# THE EFFECTS OF SPATIAL LAYOUT OF HEALTHCARE FACILITIES ON STAFF COMMUNICATION

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# ABSTRACT


## THE EFFECTS OF SPATIAL LAYOUT OF HEALTHCARE FACILITIES ON STAFF COMMUNICATION

The space occupancy patterns of staff stand out as one of the basic function of spatial configurations that affects communication, behavior and teamwork in healthcare facilities. There is a strong relationship between staff communication, behavior and the occupancy of space in healthcare facilities, since space is considered as a primary factor to shape the modes of interaction involving occupants and care protocols.

This study focuses on the space occupancy of nurses working in inpatient units (IU) as the primary form of data, and comparatively examines three different IUs with different spatial layouts, and contrasts and compares differences within. This research brings together different methods including on-site (observations, surveys, and interviews) and off-site (space syntax and statistical analysis) analytical techniques to understand the distinctive dimensions of space such as accessibility, visibility, and physical proximity.

The findings of the study reveal the potential effects of different spatial layouts and space organizations to create different densities on circulation loads, which may in turn impact occupancy, accessibility, and visibility, and also communication within the unit. Although there are morphological differences between the three units, the findings suggest that particular key areas emerge to affect occupancy. There are particular zones - to attract dense circulation- observed in the units involving staff-related areas (nurse stations, nurse rooms, and medication preparation rooms) across the corridors in units. In addition to these particular staff-related areas, the different locations including break rooms and unit secretary workstations also emerged as locations where high levels of occupancy involving staff, patients, and visitors, was observed.



**Keywords:** Healthcare Facilities, Space Occupancy, Staff Communication.

# ÖZET

## HASTANE MEKÂNLARININ SAĞLIK ÇALIŞANLARI ARASINDAKİ İLETİŞİME OLAN ETKİSİ

Sağlık yapılarında, sağlık personelinin mekân kullanımı, bireyler ve gruplar arası iletişim, davranış ve ekip çalışmasını etkileyebilen mekânsal yerleşimin temel fonksiyonlarından biri olarak öne çıkmaktadır. Sağlık yapılarında yapılı çevreler, kullanıcıların aktivitelerini düzenleyerek iletişim kalıplarını şekillendirir. Dolayısıyla, sağlık tesislerinde personel iletişimi ile mekân kullanımı arasında güçlü bir ilişki vardır.

Bu çalışma, temel veri olarak Yataklı Tedavi Ünitelerinde çalışan hemşirelerin mekân kullanımına odaklanmaktadır. Bu araştırma, farklı mekânsal yerleşimlere sahip olması nedeniyle seçilen üç yataklı tedavi ünitesini karşılaştırmalı olarak inceleyerek elde ettiği veriler ile personel iletişimi arasındaki bağlantıyı ilişkilendirmektedir. Bu çalışmada, erişilebilirlik, görünürlük ve fiziksel yakınlık gibi mekânın ayırt edici boyutlarını anlamak için, saha çalışmaları (gözlemler, anketler ve röportajlar) ve saha dışı teknikler (mekân sözdizimi ve istatistiksel analizler) olmak üzere farklı yöntemleri bir araya getirmektedir.

Çalışmanın bulguları, farklı mekânsal düzenlerin ve organizasyonların sirkülasyon yükleri üzerinde farklı yoğunluklar oluşturduğunu ortaya çıkarmaktadır. Bu doğrultuda, sağlık tesislerinin mekânsal tasarımı mekân kullanımını, erişilebilirlik ve görünürlüğü etkileyebileceğini ve birim içi iletişimin de bu parametrelerden etkilenebileceğini ortaya koymaktadır. Çalışılan üç birim arasında morfolojik farklılıklar olmasına rağmen, bulgular birim içerisindeki belirli fonksiyonların mekân kullanımını ayrıca etkilediğini göstermektedir. Özellikle birim içerisinde personel için tahsis edilmiş ilgili fonksiyonların (hemşire istasyonları, hemşire odaları ve ilaç hazırlama odaları) oluşturduğu sirkülasyon yoğunluğu nedeniyle, bu alanların birim içerisindeki koridorlar boyunca sirkülasyonu şekillendiren kilit alanlar olarak rol oynadığı gözlemlenmiştir. Ayrıca, personel ile ilgili alanların yanı sıra birim sekreterleri gibi farklı çekim noktaları birim içerisindeki sirkülasyonun şekillenmesine neden olmaktadır.

**Anahtar Kelimeler:** Sağlık Mekânları, Mekân Kullanımı, Hemşire İletişimi.

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# GLOSSARY

**Evidence-based design (EBD)** in healthcare design is based on the evidence of the impact of the design process decisions on the healthcare environment (Zhao 2013).

**Inpatient Unit (IU)** is the unit in the healthcare facilities in which the patients are kept under constant care and supervision before or after the operation. (Yataklı Tedavi Ünitesi)

**General Surgery Inpatient Unit (GSIU)** in Turkey corresponds to medical surgical inpatient unit in western hospitals. (Genel Cerrahi Yataklı Tedavi Ünitesi)

**Staff-related areas** are reserved for staff occupancy only such as nurse stations, nurse rooms, and medication preparation rooms; no patients are expected to be observed within.

**Nurse station** is defined, "they are places located close to the circulation area, where patient records are kept, dealing with the follow-up of patients in inpatient units" (Uzunay 2011, 73). (Hemşire İstasyonu)

**Nurse room** is a space reserved for nurses in the unit to serve both purposes one for a break and the other for necessary paper. (Hemşire dinlenme odası)

**Medication preparation room** is an area to prepare and dispense drugs for patients by healthcare staff. (İlaç Hazırlama Odası)

**Unit-secretary** which an assigned staff member in the unit to run the paperwork including room assignment. (Birim Sekreteri)

**Care attendant** who follows the doctor's or nurses' orders regarding the treatment and looks after the patient and also helps the nurses. (Hasta Bakıcı)

# CHAPTER 1

# INTRODUCTION

## 1.1. Background

Healthcare spaces frequently mark key moments such as birth, death, diagnosis, or healing of the disease for individuals and communities. However, healthcare facilities need to be considered as work environments for staff in which distinct care protocols take place. The qualities of the physical environments in healthcare facilities can positively or negatively affect many aspects of the healthcare experience concerning the psychological, physical, and even behavioral dimensions (Haggard et al. 1999; Sadek et al. 2016; Huisman et al. 2012). The existing literature presents cases in which the design of healthcare settings lead to negative impacts and poor quality of patient care such as medical failures, stress, fatigue, burnout, job dissatisfaction, interruptions (Donchin et al. 2003; Coiera et al. 2002; Iyendo et al. 2016; Tyson et al. 2002). The majority of research, however, suggests that healthcare environments support positive outcomes such as improve staff performance, and improved communication and interaction patterns between medical staff and patients (Devlin et al. 2003; Jonas et al. 2004; Cai 2012; Ulrich 1992). In other words, healthcare environments have been acknowledged to introduce parameters to influence behavior, movement and interaction of inhabitants. There is a growing body of research to investigate and elaborate on the implications and relationships between architectural features and users or organizational outcomes in the healthcare environments (Ulrich et al. 2008).

A well-designed healthcare environment supports staff and patient-related outcomes in many different ways, such as reducing staff stress, burnout, and other possible negative effects, and improving patient recovery and safety (Iyendo et al. 2016). Therefore, a proper spatial layout improves functioning of a healthcare facility while providing a more satisfactory and higher quality service (Huelat 2007). At the same time, design of the spatial layout can affect users' healing experience with interaction and communication between staff to staff and staff to patients (Shepley 2002).

The design of environmental features at healthcare facilities should not only consider patients and visitors, but also staff, in order to prevent the negative impacts on patients' healing process. Even, a work environment should be designed as far away from stress and fatigue as possible by providing a decent workplace environment for healthcare staff (Paul 2005). Recently, most of the studies on the effects of healthcare settings has been on patients rather than healthcare staff (Williams et al. 2008; Mroczek et al. 2005). However, there is a body of research that focus on physical work environments can affect behavior, communication, and movement patterns of staff (Dutta 2008; Tyson et al. 2002; Gharaveis et al. 2018). As the healthcare design community tends to follow the patient-centered care model in contemporary care practice, the role of healthcare professionals and their work environment are being reformulated (Dutta 2008), and this argument inevitably informs how we design and research healthcare environments.

The effects of a well-designed work environment are of great importance (Ulrich 1992) concerning the activities of care staff and patients. For instance, Tyson et al. (2002) assert that changes in patients' and visitors' behavior and movement may be a reflection of changes in the behavior of staff . It can be a result of the staff trying to adapt to the changing healthcare environment in terms of the physical features of the settings rather than the change itself (Tyson et al. 2002). As a consequence, although patients are considered as primary inhabitants in healthcare environments, the effects of design decisions need to be evaluated and investigated with both patients and staff in mind, since the interaction between the two groups –patients and healthcare staff– is critical in achieving better health outcomes (Alalouch 2009). In particular, the relationship between the healthcare staff and patients is of vital importance for healthcare quality (Paul 2005; Aiken et al. 2011).

In the hospital environments, the literature suggests two major types of interaction between users: (1) patient to healthcare staff and (2) healthcare staff to healthcare staff (Pachilova et al. 2013; Pachilova 2020). As mentioned above, there are studies to link the dimensions and levels of communication between healthcare staff to patient-related outcomes and satisfaction. The impact of a well-designed work environment on staff behavior and communication was considered to be related to the operational agenda of healthcare settings rather than the building configuration and layout, for a long time (Hillier et al. 1989). Nonetheless, discussions on the effects of building configuration and layout on people's behavior, interaction, and communication come to the forefront in

recent studies related to environment and behavior studies (Cai et al. 2012; Pachilova et al. 2013; Koch et al. 2012a, 2012b). Moreover, globally, there is an array of studies to support that spatial configuration and layouts of healthcare settings are correlated with the inhabitant's behavior, movement and even social life by supporting different communication and interaction patterns (Pachilova et al. 2013; Dutta 2008; Cai et al. 2012). However, the number of studies with particular focus on the issues mentioned so far is limited.

In Turkey, the body of research to investigate the design and utilization of healthcare environments is limited; and there is an urgent need for credible research to inform design practice. In comparison to Western healthcare practice, there are different conditions and particularities within the healthcare environments within Turkey. So this research, conducted in two major urban hospitals in Turkey, aims to provide results in a context where (1) the multi-bed patients rooms are still dominant over single-bed patient rooms, (2) patient to nurse ratio in units are high, and (3) the nurses, who should be considered as major occupants, are underrepresented in both healthcare environments and healthcare design processes. This thesis will focus primarily on space occupancy of healthcare staff, namely nurses, in Inpatient Units (IU) in Turkey with the intention to better understand movement, interaction, and space utilization patterns. Considering these parameters (movement, interaction, and occupancy), there are no benchmark studies available in Turkey as the healthcare staff's movement, experiences, and communication in their work environment may indirectly affect patient’s and organizational outcomes. The research employs qualitative and quantitative methods, in combination with the space syntax analysis, survey, interview, statistical analysis and simultaneous field observations to provide a current account on the subject.

## 1.2. Problem Statement

Potential contribution of the design of built environments to staff-related outcomes is critical within healthcare spaces (Mourshed et al. 2012). The movements, experiences, and even communication of healthcare staff who occupy spaces in a certain choreography are the key factors within care delivery processes (Dutta 2008; Gharaveis et al. 2018). Most research into healthcare settings, with focus on environment and behavior, focus on particular environmental factors such as noise, natural ventilation, and

light in order to understand the staff-related outcomes which is becoming increasingly important from safety perspective (Ulrich et al. 2004; Ulrich et al. 2008). Recently, studies on the effect of spatial configuration and placement on the communication networks of healthcare staff have become central to support both renovations and future projects (Pachilova et al. 2019).

Increasing number of healthcare facilities across the country in the last decade, alongside the effects of Corona Pandemic, have oriented public attention to the healthcare system and the hospitals in Turkey. For this reason, healthcare organizations within public and private domains are in a constant competition to claim their shares within the growing market. Considering the content of research on healthcare facilities in Turkey, how these new hospitals functions are yet to be studied in a comprehensive manner. The literature lacks accounts on how spaces are occupied and utilized at various scales. This thesis aims at contributing to the knowledge on the space utilization within existing and new healthcare facilities in the context of Turkey. By focusing on inpatient units, it is aimed to account for the activity patterns taking place in particular areas.

This research presents a series of spatial analyses of medical-surgical inpatient units. In Turkey, there is no large-scale study focusing on which spaces and how nurses occupy the spaces and how this occupancy may affect other parameters, including communication, interaction, and learning opportunities among nurses especially in inpatient units. This study will make a contribution to the gap in the literature by using multi-case studies and multi-methods in Turkey.

Healthcare environments, as repeatedly emphasized in literature, are spaces where patterns of communication and interaction have essential importance. In healthcare facilities, each unit has different functional sub-areas which require specific architectural and technological requirements. In this thesis, the focus is limited to inpatient units where the patients are kept under constant care and supervision. Since the inpatient unit is one of the key space where healthcare staff provides supervision and care for patients' well-being (Johanes et al. 2015), it should be carefully designed with attention to necessary features in order to improve the care experience of patients. Moreover, how the layout is configured in inpatient units have an effect on how staff operate and circulate in space (Dutta 2008). Recent studies have focused on the plans of inpatient units to explore the issues of collaboration and communication (Dutta 2008; Hua et al. 2012), accessibility and visibility (Johanes et al. 2015; Trzpuc et al. 2010).

Poor or inadequate communication among staff can be considered a major cause of error (Donchin et al. 2003; Alvarez et al. 2005). There are studies in literature to report that miscommunication related mistakes to lead acute consequences (Alvarez et al. 2005; Williams et al. 2010; Donchin et al. 2003; Coiera 2000). For instance, Williams et al. (2010) found that 33% of all conversations of the healthcare staff were considered inadequate or poor communication with errors in surgical intensive care units. Coiera (2000) suggests that miscommunications or communication errors may cause serious mortality and also morbidity in the healthcare environment. Contrary to the fact that inadequate or poor communication can lead to errors in the healthcare settings, there is a study that suggest that even the presence of communication in some areas of healthcare facilities, such as medication preparation rooms, can lead to errors (Duruk et al. 2016). According to Duruk et al. (2016), the interruptions of the healthcare staff during the medication preparation can lead to medical errors.

In the work environment, the occupancy of space and involvement in interaction are key factors of communication quality among staff (Penn et al. 1999). Spatial layout features of the inpatient units (such as visibility, accessibility etc.) promote the movement of staff during the space occupancy and face-to-face interaction which is the most preferred communication type (Cai 2012). As mentioned above, this study examines the occupancy of space by healthcare staff working in inpatient units as basic data, focuses on the spatial layouts of different inpatient units.

## 1.3. Research Questions

The thesis focuses on following questions:

1. What are the most frequently occupied areas in inpatient units?
2. What are the architectural features to influence space occupancy at inpatient units?
3. Do the frequently occupied areas differ for units with different layouts?
4. How do nurses perceive their units in terms of design, occupancy, and communication?

## 1.4. Research Aims and Objectives

This research focuses on space occupancy, and eventually interaction and communication in inpatient care areas units. At this point, the main purpose of this study

is to focus on the basic parameters of space affecting communication. The space occupancy and circulation stands out as the most important data in this context. Accordingly, this research employs different field techniques to understand the distinctive dimensions of communication such as accessibility and visibility.

The secondary purpose of this study is to underscore the research gap in healthcare design in the context of Turkey. In briefly, this study will contribute to the literature by providing an analysis of three inpatient units in two hospitals. The study proposes a research model by using different methods in data collection to be conducted in inpatient units with different spatial layouts. The intent is to contribute to the developing healthcare research and design literature in Turkey by offering a comparison of three different layouts in three inpatient units. This approach will be a critical resource for frontline healthcare staff and managers and designers. Within the scope of this study, the four objectives are formulated:

1. To examine the space occupancy in inpatient units and investigate associated factors.
2. To examine the movement pattern of healthcare staff that influenced by spatial layout of inpatient unit (IU).
3. To examine the layouts in terms of visibility.
4. To understand how staff evaluates their work environments in terms design, interaction, and communication.

This thesis will combine both qualitative and quantitative techniques to cover the objectives above. The results will serve healthcare designers in developing an understanding on the nature of a well-functioning healthcare environment. Taking into account the vital importance of the design of healthcare environments, this study follows an evidence-based approach to ensure the provision of better healthcare quality by contributing to the spatial layout design of hospitals that facilitates communication networks between staff and allows them to focus their attention on patient care.

## 1.5. Outline of the Thesis

The next chapter, following this introductory section, will introduce the related concepts through studies in existing literature on contemporary healthcare design and research. The studies reviewed in Chapter 2 contributes to both the framework of this theses and the methods employed in field studies. Chapter 3 presents the details of the

field techniques. The methods including questionnaire, observations, syntax analysis are introduced in relation to existing set of research tools in literature. Also, the Chapter presents the cases selected for this research. The three inpatient units from two different state hospitals are described in relation to their larger context. Chapter 4 presents findings of the field research. The sections within Chapter 4 illustrate the data emerging from the three sites. Following the results, in Chapter 5, the thesis provides a discussion on the data from the units studied. In Conclusions, Chapter 6, the thesis presents the overview of the field study and the key findings.

# CHAPTER 2

# LITERATURE REVIEW

This chapter is formulated as an exploration of key issues in healthcare research, from both theoretical, empirical, and methodical vantage points. Within the framework of the subject of the thesis, the research studies carried out in healthcare settings are discussed under three main headings in the light of the literature; spatial layout effects on healthcare staff, studies on staff communication, and the set of methodological approaches in healthcare design research.

## 2.1. The Effect of Spatial Layout on Healthcare Staff

Spatial layout of healthcare facilities helps frame users' actions that involve their experience, communication, and understanding of the environment in the space (Haron et al. 2012). Relatedly, spatial layouts can bring hospital staff together, supporting different professionals' communication and interaction in healthcare settings. There is a strong relationship between communication and the spatial layout of healthcare facilities (Penn et al. 1992), since space shapes the communication patterns by organizing the interaction network between its inhabitants (Pachilova et al. 2013; Rashid et al. 2006; Penn et al. 1992; Penn et al. 1999). In addition, Bafna (2003) asserts that spatial layout not only creates a relationship between people as a hierarchical but also assists to occur social relationship models.

Considering healthcare environments, a growing body of literature indicates that environmental features and spatial layouts could influence healthcare outcomes and also patient satisfaction indirectly by affecting behaviors, movement, and communication of healthcare staff (Lu et al. 2009; Cai et al. 2012; Sailer et al. 2013; Pachilova et al. 2015; Ulrich et al. 2008). In the study examining relations between spatial layout and human behavior, Pachilova et al. (2013) reported that healthcare staff spent “69% of their time in the charting galley, adjacent corridor and knowledge centre (with 21% of their time spent in the exam rooms)”, whereas in another case healthcare staff spent “only 46% of their time in teamwork areas and corridors (with a comparable 24% spent in

examinations)" (Pachilova et al. 2013). Similarly, healthcare staff, namely physicians and nurses, spend majority of their working hours in the same places with similar patterns of movement (Pachilova et al. 2013). It means that the configuration of layout is critical and has the potential to influence both movement and behavior patterns of healthcare staff, and their communication network within space (Cai 2012). In relation to this argument, this research focuses on various dimensions of communication by looking at patterns of movement and space occupancy in surgical inpatient units.

## 2.2. Communication in Healthcare Settings

Communication between healthcare professionals has been identified as an essential factor in reducing the stress and burnout that may arise from environmental issues in the work spaces (Coiera et al. 2002) and in increasing social relations and teamwork in healthcare settings (Cai et al. 2012; Tyson et al. 2002). Coiera (2000) asserts that the first need is to understand the nature of communication between staff in order to reduce possible negative effects like stress and increase social interaction and communication between them. Over the years of research which investigates communication pattern between people suggests that people interact with each other when they decide or intend to learn something (Coiera 2000; Coiera et al. 2002). According to the study by Covell et al. (1985), when in need to obtain information, 50% of physicians prefer talking to their colleagues rather than attending to other forms of resources during clinical practice. When Coiera et al. (1998) examined the communication of healthcare staff, they found that personal communication networks such as both planned and unplanned face-to-face meetings, written and personal notes between colleagues, phone calls were strongly preferred. On the other hand, Safran et al. (1999) examined a series of activities in a hospital that supported a computer-based information system, reported that 50% of information exchanges happened face to face between healthcare staff. This means that although hospitals are increasingly getting furnished by digital communication infrastructures, healthcare staff continue to prefer face-to-face communication (Parker et al. 2000). Relatedly, the characteristics of the spatial layout becomes important to support face-to-face communication, and in turn, influences interaction patterns of staff. Following this line of thought, then, the use of

space can be considered as a factor to affect , both directly and indirectly, health-related outcomes (Lu et al. 2009; Cai et al. 2012; Sailer et al. 2013).

In the healthcare environment, even though face-to-face communication has an important positive effect on care outcomes (Cai et al. 2012), engaging multiple communication channels simultaneously can have adverse effects by distracting healthcare staff (Coiera et al. 2002). It is also suggested that healthcare staff carry an unnecessary communication load when people ask for much information that can be accessed from information sources (Coiera et al. 2002; Parker et al. 2000). Since a number of concurrent duties may fill human memory (Reason 1990), it has been accepted that such unnecessary communication loads (interruptions) can cause negative influences on healthcare staff's memory and cognitive burden (Parker et al. 2000; Coiera et al. 2002).

The research of Coiera et al. (2002) acknowledges that a tenth of the communication (10%) consists of simultaneous and multiple dialogues, and reports that one in three communications (30.6%) can be assumed to be an interruption in the healthcare environment. Such interruptions between healthcare staff, especially under emergency events, may cause misunderstandings or misperceptions, therewith such communication can result in serious medical errors in healthcare areas (Donchin et al. 2003). Cai et al. (2012) support that the communication fails in healthcare environments can reflect in patients' care outputs and even job dissatisfaction and burnout among staff.

There is a body of research to approach the issue from different vantage points to examine the effects of poor communication between healthcare staff and to suggest that communication can be considered as a reason for the systematic error (Coiera et al. 2002). On the one hand, according to an Australian survey with a conclusion that %17 of system errors are caused by lack of communication or misunderstanding, at the same time %84 of them can be accepted as preventable (AHMAC 1996). On the other hand, a research that examined the situation in intensive care units found that 2% of the activities of physicians and nurses consisted of verbal communication which led to 37% of the errors (Donchin et al. 2003). The study by Donchin and colleagues (2013) support the argument that the lack of communication between healthcare staff is the likely reason not only for the waste of time but also for preventable failures in clinical practice that can cause injury, disability, or even mortality.

Associatively, most of the research support that both several positive and preventable negative outcomes can be related to spatial features (Weick et al. 2003; Ulrich

et al. 2008; Haron et al. 2012), so the healthcare environment is a crucial concept for its users' behavior, experience, communication, and outcomes. For this reason, the built environment of healthcare settings has been the main subject of much research and still maintains its agenda as a subject that needs to be investigated in line with changing technologies.

Even though there are technological developments in the healthcare environment day by day, face-to-face communication still has an important and dependable role between healthcare professionals' conversation (Coiera et al. 2002). Since most of these communications are spontaneous and unscheduled interactions that are affected by spatial layout, the design of the healthcare environments has great importance to support both inhabitants' satisfaction and communication (McCarthy 2004). For this reason, a careful design with a clear separation and demarcation of the spaces to be used by hospital staff and patients improves and facilitates effective communication both among staff and between staff and patients (Pachilova et al. 2013). From a spatial design perspective, then, a better understanding of the nature of communication and interaction in space will help to determine factors affecting outcomes in work environments at multiple levels (Dutta 2008).

### 2.2.1. Active Learning, Teamwork and Collaboration through Communication

The greatest role of communication among healthcare professionals is to contribute to effective learning in healthcare settings (Cai et al. 2012). Such learning among healthcare staff can support practitioners to become competent and to master the necessary skills in care process (Dutta 2008). Moreover, Dutta (2008) suggests that "informal communication also plays an important role in co-worker relationships that, in turn, affect work effectiveness and commitment" (Dutta 2008, 7). According to Becker (2007a), communication can be assumed as a practice in society which supports transfer of tacit knowledge in social space. Communication among healthcare staff cause to unwittingly transfer the tacit knowledge across members (Cai et al. 2012). In addition, tacit knowledge transfer increases efficiency in the work environment, as it provides an active interaction and teamwork among staff as well as being open to observation (Reber 1993). For this reason, efficient learning environments in healthcare settings should be

designed to support communication and interactions among healthcare professionals in order to accelerate and reinforce tacit knowledge transfer. That is to say, since the space in the healthcare environment is an active learning place for healthcare staff, the spatial layout and the characteristics of space is an important work environment to encourage impromptu communication, transaction of information (Bromberg et al. 2006).

Hua et al. (2012) argue that there is a relationship between greater collaboration among staff and enhancing healthcare quality. There is evidence to suggest that staff working with great collaboration had lower stress and burnout levels and higher job commitment and satisfied with their profession in healthcare area (Borrill et al. 2000; Rafferty et al. 2001). Borrill et al. (2000) found that teamwork has positive effects on decreasing the stress of members of the team and low possibility the leaving job or team. Similarly, Rafferty et al. (2001) reported that staff working with great collaboration can support less burnout levels and higher job commitment and more gratification for the job in healthcare area.

