1811.

Bonuel, N., & Cesario, S. (2013). Review of the literature: acuity-adaptable patient room. *Critical Care Nursing Quarterly*, *36*(2), 251-271.

Braun, V. & Clarke, V. (2012a). *Successful qualitative research: A practical guide for beginners*. London: Sage.

Braun, V. & Clarke, V. (2012b). Thematic analysis. In Cooper, H. (Ed.), *The Handbook of Research Methods in Psychology*. Washington, DC: American Psychological Association.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. QualitativeResearch in Psychology, 3(2), 77–101.

Brunton, G., Oliver, S., & Thomas, J. (2020). Innovations in framework synthesis as a systematic review method. *Research Synthesis Methods*, *11*(3), 316-330.Bree, R. & Gallagher, G. (2016). Using Microsoft Excel to code and thematically analyse qualitative data: a simple, cost-effective approach. All Ireland Journal of Teaching and Learning in Higher Education (AISHE-J), 8(2), 2811-28114.

Brown, P. P. (2013). Book Review: Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioral Sciences and Writing Literature Reviews: A Guide for Students of the Social and Behavioral Sciences.

Brown, P., & Taquino, L. T. (2001). Designing and delivering neonatal care in single rooms. *The Journal of perinatal & neonatal nursing*, *15*(1), 68-83.

Bunker-Hellmich, L. (2010). Patient focus. Developments in inpatient unit design. *Health facilities management*, *23*(3), 26.

Byan-Brown CW. (1991). The evolution of critical care medicine: an international exchange. In: Shoemaker WC, Taylor RW (eds) Critical care. State of the art. The Society of Critical Care Medicine, pp 293–309.

Cai, H. (2013). *Making" invisible architecture" visible: A comparative study of nursing unit typologies in the United States and China*. Georgia Institute of Technology.

Cai, H., & Zimring, C. (2013). Understanding cultural differences in nursing unit design with the support of Space Syntax Analysis. *Seoul: Sejong University: Edited by YO Kim, HT Park and K W Seo*.

Cama, R. (2009). *Evidence-based healthcare design*. John Wiley & Sons.

Cama, R. (2010). Linking Structure and Healing: Building Architecture for Evidence-Based Practice. *Introduction to Evidence-Based Practice in Nursing and Health Care*, 77.

Charmaz, K. (2003) 'Grounded Theory', in J.A. Smith (ed.), Qualitative Psychology: A Practicabrl Guide to Research Methods. London: Sage.

Charmaz, K., & Mitchell, R. G. (2001). Handbook of Ethnography. edited by Paul Atkinson, Amanda Coffey, Sara Delamont, John Lofland, and Lyn Lofland.

Chaudhury, H., Mahmood, A., & Valente, M. (2005). Advantages and disadvantages of single-versus multiple-occupancy rooms in acute care environments: a review and analysis of the literature. *Environment and Behavior*, *37*(6), 760-786.

Chaudhury, H., Mahmood, A., & Valente, M. (2006). Nurses' perception of single-occupancy versus multioccupancy rooms in acute care environments: An exploratory comparative assessment. *Applied Nursing Research*, *19*(3), 118-125.

Chong, G. H., Brandt, R., & Martin, W. M. (2010). *Design informed: driving innovation with evidence-based design*. John Wiley & Sons.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.

Cronin, E., Nielsen, M., Spollen, S., Edwards, N. (2007). Adult critical care. Health Care Needs Assessment (HCNA). 3rd series. University of Birmingham.

Cross, N. (1982). Designerly ways of knowing. *Design studies*, *3*(4), 221-227.

Dearholt, D., & Dang, D. (2012). Johns Hopkins Nursing evidence-based practice. *Model and Guidelines*, 2012.

Devlin, A. S., & Arneill, A. B. (2003). Health care environments and patient outcomes: A review of the literature. *Environment and behavior*, *35*(5), 665-694.

Dijkstra, K., Pieterse, M., & Pruyn, A. (2006). Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: systematic review. *Journal of advanced nursing*, *56*(2), 166-181.

Dixon-Woods, M., Agarwal, S., Jones, D., Young, B., & Sutton, A. (2005). Synthesising qualitative and quantitative evidence: a review of possible methods. *Journal of health services research & policy*, *10*(1), 45-53.

Doede, M. (2019). *Neonatal Nurses' Work in a Single Family Room NICU* (Doctoral dissertation).

Facility Guidelines Institute. (2014). Guidelines for design and construction of hospitals and outpatient facilities. American hospital association. American society for healthcare engineering.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. International Journal of Qualitative Research, 5, 80–92. Retrieved from http://ejournals.library.ualberta.ca/index.php/IJQM/article/view/4411/3530

FGI, 2014 Facility Guidelines Institute. (2014). *Guidelines for design and construction of hospitals and outpatient facilities*. American hospital association. American society for healthcare engineering.

Foster, M. J. (2013). Introduction to systematic reviews for healthcare design. *HERD: Health Environments Research & Design Journal*, *7*(1_suppl), 143-154.

Frampton, S. B., Gilpin, L., & Charmel, P. A. (2003). Putting patients first: Designing and practicing patient-centered care.

Frampton, S. B., & Guastello, S. (2010). Putting patients first: patient-centered care: more than the sum of its parts. *AJN The American Journal of Nursing*, *110*(9), 49-53.

France, D. J., Throop, P., Walczyk, B., Allen, L., Parekh, A. D., Parsons, A., ... & Deshpande, J. K. (2005). Does patient-centered design guarantee patient safety?: using human factors engineering to find a balance between provider and patient needs. *Journal of Patient Safety*, *1*(3), 145-153.

Fridh, I., Forsberg, A., & Bergbom, I. (2007). Family presence and environmental factors at the time of a patient's death in an ICU. *Acta anaesthesiologica scandinavica*, *51*(4), 395-401.

Friesen, S., Trojan, L., & Suter, E. (2008). Relating health care environment design to health quality outcomes: Post-occupancy evaluation of the ward of the 21st century. *Health Systems and Workforce Research Unit, Calgary Health Region*.

Gough, D., Thomas, J., & Oliver, S. (2012). Clarifying differences between review designs and methods. *Systematic reviews*, *1*(1), 28.s

Groat, L. N., & Wang, D. (2013). *Architectural research methods*. John Wiley & Sons.

Guest, G., MacQueen, K. M. & Namey, E. E. (2012). *Applied thematic analysis*. Thousand Oaks, CA: Sage.

Gurascio-Howard, L., & Malloch, K. (2007). Centralized and decentralized nurse station design: An examination of caregiver communication, work activities, and technology. *HERD: Health Environments Research & Design Journal*, *1*(1), 44-57.

Haggard, L., & Hosking, S. (1999). Healing the Hospital Environment: Design, Maintenance, and Management of Healthcare Premises.

Haidich, A. B. (2010). Meta-analysis in medical research. *Hippokratia*, *14*(Suppl 1), 29.

Hamilton, D. K. (2011). What constitutes best practice in healthcare design?.

Hamilton, K. (2003). The four levels of evidence based practice. *Healthcare Design, 3*, 18-26.

Hamilton, D. K. (2017). Is ICU Safety Threatened by the Straight Corridor?

Hamilton, D. K. (2017). Evidence, Best Practice, and Intuition.

Hamilton, D. K. (2018). There Is Evidence to Support Design for Health, But Rarely Proof.

Hamilton, K & Shepley, M.M. (2010). *Design for Critical Care: An Evidence-Based Approach*, Routledge.

Hamilton, D. K., & Watkins, D. H. (2008). *Evidence-based design for multiple building types*. John Wiley & Sons.

Hamilton, D. K., & Watkins, D. H. (2009). Evidence-Based Medicine and Healthcare Design. *Evidence-based design for multiple building types. Hoboken New Jersey: John Wiley & Sons*.

Hamm, L. E. W. (2011). *Improving the effectiveness of nursing work area design in inpatient care units* (Doctoral dissertation, Clemson University).

Hendrich, A., Chow, M. P., Bafna, S., Choudhary, R., Heo, Y., & Skierczynski, B. A. (2009). Unit-related factors that affect nursing time with patients: spatial analysis of the time and motion study. *HERD: Health Environments Research & Design Journal*, *2*(2), 5-20.

Heylighen, A., & Neuckermans, H. (2000). Design (ing) knowledge in architecture. *Recherche* et Architecture/Research and Architecture, 231-241.

Higgins, J. P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2019). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons.

Hughes, R. (Ed.). (2008). *Patient safety and quality: An evidence-based handbook for nurses* (Vol. 3). Rockville, MD: Agency for Healthcare Research and Quality.

James, W. P., & Tatton-Brown, W. (1986). Hospitals: design and development: Architectural Press.

Kasali, A. (2013). *An ethnographic study of the role of evidence in problem-solving practices of healthcare facilities design teams* (Doctoral dissertation, Georgia Institute of Technology).

Koch, D., & Steen, J. (2012). Analysis of strongly programmed workplace environments: architectural configuration and time-space properties of hospital work. In *8th International Space Syntax Symposium* (pp. 8146-1).

Knaus, W. A., Draper, E. A., & Wagner, D. P. (1983). The use of intensive care:new research initiatives and their implications for national health policy. *The Milbank Memorial Fund Quarterly. Health and Society*, 561-583.

Lang, J. (1987). Creating architectural theory. *The role of the behavioral sciences in environmental. design.*

Lawson, B. (2005). How designers think: The design process demystified. Burlington, MA.

Lawson, B. (2006). How Designers Think - The Design Process Demystified (4th ed.). Oxford: Architectural Press.

Lawson, B. (2010). Healing architecture. *Arts & Health*, *2*(2), 95-108.

Leaf, D. E., Homel, P., & Factor, P. H. (2010). Relationship between ICU design and mortality. *Chest*, *137*(5), 1022-1027.

Mahmoodi, A. S. (2001). *The design process in architecture: a pedagogic approach using interactive thinking* (Doctoral dissertation,

Malkin, J. (2008). *A visual reference for evidence-based design*. Concord, CA: The Center for Health Design.

Marberry, S. O. (1995). Innovations in healthcare design: selected presentations from the first five Symposia on Healthcare Design. New York: John Wiley.

Marshall, J. C., Bosco, L., Adhikari, N. K., Connolly, B., Diaz, J. V., Dorman, T., ... & Vincent, J. L. (2017). What is an intensive care unit? A report of the task force of the World Federation of Societies of Intensive and Critical Care Medicine. Journal of critical care, 37, 270-276.

McAlister, A., Lee, D., Ehlert, K. M., Kajfez, R. L., Faber, C. J., & Kennedy, M. S. (2017). Qualitative coding: An approach to assess inter-rater reliability. In *Columbus, Ohio https://peer asee org/28777: ASEE Annual Conference & Exposition*.

McCullough, C. S. (Ed.). (2010). *Evidence-based design for healthcare facilities*. Sigma Theta Tau.

McElheny, J., Gokhale, S., & McDonagh, D. L. (2015). Neurosurgical Intensive Care Unit. In Comprehensive Guide to Neurosurgical Conditions (pp. 19-31). Springer, Cham.

Newell, S., & Jordan, Z. (2015). The patient experience of patient-centered communication with nurses in the hospital setting: a qualitative systematic review protocol. *JBI database of systematic reviews and implementation reports*, *13*(1), 76-87.

Newcomb, E. M. D. (2011). *Critical Communication: Observing How ICU Environments Impact Nurse Communication*. Arizona State University.

Nightingale, F. (1863). *Notes on hospitals*. Longman, Green, Longman, Roberts, and Green. Newcomb, E. M. D. (2011). *Critical Communication: Observing How ICU Environments Impact Nurse Communication*. Arizona State University.

Nightingale, F., & McDonald, L. (2012). *Florence Nightingale and Hospital Reform: Collected Works of Florence Nightingale, volume 16* (Vol. 16). Wilfrid Laurier Univ. Press.

Ozcan, H. (2006). *Healing design: a phenomenological approach to the relation of the physical setting to positive social interaction in pediatric intensive care units in the United States and Turkey* (Doctoral dissertation, Texas A&M University).

Paez, A. (2017). Gray literature: An important resource in systematic reviews. *Journal of Evidence-Based Medicine*, *10*(3), 233-240.

Pati, D. (2011). A framework for evaluating evidence in evidence-based design. *HERD: Health Environments Research & Design Journal*, *4*(3), 50-71.

Pati, D., Harvey Jr, T. E., Reyers, E., Evans, J., Waggener, L., Serrano, M., ... & Nagle, T. (2009). A multidimensional framework for assessing patient room configurations. *HERD: Health Environments Research & Design Journal*, *2*(2), 88-111.

Pati, D., Harvey Jr, T. E., Redden, P., Summers, B., & Pati, S. (2015). An empirical examination of the impacts of decentralized nursing unit design. *HERD: Health Environments Research & Design Journal*, *8*(2), 56-70.

Peavey, E., & Vander Wyst, K. B. (2017). Evidence-Based Design and Research-Informed Design: What's the Difference? Conceptual Definitions and Comparative Analysis. *HERD: Health Environments Research & Design Journal*, 1937586717697683.

Peng, M., Qian, Z., & Zhang, L. (2020). Care for Critical Ill Patients With COVID-19: Establishment of a Temporary Intensive Care Unit in an Isolated Hospital. *Frontiers in Medicine*, *7*, 519.

Peponis, J., Ross, C., & Rashid, M. (1997). The structure of urban space, movement and co-presence: the case of Atlanta. *Geoforum*, *28*(3), 341-358.

Philbin, M. K., & Evans, J. B. (2006). Standards for the acoustic environment of the newborn ICU. *Journal of perinatology*, *26*(3), S27-S30.

Preiser, W. F., White, E., & Rabinowitz, H. (2015). *Post-Occupancy Evaluation (Routledge Revivals)*. Routledge.

Rashid, M. (2006). A Decade of Adult Intensive Care Unit Design: A Study of the Physical Design Features of the Best-Practice Examples. *Critical care nursing quarterly*, *29*(4), 282-311.

Rashid, M. (2009). Hospital Design and Face to Face Interaction among Clinicians: A Theoretical Model. *HERD: Health Environments Research & Design Journal*, *2*(4), 62-84.

Rashid, M. (2007). Developing scales to evaluate staff perception of the effects of the physical environment on patient comfort, patient safety, patient privacy, family integration with patient care, and staff working conditions in adult intensive care units: a pilot study. *Critical care nursing quarterly*, *30*(3), 271-283.

Rashid, M. (2014). Two decades (1993-2012) of adult intensive care unit design: A comparative study of the physical design features of the best practice examples. *Critical care nursing quarterly*, *37*(1), 3-32.

Rashid, M., & Zimring, C. (2003). Organizational constructs and the structure of space: A comparative study of office layouts. In *4th International Space Syntax Symposium: 2003*.

Rashid, M., Wineman, J., & Zimring, C. (2009). Space, behavior, and environmental perception in open plan offices: a prospective study.

Reynolds, L. A., & Tansey, E. M. (2011). *History of British intensive care, c. 1950–c. 2000*. Queen Mary, University of London.

Ristagno, G., & Weil, M. H. (2009). History of critical care medicine: the past, the present and the future. In *Intensive and critical care medicine* (pp. 3-17). Springer, Milano.