Dutta (2008) stressed that team members who collaborated in a care setting "reported high levels of social support during times of difficulty or stress; and perceived that there was more co-operation in the organization than those not working in teams. This led to more positive work attitudes and greater propensity to co-operate with others" (Dutta 2008, 3). It has long been acknowledged that team-based medical practice with active communication is better in delivering care (Dutta 2008; Allen 1977). With particular focus on task circumstances, for instance, Hirokawa (1990) presents a strong case to emphasize the role of communication in group decision-making. Dutta (2008) support that face-to-face communication between healthcare staff occupies a good place in comparison to other types of communication in terms of increasing job commitment, active learning during shifts, and also teamwork between staff in the healthcare environment.

### 2.2.2. Spatial Layout, Different Spaces and Communication

Healthcare environments are typically composed of areas with different functional requirements. Each space has its own technical, medical, and also architectural characteristics. Thus, spaces with different functions in health environments possess a potential to influence communication, behavior and movements of staff, and indirectly

affect patient-related outcomes (Pachilova et al. 2013; Dutta 2008; Cai et al. 2012; Ulrich et al. 2004). The different characteristics of layouts provide several opportunities for the communication, teamwork, and the transfer of tacit knowledge across healthcare staff (Cai et al. 2012). Pachilova suggests that "the spatial configuration of a building could help with bringing tribes together and having them under control or alternatively could keep them apart and enhance their social compartmentalization. Space could also bring healthcare professionals from different hierarchical levels together to speed up processes and help with overcoming cultures of conservatism" (Pachilova 2020, 108). So that, spatial layouts has proven to have a significant impact on the quality of communication (Iedema et al. 2006; Cai et al. 2012).

According to the study of Setola et al. (2013) communication and interaction between users of the health environment is high in public spaces (connections, waiting area, corridors etc.) where the core areas of different users overlap. Setola et al.'s study which examined the effects of the spatial layout on the relationship between patients and the medical staff in public spaces of three hospitals in Italy, found that "P-M (patient-medical staff) interactions happen mostly in overlapping core spaces if the two cores, public and staff, overlap or in transition spaces[1] between the two cores if they don't overlap" (Setola et al. 2013, 10). At the same time, these public areas can be considered "neutral areas" within health environments (Becker 2007b) as they are observed as places of interaction between staff, patients and visitors where informal, active communication processes take place (Iedema et al. 2006). The frequency of communication is also observed to be increasing in these spaces. Conversely, considering the spaces according to the user type in hospital, this frequency of communication may create a cognitive burden for healthcare professionals and may result in communication interruptions (Coiera 2000). Accordingly, Pachilova et al. (2013) supports that "creating a clear spatial separation of staff and patient areas facilitates good communication, both among caregivers and between caregivers and patients" (Pachilova et al. 2013, 174).

Beyond the discussions on specific zones within layouts, there is also an ongoing discussion on particular design features within healthcare environments. The nursing stations in inpatient units, for instance, is one of the current topics in healthcare design practice. There are empirical studies to argue that decentralized nurse stations can reduce

[1] In the study by Setola et al. (2013) , "transition spaces" refer to the outpatient spaces where medical staff and patients encounter.

nonverbal learning and the length and frequency of communication between healthcare staff by creating isolation compared to centralized nursing stations (Bromberg et al. 2006; Tyson et al. 2002; Dutta 2008; Zborowsky et al. 2010). Dutta (2008) found that "the more decentralized nursing unit design reduced interaction; and it did so not only for interaction among nurses, but also for interaction between nurses and doctors" (Dutta 2008, 55). At the same time, the problems are likely to arise in cases such as teamwork and assistance, as healthcare professionals at the decentralized nurse stations cannot see each other while working (Cai et al. 2012). Accordingly, Dutta (2008) found that nurses working in decentralized nurse stations create an interaction pattern around a specific station.

Some clinical units specialize according to their service type due to specific requirements concerning architectural, technological, and process-related features such as intensive care units, medical imaging and emergency areas. Inpatient units and emergency areas can be defined as moving, complex, and constantly varying areas depending on stressful environment and time. Therefore, the specific units which require special equipment and features, for example, intensive care units, include high-tech equipment to ensure the surveillance and well-being of patients (Donchin et al. 2003).

According to Coiera (2006), for instance, "in some specialized clinical units like the emergency room, where a large number of staff are physically co-located and engage in teamwork, the communication space can account for almost all information transactions" (Coiera 2006, 90). Another study by Coiera et al. (2002) demonstrated that in two emergency situations, nearly 90% of all information processes occurred within communication between medical staff. In other words, face-to-face communication constitutes most of the information exchange in the health setting (Coiera 2000), although the communication between healthcare staff in different clinical units in relation to the spatial layout may vary.

As can be understood from above, the design and layout of different functional spaces in healthcare areas have a different effect on the frequency, duration, and quality of interaction and communication among healthcare staff.

### 2.2.3. Visibility, Physical Proximity and Communication

The studies in healthcare environments revealed that visibility is one of the impressive and fundamental environmental factors that inhabitants experience in their

daily activities (Johanes et al. 2015; Gharaveis et al. 2019; Trzpuc et al. 2010). There is a growing body of research to support that visibility is a critical tool to facilitate the social interaction and communication (Johanes et al. 2015; Seo et al. 2011; Lu et al. 2012; Lu et al. 2009). A study on visibility in the inpatient units, by Johannes and colleagues (2015), state the spatial layout of the healthcare environment can provide an environment for to nurses control and supervise as a visually the patients. Besides, high visibility allows medical staff to ease overall supervision more than one patients at the same time by expanding the line of sight (Lu et al. 2012; Gharaveis et al. 2020). This is called as 'spatial transparency', which provides opportunities to see and hear other staff, to monitor patients easily, to increase communication, to facilitate non-verbal learning, to observe the work done by others, to be aware of the observation by others (Becker 2007b). According to Becker (2007b), different spatial organizations support to proximity and visual accessibility which encourage the possibility of enacting of staff, information exchange, and teamwork between staff in healthcare environment. At the same time, it has been affirmed that the productivity of employees increases during the shifts time when staff often see each other in their individual work (Penn et al. 1999). Therefore, visual and physical connectivity is considered as an essential issue to positively influence communication, interaction, observation, non-verbal learning, work efficiency, and teamwork within declared and confined space especially in healthcare environment (Becker 2007a; Gharaveis et al. 2018).

There is also a link between the users' satisfaction, behavior pattern and the spatial configuration in which enhanced access and visibility are created (Haron et al. 2012). MacAllister et al. (2019) who conducted study in a large academic teaching hospital to investigate relationship between spatial layout and patient satisfaction analyzed four spatial measures such as (1) average proximity of nurse station, (2) bed location, (3) room handedness and (4) location of first meeting area. The results of the study indicate that the environmental features including the four major parameters mentioned above have an impact on patient satisfaction. In another study, Leaf and colleagues (2010) used a data set including variables involving patient-related outcomes examined the targeted visibility measure to understand the link between spatial measures of hospital and clinical outcomes. The study emphasized that affordances in relation to visibility can have major impacts on healthcare outcomes. Leaf et al. (2010) found that the intensive care unit

mortality rates of the sickest patients were significantly higher in the rooms that have low visibility from the nurse stations.

Visual and physical connectivity are mainly shaped by layout and size of the space (Trzpuc et al. 2010), and these are considered as parameters to support communication with regards to duration and frequency (Gharaveis et al. 2020). Therefore, frequency, duration and the quality of the communication may be affected either positively or negatively in clinical units with various architectural features allowing different levels of visibility (Zborowsky et al. 2010; Trzpuc et al. 2010; Ritchey et al. 2008). Moreover, the literature confirms that visual connectivity affects three main issues in clinical units that require high visibility: (1) patients who are better supervised due to improved line of the sight (Hendrich et al. 2002); (2) reducing travel time and distance in unit (Sturdavant 1960); and (3) increased communication and contact between staff and patients (Lu et al. 2012; Ulrich et al. 2004).

Considering a study examining visibility levels in key areas, Gharaveis et al. (2020) found that if there was low visibility in an emergency department, the staff dispersed in the unit and spent a lot of time walking to communicate and to interact with collaborators, even if electronic communication devices were available. In the clinical units with high visibility, the study observed that medical staff were able to stay on the central location of the units and take care the patients, otherwise staff was distributed and greatly walked in the units when the low visible units (Gharaveis et al. 2020). Similarly, Kraut et al. (1988) corroborated that communication between staff reduced when staff were observed to be working in distant corners of the ICU. Kraut et al. (1988) state that spatial layout affects communication between users by supporting visual accessibility and physical proximity (Allen 1977; Kraut et al. 1988; Trzpuc et al. 2010).

According to Allen (1977), the probability of interaction and communication between staff is reduced significantly when the distance is more than about 30 to 50 meters. After distance reaches its limits, staff members are not likely to communicate with others as long as there is no emergency occasion (Allen 1977). Additionally, Pachilova et al. (2013) support that increased distance between clinics can lead to logarithmic reduction of communication between staff members in healthcare environments. In a similar vein, distance which affects the frequency and level of communication is an important factor for staff who is getting involved in teamwork (Kraut et al. 1988). When team members are far away from each other, they may be

ineffective against their work, with reduced levels of coordination (Dutta 2008). Even though similar closeness can be get through computer-based interfaces, according to Dutta (2008), physical proximity can be assumed the essential determinant of communication at this time.

Understandably, the location of workplaces has a direct relationship with the possibility of communicating with others (Penn et al. 1999). Also, interaction and communication opportunities are higher for people working in visible and accessible areas by others, and this is reflected in the work efficiency of the employees (Cai et al. 2012). Designers of healthcare facilities should consider to the structure and nature of visual and physical connectivity in different clinical units where can be defined as a workplace for staff, since appropriate visibility and physical accessibility can increase the modes of interaction and communication between healthcare staff (Lu et al. 2009). In brief, the visibility and physical accessibility of the healthcare environment are key concepts during design phases and during occupation as to that patients are constantly accessible and controllable to healthcare professionals (Lu et al. 2012), and it supports staff interaction and communication patterns related to social interaction and also related to the care process of patients (Gharaveis et al. 2019).

### 2.2.4. Staff Communication and Healthcare Quality

Healthcare quality is defined as the productivity of the care received by individuals and the ease of access to the healthcare facilities and care processes that individuals need (Campbell et al. 2000). In addition, the Institute of Medicine (IOM) describes this concept as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (Lohr et al. 1990, 21). The quality of care is closely tied to health-related outcomes which involve many different variables such as patient falls, mortality rates and patients satisfaction (Pachilova 2020).

Healthcare quality can be reflected in the social, psychological and physical life of people and even societies. Therefore, Campbell et al. (2000) stated that the healthcare quality becomes a more purposeful notion in human life when applied to care of an individual. Gupta et al. (2016) mention that most important factor for the evaluation of healthcare quality is the satisfaction, experience, and patient-related outcomes.

Furthermore, MacAllister (2014) explains that patient satisfaction is an important determinant for healthcare outcomes. Pai et al. (2012) categorized the evaluation of healthcare quality perceived and evaluated by patients within a conceptual framework via ten dimensions: communication, healthcare staff, physical environment and infrastructure, process of clinical care, image, trustworthiness, support, relationship, personalization and administrative procedures. Within the scope of this research, studies on the use of space and healthcare quality through Pai et al. (2012)'s first three concepts, (1) communication, (2) physical environment, and (3) healthcare staff, come to the fore.

There is an array of studies on healthcare quality supports that communication between staff influence the quality of care as a patients' satisfaction and health-related outcomes (Dutta 2008; Hua et al. 2012; Rashid 2009; Pachilova 2020). According to Hua et al. (2012), understanding the nature and effects of communication and even teamwork between staff is the most efficient factor for the delivery of healthcare quality since behaviors among them have a great value for care outputs. Hua et al. (2012) mentioned that communication and teamwork among staff plays an essential role in increasing safe care and healthcare quality in the healthcare environment and avoiding medical errors, as it supports the timely sharing of knowledge and active learning. According to Nørgaard et al. (2012), the prerequisite for proper healthcare quality is good communication between both patient to healthcare staff and healthcare staff to healthcare staff. Considering communication between healthcare staff, the results of a study investigating the relationship between teamwork and mortality in intensive care units confirmed that as the collaboration between staff improved, fewer deaths happened in ICU than expected (Wheelan et al. 2003). Similarly, Strasser et al. (2005)'s study examining in stroke rehabilitation units indicate that length of stay in the hospital is significantly associated with teamwork effectiveness. These investigations support that there is a link between healthcare outcomes and teamwork due to increasing communication between staff.

Although there is a growing number of investigations to suggest that communication and interaction have positive effects on healthcare quality (Sexton et al. 2006), there is also research to justify that communication and interaction cause negative outcomes (Parker et al. 2000; Donchin et al. 2003). For instance, Donchin et al. (2003) suggest that the exchange and transfer of knowledge between medical staff during face-to-face communication is a major problem as it can lead to miscommunication, and medical errors. Communication can both support a productive work environment, good

teamwork, and information exchange between staff, and in other respects it can lead to create unfriendly workplace for staff causing disagreement and poor relationship in the collaborations causing negative outcomes (Pachilova 2020). Pachilova et al. (2019) state that poor communication can be assumed to be among factors that negatively affects health quality. Furthermore, inasmuch as redundancy of concurrent communication can be uncomfortable for staff members, it can lead to increasing the medical errors (Parker et al. 2000).

A research by Hendrich et al. (2008) reported that nurses were observed to contact patients only a fifth of the whole time of practice. According to this study, it was stated that while the results of efficient communication between healthcare staff resulted in positive healthcare outcomes, inefficiency of it could lead to a waste of time and have negative consequences on patients. As a results, available research suggests that communication and the quality of care are interrelated. Therefore, there is a chain of causal relationship that indirectly triggers mechanisms involving communication, design of the built environment of healthcare facilities and care quality.

### 2.2.5. Summary

In this section, the nature of communication in the healthcare environment and its importance are discussed to comprehend the relationship of communication with the use of space and spatial layout in hospitals. In brief, healthcare environments are both workplaces for healthcare staff and healing places for patients, so they are of great importance for inhabitants' behavior, movements, and communication. Healthcare areas supporting different functions for different user groups are especially places where communication and interaction are 'vital' importance. It means that failure in the communication or interactions of professionals in healthcare environments can cause negative effects on the patient's care processes and also quality of care. At the same time, it has been determined in the literature that communication between healthcare staff can be considered as an important supportive issue in reducing the stress and medical failures in healthcare, and in increasing social relations, active learning, and teamwork.

The literature reviewed above suggests a strong relationship between healthcare staff's communication and the use of space in healthcare facilities, since space shapes the communication patterns by organizing the interaction network between its inhabitants.

There are several architectural parameters that affect the quality of communication between healthcare professionals, such as spatial layout, visibility, proximity, accessibility. At the same time, since most of these communication activities are spontaneous and unscheduled interactions that are affected by spatial layout, the design of the healthcare environments has great importance to support both inhabitants' satisfaction and informal learning situations. Therefore, spatial features and layout, which is an important factor affecting communication length, frequency, and quality, should be considered during the design process of the healthcare environment.

## 2.3. Research on Spatial Layouts

Human psychology and behaviors, emotions and thoughts can be associated with features of natural and built environments where people live (Montello 2007). Thus, the built environment should be rigorously considered to understand its impacts as human beings interact with the environment through certain behavioral patterns (Sadek et al. 2016). In this context, the study of interrelations between human experience, behaviors and their environments can be defined as several different names such as "environmental psychology", "environment and behavior studies", "ecological psychology", "environmental design research", "man-environment studies (Bell et al. 1996; Montello 2007; Dayaratne 2006; Altman et al. 1983). At this point, the healthcare facilities, and their spatial layouts, come to the forefront as a specific setting for environmental and behavioral studies, because of its complex and experimental structure (Haq et al. 2012).

In healthcare facilities, a rigorous research process is required to account for the role of the environment in a very sensitive and measurable way to understand the outcomes of human behavior, interaction and communication network, and cognitive processes. Recently, the notion of Evidence-Based Design (EBD) comes to the forefront in the healthcare settings research. EBD in healthcare design is based on the generation and use of evidence to impact of the design decisions within healthcare environment research and design (Zhao 2013). EBD has the potential to make healthcare safer, higher quality and more patient centered (Zimring et al. 2008). There is a set of different methods the scope of EBD used in the healthcare studies. In this section, a short survey of the methods used in studies on the spatial layout in the healthcare settings, using this

research methods framework such as space syntax, survey, and observation, will be reviewed within the framework of this research.

### 2.3.1. Space Syntax in Healthcare Research

Space Syntax is a method developed by Bill Hillier and Julienne Hanson during 1980s to systematically study the relationship between human societies and their habitats of various scales and forms: from cities to buildings, museums to hospitals (Cai 2012; Trzpuc et al. 2010; Bafna 2003). Cai (2012, 86) asserts that "the central premise of the space syntax is based on the recognition of architecture as an interaction between social logic of space and spatial logic of society". It means that, space syntax theory measures how spaces are organized and interconnected to one another, taking into account the spatial layout (Sadek et al. 2016; Pachilova et al. 2013; Serrato et al. 1999) , and determines how any change in the plan for connections (walls, doors, corridors, etc. removed or added) will change the quantitative descriptions of that space (Haq et al. 2012). Furthermore, space syntax builds explanatory theories and several evidence-based techniques to examine spatial layout by the determination of spatial factors, classifying spatial relationships under the favor of human movements, and the analysis of patterns of "genotypic" which can be described as perpetual connectivity between spaces (Hillier et al. 1989).

Researchers have developed specific computer software –such as Depthmap– to support these analyses through graphs of isovists which provide the experience of the spatial relations via vantage points, in this way aiming to increase the certainty of data (Sadek et al. 2016; Cai 2012). Accordingly, space syntax techniques bring interpretations of how space affects social behavior of people through quantitative descriptions (Trzpuc et al. 2010; Haq et al. 2012). Researchers of space syntax claim that different human roles, groups, and organizations have a link between some key spatial factors and behaviors which include planned or impromptu interaction, movements, and experiences (Penn et al. 1999; Peponis et al. 2007; Rashid et al. 2006; Sailer, and Penn 2009; Sailer et al. 2007; Serrato et al. 1999; Cai 2012). In addition, they support that spatial layout and some spatial factors can influence positively or negatively the use of space and additionally on communication and interaction networks, and also social behaviors of people in the work environment.

Most of the space syntax studies were conducted in buildings that are considered weak programmed such as museums (Peponis et al. 2007; Sailer, Budgen, et al. 2009; Rashid et al. 2006; Serrato et al. 1999). Besides, the research in facilities which were traditionally assumed as strong program buildings, such as healthcare environments, is rapidly developing (Cai 2012; Sadek et al. 2016). Although space syntax research is relatively new in healthcare facility research, it has been used to examine key issues including communication in health environments, privacy preferences in healthcare settings, usability among healthcare workers, way finding, and nurse movement (Haq et al. 2012).

The space syntax theory defines two different types of users that provide spatial relationships: residents who continuously or to some extent live and control the space, and visitors who lack control of space as they visit facilities for a limited time (Hillier et al. 1989). Space enables the meeting of these two types of people so that affects the communication and interaction pattern in it (Penn et al. 1999; Sailer et al. 2007; Sailer, and Penn 2009). At the same time, also each people group's communication pattern is supported by space in itself. Considering the healthcare environment studies, the residents represent the medical staff (nurses, physicians, and other care provides), while the visitors represent patients and their companions. As mentioned above, spaces can affect the communication, behavior and movement patterns of medical staff, and indirectly affect patient-related outcomes (Pachilova et al. 2013; Ulrich et al. 2004; Cai et al. 2012; Dutta 2008).

In a study, Lu et al. (2012) used space syntax techniques to examine movements of medical staff (nurses and physicians) in an intensive care setting based upon visibility analysis. The investigators revealed that people (medical staff) with different expertise adapted to different characteristics of the environment due to their task-related needs. It means that nurses are adapting to occupy in a specific area according to the visibility of their patients because they need to communicate with other staff for all task-related reasons, whereas, physicians are adapting to occupy in more “generic visibility areas” such as central and open spaces, to provide accessible communication for nurses and patients (Lu et al. 2012). Accordingly, the results show that nurses, who are mostly in communication, are more in accord with the visibility of their patients than nurses who do not interact.

In another study using the space syntax methods, Pachilova et al. (2013) focused on communication between two user groups (residents and visitors) by comparing outpatient clinics in two hospitals. This study found that medical staff except hospital stewards expend three out of four of their working hours in interaction spaces such as corridors, information centers while they spend one fourth of their working hours with patients in the patient care-related areas. Based on this result, the researchers assert that spatial layout can bring medical staff together and support the communication and interaction pattern of different professions in healthcare environments.

Spatial layout is not the only determinant element influencing communication between medical staff, there are many other factors affecting interaction patterns between them such as workflow and culture etc. In this direction, taking into account the specific cultural factors, Cai (2012) used the space syntax method to examine the communication needs of staff at 6 American and 6 Chinese hospitals, each supporting different nursing unit typology. The study was focused four essential factors in nursing unit: socio-cultural differences with regards to communication between staff, staff competence, spatial economy and adequate natural light in work environment. The results revealed that movement and communication pattern of staff can be influenced by interaction between spatial layout and culture. These studies provide academic caliber examples to investigate the relationships between spatial layout and medical staff communication and interaction in healthcare environments.

### 2.3.2. Administering Surveys in Healthcare Research

The surveys employ particular forms of data collection that include various on- and off-site methods where participants are asked to answer a series of oral or written questions on a particular topic (Debois 2019). The survey methods -divided into four according to the methods to be conducted such as online/computer, telephone, in-person, and mail questionnaire- can be used in almost every conceivable subject including research to inquire the perceptions of healthcare staff (Hewitt et al. 2017).

In healthcare studies, the survey is one of the most frequently employed methods to understand the experience of its users within their environments. The participants for surveys in healthcare environments typically include healthcare staff (Pachilova et al.

2013; Shepley 2002; Gharaveis et al. 2020), and patients (Nørgaard et al. 2012; Hua et al. 2012).

In particular, there are survey studies in which healthcare staff evaluate their own environments and practices (Pachilova 2020; Tasselli 2015; Sadatsafavi et al. 2015; Molzahn 2013; Mourshed et al. 2012; Shepley 2002). For example, Pachilova (2020) stated that "a staff survey to evaluate teamwork and communication as a proxy for healthcare quality was used alongside official quality of care ratings" and "semi-structured interviews with healthcare providers were conducted to get an in-depth understanding of the work environment and culture of the ward" (Pachilova 2020, 7). In addition, Adams (2008) conducted a survey to evaluate how the nursing unit provides an opportunity to learn from the perspective of assigned nurses and also graduate nurses. These studies show that in many current studies examined the healthcare settings, the survey method is used effectively to collect data by making use of the users' own experiences and perceptions. Following the techniques published in literature, this thesis employed a survey design to inquire the research questions. The intention is to provide a comprehensive picture by using different data collection tools.

### 2.3.3. Conducting Observations in Healthcare Settings

Observation is a particular kind of technique to gather data by observing participants, spaces, and activities related to the subject under investigation from observer/s' point of view (Weston et al. 2021; Baker 2006). Weston et al. (2021) emphasize that "observation is a valuable data collection method for health services researchers to identify key components involved in a topic of interest, a vital step in forming relevant questions, measuring appropriate variables, and designing effective interventions" (Weston et al. 2021, 104).

There is an array of studies on healthcare that used the different observation types such as the snapshot method (Setola et al. 2013), behavior mapping (Canakcıoglu 2016; Cai et al. 2012), and shadowing (Pachilova 2020). For example, Cai et al. (2012)'s research on the relationship between nurses' communication and typology of nurse station in ICU used the behavior mapping observation to understand interaction and movements pattern within the unit. In Setola et al. (2013)'s study, the researchers stated that "concerning behavioral and use pattern survey to reveal interactions between patients and

medical staff, the method chosen for the observation was the snapshot method: a series of photos of each space made at regular time periods during a day, in which different categories of users, positions, actions and interactions among people in the space are highlighted" (Setola et al. 2013, 5-6). As mentioned in the literature examples, the observation method is an appropriate method that can be used to explain what, when, and how a designated area is utilized in healthcare settings (Weston et al. 2021). Within the scope of this thesis we have employed two forms of observations, details of which is explained in the Methods chapter.

## 2.4. Conclusions of the Review

This section has thrown a glance at different methods used in healthcare environments studies to understand relationships between space occupancy and its effects on healthcare staff. In addition, this section shows the existing studies which analyzed the use of space through the different methods to review influences of spatial layout on communication and interaction in healthcare settings. Most of them focused on visibility, staff competence, teamwork and collaboration and also culture in terms of communication and interaction between medical staff.

Following the literature review presented, three issues come to the fore in relation to the research questions of this thesis; (1) spatial layout of healthcare environments, (2) staff' occupancy of space, and (3) communication between staff. Figure 2.1 describes how these three issues are mostly related in the literature. It means that there is an array of studies on the effects of spatial layout and plan configuration on healthcare staff' space occupancy in healthcare environments via different method tools (drawn as a red dashed line in Figure 2.1). Some research examines the relationship between communication and staff's space occupancy focusing on their movements, behavior, and experience in healthcare settings (described as a blue dashed line). Some studies also examine the interrelationship of spatial layout of healthcare facilities on communication between healthcare staff (indicated as a green line). Moreover, there is also some research examining the relationship between the three issues in Figure 2.1 and their effects on patients and healthcare outcomes.