Ritchey, T., & Pati, D. (2008). Establishing an acute care nursing bed unit size: Employing a decision matrix framework. *HERD: Health Environments Research & Design Journal*, *1*(4), 122-132.

Rodriguez, M. M., Casper, G., & Brennan, P. F. (2007). Patient-centered design: the potential of user-centered design in personal health records. *Journal of AHIMA*, *78*(4), 44-46.

Rosenbaum, S. (2011). *Improving the user experience of evidence: A design approach to evidence-informed health care.*

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data*. Sage.

Satterfield, J. M., Spring, B., Brownson, R. C., Mullen, E. J., Newhouse, R. P., Walker, B. B., & Whitlock, E. P. (2009). Toward a transdisciplinary model of evidence-based practice. *The Milbank Quarterly*, *87*(2), 368-390.

Schweitzer, M., Gilpin, L., & Frampton, S. (2004). Healing spaces: elements of environmental design that make an impact on health. *Journal of Alternative & Complementary Medicine*, *10*(Supplement 1), S-71.

Seo, H. B., Choi, Y. S., & Zimring, C. (2011). Impact of hospital unit design for patient-centered care on nurses' behavior. *Environment and Behavior*, *43*(4), 443-468.

Shang, Y., Pan, C., Yang, X., Zhong, M., Shang, X., Wu, Z., ... & Sang, L. (2020). Management of critically ill patients with COVID-19 in ICU: statement from front-line intensive care experts in Wuhan, China. *Annals of Intensive Care*, *10*(1), 1-24.

Shepley, M. M. (2002). Predesign and post occupancy analysis of staff behavior in a neonatal intensive care unit. Children's Health Care, 31(3), 237-253.

Shpuza, E., & Peponis, J. (2008). The effect of floorplate shape upon office layout integration. *Environment and Planning B: Planning and Design*, *35*(2), 318-336.

Smonig, R., Magalhaes, E., Bouadma, L., Andremont, O., de Montmollin, E., Essardy, F., ... & Lermuzeaux, M. (2019). Impact of natural light exposure on delirium burden in adult patients receiving invasive mechanical ventilation in the ICU: a prospective study. *Annals of Intensive Care*, *9*(1), 120.

Stark, A. (2004). Innovation in the design of the ICU. *Minnesota Physician*, 32-36.

Stichler, J. F. (2008). Transforming the design process.

Stichler, J. F. (2010). Weighing the evidence. Health Environments Research & Design, 3, 3–7.

Stichler, J. F. (2011). Patient- centered healthcare design. *Journal of Nursing Administration*, *41*(12), 503-506.

Stichler, J. F. (2014). Using an EBD approach for healthcare design.

Stichler, J. F. (2016). Research, research-informed design, evidence-based design: What is the difference and does it matter?.

Stichler, J. F., & Hamilton, D. K. (2008). Evidence- based design: What is it? Health Environments Research & Design, 1, 3–4.

Stichler, J. F., & McCullough, C. (2012). Same-handed patient room configurations: anecdotal and empirical evidence. *Journal of Nursing Administration*, *42*(3), 125-130.

Sturdavant, M. (1960). *Comparisons of Intensive Nursing Service in a Circular and a Rectangular Unit: Rochester Methodist Hospital, Rochester, Minn* (No. 8). American Hospital Association.

Trites, D. K., Galbraith, F. D., Sturdavant, M., & Leckwart, J. F. (1970). Influence of nursing-unit design on the activities and subjective feelings of nursing personnel. *Environment and Behavior*, *2*(3), 303.

Trzpuc, S. J. (2010). An examination of the impact of medical-surgical nursing unit configuration on nurses' communication using space syntax theory.

Ullán, A. M., Belver, M. H., Fernández, E., Serrano, I., Delgado, J., & Herrero, C. (2012). Hospital designs for patients of different ages: Preferences of hospitalized adolescents, nonhospitalized adolescents, parents, and clinical staff. *Environment and Behavior*, *44*(5), 668-694.

U.S. Department of Veterans Affairs Office of Construction & Facilities (USDVA). (2011)

Ulrich, Roger S; Zimring, Craig; Zhu, Xuemei; DuBose, Jennifer; Seo, Hyun-Bo et al. (2008). A review of the research literature on evidence-based healthcare design. *HERD*. 1 (3), 61-125.

Urlich, R., Zimring, C., Quan, X., Joseph, A., & Choudhary, R. (2004). The role of the physical environment in the hospital of the 21st century. *The Center for Health Design*.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420-421.

Urra Medina, E., & Barría Pailaquilén, R. M. (2010). Systematic review and its relationship with evidence-based practice in health. *Revista latino-americana de enfermagem*, *18*(4), 824-831.

Vaismoradi, M., Turunen, H. & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. Nursing and Health Sciences, 15(3), 398-405.

Valentin, A., Ferdinande, P., & ESICM Working Group on Quality Improvement. (2011). Recommendations on basic requirements for intensive care units: structural and organizational aspects. *Intensive care medicine*, *37*(10), 1575.

Verceles, A. C., Liu, X., Terrin, M. L., Scharf, S. M., Shanholtz, C., Harris, A., ... & Netzer, G. (2013). Ambient light levels and critical care outcomes. *Journal of critical care*, *28*(1), 110-e1.

Verderber, S., & Fine, D. J. (2000). Healthcare architecture in an era of radical transformation. New Haven, CT: Yale University Press.

Verderber, S. (2010). *Innovations in hospital architecture*. New York: Routledge.

Villar J.; Mendez S.; Slutsky A.S. (2001). Critical care medicine in the 21st century: From CPR to PCR. Crit Care 5:125–130.

Wakefield, K. L., & Blodgett, J. G. (1996). The effect of the servicescape on customers' behavioral intentions in leisure service settings. *Journal of Services Marketing*, *10*(6), 45-61.

Watkins, N., Kennedy, M., Ducharme, M., & Padula, C. (2011). Same-handed and mirrored unit configurations: is there a difference in patient and nurse outcomes?. *Journal of Nursing Administration*, *41*(6), 273-279.

Weil, M. H., & Shoemaker, W. C. (2004). Pioneering contributions of Peter Safar to intensive care and the founding of the Society of Critical Care Medicine. *Critical care medicine*, *32*(2), S8-S10.

Weiss, R. S. (1994). *Learning from strangers: The art and method of qualitative interview studies*. New York: Free Press.

Wijdicks, E. F. (2012). *Famous first papers for the neurointensivist*. Springer Science & Business Media.

Wijdicks, E. F.; Worden, W. R.; Miers, A. G., & Piepgras, D. G. (2011). The early days of the neurosciences intensive care unit. In *Mayo Clinic Proceedings* (Vol. 86, No. 9, p. 903). Mayo Foundation.

Witteman, H. O., Dansokho, S. C., Csolquhoun, H., Coulter, A., Dugas, M., Fagerlin, A., ... & Ivers, N. (2015). User-centered design and the development of patient decision aids: protocol for a systematic review. *Systematic reviews*, *4*(1), 1-8.

Wolfinger, N. H. (2002). On writing fieldnotes: collection strategies and background expectancies. *Qualitative research*, *2*(1), 85-93.

Yi, L., & Seo, H. B. (2012). The effect of hospital unit layout on nurse walking behavior. *HERD: Health Environments Research & Design Journal*, *6*(1), 66-82.

Zborowsky, T., Bunker-Hellmich, L., Morelli, A., & O'Neill, M. (2010). Centralized vs. decentralized nursing stations: Effects on nurses' functional use of space and work environment. *HERD: Health Environments Research & Design Journal*, *3*(4), 19-42.

Zeisel, J. (1975). Sociology and Architectural Design. New York: Russell Sage Foundation.

Zhang, Y., Soroken, L., Laccetti, M., De Castillero, E. R., & Konadu, A. (2015). Centralized to hybrid nurse station: Communication and teamwork among nursing staff. *Journal of Nursing Education and Practice*, *5*(12), 34.

Zimring, C., & Bosch, S. (2008). Building the evidence base for evidence-based design: editors' introduction. Environment and Behavior, 40(2), 147-150.

Zimring, C., Joseph, A., & Choudhary, R. (2004). The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. *Concord, CA: The Center for Health Design*.

ZISKO-AKSAMIJA, A. (2008) Knowledge Management in Architecture and Construction Industry, in A. Koohang, K. Harman, J. Britz (eds.) Knowledge Management: Research and Application, Informing Science Press, Santa Rosa, California; 213-52.

# APPENDICES

## A. Participant recruitment email

konu: Araştırma projesine katılma daveti.

Merhaba Sayın [katılımcının ismi],

Halen Orta Doğu Teknik Üniversitesi, Mimarlık Bölümü, Bina Bilgisi dalında Doktora çalışmalarımı sürdürmekteyim. Araştırma alanım Sağlık Yapıları üzerinedir. Çalışmamın bir bölümünde hastane tasarımı yapan mimarların görüşlerine yer verilmektedir. Görüşme formatı Üniversitemizin de onayladığı Etik Kurallara uyularak hazırlanmıştır. Görüşme yaklaşık 35 dakika sürecek ve açık uçlu sorular seklinde olacaktır. Görüşleri alınan mimarların ve bürolarının isimleri gizli tutularak ve tez çalışmasında X bürosu, mimar X şeklinde kodlanarak belirtilecektir (görüşme büro sahibi yerine sağlık yapıları tasarımında tecrübeli olan Mimar(lar) ile de yapılabilecektir).

Çalışmalarıma vereceğiniz destek benim için çok değerli olacak ve memnun edecektir. Konu hakkındaki görüşlerinizi öğrenmek ve eğer mümkün ise bir randevu almak istiyorum.

Saygılarımla,

Negar Sioofy Khoojine
Ph.D. Candidate
Middle East Technical University (METU), Department of Architecture
+90[redacted]
negar.khoojine@metu.edu.tr

## B. Interview guide in the Turkish language

| Bölüm 1: "Mimarların genel bilgisi" | | | |
|---|---|---|---|
| **Bölümün amacı** | **Sorular** | **Ek bilgi** | **Zaman** |
| **Mimarların kişisel bilgilerini ve çalışma tecrübelerini elde etmek.** | a) Kaç yaşındasınız?<br>o 25- 34<br>o 35- 44<br>o 45- 54<br>o 55- 64<br>o 65 ve üzeri<br>a) Sağlık tasarımı veya hastane tasarımı alanında kaç yıl tecrübeniz var?<br>b) Mimarlıktaki eğitim seviyeniz nedir? (Örneğin, Lisans, Yüksek Lisans, veya Doktora) | Cevaplar çok kısa olmalı. | 1 dakika dan az |
| **Bölüm 2: "Hastanede Yoğun Bakım Ünitesi ile ilgili mimarların genel yaklaşımı"** | | | |
| **Bölümün amacı** | **Sorular** | **Ek bilgi** | **Zaman** |
| **Mimarların hastanedeki Yoğun Bakım Ünitesi ile ilgili genel yaklaşım görüşlerini anlamak.** | a)Yoğun Bakım Ünitesinin hastanedeki en belirgin özelliklerini ve rollerini tanımlarmısınız?<br>b) Sizce hastanede. Yoğun Bakım Ünitesinin ne tür fiziksel ilişkileri olmalı? (Yoğun Bakım Ünitesinin hastanedeki diğer hemşirelik uniteleri ile ilişkileri, Yoğun Bakım Ünitesinin hastanedeki yerleşmesi vb.) Lütfen basit şemalarda veya çizimlerle belirtin. | Cevaplar, Yoğun Bakım Ünitesi hastanenin bir parçası olarak göze alınmalıdır. | 2 dakika |
| **Bölüm 3: "Mimarların Yoğun Bakım Ünitesinin mimari özellikleri hakkında yaklaşımı"** | | | |
| **Bölümün amacı** | **Sorular** | **Ek bilgi** | **Zaman** |
| **Mimarların Yoğun Bakım Ünitesinin mimari özellikleri hakkındaki yaklaşımlarını anlamak.** | a) Yoğun Bakım Ünitesinde ne tür mimari mekanları belirliyorsunuz? (Örneğin, hastanın mekanı, hemşirenin mekanı vb.)<br>b) Yoğun Bakım Ünitesinin mekanlarının genel mimari özelliklerini ve ekipmanını anlatabilir misiniz? (Örneğin, teknik ve tıbbi ekipman, mobilya vb.)<br>c) Yoğun Bakım Ünitesinin tasarımında ne tür mimarı plan düzeni tercih edersiniz? (Örneğin, dikdörtgen, dairesel, vb.) Neden? Lütfen basit şemalarda veya çizimlerde belirtin. | Sa: Cevaplar sadece mimari mekanları içermelidir.<br>Sb: Cevaplar, Yoğun Bakım Ünitesinin mekanlarının genel özelliklerinin detaylar olmadan açıklanması beklenmektedir. (Örneğin, hasta mekanının özellikleri, hemşire mekanının özellikleri vb.). | 15 dakika |

| Bölüm 4: "Mimarların Yoğun Bakım Ünitesindeki erişilebilirlik özellikleri hakkındaki yaklaşımı" | | | |
|---|---|---|---|
| **Bölümün amacı** | **Sorular** | **Ek bilgi** | **Zaman** |
| **Mimarların Yoğun Bakım Ünitesinde erişilebilirlik özellikleri hakkındaki yaklaşım larını görsel ve fiziksel erişilebilirlik açısından anlamak.** | a) Sizce, Yoğun Bakım Ünitesinde hemşire istasyonu / hemşire işyeri nedir? Ve hemşire istasyonunun özellikleri nelerdir? (Örneğin, hemşire istasyonunun büyüklüğü, şekli, Yoğun Bakım Ünitesindeki yerleşmesi, mimarı plan düzeni, kapıları, vb.)? Lütfen basit şemalarda veya çizimlerde belirtin.<br>b) Sizce, Yoğun Bakım Ünitesinde hasta odası nedir? Ve hasta odasının özellikleri nelerdir? (Örneğin, hasta odasının büyüklüğü, şekli, Yoğun Bakım Ünitesindeki yerleşmesi, mimarı plan düzeni, ekipmanı vb.) Lütfen basit şemalarda veya çizimlerde belirtin.<br>c) Yoğun Bakım Ünitesindeki hasta ve hemşire mekanı arasında fiziksel ilişkiler sağlamak için tasarım sürecinde hangi mimari özellikleri göz önünde bulundurursunuz? (Örneğin alan girişleri, mekanlarının arasındaki fiziksel mesafe, mekan büyüklüğü, mekanlar arası ilişkiler vb.) Lütfen basit şemalarda veya çizimlerde belirtin.<br>d) Yoğun Bakım Ünitesindeki hasta ile hemşirenin mekanı arasında fiziksel ilişkiler sağlamak için tasarım sürecinde hangi malzeme / ekipmanı göz önünde bulundurursunuz? (Örneğin kapı, pencere, yatak, tıbbi ekipman, Teknik ekipman, vb.) Lütfen basit şemalarda veya çizimlerde belirtin. | S c & S d: Cevaplar, Yoğun Bakım Ünitesinde hemşire ve hasta mekanlarının arasındaki ilişkilerinin önemine (erişim açısından) odaklanmalıdır. | 15 dakika |