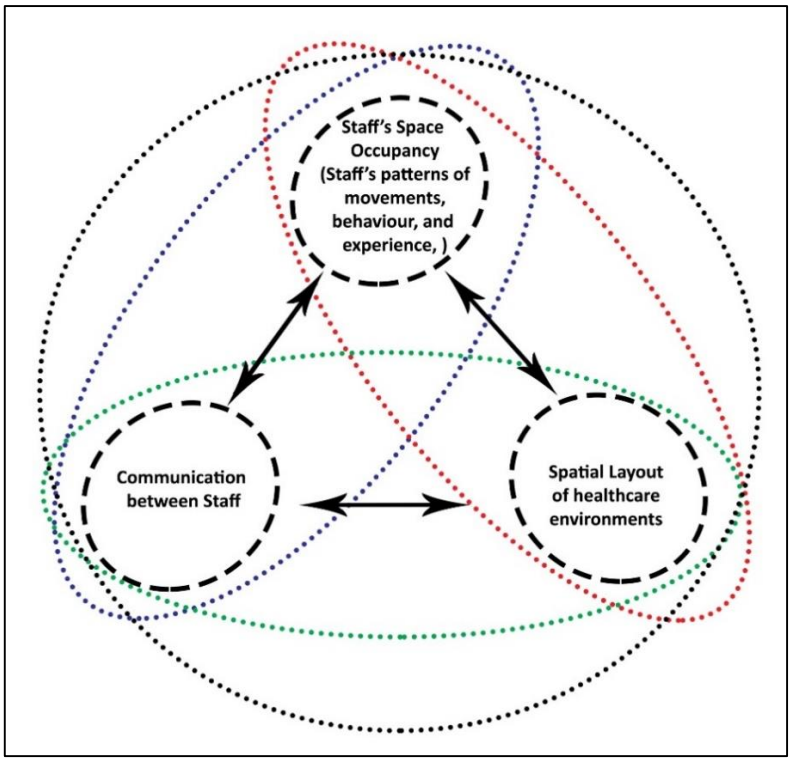


Figure 2.1. Formulated three issues in healthcare studies (Sourced by Author)

The literature suggests that planimetric features of healthcare environments including visibility, physical proximity and accessibility are usually correlated with communication, interaction, and collaboration between staff (Becker 2007b; Gharaveis et al. 2018; Dutta 2008). Moreover, there are specific research studies to emphasize configuration and organization within layouts to impact, directly and indirectly, care and healing processes and quality of care (Cai et al. 2012; Lu et al. 2009; Pachilova et al. 2015). Therefore, understanding the behavior patterns within healthcare environments emerges as one of the key issues. By focusing on observational data and self-reports, this research aims at inquiring the key issues introduces above in the context of Turkish healthcare system.

# CHAPTER 3

# RESEARCH DESIGN AND METHODS

The introduction of the problem within the Chapter 1, and the critical review of the developing research in healthcare settings had informed the set of methods to be employed in this research. The research focuses on three inpatient units in two public hospitals, each having different spatial layout characteristics. This chapter details the stages of data collection and analysis techniques of the project.

## 3.1. Research Design

The research is designed as a multi-site investigation using a combination of several field strategies. The inpatient units are selected according to their variations within layouts and availability. Three inpatient units in two hospitals (mentioned as Hospital A and Hospital B) provides a range of differences concerning their layouts. Thus, the study aims at exploring the variation in staff's space use which is hypothesized to influence the staff's communication pattern. Following this hypothesis, which was studied in literature from different vantage points, in this thesis, the research is designed to explore the occupancy patterns in high-risk environments like inpatient units where even minor improvements in design might positively impact health outcomes. The research is designed to examine how the spatial layout and configurational features (visibility, access, distance, etc.) have an effect on staff's use of space and how these effects reflect the communication pattern of staff and patients' outcomes. The research brings together different methods including on- and off-site techniques. The field methods include field observations, surveys, and interviews, while the off-site method includes space syntax analysis. These methods are also used on 3 general surgery units (GSIU)[2] selected from two different hospitals.

Hospital A is a state-owned training and research hospital, under the administration of a large scale university with 9 buildings established in 1982. It is located in Izmir, Turkey on a dense campus setting where medical facilities are clustered.

[2] GSIU in Turkey corresponds to medical surgical inpatient unit in western hospitals.

According to reports published in the hospital website[3], an average of 2750 operations is performed annually in the GSIU, which has an inpatient service with a capacity of total of ninety-seven beds. Since the bed capacity was proven to be insufficient, the administration decided to establish another inpatient unit on the same floor. The unit was made available after a renovation process executed in 2014 and the general surgery department was divided into two fully organized units with differences concerning layouts. The administrative plan for the two units suggests that Case 1 is reserved for cancer patients, whereas Case 2 is for patients with stomach, breast, and goiter disorders. However, this distinction has not yet been made according to the ailments. Currently, there is no case-based distinction between Case 1 and Case 2, and patients are admitted to the units based on availability.

Hospital B is also a state hospital with a total capacity of 300 beds. It was established in 2018, located in a peripheral district in Izmir, Turkey. It is projected and executed as one of the city hospitals; an emergent healthcare model that was followed by the government in Turkey since 2017. City hospitals are the healthcare typology that emerged as a part of the Health Transformation System, which is aimed to be built with large-scale hospitals, high bed capacities, and different investment methods (Nevrim 2020). They are divided into two according to the owner who built the building; those built by the state like Hospital B, and those built with public-private partnerships.

Hospital B is the newest facility to be studied in this research. Yet, the hospital did not publish any data concerning their annual GSIU operations. In Hospital B, the GSIU (Case 3) was selected to conduct field research.

### 3.1.1. Timeline

In the research, necessary permissions from various administrative bodies were obtained for field research within an extended schedule (Table 3.1). First of all, ethics committee permissions were obtained from the institution to which the research was affiliated. The necessary permissions required to access Hospital A were obtained from the relevant rectorate offices and the chief physician of the teaching and research hospital. The permissions for Hospital B, on the other hand, were processed at the Izmir Provincial

[3] https://hastane.deu.edu.tr/index.php/tibbi-birimlerimiz/eriskin-hastanesi/tum-birimleri-gor.html?id=154

Health Department, to which the facility is affiliated with and the chief physician of the hospital. The paperwork for permissions took almost five months, spanning from March 2021 to August 2021.

Table 3.1. Time schedule

| | the year of 2021 | | | | | | | | | | the year of 2022 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | March | April | May | June | July | August | September | October | November | December | January | February | March | April |
| Creating Data Collections Tools | | | | | | | | | | | | | | |
| Ethics Committee Permissions from IZTECH | | Home Institution | | | | | | | | | | | | |
| Permissions for Field research | | | | for Hospital A | | | | | | | | | | |
| | | | for Hospital B | | | | | | | | | | | |
| Field Research | | | | | | | for Hospital A | | | | | | | |
| | | | | | | | | for Hospital B | | | | | | |
| Analysis | | | | | | | | | | | | | | |
| Report/Thesis Manuscript | | | | | | | | | | | | | | |

Following the literature review, the survey and two observation protocols were created before applying and obtaining necessary permissions. The samples of data collection tools were presented within the permission application documents. After obtaining permissions, the field study schedule -organizing the visits to the three units- was created. During the visits to hospitals, the researcher herself conducted the observations and surveys, following a script. The field work for all three units was completed in a total of three months, spanning from September 2021 to November 2021. Following by analysis was conducted spanning from November 2021 to February 2022, and a report of the study was completed spanning from January 2022 to April 2022.

## 3.2. Research Tools and Methods

This study employed a mixed-method approach including qualitative and quantitative techniques for data collection and analysis. For data collection, the research employed mainly three different techniques; field observations, a survey, and semi-structured interviews. In complimentary to these data collection protocols, the researcher also took photos at each unit and obtained the as-built layouts. The layouts were then further processed for Space Syntax analysis. This sub-section presents below the details of the techniques followed.

### 3.2.1. Staff Survey

Within the scope of this research, a survey was developed to inquire the research questions. The surveys were conducted during the Coronavirus Pandemic. The staff at designated units were extremely busy so it was decided to conduct the paper-based surveys within the units. The surveys were designed to last no more than 10 minutes.

Before the survey was distributed to the participants, a draft was pre-tested with 5 individuals who represented the target group; an academic nurse, a retired nurse and three practicing nurses, and feedbacks were received about the content and order of the questions. Before administering the survey, the intention was to run a test-retest analysis in another unit in Hospital A. However, due to the assignment strategy, which always generated a different mix of nurses at shifts, the test-retest study was avoided since it was always impossible to have the same group of nurses at units. Instead, we have conducted another pilot study at a cardiac inpatient unit at Hospital A, in order to field test, the question set employed in the survey. After minor changes to improve the wording in questions, the survey reached its final status (Appendix C).

The final version of the survey, which was modified according to the feedback received, was distributed during shift hours to the staff who volunteered to participate at the units where the research was conducted.

The survey includes 19 questions including multiple-choice, and open-ended ones, alongside a drawing task at the end which aimed at generating self-reports on staff's behavior patterns in respective units. The staff survey consists of three different content groups to acquire data in relation to the research intentions. The first content group includes demographic questions such as age, gender, job description and experiences of staff. The second content group concerns the interaction with and accessibility to colleagues in the units studied. These questions aimed to analyze the communication patterns and frequency between staff. The third content group within the questionnaire is the reflections of the spatial layout of the hospital area as the working environment of the staff on the use of the space by the healthcare staff. The gathered information from this survey was analyzed through quantitative techniques. To understand the differences between the three units studied, the one-way ANOVA protocol was used to analyze the descriptive results of the survey questions. In the drawing task, on the other hand, the participants were given a simple layout of their units and were asked to mark the most

frequent routes they follow on an average day. A sample of staff survey was included in Appendix C.

### 3.2.2. Field Observations

A series of simultaneous field observations were used to apprehend the nature of the communication patterns during the working time daily routines of healthcare staff. Two types of field observations were designed and conducted to understand dynamics of care processes within the examined inpatient units. The first type required the researcher to move within units to capture the staff occupancy, whereas the second involved tracking the movements of the staff members, one at a time. For these two types of observations two different observation data recording sheets were generated for each unit. After developing an understanding on the work environment within the units, the researcher initiated the observations, details of which were introduced below.

#### 3.2.2.1. Location Mapping Observations

The intention in the location mapping observations was to record, over the course of the route, the exact locations of the practicing staff within the unit. The recordings were processed simultaneously digitally on the observation sheets using a digital tablet. Two different schemes were created on observation sheets for easier separation of the data obtained. The researcher has recorded both the staff type (physician, nurse, care attendant and patient) and the activities at the moment of observation (sitting, walking, talking and standing). Within the scope of this research we have focused on the locations and activities of nurses at each unit.

In the location mapping observations, the researcher completed a single tour on the route determined within each unit 10-12 times a day at 10-minute intervals and located the healthcare staff on the floor plan. These tours were carried out between 08.00 am and 17.00 pm, which are the shift hours in the unit. A mentioned observation data recording sheet was included in Appendix A.

### 3.2.2.2. Nurse Activity Observations

The nurse activity observations involved tracking the activities of a single nurse unobtrusively in period of five to ten minutes within units. At each unit, different nurses were observed and recorded on the nurse activity observation sheet. Observations were conducted 5-7 times a day, both in the morning and in the afternoon of different work days. A mentioned observation data recording sheet was included in Appendix B.

## 3.2.3. Interviews

The intention with interviews was to obtain knowledge about the environment, the work protocols within units, and the use of space. Interviews were conducted with the unit nurse managers at each case to better understand staff working processes and perceived burden in different situations, and the nature of teamwork and communication among staff. Since this thesis was carried out in three different units within two different hospitals, the interview was conducted with the unit nurse managers. The interviews were designed as semi-structured to include particular questions to capture necessary information (Table 3.2). No audio-recording device was used during the interview in order not to put any pressure on the respondents and not to affect their answers. Each answer was taken note of by the researcher. In interviews, there are 7 questions which are consisting three different contents such as general information about examined IU, healthcare staff working process and their communication, and spatial layout of IU's effects on staff communication.

Table 3.2. Semi-structured Interview Questions

| **Interview Questions** |
| --- |
| 1) In Units;<br>a) The number of beds,<br>b) The number of nurses,<br>c) The number of rooms,<br>2) What is the average number of patients for whom nurses are responsible? |

(Con. on next page)

Table3.2 (cont.) Semi-structured Interview Questions

| |
|---|
| 3) How is the distribution of nurses to patients in the unit? |
| 4) How / who determines which patient will come to which room? |
| 5) Do you think that the physical structure of the service has an effect on communication between staff? |
| 6) Do the patients for whom the nurses are responsible gather in one place in the unit or can they be scattered? |
| 7) If you had to change one thing in the unit, what would you change? |

### 3.2.4. Space Syntax Analysis

Space syntax is now considered as one of the reliable methods employed in healthcare research to develop an understanding of the formal qualities of layouts as they accommodate various activities within (Sadek et al. 2016). In this study a syntactic analysis was also included to enrich the inquiry by interrelating the data emerging from different methodological tools.

First of all, obtained floor plans of the inpatient units of the three hospitals were compared with the current state of the units and evaluated in terms of their correspondences. Then, the digital floor plans were converted to DXF format to generate graphics to be analyzed in the Depthmap X software. As part of the space syntax method, these floor plans used to exemplify the spatial layout as visual graph analysis (VGA).

VGA is based on eye-level, considering people's visual experience (Turner et al. 2001). Therefore, only walls are considered as an obstacle for the eye of people in 2D floor plans imported to Depthmap. Other elements in the floor plan such as windows, doors, glass partition walls have been removed. The results were used to range from a red to blue color scheme to understand the relationship of space with other spaces. While the red in the color scheme expresses how integrated the space is, the blue expresses how separated it is. Therefore, VGA was made visually intelligible before analysis. This makes it easy to visually compare the results of visibility analysis between three different hospitals. The results obtained from the VGA also enabled several numerical measurements to be calculated such as connectivity, integration HH and step depth. These criteria were chosen based on previous studies; the behavior and also interaction of

hospital users can be affected by integration or connectivity (Alalouch 2009; Pachilova 2020; Cai 2012; Lu et al. 2012), or step depth analysis (Cai et al. 2012, 2013).

Space syntax analysis provides important data for this study to understand the key areas in the three case studies. These data will form a base in order to consider and include other methods of the study. Therefore, data from two types of observations from fieldwork will be processed into plans and intersected with the results of space syntax. A comparison of methods will be presented and discussed in the Chapter 5.

## 3.3. Case Studies

The literature review suggests that staff's space occupancy is important issue for both communication pattern of staff and patient outcomes, and staff productivity (Sadek et al. 2016). Considering this issue, the nurses, who are the permanent staff of the selected units and who monitor the patients' condition and make the first intervention, are the selected as the sample group for this study.

This research was conducted in the three different general surgery inpatient units (GSIU) in two different public hospitals in İzmir, Turkey. The purpose of choosing GSIU is that requires a nurse workload and has a dynamic patient circulation. It is one of the most common critical departments across the inpatient services in Turkey.

The three cases studied in this research were chosen based on the variety in their spatial configuration. The ease of securing permissions was also crucial within the scope of this thesis. And also the selected hospitals vary hospital type and scale. The preliminary work on granting permissions provided a short list of healthcare organizations to collaborate with. The research progressed with the two candidate hospitals that agreed to participate. Within the two hospitals, three units with different spatial characteristics were identified to conduct the field work. In this section, information about selected GSIUs from two hospitals will be described. Below is presented a location of cases in the hospitals (Figure 3.1) and a chart to compare three units (Table 3.3).

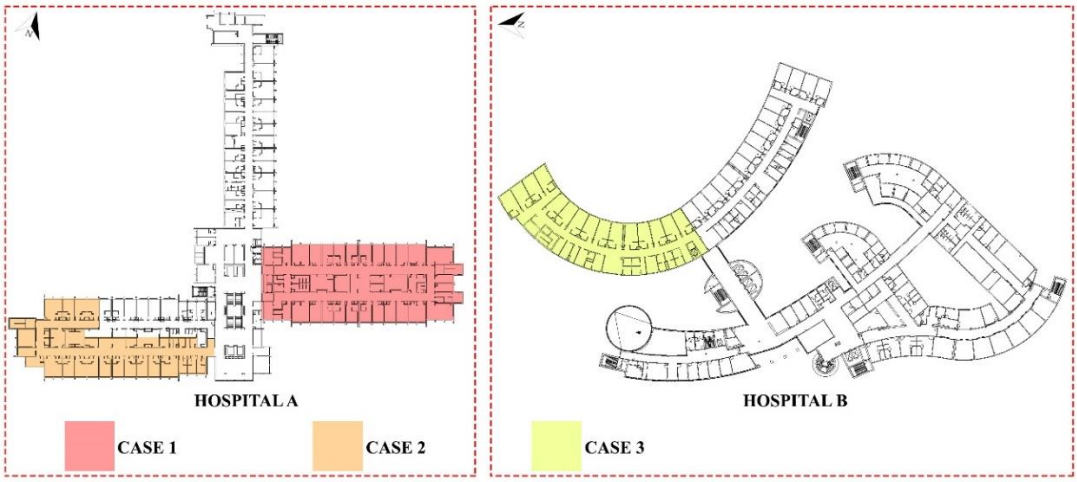


Figure 3.1. Location of the cases in the hospitals

Table 3.3. Comparing three units

| Cases | Gross Area (sqm) | Staff Area (sqm) | Patient Area (sqm) | Circulation Area (sqm) | Service Area (sqm) | Typical Patient Room (sqm) | Location of Hospital | Unit Condition | Type of Plan Layout | Location of Staff-Related Area in Unit | Nurse Station Model | Presence of Unit-Secretary in Unit | Nurses in Shifts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case 1 | 1283,81 | 106 | 700 | 347 | 131 | 27 | Hospital A | Earliest Built Unit | Race track | Clustured | Centralized | Yes | Non Fixed |
| Case 2 | 839,58 | 98 | 437 | 240 | 65 | 25 | Hospital A | Renovated Unit | L-Corridor | Distributed | Centralized | No | Non Fixed |
| Case 3 | 995,03 | 97 | 543 | 272 | 82 | 33 | Hospital B | Newest Unit | Radial | Clustered | Centralized | Yes | Fixed |

high value | low value

## 3.3.1. Case 1

Case 1 is located second block and fourth floor of the state-owned training and research facility, Hospital A. It is located in center of Izmir, Turkey on a campus where medical faculties are also accumulated. Considering the architecture, Case 1 is the oldest unit in this study.

The spatial layout can be regarded as a race-track typology, with the perimeter of the layout is occupied with patient rooms whereas the center of the unit included staff-related and service areas (kitchen, cleaning room, personnel room, restrooms etc.) (Figure 3.2). The gross area of Case 1 is 1284 square meters including 106 square meters are staff areas, 700 square meters are patient areas, 347 square meters are circulation and also 131 are service areas. A typical patient room is 27 square meters with patient beds and visitor sofas. Eight of the patient rooms have bathrooms including a WC with a shower area.


Figure 3.2. Case 1 Schematic Layout Plan

The nurse station is located in middle of the unit with a partial vista to the two long corridors of the unit (Figure 3.3 (left)). Normally, the unit has two entrances, but due to the Pandemic restrictions, one of them was closed to control the circulation of the visitors. There are two main corridors (Figure 3.3 (right)) and with two connections (one by the nurse station and the other on the far end of the unit) and a by-pass which is located by the patients' WC area that serves the entire unit (Figure 3.2). There are twenty-four patient rooms in the unit. The unit originally had 60 beds capacities however, after the Pandemic the number of beds went down to 38-42 distributed in single-bed and double-bed rooms.

Figure 3.3. Nurse station (left), Unit corridor (right)

### 3.3.2. Case 2

Case 2 is located third block and fourth floor of the Hospital A which is a state-owned training and research hospital. While it previously served as a mixed unit, it was renovated between 2013-2014 and converted into a general surgery inpatient treatment unit.

The spatial layout of Case 2 was organized around a L-shaped corridor (Figure 3.4). There is a main corridor (Figure 3.5 (top)) with a length of 59 meters, and auxiliary corridor in the unit. In addition to the continuous circulation area, the medication preparation room is used as a bypass corridor by the unit staff. The middle areas of the unit is equipped with nurse station (Figure 3.5 (bottom)), nurse lounge, treatment areas and also service areas. The patient rooms, physician and nurse room was located in the perimeter of the unit.


Figure 3.4. Case 2 Schematic Layout Plan

The gross area of Case 2 is 840 square meters including 98 square meters of staff areas, 437 square meters of patient areas, 240 square meters of circulation, and also 65 square meters of service areas. A typical patient room is 25 square meters with bed spaces, visitor sofas, and also bathroom. Each patient room have bathrooms including a WC with a shower area. There are seventeen patient rooms in the unit. The unit originally had 37 beds capacities however, after the Pandemic the number of beds decreased to 20 distributed in single-bed and double-bed rooms and also multi-bed spaces.

Figure 3.5. Main corridor (top), Nurse station (bottom)

Case 1 and Case 2 do not have fixed staff, and a total of 70 nurses work in shifts in both units. Following the original management protocol, there is an average of 10 patients under the responsibility of a single nurse. Due to the precautions in the Pandemic, the nurse administrators reported a considerable shortage in staffing, that changed the ratio of nurse/patient to fifteen. The patient in the unit provided care by different groups of nurses during shifts day and night. While distributing the patients' assignments among the nurses, the distribution is made by considering the nurse profile, experience, patient load, and even the walking distances of the nurses within the unit. The distribution of patient responsibilities in both units is done by chief nurse. Patients are assigned to rooms primarily by the physicians and unit secretary, in consultation with the chief nurse. In special cases (patients who have had serious contact, who need isolation, who need closeness to the toilet in old age, etc.), the chief nurse has the authority herself to decide on the room assignments.

### 3.3.3. Case 3

Case 3 is located at the second floor of the B Block of Hospital B which was established as a state hospital in 2018. It is the newest unit in this study. The unit studied at Hospital B, Case 3, has a radial-corridor typology (Figure 3.6). The patient rooms were designed in the both east and north ends of the floor (Figure 3.7). The west of the unit was equipped with nurse station, physician room, treatment area, and also service areas. The nurse station is located middle of the corridor to easy access to patient rooms.

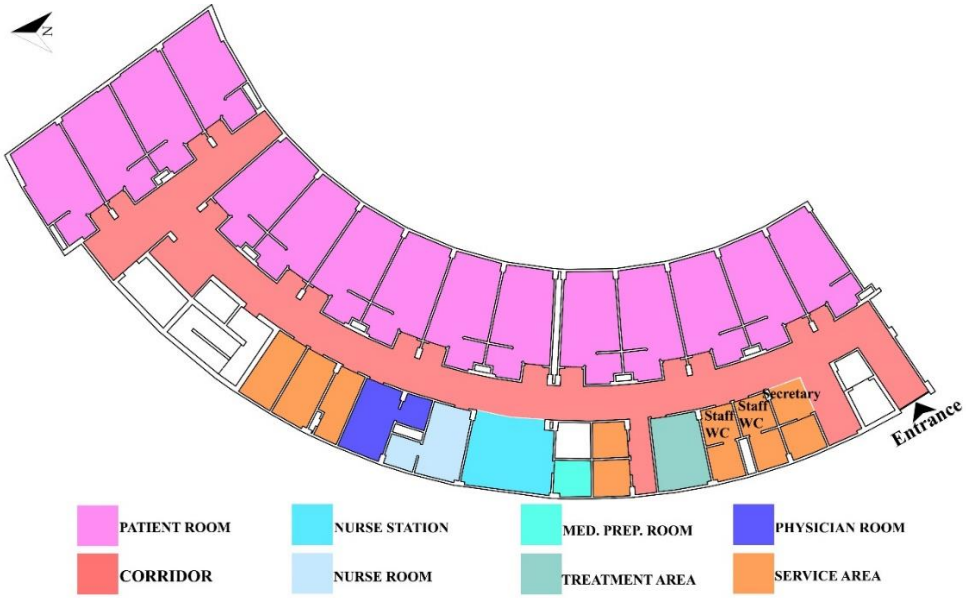


Figure 3.6. Case 3 Schematic Layout Plan

The gross area of Case 3 is 995 square meters including 97 square meters of staff areas, 543 square meters of patient areas, 272 square meters of circulation and 83 square meters of service areas. A typical patient room is 33 square meters and has bed spaces, visitor sofas, and a bathroom including WC and shower area. There are fifteen patient rooms, and it had 30 beds capacities as a double-bed spaces. Case 3 entrances are controlled with a personnel card. Visitors cannot enter unless they register at the out-unit secretary desk.

Figure 3.7. Corridor of Unit (left and right)

In Case 3, there is an average of 8 patients under the responsibility of a single nurse. From an organization point of view, in Case 3 nurses are matched to practicing physicians, therefore incoming patients are linked to a physician and a nurse in the unit. So the chief nurse in the unit does not need to assign patient to nurses. Each nurse has the authority to determine the placement of the patients in the rooms according to the patient's intervention status. Patients who are more critical status and may require rapid intervention are placed in rooms close to the nurse station, while patients with more stable conditions are placed in farther rooms.

# CHAPTER 4

# RESULTS

This chapter reports the data collected through on- and off-field investigations at the three general surgical units studied. Initially a basic comparison of the units is presented. Then the results are presented in an order following the research tools; staff surveys, space syntax analysis, and two types of observations conducted on-site.

## 4.1. Basic Comparison of Units

This section starts with a general description and metrics to compare and contrast the three units (Table 4.1). The table compares eight spatial and process related features including number of nurses, number of patient room, number of bed, gross area, staff area to unit area ratio, patient area to unit area ratio, circulation to unit area ratio, and service area to unit area ratio. The intention here is to portray the differences other than the layout configuration at the three units.

Table 4.1. Basic comparison of three case studies

| Cases | Total Number of Nurses in GSIU | Nurse to Patient Ratio | Number of Patient Room | Number of Bed | Gross Area (sqm) | Ratio of Staff Area | Ratio of Patient Area | Ratio of Circulation | Ratio of Service Area |
|---|---|---|---|---|---|---|---|---|---|
| Case 1 | 70 | 1/10 | 24 | 38-42 | 1283,81 | 8,24% | 54,47% | 27,05% | 10,24% |
| Case 2 | | 1/10 | 17 | 20 | 839,58 | 11,68% | 52,00% | 28,62% | 7,70% |
| Case 3 | 9 | 1/8 | 15 | 30 | 995,03 | 9,74% | 54,58% | 27,29% | 8,39% |

high value | low value

There is an overall number of 70 nurses in shifts, to cover the labor in Case 1 and Case 2. The reason is that Hospital A includes a college of nursing to support the nursing workforce within the hospital. The two units, Case 1 and 2, do not have fixed nurses, and the management has a flexible assignment strategy for nurses with the inclusion of trainee nurses coming from the College of Nursing. On the other hand, Case 3 which is located a state hospital includes only 9 nurses in shifts, assigned to the surgical unit studied in this research.

Case 1 includes 24 patient rooms within 38 bed capacities, before the Pandemic it had 60-bed capacities allowed by the very same layout (Figure 4.1). Half of the rooms at Case 1 are double-bed patient rooms, whereas half of them are single-bed rooms. In Case 2, there are 17 patient rooms which are include single-bed, double-bed, and multi-bed rooms. Before the Pandemic, Case 2 had 37 beds capacities, but during the Pandemic, the capacities were decreased to 20 beds. Case 3 has only 15 double-bed patient rooms.

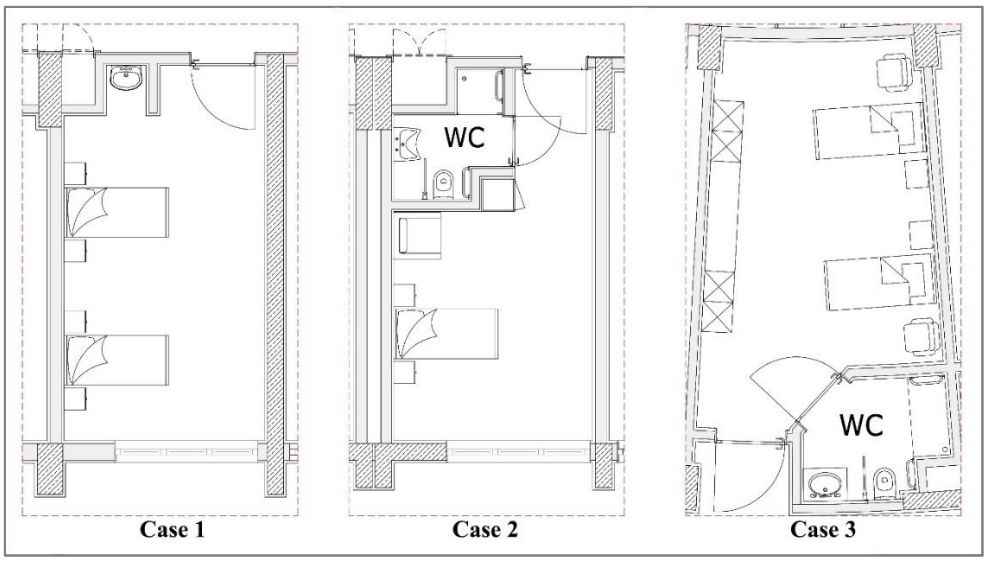


Figure 4.1. Typical room layouts at the three units

The gross area of Case 1 is 1284 square meters (38-42 beds), Case 2 is 840 square meters (20 beds), and Case 3 is 995 square meters (30 beds). The last four columns of Table 4.1. represent the ratios of the four different areas categorized by spatial functions to the overall unit area (in detail Figure 4.2). The gross area of the units is compared in four different ratios in Table 4.1; staff areas (nurse station, physician rooms, medication preparation areas, secretary, staff rooms and staff toilets), patient areas (patient rooms and treatment rooms), service areas (kitchen, cleaning rooms, laundry rooms, and storage), and circulation.

Considering the ratio of staff area to overall unit area, Case 2 has the highest ratio with 11.68%, while Case 1 has the lowest ratio as the ratio with 8.24%. When the patient area in the unit is considered, several typological differences are calculated according to the different spatial functions used by patients. In Case 1, 8 out of 24 patient rooms have a toilet. The patients in rooms without toilets are observed to use the common toilets within the unit. So, when calculating the patient area to unit area ratio for Case 1, these

common toilets are included in the patient area. For Case 2 and 3, since each room has an individual toilet in it, the ratio of the patient area to overall unit area represents patient rooms and treatment rooms. In addition to these, the preparation room for surgery and waiting room designed for patients are included in the patient area in Case 3.

The circulation has almost the same percentages in selected units (27,05% in Case 1, 28,62% in Case 2, 27,29% in Case 3), while there are differences considering the depth and width of the corridors. While the Case 1 and 2 has the same corridor width as 2.70 meters, the Case 1 has a total area of 347 square meters, whereas Case 2's corridor area is 240 square meters. The area of corridor in Case 3 is 272 square meters, with a corridor width of 2.61 meters. Considering the ratio of service area to overall unit area, Case 2 and 3 have the same percentage, while Case 1's percentage is higher (10,24%) than the other two.

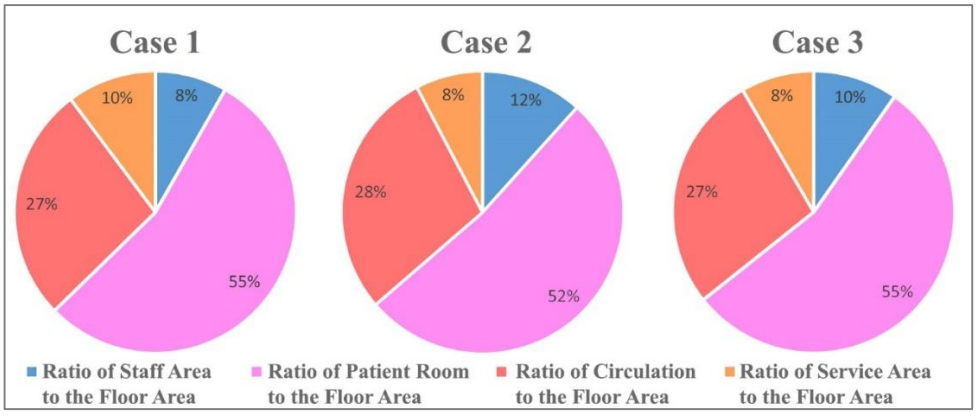


Figure 4.2. Ratio of functional areas to overall areas in units for each case

According to the basic comparison analysis of this study based on the spatial metrics, the ratio of areas reserved for different functions by the units is very close in three case studies. Although there is a difference in total square meters of units, the number of beds, and the number of patient rooms, the ratios of areas such as staff area, patient areas, circulation, and service areas to the total area of the three units are very close to each other. This means that the different spatial functional areas to the total unit area does not differ significantly between units. In contrast, one of the main differences between the units is the nurse numbers, this depends on the scale and function of the hospitals to which the units are located. Besides this difference, units are separated from each other in spatial configuration, which is the focal point of this study. This separation

between units gathered from different methods of this study will be mentioned in the next sections.

## 4.2. Results of Staff Survey

The paper-based survey set was delivered to the nurse in charge during the first day of the fieldwork at each unit and was collected back on the final day of the field work. In the process of tabulation, the results of the survey were transferred to an MS Excel worksheet and each question was monitored initially through descriptive statistics. Following the content groups, the sub-sections bellow presents the results of the survey.

### 4.2.1. Demographic Results

The target population included nurses who worked in the designated units. In total, the survey was responded by 11 nurses in Case 1, 18 nurses in Case 2, 7 nurses in Case 3, with a total number of 36 participants (Table 4.2). The ages of the respondents ranged from 23 to 45, with the mean age is 32. In Case 1, 45,5% (5 respondents) were between 20-30 years old, 45,5% (5 respondents) were between 31 to 40 years old, and 9,1% (1 respondents) were more than 41. In Case 2, half of the sample (9) were between 20 to 30 years old, 27,8% (5 respondents) were between 31 to 40, and 22,2% (4) were between over 41 years old. In Case 3, most of the sample (57,2%) were 20 to 30 years, 28,6% (2) were 31 to 40 and 1 of the respondents (14,3%) were more than 41 years old. While almost all of the sample is female, we have observed two practicing male nurses; one at Case 2 and the other at Case 3.

Table 4.2. Sample analysis in three case studies

| Demographics | | Case 1 | Case 2 | Case 3 |
|---|---|---|---|---|
| Age | 20-30 | 5 (45,5%) | 9 (50%) | 4 (57,2%) |
| | 31 -40 | 5 (45,5%) | 5 (27,8%) | 2 (28,6%) |
| | 41+ | 1 (9,1%) | 4 (22,2%) | 1 (14,3%) |
| Gender | Male | 0 | 1 | 1 |
| | Female | 11 | 17 | 6 |

The respondents reported their work experience via two different questions in the survey. First of all, Figure 4.3 illustrates the respondents' total years of experience in

healthcare practices (the question number 4 in the staff survey). When comparing case studies, it is observed that the majority of nurses in all three units have more than ten years of experience in nurse (Case 1 36.4%, Case 2 38.9%, and Case 3 57.1%). In Case 1, 27.3% of nurses are beginning-level nurses working in the unit with less than three years of experience, while 27.8% of nurses in Case 2 are beginning-level nurses (less than three years of experience) and 28.6% of nurses in Case 3 are beginning-level nurses.

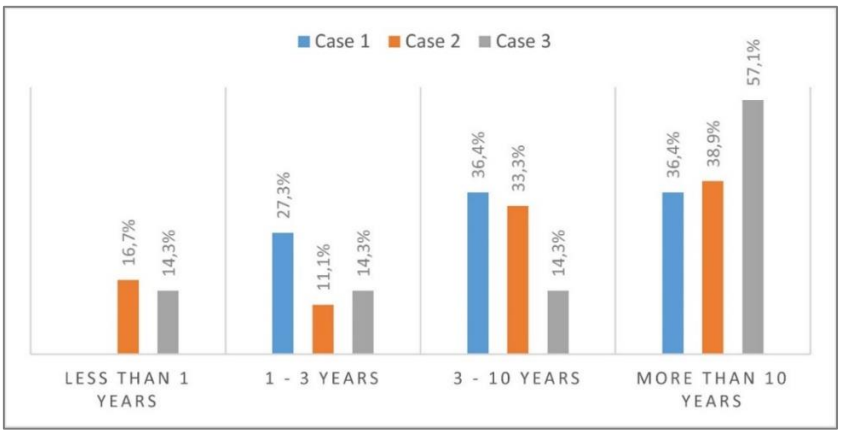


Figure 4.3. Total years worked in healthcare practices

Another experience related question (the question number 5 in the survey) investigated the number of years that the participants spent in their current units. Accordingly, Figure 4.4 summarizes the results for the question. 28.6% of the total respondents in Case 3, 22,2% in Case 2 have been working in the unit for less than a year, while 36,4% of the total respondents in Case 1, 22,2% of the respondents in Case 2 have been working in the unit for more than 10 years.

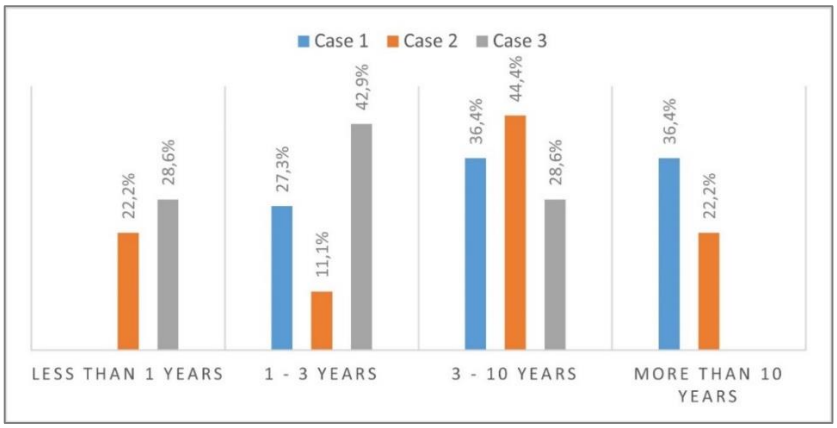


Figure 4.4. Total years worked in the unit studied

### 4.2.2. Interaction and Accessibility

The second part of the survey contains self-reported information on nurses' daily activities, their self-reported levels of interaction and accessibility within the unit. The results of the question 6 in the staff survey show that in Case 1 and Case 2, nurses are assigned to the care of 8 to 12 patients on an average day, while in Case 3 percentage of patients' care on an average day varies from 4 to more than 12 patients (Figure 4.5). 57,1% of the nurses worked in Case 3 are responsible more than 12 patients on an average day.

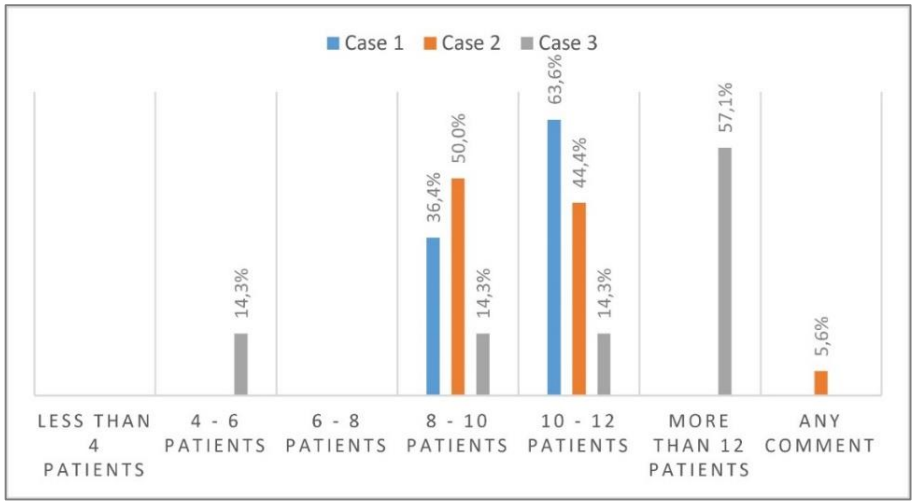


Figure 4.5. Percentages to demonstrate the levels of nurse to patient ratio at units studied

The next three questions were formulated to understand interaction between nurses and accessibility by co-workers (Figure 4.6). The results show a similarity between the three units. The nurses in all three units reported that they were knowledgeable about the patients assigned to their co-workers (question number 8). On the other hand, the question number 9 in the survey is related that the majority of the nurses from all units reported that they were in communication with every co-worker during the day. Also, the question number 13, the nurses responded in each unit reported that they thought they are accessible to their colleagues working in the unit.

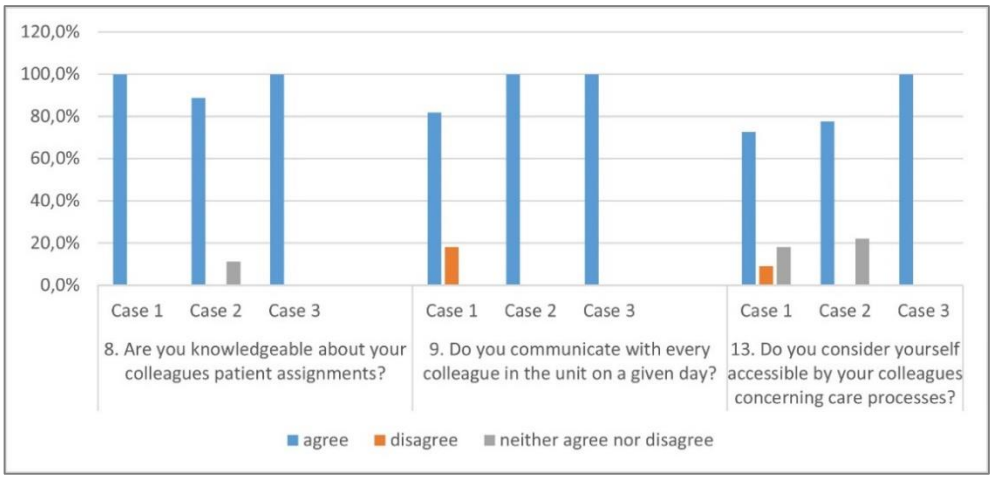


Figure 4.6. Questions concerning staff interaction and accessibility

For the question 10 in the staff survey, the respondents from all three units reported similar areas as the most preferred break areas to communicate with their colleagues during breaks (Figure 4.7). In Case 1 and Case 3, the nurses reported that they preferred only the nurse room and nurse station for communication with colleagues. In Case 2, however, the participants mentioned other areas as the preferred places for communication. The nurses from Case 2 (13% respondents) reported that the corridors within the unit are the second preferred area for communication with colleagues. At the same time, nurse station and also patient rooms are preferred spaces to communicate in Case 2.

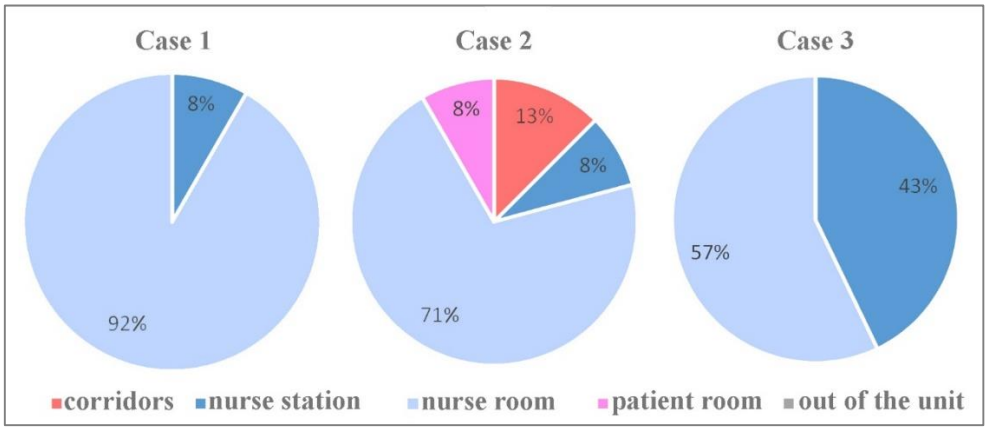


Figure 4.7. Percentage of the most preferred place to communicate with colleagues

On the other hand, question number 11 investigated the most preferred mode of communication (Figure 4.8); the participants, in almost equal percentages, stated that they

communicate to their colleagues by calling out and by telephone in Case 1 and 2. In Case 3, 85,7% of respondent report that they predominantly prefer to communicate by calling out to their colleagues.

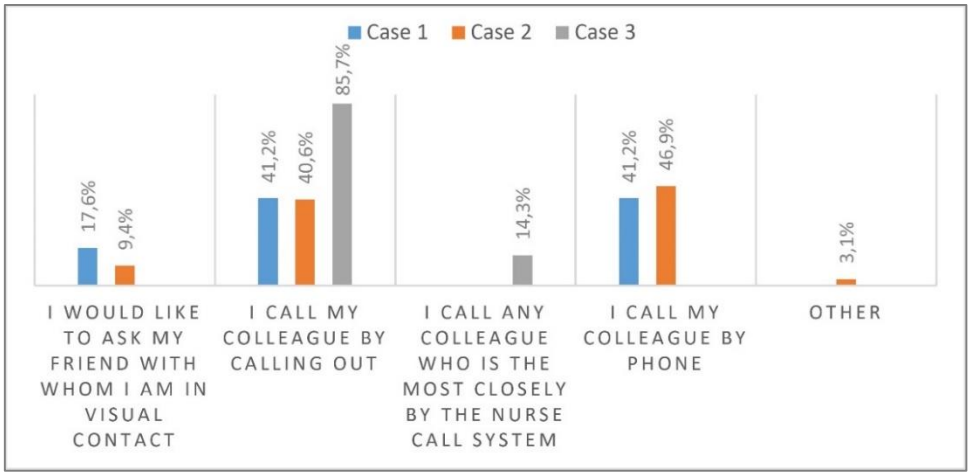


Figure 4.8. Percentage of the most preferred communication channels

### 4.2.3. Spatial Layout

This section presents the questions in survey with specific focus on the self-reported assessment of the spatial configurations and staff communication within the three units studied The results of the three questions are presented in the table below (Figure 4.9).

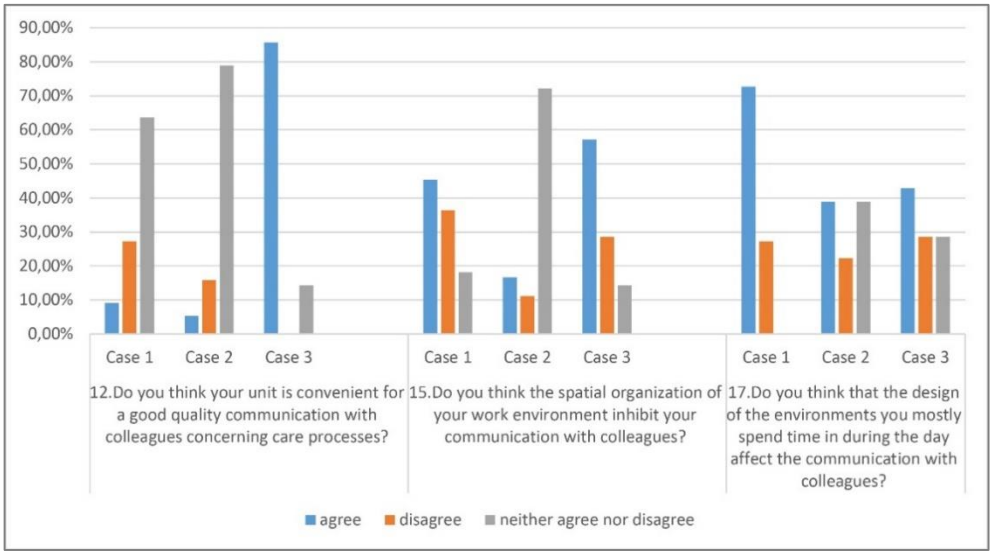


Figure 4.9. Questions concerning staff communication and spatial features

The question 12 in the staff survey is related to convenience of the unit for a quality communication among co-workers. Most respondents from Case 1 (63,64% of respondents) and Case 2 (78,9% of respondents) reported that their units were partially convenient on the matter, while in Case 3, most respondents found their unit convenient for quality communication.

The other related question (question number 15) investigated whether the spatial layout of units hinder communication among healthcare staff. 45,5% of the respondents from Case 1 and 57,1% of the respondents from Case 3 reported that spatial layout of unit hinders the communication between co-workers, while 72.2% of the respondents from Case 2 think that the spatial layout of the unit partially hinders communication.

One final question in this group (question number 17) asked participants to assess the design of the frequently occupied areas in the unit in relation to the communication with colleagues (Figure 4.9). In Case 1, 72,7% of the respondents reported that the design of the area where they spent most of their time-affected the communication between staff. In Case 2, the majority reported that they were either undecided or thought that the design had an effect on the communication between colleagues. In Case 3, on the other hand, the majority (42,9%) thought that the design had an effect on the communication between colleagues.

A one-way ANOVA test was conducted to understand if there was a significant difference beyond the descriptive statistics for the reported three questions in Table 4.3. Only question 12 in the entire survey suggested a significant difference after running the one-way ANOVA test (Q12: Do you think your unit is convenient for good quality communication with colleagues concerning the care process?). The mean of the results shows that the most convenient unit for good quality communication is Case 3 (mean:2.85), afterward Case 2 (mean:1.94), and Case 1 (mean:1.81). In other words, the findings of the ANOVA suggest that the respondents' answers change across units with different spatial configurations.

Table 4.3. Descriptive statistics and One-way ANOVA results for question #12

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| 1.00 | 11 | 1.8182 | .60302 | .18182 | 1.4131 | 2.2233 | 1.00 | 3.00 |
| 2.00 | 18 | 1.9444 | .41618 | .09809 | 1.7375 | 2.1514 | 1.00 | 3.00 |
| 3.00 | 7 | 2.8571 | .37796 | .14286 | 2.5076 | 3.2067 | 2.00 | 3.00 |
| Total | 36 | 2.0833 | .60356 | .10059 | 1.8791 | 2.2875 | 1.00 | 3.00 |

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Table 4.3 (cont.) Descriptive statistics and One-way ANOVA results for question #12

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 5.312 | 2 | 2.656 | 11.784 | .000 |
| Within Groups | 7.438 | 33 | .225 | | |
| Total | 12.750 | 35 | | | |

In the survey (question number 14), the respondents were asked to rate the spatial quality of the units on a scale from one to ten space (Figure 4.10), the majority of participants from Case 1 rated their units spatial quality as average, corresponding to five. The spatial quality of Case 2 and Case 3 indicated the same average of 6,2.