| Bölüm 5: "Mimarların Yoğun Bakım Ünitesinin tasarım sürecinde yaklaşım kaynakları" | | | |
|---|---|---|---|
| **Bölümün amacı** | **Sorular** | **Ek bilgi** | **Zaman** |
| **Yoğun Bakım Ünitesinin tasarım sürecinde mimarların hangi bilimsel veya yasal kaynaklara başvurduğunu anlamak.** | a) Yoğun Bakım Ünitesinin tasarım sürecinde ne tür veri kaynaklarını kullanıyorsunuz? (Örneğin, kişisel tecrübeler, mimari yönetmelikler, vb.)<br>b) Yoğun Bakım Ünitesinin tasarım sürecinde ulusal ve uluslararası yönetmelikler rolü hakkında ne düşünüyorsunuz? Lütfen yönetmeliklerin adlarını belirtin. Örnekler ile ve şemalar ile açıklarmısınız?<br>c)Yoğun Bakım Ünitesinin tasarım sürecinde bilimsel/ akademik araştırmaları / yayınlanmış veya yayınlanmamış araştırmaları mı kullanıyorsunuz? Eğer evetse, lütfen örnekler verin. | | 10 dakika |

## C. Approval of the interview guide from the human subjects ethics committee at Middle East Technical University (METU)

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

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08 AĞUSTOS 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Mualla ERKILIÇ

Danışmanlığını yaptığınız doktora öğrencisi Negar Sioof KHOOJİNE **"Investigation of ICU (Intensive Care Unites) Design Referring to Evidence-Based Knowledge for Healthcare Architecture"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-FEN-045** protokol numarası ile **08.08.2018 - 30.12.2018** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Doç. Dr. Emre SELÇUK
Üye

Dr. Öğr. Üyesi Pınar KAYGAN
Üye

## D. Consent form in the English and Turkish language

**Informed Consent Form**

I am Negar Sioofy Khoojine, the Ph.D. student in the department of architecture at Middle East Technical University (METU), Ankara, Turkey. The aim of this study is to investigate healthcare architects' approach about *Intensive Care Unit* (*ICU*)'s design features. For achieving this aim, I will ask you 15 questions in five main sections about architectural features of *ICU*. The interview will take approximately 45 minutes. Participation process in this study is absolutely on a voluntary basis. It is your own right not to continue answering any question if you feel uncomfortable and you are free to withdraw at any time. The interview will be audio- recorded and your names will not be published in research records. This interview will be kept completely confidential and the information obtained will be used in the researcher's doctoral thesis.

Thank you for your participation. For any further information concerning the study, you can contact the researcher Negar Sioofy Khoojine via this email: negar.khoojine@metu.edu.tr or via this telephone number: [redacted] or via this address: [redacted].

*I am participating in this study of my own will. I am also aware that I can quit participating whenever I want. I give my consent to use the information that I provide for scientific purposes by signing below.*

Name, Surname:

Date: ------/------/------

Signature:

**Rıza formu**

Ben Negar Sioofy Khoojine, Orta Doğu Teknik Üniversitesi (ODTÜ) - Ankara, Turkey - Mimarlık Bölümünde, Doktora öğrencisiyim. Bu çalışmanın amacı, sağlık hizmetleri tasarımıyla ilgilenen mimarların, Yoğun Bakım Ünitesinin tasarım özellikleri hakkındaki yaklaşımı araştırmaktır. Bu amaca ulaşmak için, Yoğun Bakım Ünitesinin mimari özellikleriyle ilgili beş ana bölümde, 15 soru soracağım. Görüşme yaklaşık 45 dakika sürecektir. Bu çalışmaya katılım süreci kesinlikle gönüllü olarak gerçekleşmektedir. Herhangi bir rahatsızlık duyduğunuz an sorulara cevap vermeme hakkınız saklıdır, ve herhangi bir zamanda geri çekilmek icin özgürsünüz. Görüşme ses kaydı olacak ve isminiz araştırma kayıtlarında yayınlanmayacak. Bu görüşme tamamen gizli tutulacak ve elde edilen bilgiler araştırmacının doktora tezinde kullanılacaktır.

Katıldığınız için teşekkürler. Çalışma ile ilgili daha fazla bilgi için, Negar Sioofy Khoojine ile bu e-posta adresi aracılığıyla: negar.khoojine@metu.edu.tr, veya bu telefon numarasıyla: [redacted], veya bu adres üzerinden: [redacted], iletişime geçebilirsiniz.

*Kendi isteğimle bu çalışmaya katılıyorum. Ayrıca istediğimde katılımı bırakabileceğimin de farkındayım. Bilimsel amaçlar için sağladığım bilgilerin aşağı imzalayarak kullanılmasına izin veriyorum.*

Ad, Soyad:

Tarih: ------/------/------

İmza:

## E. Debriefing form in the English and Turkish language

Debriefing Form

This study has been carried out by Negar Sioofy Khoojine, who is a Ph.D. student in Middle East Technical University (METU), faculty of architecture, department of architecture, to be used in her doctoral thesis. Due to the technological and medical improvements, the *patient-centered design* is going one of the most important design trends in the healthcare design field by considering patients' necessary requirements at the center of the design process. Among different types of *nursing units*, architectural spaces of *Intensive Care Unit* (*ICU*), requires complex design considerations that would constantly provide visual and physical control of patients by nurses.

Insufficient knowledge of healthcare architects about *accessibility* features of *ICU*'s organization can easily provide an environment that constrains patients' *safety* and nurses' *efficiency*. Therefore, healthcare architects should consider *accessibility* features in decision- making process of *ICU*'s design. Recently, *Evidence- Based knowledge* (*EBK*), as a methodology, provides solutions to improve the decision- making process of *ICU's* design. The aim of this study is to investigate architects' approach about *visual* and *physical accessibility* features in *ICU* to provide more effective *patient- centered ICU*. As an empirical part of this study, a face-to-face semi- structured (open- ended) interview is going to be done to disclose healthcare architects' interest related to the nature of *ICU's accessibility* features. The results will be evaluated with the scientific findings of *Systematic Review* (*SR*) - as a methodology of *EBK*- that is achieved in the earlier part of the research.

The data obtained will only be used in the researcher's doctoral thesis. For further information, about the study and its results, you can refer to the following name. I would like to thank you for participating in this study.

Negar Sioofy Khoojine: Email: negar.khoojine@metu.edu.tr, Tel: [redacted]

Bilgilendirme Formu

Bu çalışma Orta Doğu Teknik Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, Doktora Öğrencilerinden Negar Sioofy Khoojine' nin tez çalışmasının bir bölümü olan ampirik araştırmada kullanılmaktadır. Bugün Teknolojik ve tıbbi gelişmeler, sağlık tasarımı alanında *hasta-merkezli tasarım*, yani hastaların öncelikli ihtiyaçlarını göz önünde bulunduran bir anlayışı öne çıkarmaktadır. Hastane yapıları bünyesinde yer alan farklı hemşirelik uniteleri arasında, *Yoğun Bakım Ünitesi* (YBÜ), hemşireler tarafından hastaların sürekli ve yoğun olarak görsel ve fiziksel kontrolünü gerektirmesi nedeniyle, mimari mekansal anlamda karmaşık bir yapı göstermektedir.