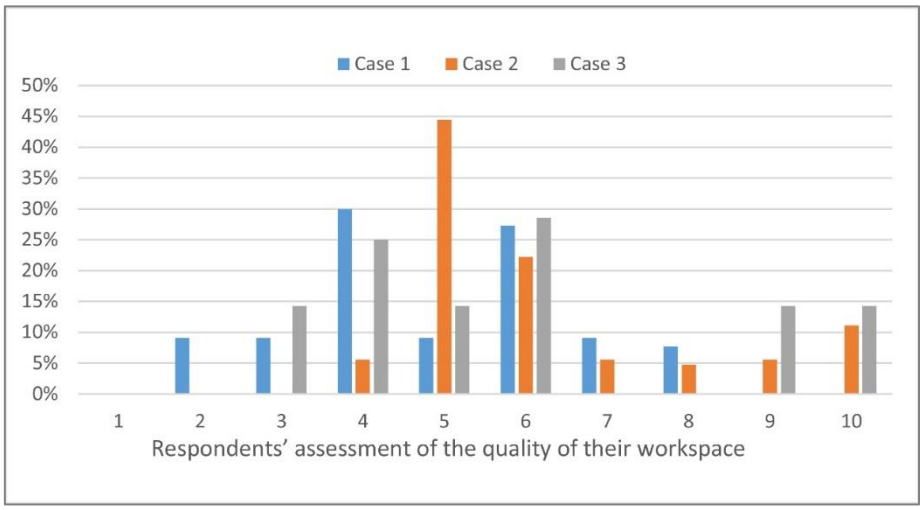


Figure 4.10. Ranging preferences to quality of space of units (1= low quality, 10=high quality)

Considering adverse effects of the unit designs on healthcare staff' communication (question number 16 in the survey), 76,9% of respondents from Case 1, 85,7% of respondents from Case 2, 57,1% of respondents from Case 3 reported that physical distances are the most adverse effect on communication with healthcare staff (Figure 4.11). In addition, 15,4% of respondents from Case 1, 14,3% of respondents from Case 2, 28,6% of respondents from Case 3 mentioned the spatial layout of their units as another barrier to staff communication. In Case 1 and Case 3, a few respondents reported that there are other factors that affect adversely communication with healthcare staff, but nobody describes the other factors as a briefly.

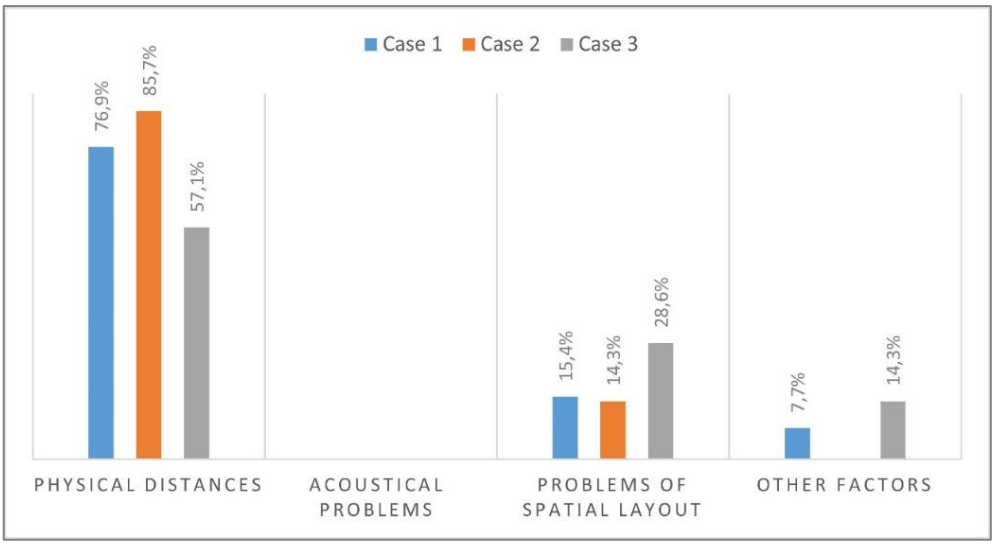


Figure 4.11. Respondents' report on the negative aspects of the unit on staff communication

An open ended question (question 18) in the survey inquired what the participants would change in the spatial arrangement of the unit if they were given the opportunity. The diagram below categorizes the qualitative data that emerged. Since the units differentiate in terms of design, a variety of answers were obtained (Figure 4.12). In Case 1, for instance, participants focused, in almost equal percentages, on changing three features in the unit: (1) having a larger nurse room, (2) having a toilet in every patient room and (3) having larger patient rooms. The responses of Case 2, on the other hand, indicated that respondents would like to change again particular features as in Case 1. In addition, most of them (69% of respondents from Case 2) would like to relocate the location of the medication preparation room to the middle of Case 2. There are three different responses, in equal percentages, in Case 3 related to authority of unit's entrance door, length of the corridor and also replacement of unit floor materials. Since the entrance door of Case 3 is controlled both by the out-unit secretary and with a staff' ID scanner, the participants want to add the authorization to open the door to the nurse station.

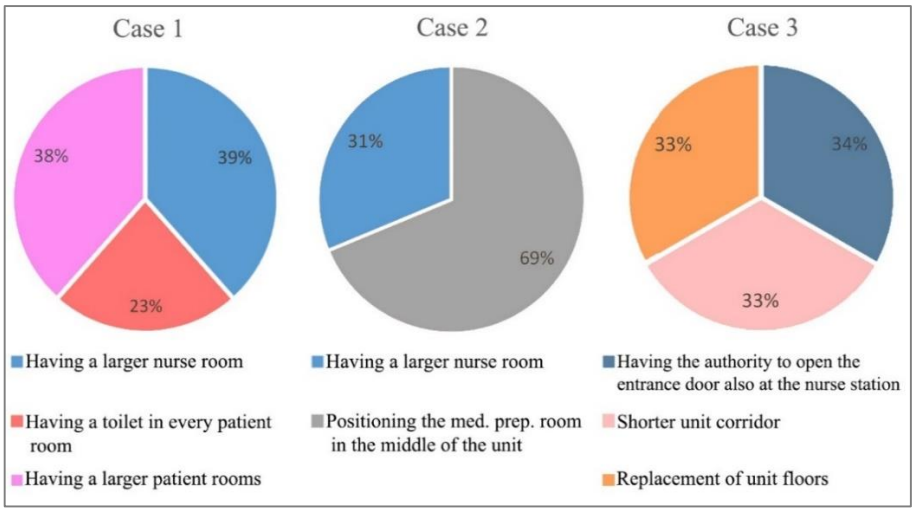


Figure 4.12. Percentage of change in the spatial arrangement of the unit if participants had the opportunity

The last question in the survey (question number 19), involving a drawing assignment, the respondents were asked which major routes they followed in the unit on a given day. Most of the respondents drew similar routes in each unit (shown as a red line in Figure 4.13 with a single sample selected from each unit). The graphic (Figure 4.13) shows that in Case 1 and Case 2, the medication preparation room (hatched by green area) emerged as a significant destination, even over the nurse stations (hatched by blue area). Moreover, respondents, rightfully, indicate the medication preparation rooms as shortcuts (by-pass corridors) that connect the main corridors within the two units, Case 1 and Case 2. On the other hand, the nurse station is considered as a more important space by respondents due to the size and shape of the medication preparation room in Case 3. The nurse room (hatched by yellow area) in each unit is also a stopover on the route used during the day.

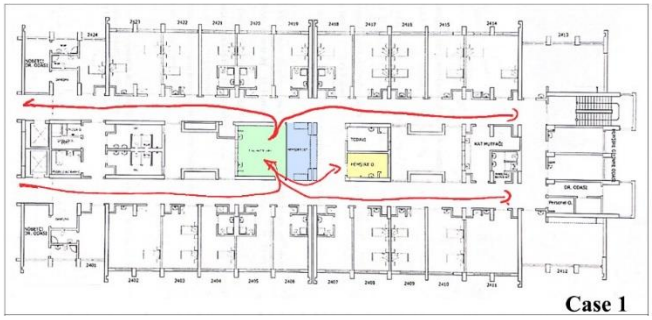


Figure 4.13. Samples of major routes at each unit drawn by the respondents

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Figure 4.13 (cont.) Samples of major routes at each unit drawn by the respondents

## 4.3. Results of Space Syntax Analysis

For spatial analysis, the research focused on the measures of connectivity, integration HH, and step depth via visual graph analysis (VGA) / isovists mapping to understand space occupancy and also interactions of healthcare staff in selected inpatient units. The analysis of these space syntax graphs is presented in this section.

### 4.3.1. Syntax Analysis for Case 1

The connectivity considered as the connection of any point in space with other points visually (Lu et al. 2009). Thus, the greater the openness of the space can be assumed as a more connected space in the spatial system (Haq 2013). The connectivity analysis shows that Case 1 has visually well-connected corridors that unify its overall spatial structure (Figure 4.14). There are four junction points of the main corridors (1 and 2 in the Figure 4.14) are identified as the highest connectivity areas. These junction points enclosed the nurse station (3) as the most connected intersection area in Case 1. In addition, the connection axes which are the longest line of sight directly related to the nurse station. On the contrary, the nurse room (4) and treatment room (7) where is located in front of the nurse station which is located at an intersection of connected areas are the

least in connectivity. Even though the physician room (5) and personnel room (6) is located last room of the entrance corridor (2), they are the directly connected area in this line of sight. The bypass corridor (8), auxiliary corridor (10 and 11), as well as medication preparation room (9) can be assumed as comparatively high connected secondary corridors associating the north and south of the almost symmetrical spatial system. Although the patient rooms are generally less connected spaces, the patient rooms in the line of sight of the spaces considered as secondary corridors are more connected. Conversely, other patient rooms within toilets are the least connected patient rooms. The maximum connectivity value is 6062, while average value is 1715,31.

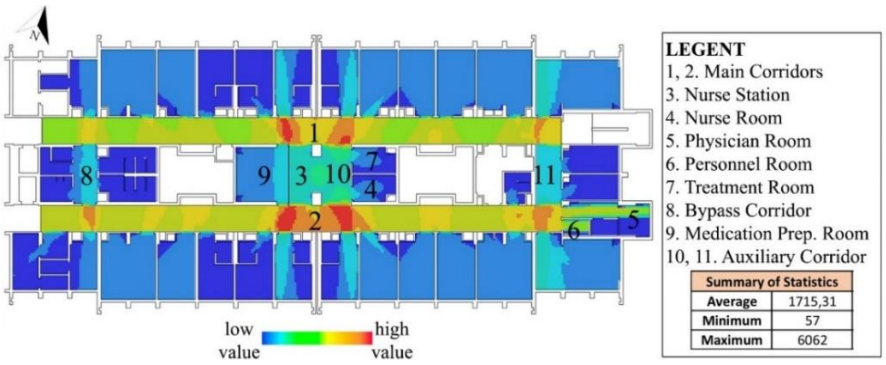



Figure 4.14. Connectivity of Case 1

Since integration is a value used to measure the accessibility of the space, the high levels of integration indicates more accessible, more public, and more integrated spaces compared to other areas providing users with more possibilities to act in the space (Kim et al. 2010). The most integrated area is represented by drawing from red to blue in global integration analysis. The global integration analysis of Case 1 supports that the most integrated areas have occurred at the intersections of the main corridors (1 and 2) with secondary corridors (8,9, and 10) (Figure 4.15). However, in detail, the entrance corridor (2) is more integrated than the northern corridor (1), since the corridor is longer, as there is a physician room and personnel room at the end of the entrance corridor. The vicinity of the nurse station is the most integrated area like in connectivity analysis. It means that the nurse station is located middle of the most public and the most accessible area in the spatial system. The integration of the patient rooms at the line of the bypass corridor (8) and auxiliary corridors (10 and 11) is higher than the other patient rooms, since it is related to vicinity of the most integrated area. Even though the connectivity of nurse room (4)

and treatment room (7) is the least, their integration of them can be assumed as a nearly public area because of their proximity of them to the most integrated area. The maximum integration value of Case 1 is 11,05, while average value is 6,47.

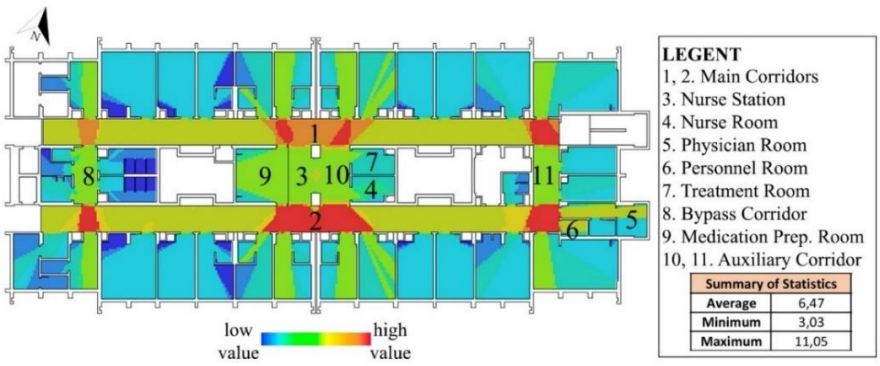



Figure 4.15. Global Integration of Case 1

In space syntax, Step Depth is a kind of isovist that expresses the visibility of all points from a given point in measuring the metrical distance in the space by describing the change of direction (Turner 2004). In this research, the center of the nurse station (3) was determined as a location to measure the distances and number of directions from that location to all others (Figure 4.16). The nurse station is located one-step away from directly nurse related spaces such as medication preparation room (9), nurse room (4), treatment room (7). In addition, the main corridors (1 and 2), and 6 out of 24 patient rooms which are closer to the nurse station have higher visual step depth compared to other ones. This supports to easily visual and physical accessibility of the nurse station, while this can result in low privacy for nurses due to higher step depth of the nurse station from other layouts. On the other hand, the other patient rooms can be accessible nearly two or three step depths from nurse station. The average step depth value of Case 1 is 2,61.

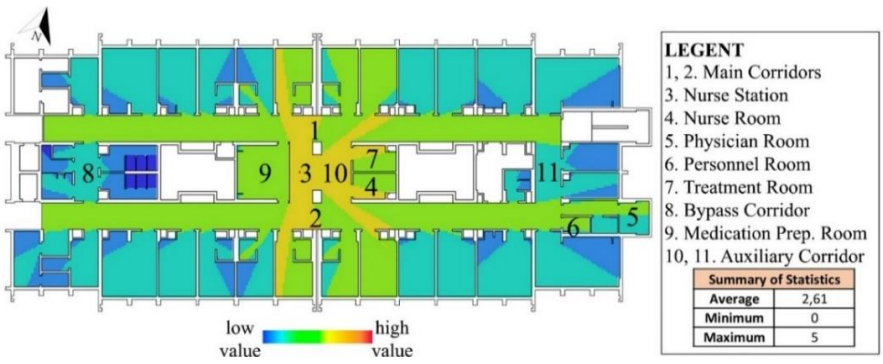



Figure 4.16. Step Depth from Nurse Station of Case 1

### 4.3.2. Syntax Analysis for Case 2

The connectivity analysis of Case 2 identifies that the main corridor (1) from the entrance to the nurse room (3) are more connected areas than the entire spatial system (Figure 4.17). The secondary corridor (2) is relatively less connected than main corridor. Considering the whole system, in front of each staff related spaces includes a nurse station (5), nurse room (3), physician room (4), and also medication preparation room (7) is the most connected area. These connected areas can be cause possible communication and interaction between healthcare staff. In addition, service areas (6) that are cleaning rooms are the less connected zone, just as almost all of the patient's rooms has the same and the low connectivity in Case 2. The highest connectivity value is 5199 and the average value is 1512,33.

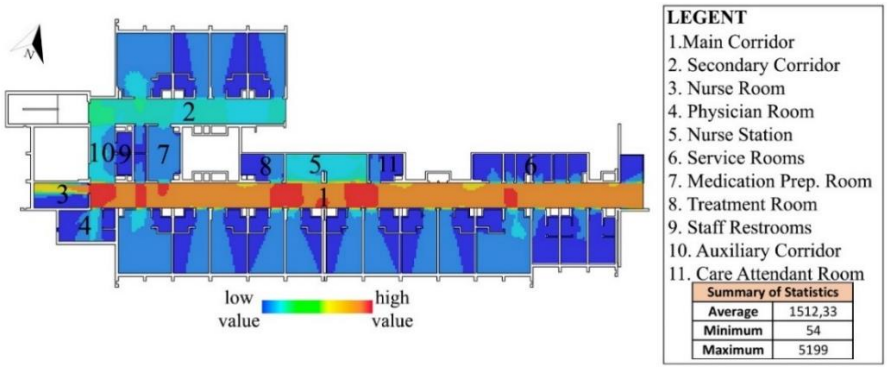



Figure 4.17. Connectivity of Case 2

The global integration analysis of Case 2 shows that the intersection between the main corridor (1) and auxiliary corridor (10) is the most integrated area in the whole structural system (Figure 4.18). This area where is in front of the nurse room (3) and physician room (4) is the most accessible, and public area of the Case 2. Nurse room (3) and physician 's room (4) can be easily accessible areas for users other than healthcare staff, due to their proximity to the most integrated area. It means that they could not be assumed as specific areas for only healthcare staff because of the easy accessibility of their location in Case 2. Moreover, the intersection between medication preparation room (7) where is used as a bypass corridor by nurses to access secondary corridor (2), and main corridor (1) is the most integrated area too. The secondary corridor (2) is the more segregated area than the main corridor (1). So that the patient rooms where are related to

the secondary corridor (2) are more private areas than the others where are connected to the main corridor (1). Service areas (6), nurse station (5) and treatment area (8) have almost the same and medium integration value in the whole system of Case 2. The maximum integration of Case 2 is 11,63, while average integration is 6,12.

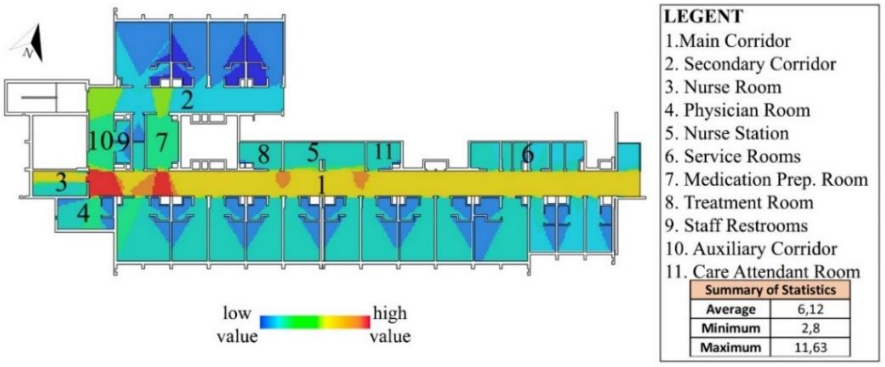



Figure 4.18. Global Integration of Case 2

The step depth analysis, in which the center of the nurse station (5) was determined as the focal point, is presented in Figure 4.19. 5 out of 17 patient rooms where are connected to the main corridor (1), treatment area (8), personnel room (11), and also main corridor (1) are primary closer areas to the nurse station. In addition, nurse room can be assumed as a one-step away from nurse station (5). The other patient rooms where are connected to the main corridor (1) are two-step away from nurse station. There is a clear distance between the patient rooms where are related to the secondary corridor (2) and nurse station (5) which are connected both by the auxiliary corridor (10) and by the medication preparation room (7). They have the outermost visual step depth area in the spatial system in Case 2. The average step depth value of Case 2 is 2,95.

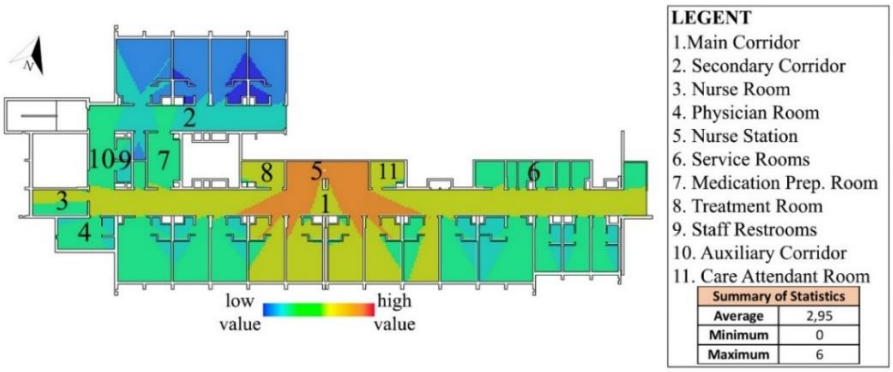



Figure 4.19. Step Depth from Nurse Station of Case 2

### 4.3.3. Syntax Analysis for Case 3

In Case 3, the connectivity analysis shows that the areas located nearly to the middle of the main corridor (1), and in front of the nurse station is the most connected areas within the spatial system (Figure 4.20). This is because the space is the most divided by other spaces in the spatial system of Case 3. The intersection points between the secondary corridor (2) and main corridor (1), at the same time, between in front of the unit secretary (12) and the main corridor can also be considered as connected areas, while creating the longer vertical visual sight of views in the system. These points create an environment for interaction between users of the Case 3. The west of Case 3 which includes healthcare staff areas and service areas except for both the nurse station (5) and waiting area (11) are the least connected areas of the system. Except for patient rooms associated with junction points, the others are less connected areas. The maximum connectivity value is 4846 and the average value is 1273,31.

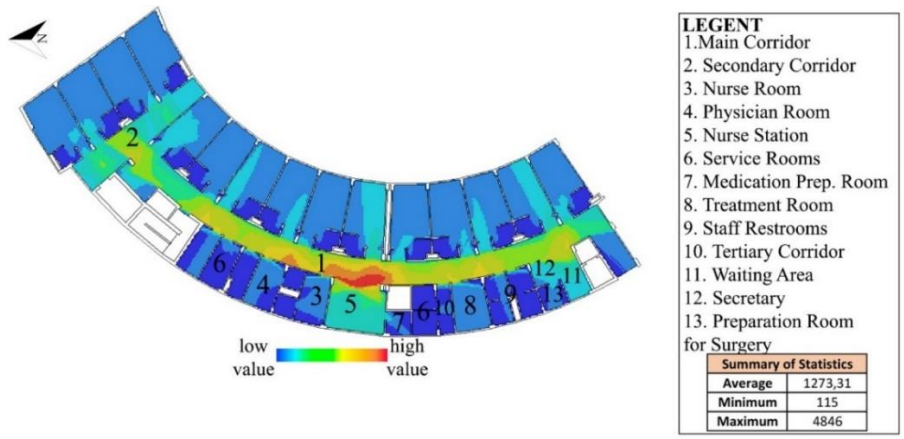



Figure 4.20. Connectivity of Case 3

Considering the integration analysis of Case 3, the largest integrated areas are located in the center of the main corridor (1), as in the connectivity analysis (Figure 4.21). Since the integration value reduces as it moves away from the center of the main corridor (1), the integration value of the spaces like the nurse station (5), medication preparation room (7), and also along the main corridor close to the most integrated area are higher. These areas can be considered as a more public and accessible areas in the unit. 3 patient rooms where are located ends of the secondary corridor (2) are less segregated areas than

other patient rooms. The maximum global integration of Case 3 is 11,58, while average global integration is 5,88.

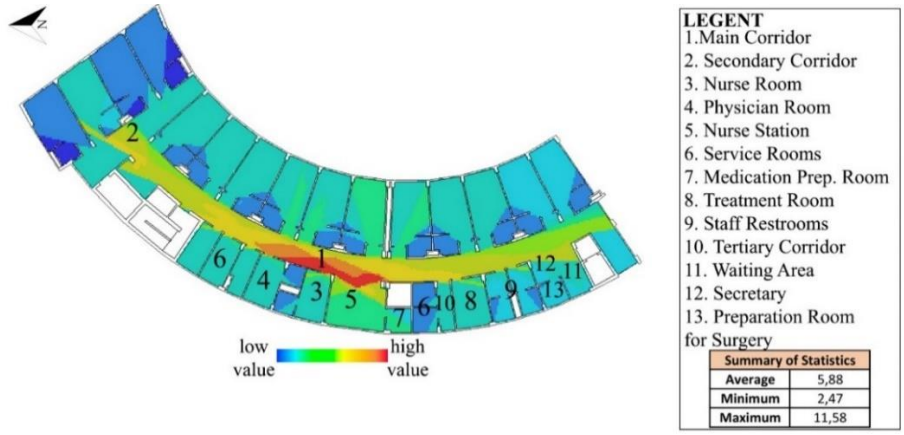



Figure 4.21. Global Integration of Case 3

In the step depth analysis, the nurse's desk (5) is accepted as the central space and shows the visual and metric distances of the spaces in Case 3 according to this selected center (Figure 4.22). The nurse station is arranged as a one-step away from the main corridor (1), so the spaces which directly connected to the main corridor (1) such as service rooms (6), spaces related to healthcare staff (3,4,7,8,9,12), and 12 out of 15 patient rooms are distant two-step away from the nurse station. Since the Case 3 typology is radial and the main corridor (1) provides a visible line of sight and accessibility along the corridor, it ensures that the spaces connected to this corridor are visually and metrically close. The average step depth value of Case 3 is 2,06.

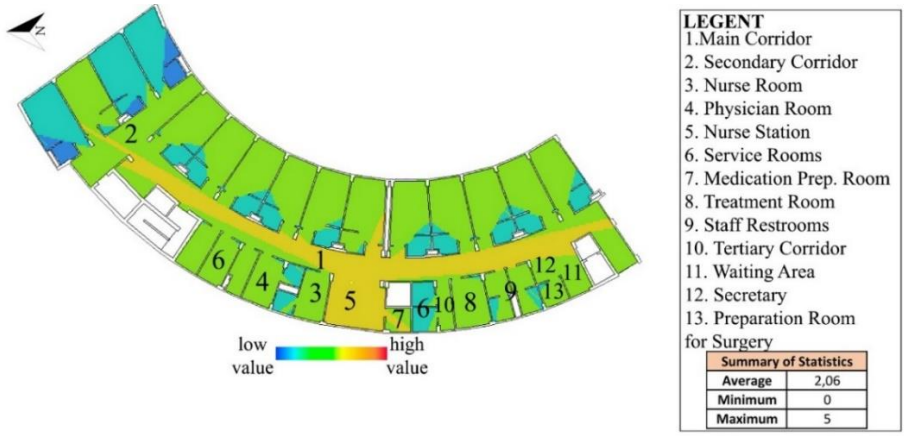



Figure 4.22. Step Depth from Nurse Station of Case 3

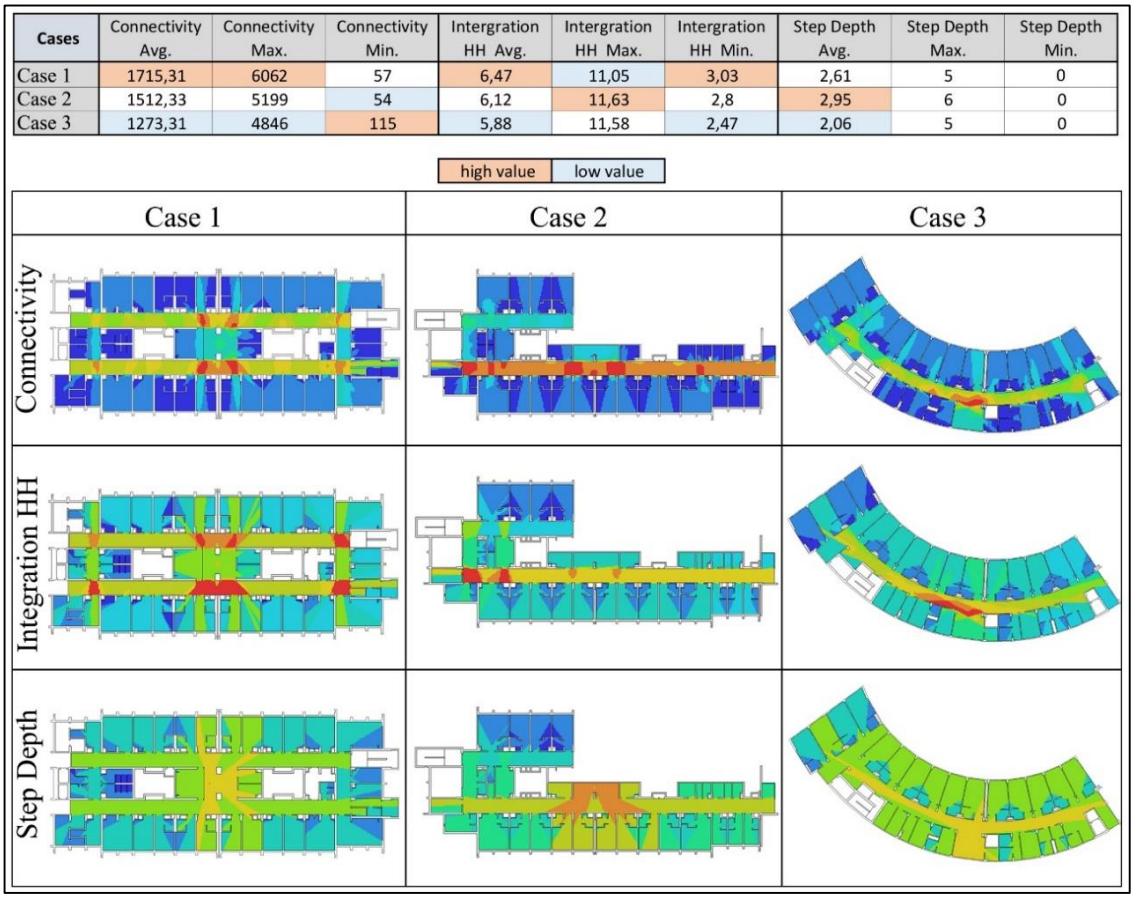
### 4.3.4. Comparison of Space Syntax Analysis

This section will compare results of space syntax analysis of each unit studied. The metric data gathered from VGA and the organization of spatial layouts of different key functions in each unit will be presented according to space syntax analysis.

The metric data collected from three different VGAs such as connectivity, global integration and step depth analysis with the nurse station as the focal point are presented in the Table 4.4. The most connected one in case studies is Case 1 with an average connectivity values of 1715,31, while the least connected one is Case 3 (1273,31). The plan of Case 1 was organized as a race-track typology; the nurse-related functions of spaces were located in the center of the unit while the patient zone surrounded out of the unit. Since nearly all of the rooms are directly connected to main corridors, the typology of Case 1 enables a more connected unit visually than the other units.

Table 4.4. Comparison of the space syntax metric data of units

| Cases | Connectivity Avg. | Connectivity Max. | Connectivity Min. | Intergration HH Avg. | Intergration HH Max. | Intergration HH Min. | Step Depth Avg. | Step Depth Max. | Step Depth Min. |
|---|---|---|---|---|---|---|---|---|---|
| Case 1 | 1715,31 | 6062 | 57 | 6,47 | 11,05 | 3,03 | 2,61 | 5 | 0 |
| Case 2 | 1512,33 | 5199 | 54 | 6,12 | 11,63 | 2,8 | 2,95 | 6 | 0 |
| Case 3 | 1273,31 | 4846 | 115 | 5,88 | 11,58 | 2,47 | 2,06 | 5 | 0 |



Case 1 had the highest average global integration with 6,47, while Case 2 had the lowest one with 5,88. Since the integration analysis of Case 1 has the most intersection points and maximum integration value (6062) compared to the other units, the Case 1 can provide more communication and encounter areas to its users. It means that Case 1 has a more communicative, visually more permeable spatial layout than others. Considering three case studies, the most connected areas of the units were designed to be directly related to the nurse stations. In other words, the nurse station of each unit is designed to be located in the most public, most accessible and most communicative spaces of the units.

Considering nurse station as a focal point in step depth analysis, Case 3 has the lowest step depth value (2,06) even though it seems closer to other spaces in a spatial system due to its radial typology (Table 4.4). Since Case 3 has a radial topology, the central location of the nurse station and being one step away from almost all other spaces can have a positive impact on the communication between nurses there. On the contrary, the nurse station of the Case 2 has the highest step depth value (2,95) due to its wide sight compared to other spaces, although most of the spaces in the system are out of sight of it.

## 4.4. Results of Field Observations

This section presents the results of the two types of observations conducted in settings; location mapping and nurse activity observations. The results are presented through graphics in which the entire set of observations are inscribed on the layouts.

### 4.4.1. Location Mapping Observations

The location mapping observation involves recording the position of each staff member as the observer walked through determined routes in the units. In the location mapping observation, two different forms of graphics were used according to occupation (physician, nurse, care attendant and patient), and the activity (sitting, walking, talking and standing) of the staff. The figures below (Figure 4.23, Figure 4.24, Figure 4.25) present samples of location mapping observations with all users traces in a single day at units.

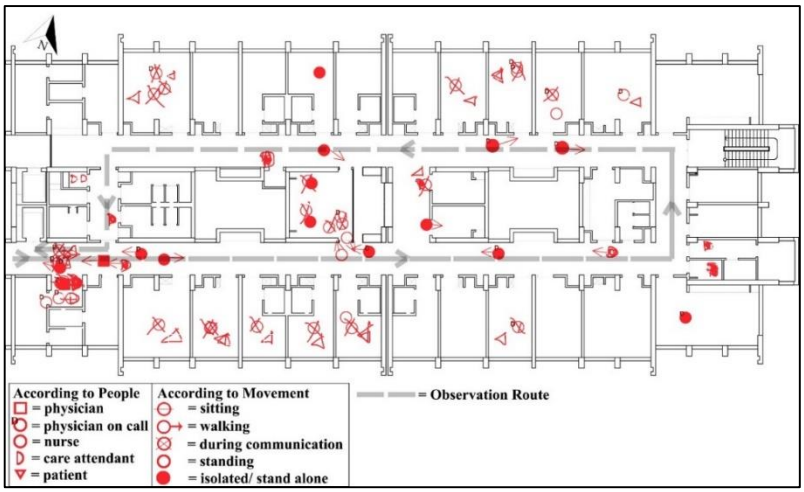



Figure 4.23. All Staff Traces in a one day of Location Mapping in Case 1

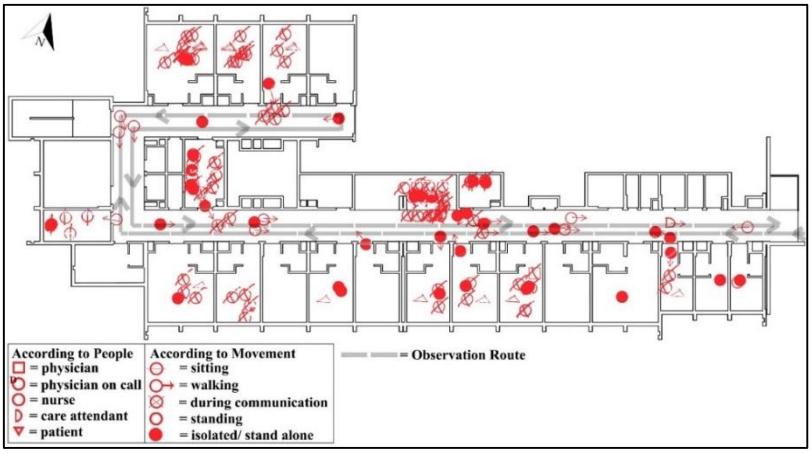



Figure 4.24. All Staff Traces in a one day of Location Mapping in Case 2

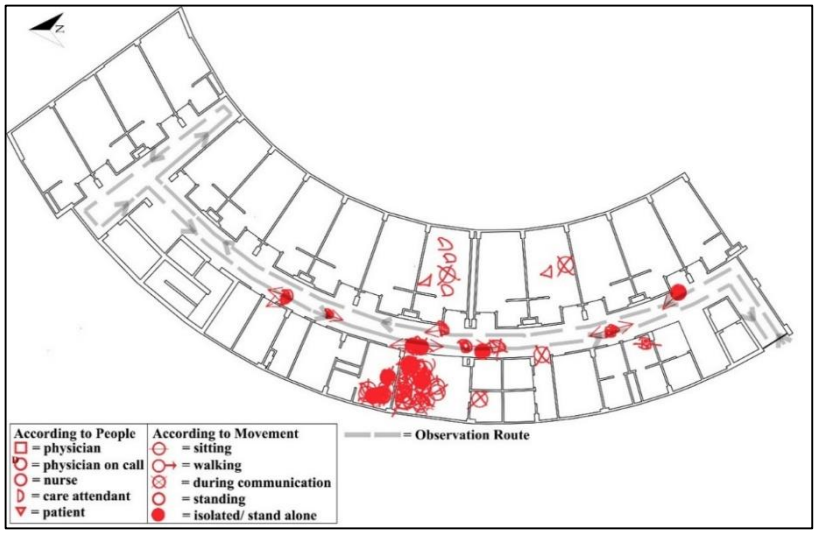



Figure 4.25. All Staff Traces in a one day of Location Mapping in Case 3

There is a total number of 105 instances recorded over a 10 day of observations at Case 1 (Figure 4.26). The graphic below (Figure 4.26) indicates that there is accumulation of staff at the entrance of the unit (marked by red dashed circle line). This accumulation can be related to the fact that staff working in the unit are in constant communication with the unit secretary for the purpose of information exchange about patients. At the same time, the accumulation at the entrance of the unit is not only a crowd formed by the healthcare staff but also occurs as a result of the fact that there are patients and family members (not recorded in observations) who want to get information from the physicians in and around the physician's room next to the unit secretary during the day. In addition, the south corridor, was observed to host more users than the northern corridor due to location of the entrance of the unit on the southern corridor. The intersection of the south corridor and the auxiliary corridor (marked with a blue dashed line Figure 4.26) was also observed as one of the frequently occupied areas since this is the area where the circulation routes meet.

At the same time, this particular junction also facilitates encounters for healthcare staff who are headed to the medication preparation room (marked by green dashed line) and the nurse station (marked by the purple dashed line). The medication preparation room was also observed to get frequently used by nurses and physicians on-duty both as a drug preparation area and bypass corridor transferring between main corridors. Moreover, the nurse station in Case 1 is an important area frequently used by trainee nurses coming from the College of Nursing, and physicians on-duty who are using computers there. Also, the nurse room (marked by the black dashed line) was observed to be frequently occupied by nurses.

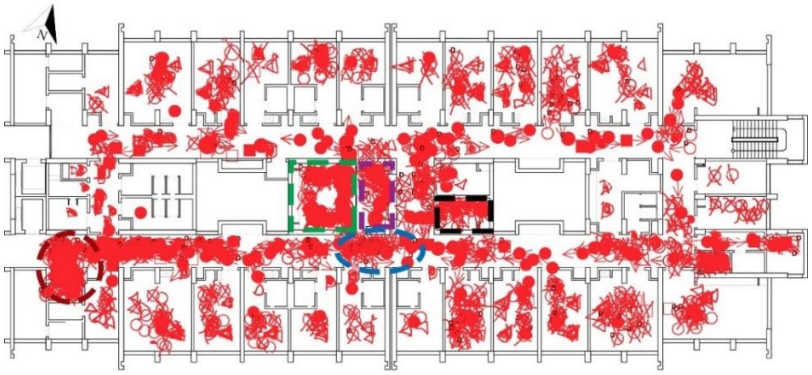


Figure 4.26. Staff Traces of Location Mapping in Case 1

There is a total number of 115 events recorded over a 10 day of observations at Case 2 (Figure 4.27). Since the main corridor is the entrance corridor to the unit, many location mappings of healthcare staff were recorded along this corridor. Moreover, as all the functions required for the unit are located along the main corridor, this space was observed to be the main element of the circulation routes in the unit. The nurse room (marked with a black dashed line) at the end of the entrance hall was observed to host nurses over the course of the shifts. It was observed that there is an accumulation in the nurse station (indicated by the purple dashed line), in the graphic presented below, Figure 4.27. At the same time, the recordings suggest a dense area right in front of the nurse's station. As a reason for this crowd, it can be associated with the fact that the nurse station is the first place for those who want to get information about the patients since there is no secretary in the Case 2. Another note to mention concerning the frequently occupied areas, the medication preparation room (indicated by the green dashed line) was also observed to be used as a transition area from the main corridor to the secondary corridor. Related to this, the auxiliary corridor at the west end was observed to be used rarely by staff to circulate to the four rooms on the northern corridor.

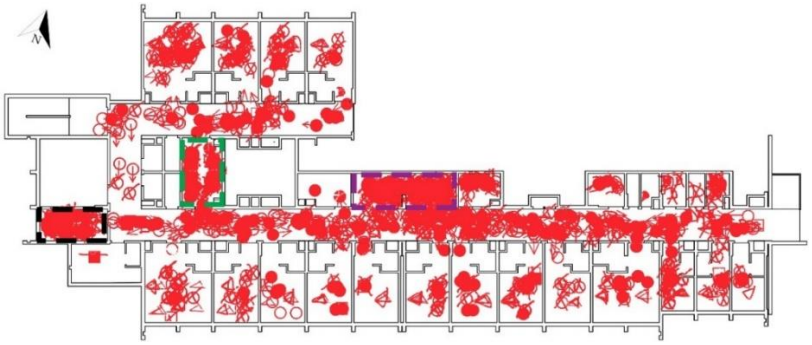


Figure 4.27. Staff Traces of Location Mapping in Case 2

There is a total number of 97 instances recorded over a 10 day of observations at Case 3 (Figure 4.28). There is an excessive density in both the nurse room (marked by the purple dashed line) and the nurse station (marked by the black dashed line). It is observed that healthcare staff, especially nurses, predominantly occupy these two areas in the time left from actual care process due to the low number of occupied patient beds at Case 3. In addition, despite the graphic below, Figure 4.28, demonstrated that the main corridor of the unit has heavy circulation traffic, south half of it is the most used by staff. Moreover, the presence of a secretary (marked by the blue dashed line) is another reason

for the circulation density on the south side of the main corridor. The reason for it is related that the south of the corridor is considered directly as a welcoming area for users from the entrance of the unit thanks to the radial typology of the unit. On the contrary, the secondary corridor at the north end of the unit is the least used by staff. Although the medication preparation room (marked by the green dashed line) is frequently used when patients need to control the condition or intervention, it is a space that is used only when necessary, since it is located in the corner of the spatial system and is smaller than other spaces in terms of dimensions.

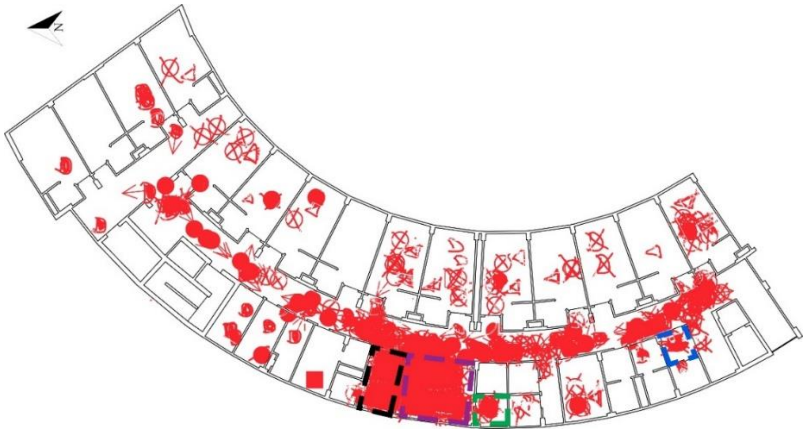


Figure 4.28. Staff Traces of Location Mapping in Case 3

### 4.4.2. Nurse Activity Observations

Nurse activity observations involve a five to ten minutes' activity recording following a shadowing method. When the nurse was observed constant in space, the position was marked as a filled circle. When the nurse was on the move, the location was represented as a hollow circle by researcher on the observation sheet.

The data from 51 observation sessions at Case 1 is shown in Figure 4.29. Although there was excessive nurse circulation in the main corridors of Case 1, it was observed that the south corridor hosts more nurse activity. Given the entire patient beds are occupied in the unit, one plausible inference to mention is that the unit entrance on the northern corridor is cancelled due to the restrictions introduced during the Pandemic. Thus, the only entry from the hospital's main hallway is now on the southern corridor, which makes it busier compared to the northern one. On the other hand, it is observed that the auxiliary corridor on the west end and the bypass corridor that connects the patient restrooms

(hatched by orange area in Figure 4.29) to the main corridors on the east end are used less by nurses. The graphic presented above, Figure 4.29, suggests that the most frequently used space by nurses is the medication preparation area (hatched by green area). Moreover, patient rooms (hatched by pink area) that are closer to the medication preparation room are used more frequently than farther ones, this may be due to the fact that patients who are in more critical condition and may require rapid intervention are placed in patient rooms closer to the medication preparation room. In addition, the nurse room (hatched by yellow area) is observed as the place where the most time is spent by nurses on non-task-related activities. However, it is noteworthy that the nurse station (hatched by blue area) in the Case 1 is not used by nurses as a transit or frequent destination. This can be related to the fact that the nurses' shifts in the unit pass between the medication preparation room, the patient's room, and the nurse room due to the patient density of the Case 1.

Figure 4.29. Traces of Nurse Mapping in Case 1

In Case 2, 49 observation recordings were gathered during the fieldwork (Figure 4.30). It is obvious that the main corridor hosts over-abundant nurse circulation loads in Case 2. This is because the main corridor is both an entrance corridor and is the main artery of the unit which contains all functions related to the unit. The northern (secondary) corridor does not have a very heavy circulation as it is used only when intervention is required to the patient rooms to which it is connected. However, most of the nurse's actions in the transition from the main corridor to the secondary corridor are not from the auxiliary corridor on the east end of the unit, but from the medication preparation room (hatched by green area in Figure 4.30), which is used by nurses as a bypass corridor. Figure 4.30 shows that the medication preparation room is the most frequent haunt of

nurses in Case 2. Since there were intern nurses during the observations of Case 2, it was observed that the staff used the nurse station (hatched by blue area) which is the easiest place to observe the senior nurses, as a frequent destination in order to support active learning in the unit.

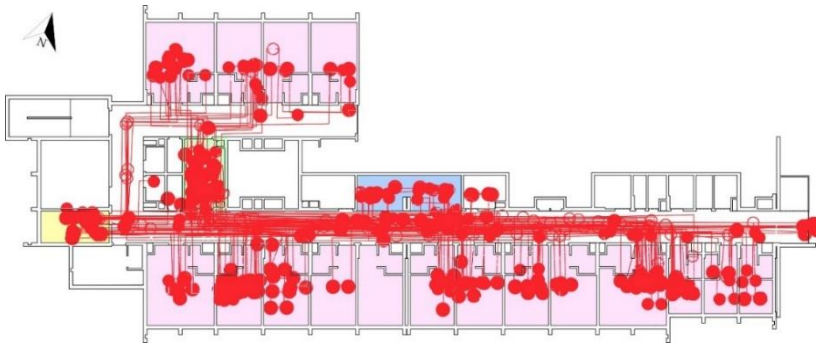


Figure 4.30. Traces of Nurse Mapping in Case 2

The nurse activity traces gathered from 48 observations at Case 3 is presented in Figure 4.31. Even though there was most of the nurse activity in the main corridors of Case 3, the segment that is close to the unit entrance was observed to be densely occupied compared to the segment on the other end of the nurses' station. It can be related that south end of the corridor connects to the entrance of the unit. In the graph shown below, Figure 4.31, it is observed that the nurse station (shaded with blue) is used as a destination in almost every nurse activity observed in the corridor. Moreover, the nurse room (shaded with yellow) and the treatment area (shaded with orange) are frequently used spaces by nurses in Case 3. Since the medication preparation room (shaded with green) is not directly connected to the main corridor, considering the whole spatial system, it is a relatively small room and is located in the background of the nurse station.

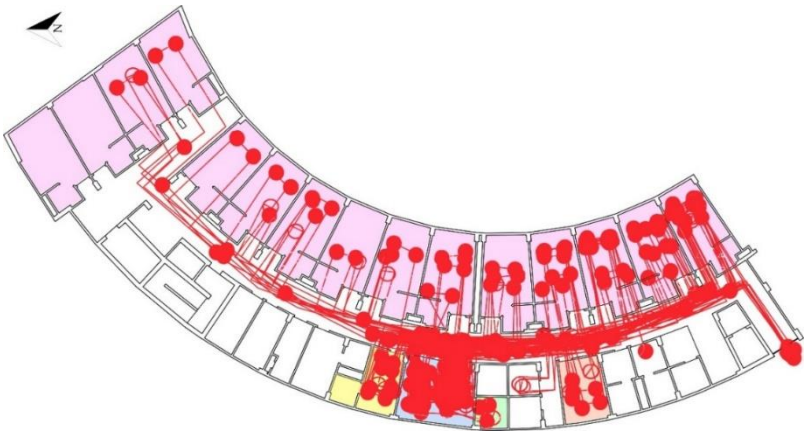


Figure 4.31. Traces of Nurse Mapping in Case 3

The results of the study are presented by compiling the data obtained from multi-methods. In the next section, the results of the study will be brought together and the research questions will be answered.

# CHAPTER 5

# DISCUSSION

The current chapter compares and contrasts the set of results of the multi-site field study, and provides a discussion of findings in relation to the relevant literature introduced earlier. The implication of the results will be discussed concerning the key areas that are typically considered as critical in interactions among nurses. The areas to be discussed include (1) Corridors, (2) Nurse Stations, (3) Nurse Rooms, and (4) Medication Preparation Rooms. The chapter mainly discusses the results in relation to the differences in unit spatial layouts.

## 5.1. Corridors

The results from the three units suggest that corridors were the most frequently occupied areas in all three case studies. Obviously, the result is not surprising since the corridors are acknowledged to be significant for circulation, access, and control within the healthcare environment. Corridors are defined as areas that provide accessibility between units and sub-spaces within units in the healthcare design standards regulation of the Ministry of Health in Turkey (Saglik Bakanligi 2010). In addition, Tandogan (2012) asserted that, in line with the data obtained from World (FGI 2010) and Turkish health standards (Saglik Bakanligi 2010), the physical measures of corridors in healthcare facilities affect other variables including accessibility between units and zones, traffic loads, levels of comfort and security.

This study posed a related question in the nurse survey in order to understand the role of the corridors for communication in the unit (the question 10; where, in your unit, do you prefer to have a conversation with a colleague concerning care process?). Only the respondents from Case 2 (13% of respondents) mentioned the corridors as frequently preferred space for communication with colleagues. Concerning the overall results for the same question in the survey, the corridors were not reported to be the areas preferred for communication and interaction among colleagues. Therefore, while the corridors are observed to be occupied by nurses, the staff does not prefer to have their verbal interaction

within corridors. It means that for many respondents, corridors are not considered as a special area that can be occupied for communication. Most of the respondents mentioned that, the areas for staff communication included nurse rooms (92% from Case 1, 71% from Case 2, and 57% from Case 3) are preferred mostly, followed by nurse stations (8%, from Case 1, 8% from Case 2, and 43% from Case 3), and patient rooms (only 8% of respondents from Case 2).

However, considering the observation recordings and the space syntax analysis, the corridors emerge as the potential areas to facilitate encounters as the staff frequently travel through the unit. The observation results from the three cases in this study suggest that corridors are places where many planned and unplanned encounters take place, as well as being transition areas for healthcare environments. The description in the literature suggests that corridors are key spaces where both healthcare staff spend most of their shift time and therefore support the communication and learning by allowing gatherings and planned and unplanned encounters (Iedema et al. 2006; Pachilova et al. 2013; Setola et al. 2013; Adams 2008). In addition, Adams (2008) expressed that "the corridors also provided an important opportunity for the nursing students to approach the GN[4] and express uncertainty, and the GN to provide advice in return, demonstrating independence and the confidence" (Adams 2008, 103). In line with Adams (2008) characterization, the observations in units in this study suggested that the corridors provide an environment for both communication and information exchange between staff alongside the passing area. However, as mentioned earlier, in the paper-based surveys, the nurses did not mention corridors as the primary space for communication.