Sağlık hizmetleri tasarımıyla ilgilenen mimarlarin, *Yoğun Bakım Ünitesinin* organizasyonunun erişilebilirlik özellikleri hakkında, yetersiz bilgileri, hastaların güvenliğini ve hemşirelerinin verimliliğini kısıtlayan bir ortam sağlayabilir. Bu nedenle, sağlık hizmetleri tasarımıyla ilgilenen mimarların, *Yoğun Bakım Ünitesinin* tasarımının karar verme sürecinde erişilebilirlik özelliklerini dikkate almalıdır. Son zamanlarda, Kanıta-Dayalı Bilgi (KDB), bir metodoloji olarak, *Yoğun Bakım Ünitesinin* tasarımının karar verme sürecini iyileştirmek için çözümler sunmaktadır. Bu çalışmanın amacı, daha etkili hasta merkezli YBÜ sağlamak için, mimarların yoğun bakımda görme ve fiziksel erişilebilirlik özellikleri hakkındaki yaklaşımı araştırılmasıdır. Bu çalışmanın ampirik bir parçası olarak, sağlık hizmetleri tasarımıyla ilgilenen mimarların *Yoğun Bakım Ünitesinin* erişilebilirlik özelliklerinin doğasına ilişkin ilgisini açıklamak için yüz yüze yarı yapılandırılmış (açık uçlu) bir anket - görüşme yapılacaktır. Sonuçlar, araştırmanın önceki bölümünde elde edilen, Sistematik Incelemenin - KDB'nın bir metodolojisi olarak - bilimsel sonuçlar ile değerlendirilecektir.

Elde edilen veriler sadece araştırmacının doktora tezinde kullanılacaktır. Daha fazla bilgi için çalışma ve sonuçları hakkında aşağıdaki isme başvurabilirsiniz. Bu çalışmaya katıldığınız için teşekkür ederiz.

Negar Sioofy Khoojine: Email: negar.khoojine@metu.edu.tr, Tel: [redacted]

## F. Example of interview transcript

**I.209102018**

***Q. B1, a)* Kaç yaşındasınız?**

- 25- 34
- 35- 44
- 45- 54
- 55- 64
- 65 ve üzeri

***Q. B1, b)* Sağlık tasarımı veya hastane tasarımı alanında kaç yıl tecrübeniz var?**

3 yil

***Q. B1, c)* Mimarlıktaki eğitim seviyeniz nedir? (Ö rneğin, Lisans, Yüksek Lisans, veya Doktora)** lisans

***Q. B2, a) Yoğun Bakım Ünitesinin* hastanedeki en belirgin özelliklerini ve rollerini tanımlarmısınız?**

Aslinda hijyen gereken bir yer, bu sadece temizlik gibi degilde, mekanik acisindan da onemli. Yonetmelik aklima geliyor hep, cizim yaptigim icin. Aslinda, konu cok saglik ve tibbi konu oldugu zaman, cok fazla müdahale sansimiz olmuyor. Bence, hani beli bir modular olarak, iste, arena tipi dedikleri, yada, her oda bitane olacak ve bi sekilde yataklari olcak. Dolaysiyla, biz saglik bakanligindaki standatlara gore tasrarim ediyoruz. Genel bir metre kare tablusu oldugu icin, bir tasarim beklenmiyor, ve beklenmemeli. Mesela, hani minumumda kose kalacak ve hani temizligini sagliya bileceyi bir sekilde olacak.

***Q. B2, b)* Sizce hastanede. *Yoğun Bakım Ünitesinin* ne tür fiziksel ilişkilerı olmalı? (*Yoğun Bakım Ünitesinin* hastanedeki diğer hemşirelik uniteleri ile ilişkileri, *Yoğun Bakım Ünitesinin* hastanedeki yerleşmesi vb.) Lütfen basit şemalarda veya çizimlerle belirtin.**

Aslinda bununla alakali ben sey, sematik cizimler hazirlamistim. Yogun bakimi bilimi burada, bu kankorse dedigimiz bilim veya disardan giris olarakda yapabilirsiniz. Burada aslinda en onemli sey ameliyathaneyle olan direct baglantisi, ve dis hastayla, ic hasta birbirine karismadik icin, ic hastanin genal sikolasiyuu yani aslinda bnece, su bi ic hasta koridor olsa, burden hic biyera karismadan sadece burden yada ameliyathaneden mesela, direct olarak baglantisi olan bir yer.

Tabikide turkiyedeki standartlara gore, mesela su kul eger sadece ic hastanin, bu baglantisi olmali, cunku yine buralar karismadan gidebilir. Ya, buradaki hasta, herhangi bi baska bilime getirecekse, bunlarla alakali baska bir sey dusunuyorum.

Cunku burasi eger ki bir filtera alani olursa, bunun gerisinde kalacak alan bazi destekler olur. Bu sekilde, dikdörtgen pilani hastalari goemek icin daha uygun.

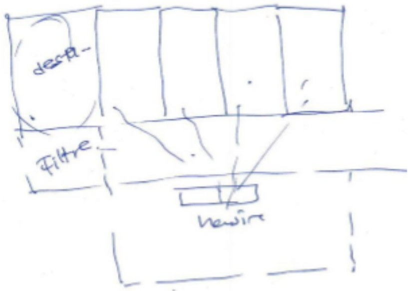


Figure 2: Floor plan of ICU. (I.2)

***Q. B4, a)* Sizce, *Yoğun Bakım Ünitesinde* hemşire istasyonu / hemşire işyeri nedir? Ve hemşire istasyonunun özellikleri nelerdir? (Örneğin, hemşire istasyonunun büyüklüğü, şekli, *Yoğun Bakım Ünitesindeki* yerleşmesi, mimarı plan düzeni, kapıları, vb.)? Lütfen basit şemalarda veya çizimlerde belirtin.**

Bi kare aslinda personelin kendine ozel mekanlari olmadigi icin, ve surekli bir gurultu icerisinde bulunduklari ve dinlerken bile, buna maruz kaldiklari icin, iste biraz ayrilmak istediklerini soylemis personel, o yuzden aslinda personelin, bi hemsire deski olarak bakilmamali bence. Gercekten dinlenmek icin mekanlari olarak bi bakilmali. Hemsire deski yani diyelim ki bu ana sirkülasyon hattı, ve ortalama hemsire deski kac metrekare olmali, simdi icerisinde, iste ilac, ekipman, depo, temiz ve kirli melzeme olmasi lazim. Burasi koridor, burasi da hemsirenin deskini cizdim, suradaki mahallelerin cizdikleri diyelim, ki bunun su yaninda, soyle bir koridor yapim, burada iki tane destegi, iste buradan belki direk girebilir, bunlarda soyle, girebilir, hem ikiside olabilir, daha iyi olur belki, ondan sonra sunlar yogun bakimdaki hastalarin odalari.

Yine sey, maximum gozlem, bunun haricinde, suralar, soyle kucuk deskler koyuyoruz. Burada hem hastayla alakali not aliyorlar, hemde kolayca gozlem yapabiliyorlar. Bunlari mumkun oldugunca şeffaf cam tercih ediyoruz. Hata saglik bakanliginda ki standartları surayi seffaf ve cam olmasin istiyor. Yani burada eger bi hemsire varsa, diyer oda daki kisiyi gorebilmesi lazim, ama biz bunu, hasta mahremiyet acisindan olmamasini dusunuyoruz. Onun haricinde, yataklari genelde soyle konumlandiriyoruz, cunku buradan isik geliyor ve hemsire kolayca hastayi gozlem yapsin diye.

Mesela odalarini ciziyorum. Yine buralarda da deskleri olmasi lazim, ortalama sunlarin da iste, 8 metrekare, 40, hemsire istasyonu 15.5, cok rahat 60 metrekare falan olmasi gerekiyor. Cunku, yeterli geliyor. Sadece bunlar depo ekipman ilac falan, bu aklima geliyor hemsire istasyondan.

Baska bi tip de var, open ward, karsilastik. Mesela burada bir hasta var, burdayiz, bitane hemsire burada gozlem yapiyor, her biri (hasta) gozlem altinda dusune bilirsiniz. Hemsire alanlari, belkide buralarda olabilir. Burden yine bir sirkülasyon hattı olabilir. Ama her biri bi mahallelerin icinde olabilir. Filteralari buraya koyabiliriz, ekip gecebilecegi icin. Bu sekilde bir oda icinde, birden fazla hasta olabilecegi olabilir. Ama tek kisilik odalar tabi daha uygun olur. Cunku, burada kendi icinde hava sirkülasyonu sagliyor, mekanik anlaminda, hava uflemesi oluyor, ve yada ucuncu basamak, ve biz sadece alanlarin isimlerini degistiriyoruz. Bizim icin fark etmiyor.

Veya bazen izolasyon odalari oluyor. Filtera alanindan geciyor. Doktor yikamasi burada oluyor. Surasida minumum 2.4, hatta 2.4 ve 2.3 arasi aliyoruz. Cunku, buradaki hava dongusu cok onemli oluyor. Burada, ilk kapi aciliyor, sediye buraya geliyor, bu kapandiktan sonra ikinci kapi aciliyor. Buda izolasyon odasi oluyor, bu sekilde.

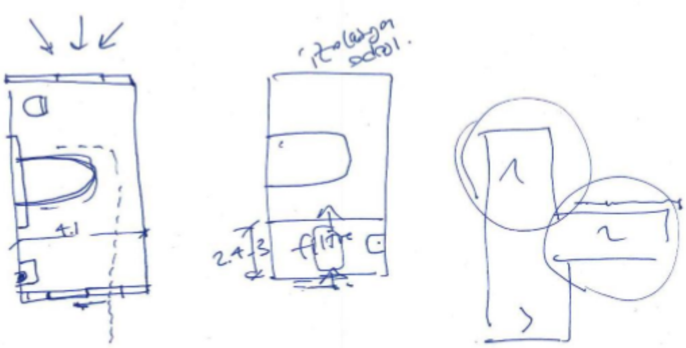

Figure 5: Patient room inside ICU. (I.2)

***Q. B4, c) Yoğun Bakım Ünitesindeki* hasta ve hemşire *mekanı* arasında fiziksel ilişkiler sağlamak için tasarım sürecinde hangi mimari özellikleri göz önünde bulundurursunuz? (Örneğin alan girişleri, mekanlarının arasındaki fiziksel mesafe, mekan büyüklüğü, mekanlar arası ilişkiler vb.) Lütfen basit şemalarda veya çizimlerde belirtin.**

Aslinda soyle bisey soyleyebilirim. Hemsire maximum gozlemi olacak hastaya ve nekadar merkezi olursa okadar iyi. Ama onun haricinde, ben cok tecrubeli degilim ama, bunlar genelde yatak kollarinda yer aliyor. Dolaysiyla, biz extradan ona form veriyoruz. Burasi yogun bakim oldugu icin daha iyi gozlenmek degil de, o kolda aynisin cozmek zorunda oldugumuz icin, buda bi kısıtlayıcı faktor oluyor. Onun haricinde, yani tabiki, butun yataklari gozlemniyecek bir sekilde (hemsire), eger bitane yetmiyorsa, ikitane, az yatak olsa bile o formun icinde onu cozmemiz gerekiyorsa, iste sayisini artirarak (hemsire), yani ona bi cozum yapmaya calisiyoruz.

Erisebilmek belki mesela teknolojik olarak cozumlenebilir. Dusunuyorum, ne bilim hastanin atesi yükseldiği zaman, bi signal gidebilir. Cunku sonucta saglik bakanligi da belirli bir standartlar veriyor, hemsire sayisi mesela. O kadar hemsire bakiyor onlara. Yani belki bunlar (hemsireler) daha cok teknoloji kullansalar, iste nebilim, monitorla belki, hemsire istasyonla direk baglanti olarak, gozlemlicekler. Hem belkide iste, hastanin kalp atisi degisti, direk oraya signal gidiyor.

***Q. B4, d) Yoğun Bakım Ünitesindeki* hasta ile hemşirenin *mekanı* arasında fiziksel ilişkiler sağlamak için tasarım sürecinde hangi malzeme / ekipmanı göz önünde bulundurursunuz? (Örneğin kapı, pencere, yatak, tıbbi ekipman, teknik ekipman, vb.) Lütfen basit şemalarda veya çizimlerde belirtin.**

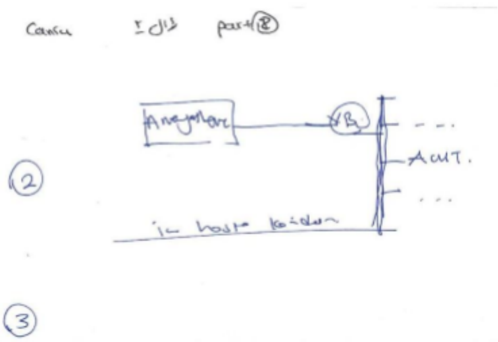

Figure 1: Physical relationships of ICU with other wards. (I.2)

**_Q. B3, a) Yoğun Bakım Ünitesinde_ ne tür mimari mekanları belirliyorsunuz? (Örneğin, hastanın mekanı, _hemşirenin mekanı_ vb.)**

Hasta odalari ve hemsire istasyonu yogun bakim icindeki onemli mekanlardan. Mesela hemsire istasyonun arkasi icin, iste, ilac odasi, temiz melzeme ve camasir, kirli oda, depolar, hemsire deskleri, hemsire istasyunu kendisi.

**_Q. B3, b) Yoğun Bakım Ünitesinin_ mekanlarının genel mimari özelliklerini ve ekipmanını anlatabilir misiniz? (Örneğin, teknik ve tıbbi ekipman, mobilya vb.)**

Hemsire, yogun bakim tek kisilik odasinda, soyle onemli oluyor, hep hastayla gorsel acisindan surekli iletisimde olmasi gerekiyor. O yuzden, genelde seffaf cam kulanmaya calisiyoruz. Hemsirenin ozelligi, bikare, cok net bisekilde, hastayi gore biliyor olmasi lazim. O yuzden, tam merkezi konumlarda yapiyoruz. Yonetmeliklere gore yani. Onun haricinden, yataklar var, hemsire istasyonlarimiz var, yani, iste, hemsire not aldigi, bakisin sagladigi gibi, hemsire istasyonu olmasi gerekiyor.

Ve her sey mumkun olduguca antibacterial tercih ediyoruz. Bunun hakinda, yani zaten uc seviye oluyor yogun bakimi, ve oradaki ekipmani ona gore belirliyoruz. Acikcasi, mekan bu, metre karesi bu, ikinci, birinci, ucuncu bu soyliyoruz, ondan sonra firmalar anlasip hangi seyleri seciyorlar karar veriyorlar, bu sekilde.

**_Q.B3, c) Yoğun Bakım Ünitesinin_ tasarımında ne tür mimarı plan düzeni tercih edersiniz? (Örneğin, dikdörtgen, dairesel, vb.) Neden? Lütfen basit şemalarda veya çizimlerde belirtin.**

Bi kare, tip olarak, bi hastaya, bi yatak odasi dusecek, cunku sonucta, burada hastalar biraz daha kritik durumunda olurlar, hem birbiriyle, hem havayla gecan sorunlar olur. Onun harcinda dediginiz gibi, mecbur olarak, minimum kose sayisi istiyorlar standartlarda, cunku nekadar fazla kose varsa, o kadar sorun olur hasteleri gormek falan. O yuzden, iste yuvarlak yapabileceğimiz icin aslinda, yani bi ameliyathane kadar duzenlemedigimiz icin, mecburi olarak kare biciminde dusunuyoruz. Yani dikdörtgen aslinda, ve iste, cok basit bence, cok sey yapmadan, nasil anlatsam, karmasik hale getirmeden, cunku maximum soyle gozlemleri olabilecek sekilde yapilmali. Bence onun haricinde iste burada da yine, hemsirenin destekleri olsa bile, burada baska biryer ve destekler iste, o bahs ettimiz, iste ordek surgu, ve temizlikler.