In the context of Turkish healthcare system, there are a few studies in literature to introduce the discussions around corridors. For example, Canakcıoglu (2016), who investigated patients' perception of space in pediatric treatment areas, stated that "considering the behavior mapping of all user groups, it can be said that the corridor in the unit undertakes a task far beyond its function of providing the connection between spaces; the corridor is an intersection point in the context of the behavior of all users in the unit" (Canakcıoglu 2016, 169). In addition, Guc et al. (2012) mentioned that the corridors mostly occupied by patients are important spaces to support the interaction between all users in healthcare environments.

[4] Graduate nurses is abbreviated as 'GN' in the study of Adams (2008).

The nurse activity observation records also suggest that there are key locations within corridors to attract even further levels of circulation. When such densely occupied locations on corridors were compared through a graphic representation, the visuals suggest that particular staff-related areas generate extensive levels of circulation across the corridor (hatched by red area in Figure 5.1) including the nurse room (hatched by yellow area), the nurse station (hatched by blue area), the medication preparation room (hatched by green area).


Figure 5.1. Density on corridors based on observation records in each units

The areas mentioned above (nurse room, nurse station, and med preparation room) are reserved for staff occupancy only; no patients are expected to be observed within. Also, these areas give the staff an opportunity to interact with colleagues without the existence of outsiders. The staff-related areas in cases 1 and 3 were compactly positioned together, whereas in Case 2, they were distributed across the unit (Figure 5.1). The spread of these densely occupied areas throughout the corridor in Case 2 (marked red in Figure 5.1) may be related to the distribution of staff-related areas in the spatial layout of the unit. Although there is no clear evidence on this issue, densely occupied areas in Case 2 are observed to extend along the main corridor, perhaps because the staff-related areas encourage staff to walk more.

On the other hand, there may be other inferences to arrive at as the densely occupied spaces extend across the three units with different syntactic features. The extended red spaces on corridor in Case 2, represented in Figure 5.1, may increase awareness of the patient care process and the supervision of more patient rooms by nurses. At the same time, it is possible to argue that the distributed density may facilitate better communication among staff members since areas of interactions are not centralized within the unit. Although this seems to be the reason why employees walk more distances, it may be helpful for more in control of patients' care by staff, as it increases the staff's

travel within the unit. In terms of monitoring patients and facilitating enhanced interaction among staff, it may be better to have staff-related areas distributed within the unit locating them clustered around a certain location in units.

The location of densely occupied areas and the intensity vary according to other functions that regulate the circulation within the unit. Several functions within the unit like the unit secretary (hatched by orange area in Figure 5.1), has the potential to affect the location and density of staff occupation. Since cases 1 and 3 have in-unit secretaries, people, including staff and patient relatives who require specific information about patients occasionally create a circulation load in front of the secretary (Figure 5.1). Therefore, the circulation load of the corridor is observed to be accumulated in front of the secretary instead of across the corridor in cases 1 and 3. Such situations were recorded in our nurse observation sessions (Figure 5.2).

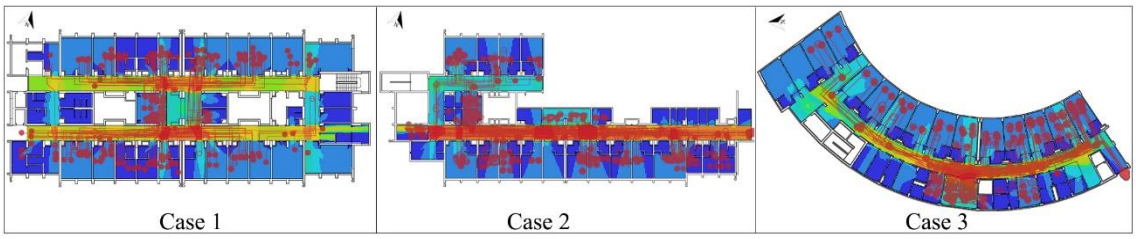



Figure 5.2. Combined Traces of Nurse Mapping with Space Syntax Analysis

In Case 2, there is no secretary located inside the unit. Therefore, people directly visit the central nurse station, the nurse room, or medication preparation room to interact with staff for their questions or information exchange. For this reason, the accumulation areas are observed in front of these staff-related areas throughout in the corridor in Case 2. The findings have emerged that several attraction points alongside staff-related areas such as the location of the secretary area affects circulation patterns within the units observed. In briefly, there are areas (nurse station, nurse room, medication preparation room, and secretary) to generate circulation which causes an increased chance for encounters among staff. The location of these areas is important to enhance potential communication among nurses.

The survey results indicate that one in three survey respondents at Case 3 complained about the length of the corridor. Comparing the length of the main corridors at the three units, Case 3 has the longest over the other two (the Case 1; 53,5 meter, the

Case 2; 59 meter, the Case 3; 61 meter). On the other hand, the nurses at Case 3 reported that they are assigned to care of more than 12 patients on an average day, while most of the respondents from cases 1 and 2 are assigned to care from 8 to 12, which makes the length of the corridor in Case 3 critical as the nurses were responsible for more patients. However, based on the number of patient assignments and total length of the unit corridor, it is expected to have nurses of Case 3 travel more within the unit on a given day. The radial typology of Case 3 may cause the unit corridor to get perceived longer by nurses. On the contrary, the literature supports that radial units enable better visibility for healthcare staff than single and double corridor unit types, as more patient rooms can be seen from the corridor, therefore, literature stated that nurses could walk less in the unit (Lu et al. 2010; Ulrich et al. 2008).

The morphologies of the units are different to reflect various unit typologies; race-track (Case 1), L-shaped corridor (Case 2), and radial corridor types (Case 3). However, it was observed that densely occupied areas on the corridor represent similar locations in each unit like in front of the staff-related regardless of the typological differences with the units.

## 5.2. Nurse Stations

The literature defines the nurse stations, “they are places located close to the circulation area, where patient records are kept, dealing with the follow-up of patients in inpatient units” (Uzunay 2011, 73). Accordingly, the healthcare design standards regulation of the Ministry of Health Turkey defined nurse stations as “areas that provide visual or equivalent medical observation for the care of post-anesthesia patients or for patients in similar emergency situations” (Saglik Bakanligi 2010, 10). In addition, the nurse station is the intersection work area both the activities related to inpatient units like charting, caring, etc., and interaction and communication between doctors and the nurses such as information shared or socialization (Zook et al. 2019; Ozcan 2004; Bromberg et al. 2006; Mourshed et al. 2012). In line with this definition, the nurse stations in the three units were observed to be the key areas to facilitate staff communication during shift time.

In the three units observed, the number of nurses and the number of patients per nurse vary. Another variation is how the care-related areas organize around the nurses’ stations and across the units. For instance, the nurse stations in cases 1 and 3 were

surrounded by staff-related areas including nurse room, and medication preparation room, whereas, the nurse station in Case 2 was designed in a location away from other staff-related areas (Figure 5.1). In detail, on the other hand, the organization and the furnishing of the three stations also vary. The station in Case 1, for example, opens to the two main corridors in the unit, where as in cases 2 and 3, the station was located by the primary corridors that span across the units (Figure 5.3).

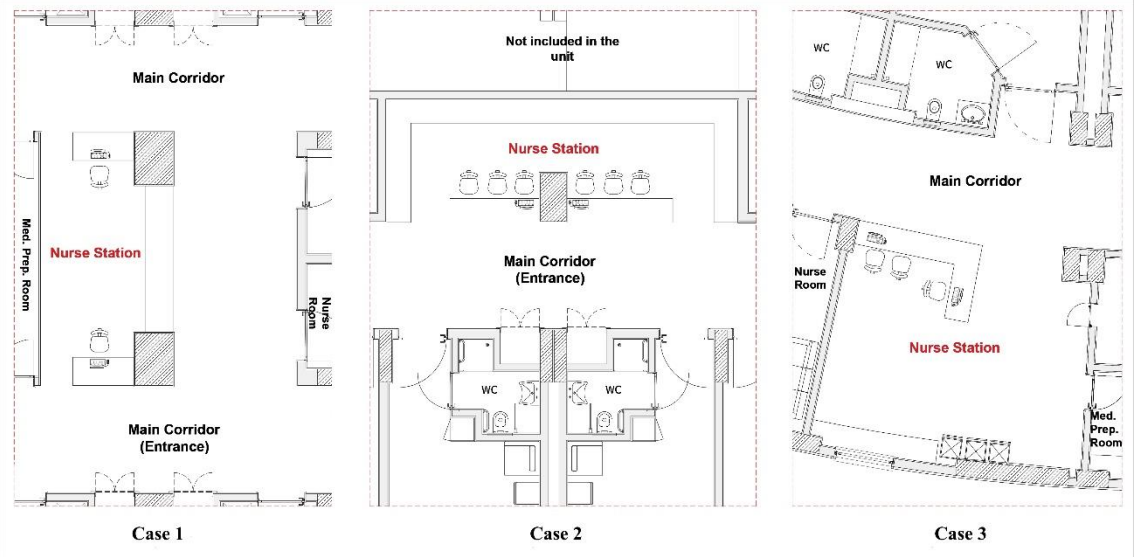



Figure 5.3. Nurse station layouts at the three units

In the three units studied, the nurse stations were generally located at the center of the unit and were observed to be frequently occupied by physicians and trainee nurses more than resident nurses of the unit. The relevant literature in Turkey -showing a developing interest in the design of nurse stations- occasionally labels these areas as "staff stations" in some studies which developing interest with the nurse station (Ozcan 2004). There are also studies to introduce physicians as frequently occupying nurses' stations (Canakcıoglu 2016; Pachilova 2020; Zook et al. 2019). Adams (2008) stated that, "the fact that the graduate nurses primarily interacted with doctors around the outside edges of the nursing station can be understood by seeing this area of the nursing station as an extension of the corridor, and therefore neutral zones[5]" (Adams 2008, 102).

[5] The "neutral space" is an area that no possessed by any user groups and can be occupied the users of the space (Becker 2007b).

According to the results of the observations in Case 3, the nurse station is one of the more preferred areas by also physicians and care attendants along with nurses. The physical qualities of the station at Case 3, which is the newest among the three, is observed to be better concerning the opportunities for natural light, furniture it offers to the staff. The nurse stations in cases 1 and 2 are also occupied by other professionals like physicians, trainee nurses rather than by assigned nurses who worked in these units. There is no substantial data, other than the graphical analysis presented earlier, to suggest that nurse station occupancy differs across the cases.

During the observations on site, it is recorded that the nurse stations in Case 1 and Case 2 are densely occupied spaces by trainee nurses coming from the College of Nursing, and physicians on-duty who are using computers there for daily charting. Seemingly, the computer at the nurse stations, used for charting and other purposes, was a factor affecting the staff's occupancy. The trainee nurses, when not assigned to task by the nurses at units, were observed to spend their shifts time studying at the nurse station, in an isolated manner. Since the staff room, reserved for resident nurses in the unit, is inadequate to serve all nurses, the trainee nurses are heavily observed to occupy the nurse station at most times in cases 1 and 2.

In any event, the nurse station is not reserved for nurses' use only, observed as a space to increase the physical interaction between staff. According to Pachilova (2020), this issue queries the significance of recent discussions on the nurse station, whether it is designed as centralized or decentralized, in order to be used by different professionals. Zook et al. (2019) supported that " the staff who attend to ICU patients throughout their shift, ICUs fold in more transient peers, such as occupational therapists, pharmacists, respiratory therapists, and possibly medical residents, among others, some of whom move throughout the hospital over the course of the day. On-unit integrated work areas may serve to mix these groups as transitory communities of practice" (Zook et al. 2019, 12).

There are differences between morphologies and the size of the three cases studied. However, it was observed that nurse stations (hatched by blue in Figure 5.1) were placed at the most central and most integrated points of the units in each unit. In other words, even though there are differences between the spatial features of the units, they are designed to consider several common architectural features. It was supported by Pachilova (2020) who referred to "some genotypical spatial relationships between

functions found in all hospital wards despite their typology or size" (Pachilova 2020, 385).

## 5.3. Nurse Room / Nurse Break Room

The nurse break room is an important backstage area to facilitate nurses' needs during breaks such as the eating, socialization, privacy, casual meeting, and comfort of the nurses (Cai 2012; Adams 2008). The literature suggests these areas to be located both in the center of the unit and near the nurse station to ease the control of the patients by nurses in case of emergencies in order to encourage nurses to occupy this area frequently during break (Adams 2008; Nejati et al. 2015). It is observed that the nurse room in the three cases studied was located to the center of the unit.

The results of the survey showed that the nurse's room is the most preferred place to communicate with colleagues, 92% of the respondents in Case 1, 71% in Case 2, 57% in Case 3. At the same time, it is evident in the survey where nurses were asked to draw their frequent paths within the unit that the nurse rooms were predominantly marked by the participants. It is observed that how the nurse rooms are being utilized at each unit varies. The nurse rooms in Case 1 and Case 3 (Figure 5.4), are used as relatively secluded break rooms and facilitate mundane activities like eating, drinking, socializing with colleagues. Moreover, the door of the nurse room in Case 1 was observed to be kept close all the time during the fieldwork, which may be due to not being disturbed during break times.

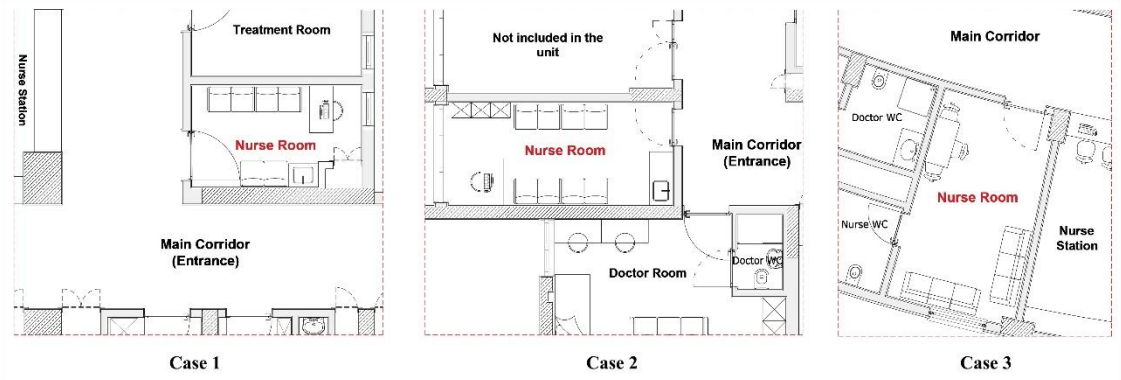



Figure 5.4. Nurse room layouts at units

Conversely, the nurse's room in Case 2 is used as both a break room like in Case 1 and Case 3, and an office by the nurses with administrative duties in the unit, using a computer for charting purposes. Besides, functional differences, there are several spatial differences between Cases 1 and 3, and Case 2. The nurse room in Cases 1 and 3 are closely located with staff-related areas, while the nurse room in Case 2 is placed away from other key staff-related areas (Figure 5.4).

According to the results of the survey, the nurses expressed their dissatisfaction with the room and stated that they would like to change the nurse's room into a larger space if possible. The literature clarifies that the nurse break room should be close to staff-related areas, protect nurses' privacy from patients and visitors, support nurse interaction, and facilities for nurses' respite time, thus, it can affect staff positively, and this is indirectly reflected in inpatient care (Zhu et al. 2022; Nejati et al. 2015). Moreover, Zhu et al. (2022) explained the relationship between break area and nurses as "well-designed break areas also were perceived to have positive impacts on nurses' mental and physical health (help emotion regulation and decrease job-related health concerns), patient outcomes (increase nurses' productivity and care quality), and organizational outcomes (increase nurses' job satisfaction, sense of belonging to the hospital, and interpersonal relationship)" (Zhu et al. 2022, 83). Therefore, in addition to the fact that nurse rooms can be designed close or far from the staff-related areas in our study, the qualification of the function provided to the nurses comes to the forefront in this study. Furthermore, it was observed that the nurse's room stand out in two separate functions a nurse's office or a nurse's break room. Therefore, within the context of Turkish healthcare system, a clear distinction should be made between the function of whether the nurse room will be used as a nurse's office or a nurse's break room in the unit.

## 5.4. Medication Preparation Room

The medication preparation room needs to be an area reserved for staff who prepare and dispense drugs for patients, providing an environment that will not distract nurses and is not interrupted by colleagues, patients, or visitors (Adams 2008; Duruk et al. 2016; Potter et al. 2005). The literature has concluded that healthcare staff do not interact with colleagues in this area, they act as if there is an invisible barrier surrounding the working nurse in there (Adams 2008). Whereas some of the study observed that the

medication preparation room can be assumed as a loud space due to interruptions that can be caused medical errors (Carayon et al. 2004; Potter et al. 2005).

In Turkey, the medication preparation room is an area that can bring about interruptions and also medical errors with communication with colleagues, information exchange, consultation, active learning as well as drug preparation as it is shared by many healthcare staff (Duruk et al. 2016). In this regard, during the field study of the research, it was observed that the doors of the medication preparation rooms at three units were always open and the nurses using the room were in interaction with each other as well as preparing the drugs in three studies units. In other words, these areas were not observed as isolated areas.

When considering the spatial layout of the three units studied, there is a variety considering the location and the morphology of the medication preparation room. In Case 3, it is a relatively small room (7.5 square meters) located behind the nurse station without any direct access to the main corridor. The medication preparation rooms in Case 1 and Case 2 are observed to be used as by-pass connection areas to connect the main corridors (Figure 5.5). The results of the drawing tasks in survey suggest that the medication preparation room emerged as a one of the key areas located on nurses' pathways during their shifts in Cases 1 and 2. On the contrary, in Case 3, most of the respondents did not include the medication preparation room in their most-used daily routes. In other words, the medication preparation room had emerged to be one of the frequent destinations for nurses from Cases 1 and 2, even over the nurse stations. Moreover, nurses use these rooms as both drug preparation and circulation shortcut in the Cases 1 and 2. In other words, the medication preparation rooms in Cases 1 and 2 were not observed as isolated and away from circulation areas, whereas the medication preparation room in Case 3 was observed as relatively isolated. It means that the medication preparation rooms can affect both the space occupancy of the nurses and the occupation density of the corridors due to their spatial features in unit. Therefore, the results show that the medication preparation rooms are one of the attraction points to affect the circulation patterns within the unit.

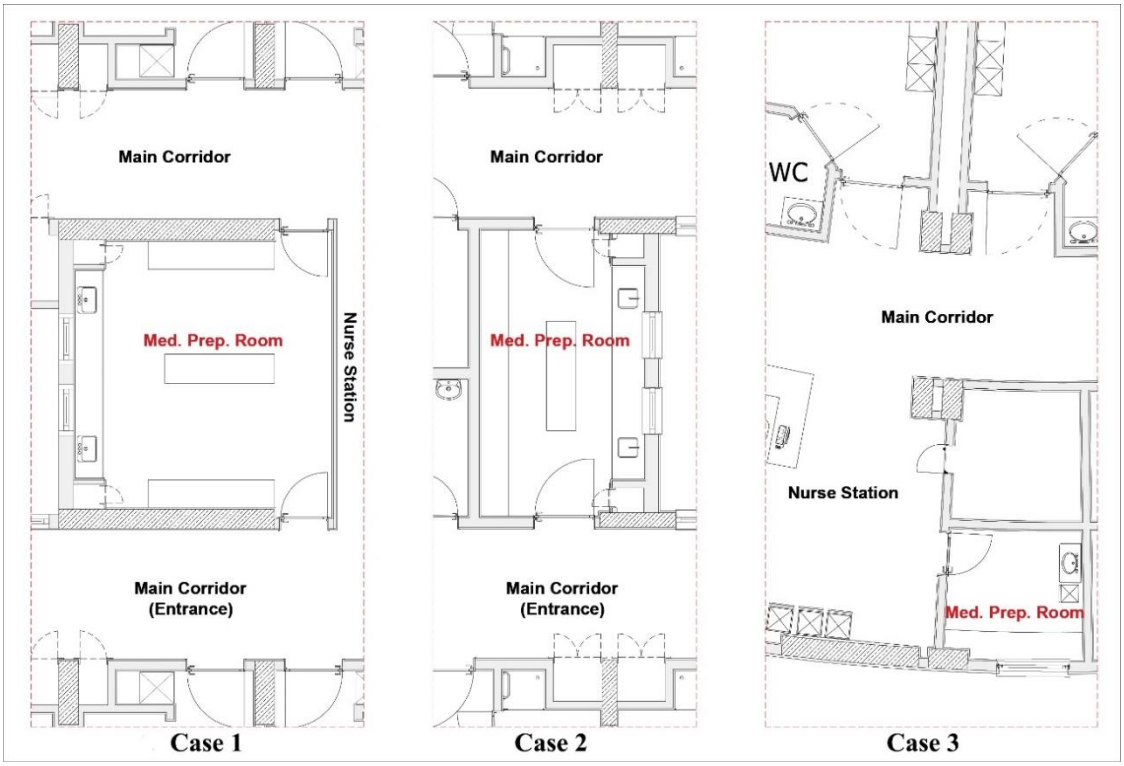



Figure 5.5. Medication preparation room layouts at units

The medication preparation rooms are not located centrally in Case 2 unlike Cases 1 and 3. It was emphasized in the survey results by the nurses that there was a configuration problem of the medication preparation room in Case 2, since a segment of the northern corridor of Case 2 was used by another unit. Thus, despite the fact that the medication preparation room connected both corridors, it remained at the west end of the Case 2. This finding, which was interpreted considering the spatial layout of Case 2, was also supported by 69% of the respondents within the survey results (survey question number is 18; if given the opportunity, what would you change in the spatial organization of your unit?). The nurses stated that the location of the medication preparation room in Case 2 caused nurses to walk more during shifts in the unit. During the interview with the nurse manager at Case 2, who was involved in the renovation process of the unit two years ago, she stated that there was a configuration problem of the medication preparation room, but it was designed according to the best solution that could be done during the renovation process.

There are studies supporting that medication preparation rooms are used in a way that supports communication, interaction, and also information exchange between staff (Carayon et al. 2004; Duruk et al. 2016). The literature also provides examples of med

preparation rooms which were designed in isolation from interactive areas in units (Adams 2008). However, as mentioned above, the literature meets on the common ground that the medication preparation rooms should be designed far away from both circulation and also communication areas to support that not to interrupt the nurses by others in order to reduce medication errors during the drug preparation. Furthermore, there is a study support that the medication preparation rooms should be designed as a "sterile cockpit" (Fore et al. 2013). Fore and colleagues (2013) stated that "applying the sterile cockpit principle to inpatient medical units is a feasible approach to reduce the number of distractions during the administration of medication, thus, reducing the likelihood of medication error" (Fore et al. 2013, 106). It was observed that the medication preparation room in Case 3 is relatively isolated, as supported by the above-mentioned research. Whereas, the medication preparation rooms in cases 1 and 2 are designed as a circulation area and also provide an environment for communication between staff. Therefore, although interruptions or medical errors were not the subjects of this study, in the line with the literature, medication errors or medical interruptions can occur in these medication preparation rooms further occupied for also different functions as well as drug preparation.

## 5.5. Different Unit Types

James et al. (1986) categorized the unit design according to their spatial configuration into seven different types; open or Nightingale, corridor or continental, duplex or Nuffield, racetrack or double corridor, race-track, cruciform of cluster and radial (Figure 5.6). According to Figure 5.6, The three case studies examined in this research spatial layouts can be classified based on the hospital unit design frameworks of James et al. (1986) such as race-track (Case 1), L-shaped corridor (Case 2), and radial corridor (Case 3). Although the morphology of Cases studied in this research do not fully correspond to the categories offered by James et al. (1986), it is possible to contextualize the units within the chart below by suggesting: Case 1 follows the racetrack or double corridor model, Case 2 follows corridor and continental model, and Case 3 resembles a segment of a radial model.