Hemsire hastalari gormesi gerekiyor. O yuzden, şeffaf cam ve pencere olmasi gerekir hasta odasi ve corridor arasinda. Hani, bunlari bile bakarak yapiyoruz, hic bir hasta bosda kalmayacak, bu sekilde. Oda aslinda merkeziyetle alakali yani hemsirenin merkeziyeti, yani mimari olarak.

***Q. B5, a) Yoğun Bakım Ünitesinin* tasarım sürecinde ne tür veri kaynaklarını kullanıyorsunuz? (Örneğin, kişisel tecrübeler, mimari yönetmelikler, vb.)**

Diyer ulkelerin yonetmeliklerinde aslinda kullanmaya calisiyoruz. Bizim yonetmelikleri zaten, uygulamak zorundayiz. Cunku, saglik bakanligiyla, bu toplantilar oluyor. Her birinin gerektigine bakiyoruz (saglik bakanligin standartlari). Ve bunlari tekrar tekrar control ediyoruz. Cunku onlarinda onay asamasi oluyor. Onaylanmasi gerektigi icin, bi kare ulkemizin yonetmeliklerin dikkate almamiz gerekiyor.

***Q. B5, b)* Yoğun Bakım Ünitesinin tasarım sürecinde ulusal ve uluslararası yönetmelikler rolü hakkında ne düşünüyorsunuz? Lütfen yönetmeliklerin adlarını belirtin. Örnekler ile ve şemalar ile açıklarmısınız?**

Aslinda bir suru yonetmelik isin icine giriyor. Cunku yogun bakimda, yangin kacisi soz konusu, yani bi tek yogun bakim yonetmelikler degil aslinda, baska yonetmelikler mesela Australian standardi yada FGI (Facility Guidelines Institute). Onun haricinde, medikal danismanimiz var, bizi bu konularda cok yonlendiriyor. Onun haricinde, medikal danismanimiz var, bizi bu konularda cok yonlendiriyor.

Mesela, ICU metrekaresini belirletirken de yonetmeliklerin etkisi cok var. Yani, mimarlar karisa bilir ve bizim yonlendirmemizle biseyler ortaya cikiyor. Biz tasarim olarak biseyleri kendi anlanimizda odun vermeden, biseyler ortaya koyoyoruz ve calisarak herkesin istediklerini yapmaya calisiyoruz.

Sonucta burada bir hastane yapiliyor. Yani, insan sagligi soz konusu. Yani biz once fonksiyon yapiyoruz, ondan sonra hastanenin bicimi yani hastanenin formu, cunku bunun bi kullanicisi var, onu memnun etmekten ziyade, o kisinin saglikdan bahs ediyoruz. O yuzden, hani bi ville cizerken, yangin yonetmeligi ne kadar onemli etkisi olabilir ki. Ama burada saglik soz konusu oldukca, bence biraz mimari kompleksi arka plana atmak gerekiyor. Ama bence, bu benim fikrim. Ama tabikide hani baktigimizda, utanacak biseylerde yapmiyoruz. Onu kalibin icine soklmaya calisiyoruz aslinda.

Ama, en basta bisey ortaya ciktiginiz icin, zaten onun ustunden degistirme yapiyoruz. Ama, ana hati hicbir zaman etkiliyemezler mimarlar. Cunku, yogun bakim konusunda ne kadarina müdahale edebilirler ki bir mimar, tasarim cok standartlara bagli, mesela hemsire yeri, izolasyon odalari, vesaire. Gereken seyleri zaten biliyoruz.

***Q. B5, c) Yoğun Bakım Ünitesinin* tasarım sürecinde bilimsel/ akademik araştırmaları / yayınlanmış veya yayınlanmamış araştırmaları mı kullanıyorsunuz? Eğer evetse, lütfen örnekler verin.**

Kendi adima kullanmadim, akademik araştırmalar yani.

ama baskasinda (open ward) bu hava uflemesi mecburi oluyor. Biz eski projelere bakarak yeni projeler ciziyoruz, yeni standatlari uyguluyoruz. Daha cok tek kisilik odalarla karsilasiyoruz, yani biz simdi hastaneler ciziyoruz. Saglik bakanliginda boyle olmasini istiyor.

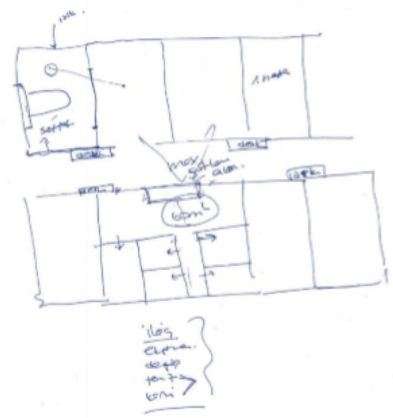

Figure 3: Nurse station inside ICU. (I.2)

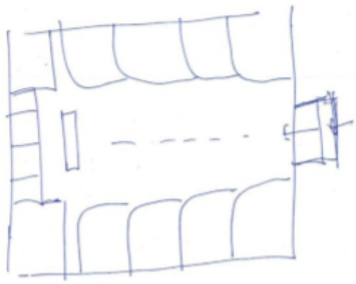

Figure 4: Open ward of ICU. (I.2)

***Q. B4, b)* Sizce, *Yoğun Bakım Ünitesinde* hasta odası nedir? Ve hasta odasının özellikleri nelerdir? (Örneğin, hasta odasının büyüklüğü, şekli, *Yoğun Bakım Ünitesindeki* yerleşmesi, mimarı plan düzeni, ekipmanı vb.) Lütfen basit şemalarda veya çizimlerde belirtin.**

Iste disardan isik olacak seklinde, soyle, yatak soyle konumlanıyor, hasta basi burasi, bazen iste sey giriyor, ziyaretcisi hastanin. Biz ortalama surada 3 metre kayar kapi yapiyoruz. Yani 1.5, 1.5, birisi diyerin ustune kayiyor gibi. Cunku sonucta sediyeler gelecek, lavobolar oluyor, doktor laobosi, elin yikayip oyle cikiyor. Cunku buradan, bu odalari, yalnis hatirlamiyorsam standartlara gore minimum 4 isteniyor. Cunku hem geciyor buradan 4.10 hatirliyorum, yalnis hatirlamiyorsam eger. Hep tek kisilik tasarliyoruz.

Biz yogun bakimin tipin tasarim ediyoruz, birinci, ikinci, ucuncu basamak ve bizim icin fark etmiyor hangi basamak oldugu. Onlari medikal danismani karar veriyor. Kacinci derece olmasina karar veriyor. Bize sadece deniliyor ki burasi birinci, ikinci

## CURRICULUM VITAE

### PERSONAL INFORMATION

Surname, Name: Sioofy Khoojine, Negar
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Date and Place of Birth: 2 April 1984, Iran
Marital Status: Single
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### EDUCATION

| Degree | Institution | Year of Graduation |
|---|---|---|
| MS | Islamic Azad University, North Tehran Branch. Tehran, Iran. Architecture. | 2011 |
| BS | Islamic Azad University, Tabriz, Iran. Architecture. | 2008 |
| High School | Alzahra High School, Tabriz, Iran. | 2002 |

### FOREIGN LANGUAGES

Persian (Mother's language), Azeri (Mother's language), Advanced English, Advanced Turkish, Intermediate Arabic, and Intermediate French.

### ACTIVITIES

Painting, Photography, Music, Reading, Dance.