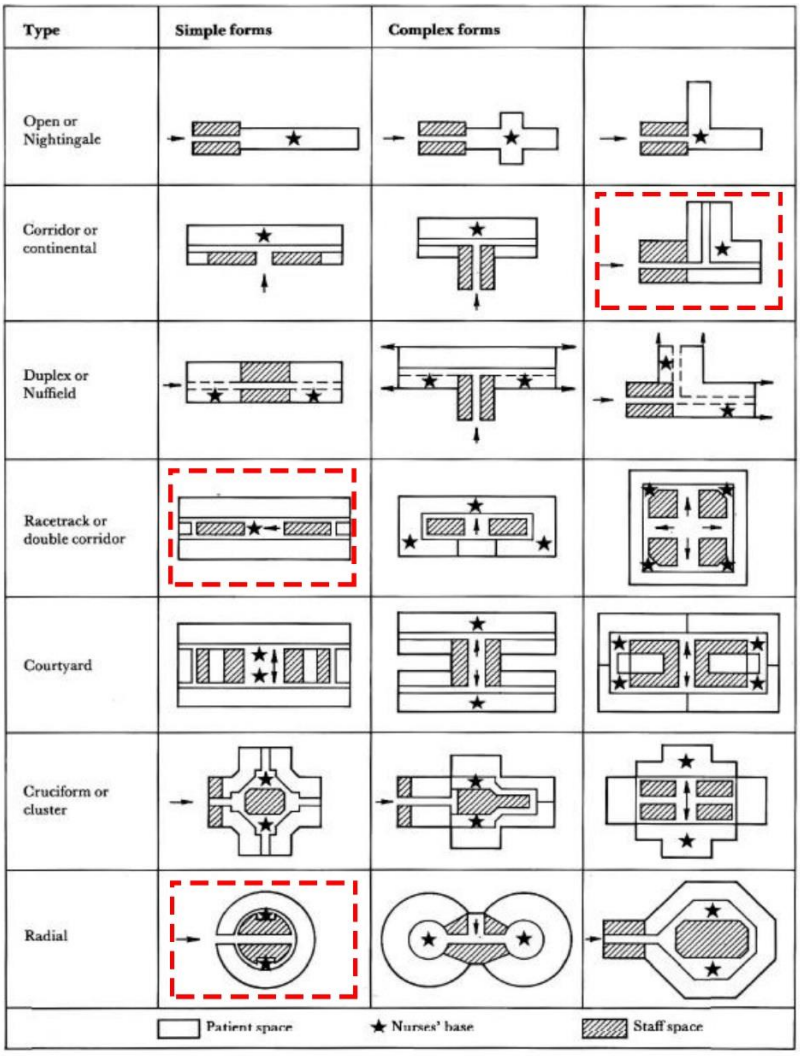



Figure 5.6. Different unit typologies by (Source: James et al., 1986)

The greater the integration of space, it becomes the more public, the more accessible (Kim et al. 2010). Therefore, the more public and accessible areas can support to provide better communication between their users. In this regard, it has been stated in some studies that radial unit types provide more visibility because they offer more viewing angles from a single point, followed by a double corridor (Lu et al. 2010; Zook et al. 2019). Moreover, Zook et al. (2019) stated that "curving hallways, patient room layouts with corridor-side bathrooms, and canted patient room layouts all tend to increase both the number of intervening convex spaces from nurse station to the bedside, and also the variability within units, so that in the same unit some patient rooms may feel much closer and more accessible than others that are nearby" (Zook et al. 2019, 12).

The space syntax results suggested that the most integrated unit is Case 1 with a race-track type, whereas the least integrated unit type is Case 3 with a radial corridor. According to the survey results (the question number 16: what are the negative aspects of your unit on the communication network?), 85,7% of respondents from Case 2, 76,9% of respondents from Case 1, 57,1% of respondents from Case 3 indicate that the unit design, especially physical distances, has negative impact on the communication between staff within the unit. In other words, the nurses referred that the Case 3 (radial corridor type), the newest unit, has a better effect on communication between staff, following by Case 2 and Case 1. When comparing the results of the survey and the space syntax, the least integrated unit with a radial corridor (Case 3) is mentioned by nurses as having a more favorable effect on communication between staff. In brief, unlike the literature, the results of the study found that the least integrated plan type (Case 3 as a radial corridor) support more communication and interaction in the unit. That is to say, there is no consistency between the space syntax results and the survey results in this study. In other words, the findings show that the different factors within the unit can go beyond the spatial configuration and weaken the effect of it on communication between staff.

# CHAPTER 6

# CONCLUSION

A growing body of the literature suggests that there is a strong relationship between spatial layout and communication in healthcare especially between staff, as it indirectly affects healthcare quality as well as patient care (Pachilova et al. 2013; Cai et al. 2012; Haron et al. 2012). For example, Pachilova et al. (2013) stated that "the spatial organization of buildings influences communication patterns and as such configuration matters" (Pachilova et al. 2013, 182). On the other hand, "spatial metrics demonstrate strong correlation to nurses' distribution, interaction, and co-awareness" (Cai et al. 2012, 13). Because, spatial layout in healthcare facilities can gather the healthcare staff during shift time, affecting their experiences, communication, behavior. Following the line of argument concerning communication and interaction in healthcare settings, this research aimed at examining a primary parameter -occupancy- that is considered as one of the main variables to impact communication between nurses as occupancy of the space in inpatient units.

This research employed multiple techniques to focus on related architectural parameters like visibility, accessibility, physical proximity to understand the space occupancy of staff in units. In this research, three inpatient units from two state hospitals in Izmir are studied to examine the research questions through on-site (observations, surveys, and interviews) and off-site (space syntax and statistical analysis), analytical techniques. The findings of the study revealed that the different spatial layouts and space organizations created different patterns of occupancy concerning circulation loads, access, and visibility.

Although there is a morphological difference between the three units, the findings suggest that particular functions emerge to affect occupancy. Corridors are key areas where nurses mostly spend time, supporting their communication, interaction and active learning, as well as their access from place to place. More importantly, the research has identified several attractors on corridors to generate extensive circulation. It has been determined that the most attractive areas observed are nurse stations, nurse rooms, and medication preparation rooms in the units studied. In line with literature, corridors are

important key areas where occupation was observed. But more importantly, there should be specific areas within the unit that only medical staff can use. In contrast, in three case studies, mentioned specific areas were ignored in each unit. Therefore, the corridors take on an excessive role in three case studies. In other words, the access role of the corridor in the unit can go beyond its functions.

The nurse stations, mentioned above as one of the mentioned key, shaped the direction and also intensity of the circulation loads on the corridor. In addition, since the zones around nurse stations were observed to generate circulation, how and where the stations are located on corridors and in relation to other densely occupied areas become important. The nurse stations which are typically located close to the center of the units emerged as meeting hubs where healthcare staff was observed to be spending most of their shifts. The field studies presented in this thesis suggest that an array of professionals including nurses, physicians, care attendants, and also trainee nurses were observed to be occupying nurse stations during their shifts. In line with the literature, the important point is that centralized nursing stations enhance interactions and opportunities for communication between not only nurses but also other healthcare staff such as physicians, trainee nurses, and care attendants.

The field studies also suggest the key role of nurse rooms which are accessible and centrally located in relation to the nurse stations at the three units. The literature emphasizes the role of nurse rooms as spaces for spending time during breaks and for creating opportunities for informal communication for nurses. In three cases, it is observed that there is a functional difference in how nurse rooms are occupied in relation to organization of the units. The nurse rooms in two studied units (Case 1 and Case 3) which are used as break rooms, and are located close to the staff-related areas, whereas the nurse room in Case 2 which is used as both nurse break room and nurse's office, is located far away from staff-related areas. It is necessary to distinguish the function of nurse rooms and to meet the demands of nurses in order to design better functioning areas for staff.

The existing research suggests that the medication preparation room in units which is one of the important areas for care processes should be carefully located on floor plates in order to avoid extra circulation loads in and through the space. The room should be designed, as literature suggests, to provide an environment that will minimize distractions since the communication and interruptions in the medication preparation

rooms may lead to medical errors. However, there are also studies to report that medication preparation rooms are used as a communication and interaction area, in contrast to the investigations to frame medication preparation rooms as "sterile cockpits". In one of the units studied (Case 3), the medication preparation room was located in a relatively isolated zone which was separated from the main circulation route. However, the medication preparation rooms in the other two units studied (1 and 2), were observed to be the spaces utilized for interaction, communication, and information exchange, as well as preparing drugs. Furthermore, these spaces were used as bypass corridor to connect main corridors in units. Therefore, these two medication preparation rooms at cases 1 and 2 have shaped the intensity and the direction of circulation loads of the nurses' occupancy since they emerged as the most frequently travelled routes of the nurses. Although it can be seen better for circulation in the cases 1 and 2, there is no data to understand the interruptions or medical errors in the three studied units. As a result, while designing medication preparation rooms, it is the designers' responsibility to consider parameters such as choosing the location and size within the unit, as well as how they relate to circulation and other dense spaces.

In addition to staff-related areas, it has been understood that there are different attraction points that created density in terms of circulation on corridors. The work stations for the unit-secretaries are observed as one of these attraction points that can shape the density and location of the circulation pattern. It has been understood that the shortcuts created by the nurses in the unit are important. So, the accumulation in front of the unit secretaries can affect the intensity and the direction of the circulation. Since, the unit-secretaries run the paperwork for inpatients, in units with a secretary (cases 1 and 3), people who want to get information about the patients apply to the secretaries, which eventually created additional circulation over the corridor.

There is a difference between the organization of particular staff-related areas (nurse stations, nurse rooms, and medication preparation rooms) in the three studied units. In two units (Cases 1 and 3), these areas were located in close proximity, whereas these areas in the Case 2 were scattered across in the unit. According to the nurse activity observation results, it was determined that in Case 2 where the staff-related areas are scattered, the densely occupied areas are spread through the unit corridors. Whereas, in Cases 1 and 3 where staff-related areas are in close proximity, the analysis of densely occupied areas suggested a compact zone limited to these specific areas in the spatial

system of units reduced the nurse walking distances in these units. However, when the dense areas are extended across the corridor, it may increase the opportunities to further monitor patients as nurses travel along the corridor to access nurse stations, nurse rooms, or medication preparation rooms. On the contrary, compactly placed staff-related areas are constantly gathered the healthcare staff at specific locations. Therefore, they can support a better quality of communication between healthcare staff.

## 6.1. Merit of the Study

This research primarily examined the space occupancy of the nurses who are the constant users of healthcare environment in three surgical inpatient units and its potential impact on the communication between staff. There are limited number of studies in Turkey, especially focusing on space occupancy in healthcare environments. In a pediatric treatment unit in Turkey, Canakcıoglu (2016) studied "the interaction between the physical environment components of the healthcare buildings, which is considered as a design problem, and the sick children and their companions who are treated in these health environments, as well as the nurses" (Canakcıoglu 2016, 4). Relatedly, Canakcıoglu (2016) focuses on the social conditions of the pediatric treatment unit to examine behavior maps of the visitors, nurses, and caregivers who occupy the unit simultaneously with the children. However, there is no study to conceptualize and investigate nurses' space occupancy compared in units with different spatial characteristics in Turkey. In this regard, this study is one of the first and is an exemplary study as an exploration of this issue. Accordingly, this study constitutes important basic data to contribute to the literature. Considering the key role of nurses in healthcare environments, this study makes an important contribution by emphasizing their practices and potential contributions, as knowledgeable participants, in healthcare design practice. In this study, nurses provided feedback about the perception of their work environment to improve the care processes and outcomes, therefore the nurses should be considered as primary participants in the design and programming processes, since the slightest improvement in the healthcare environment can save lives.

This study used several methods as an on-site and off-site method to understand the space occupancy of the nurses. Two different types of observation which is one of the basic methods of the study, add a different value to the study. This study focused on the

practices of nurses in space and considered them as the main users of the units. In this regard, this research focused on the group of professionals whose opinion should be sought for the design phase of the inpatient units in Turkey as well.

## 6.2. Limitation and Further Studies

The study had limitations, as the field studies took place during the Covid 19 pandemic. Therefore, due to restrictions, the major limitation of this study was the number of cases studied. The initial plan, which will be revisited during the post-covid phase, was to examine more cases and conduct observations for longer periods of time. The study was carried out in three units from two hospitals. Even though the spatial layout, size and the operation of the unit are different in each unit, the small number of the cases made difficult to compare at times. For this reason, the number of the cases studied will be increased in further studies to determine comprehensible results.

In addition, there are some methodical limitations in the study. First of all, the survey was conducted with a small number of respondents due to limited number nurses in selected units. Comparing the small number of collected survey data with statistical analysis limits the results of the study. On the other hand, within the scope of this study, 10-11 location mapping observations and 5-6 nurse activity observations were made per day in each unit. In the further studies, both the number of participants in the survey and the number of observations gathered in the case studies will be increased so that more meaningful results can be obtained.

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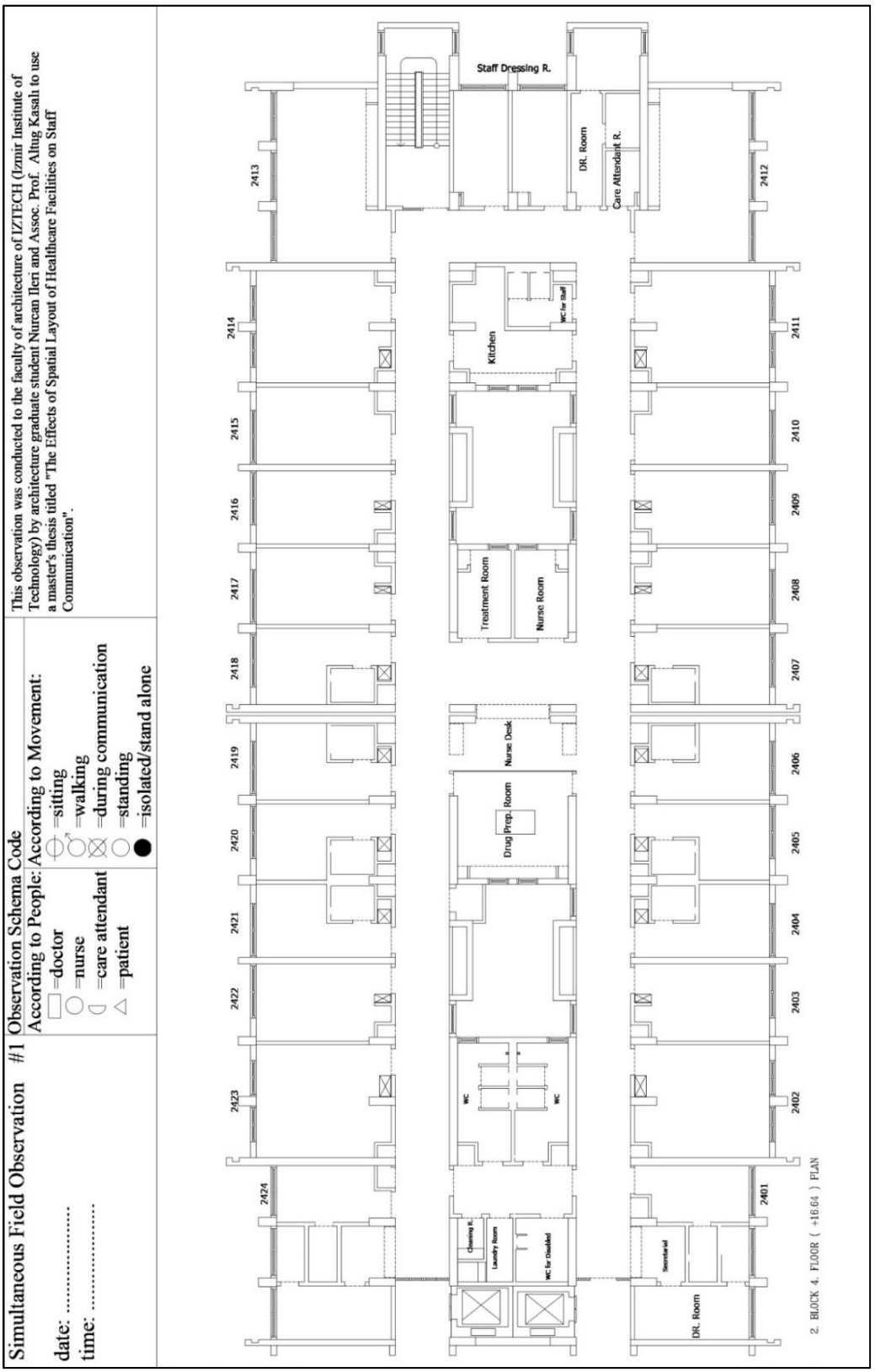
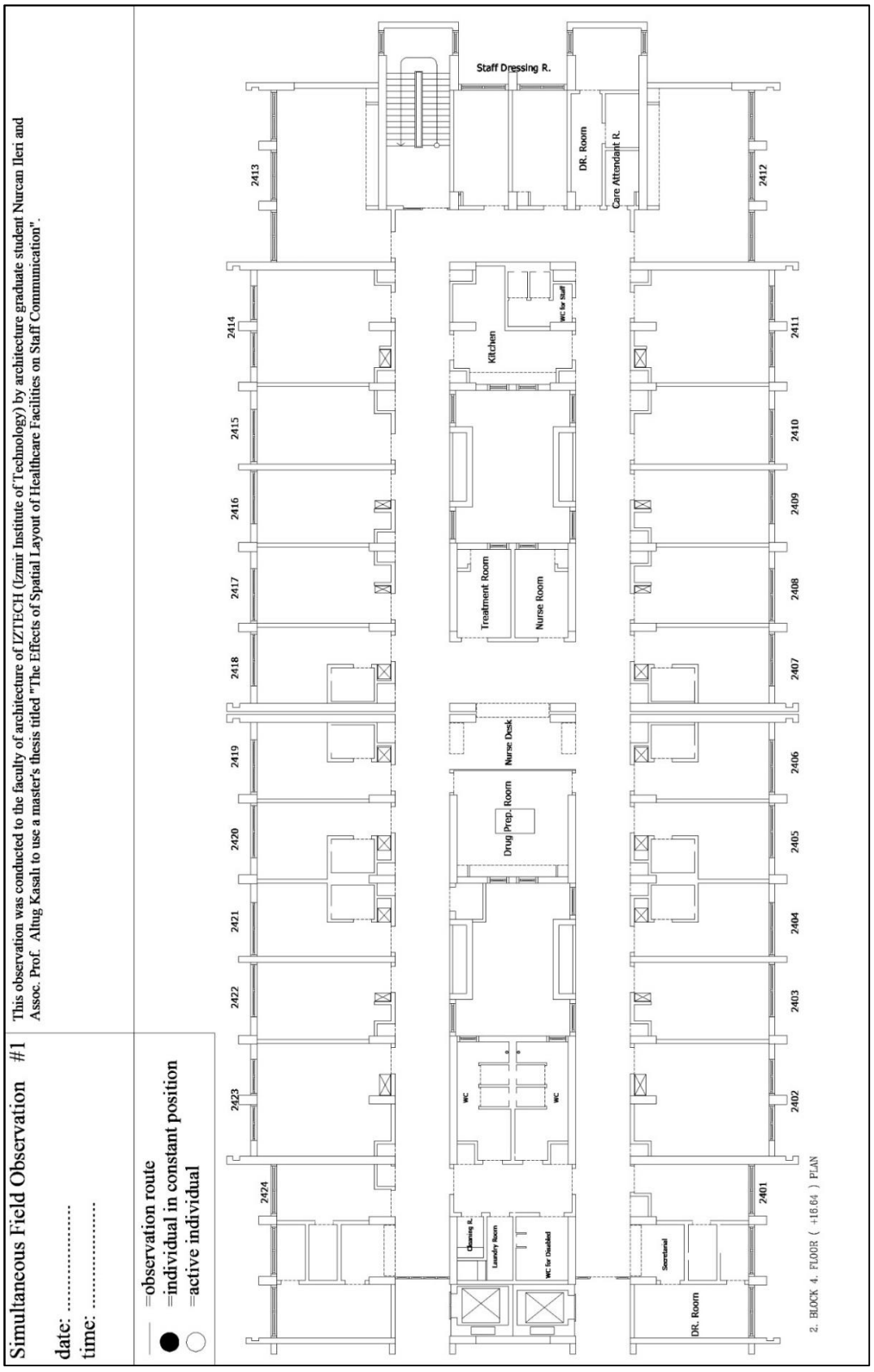
# APPENDICES

APPENDIX A. Location Mapping Observations Data Recording Sheet 1 (the example sheet of Hospital A, Case 1)



APPENDIX B. Nurse Activity Observations Data Recording Sheet 2 (the example sheet of Hospital A, Case 1)



# APPENDIX C. Sample Staff Survey

This observation was conducted to the faculty of architecture of IZTECH (Izmir Institute of Technology) by architecture graduate student Nurcan Ileri and Assoc. Prof. Altug Kasali to use a master's thesis titled "The Effects of Spatial Layout of Healthcare Facilities on Staff Communication". Your answers to this survey will not be used for any purpose other than this research. We ask you to participate in this survey, which takes no more than 10 minutes to complete.

**Staff Survey**

1. Age: ……
2. Gender: ……
3. Occupation: ……
4. **For how long have you been practicing as a nurse**?
   **a)** 0 - 1 years, **b)** 1 - 3 years, **c)** 3 - 10 years **d)** 10+ years
5. **For how long have you been working in this unit**?
   **a)** 0 - 1 years, **b)** 1 - 3 years, **c)** 3 - 10 years **d)** 10+ years
6. **On a given day, what is the number of patients that you provide care for**?
   **a)** less than 4, **b)**4-6, **c)** 6-8, **d)** 8-10, **e)** 10-12, **f)** more than 12
7. **How much bedside time do you spend on average for a single patient over the course of the day**?
   **a)** 10 - 30 min., **b)** 31 min. - 1 hour, **c)** 1 - 2 hour, **d)** 2 - 4 hour, **e)** 4 + hour
8. **Are you knowledgeable about your colleagues patient assignments**?
   **a)** Agree, **b)** Disagree, **c)** Neither Agree Nor Disagree,
9. **Do you communicate with every colleague in the unit on a given day**?
   **a)** Agree, **b)** Disagree,
10. **Where, in your unit, do you prefer to have a conversation with a colleague concerning care process**?
    **a)** Corridors, **b)** Nurse Desk, **c)** Nurse Room, **d)** Patient Room, **e)** Out of the Unit,
11. **When help needed, which communication channels are used in your unit**?
    **a)** I would like to ask my friend with whom I am in visual contact.
    **b)** I call my colleague by calling out
    **c)** I call any colleague who is the most closely by the nurse call system
    **d)** I call my colleague by phone
    **e)** Other……
12. **Do you think your unit is convenient for a good quality communication with colleagues concerning care processes**?
    **a)** Agree, **b)** Disagree, **c)** Neither Agree Nor Disagree,

    **12.1.** Why?
    ……
    ……
    ……

1

Sample Staff Survey Sheet, first page

**13. Do you consider yourself accessible by your colleagues concerning care processes?**

**a)** Agree, **b)** Disagree, **c)** Neither Agree nor Disagree,

**14. How would you rate the spatial quality of your unit, on a scale of 1 to 10?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|

**15. Do you think the spatial organization of your work environment inhibit your communication with colleagues?**

**a)** Agree,

**b)** Disagree,

**c)** Neither Agree Nor Disagree,

**15.1.** Why?

……

……

**16. What are the negative aspects of your unit on the communication network?**

**a)** Physical distances

**b)** Not acoustically favorable

**c)** Problems in the spatial layout

**d)** Other ……..……..……..……..……..

**17. Do you think that the design of the environments you mostly spend time in during the day affect the communication with colleagues?**

**a)** Agree,

**b)** Disagree,

**c)** Neither Agree Nor Disagree,

**18. If given the opportunity, what would you change in the spatial organization of your unit?**

……

……

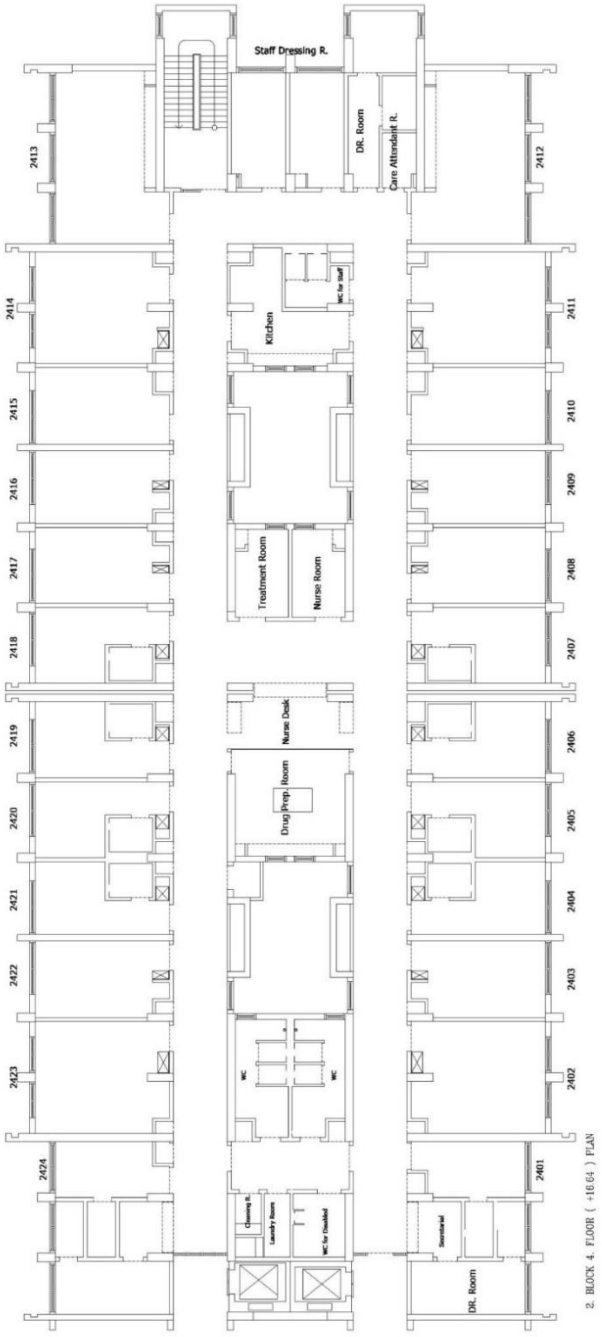
……

**19. Would you mark the major routes you cover in a given day?**

**(The plan of the unit is given on the 3rd and last page.)**



Sample Staff Survey Sheet, second page




Thank you for your participation in the survey. Contact numbers for any questions or comments:
Researcher Nurcan İleri (nurcan_ileri@hotmail.com) (0 546 4757823)
IZTECH (Izmir Institute of Technology), Assoc. Prof. Altug Kasalı (altugkasali@iyte.edu.tr) (0 532 4521360)

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Sample Staff Survey Sheet, third and last page[6]

[6] 3rd and last page of the staff survey was changed according to the unit plan.