Design Analysis and Space Layout in the Radiology Installation of Buleleng District Hospital

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ABSTRACT

The Regional General Hospital of Buleleng Regency is a government-owned type B general hospital that has received full accreditation and serves as a teaching hospital in Bali. This study aims to analyze the design and layout of the Radiology Installation at RSUD Kabupaten Buleleng and evaluate the effectiveness of services and the implementation of Health and Safety (K3) for radiation workers. This research uses a descriptive qualitative method through direct observation, interviews with 10 respondents, and documentation. The results show that the Radiology Installation at RSUD Kabupaten Buleleng is divided into Central Radiology and Emergency Radiology, both of which face several challenges in service processes due to suboptimal design and layout, such as inefficient patient flow and non-ergonomic spaces. The implementation of Radiology K3 complies with current regulations. Several design and layout innovations have been proposed to the hospital management, but their implementation cannot be realized at this time.

Keywords: *Design, Layout, Effectiveness, Health, Safety*

ABSTRAK

Rumah Sakit Umum Daerah Kabupaten Buleleng adalah rumah sakit umum milik pemerintah kabupaten Buleleng dengan status Rumah Sakit tipe B yang telah terakreditasi Paripurna dan merupakan salah satu rumah sakit pendidikan di daerah Bali. Penelitian ini bertujuan untuk menganalisis desain dan tata letak ruang di Instalasi Radiologi RSUD Kabupaten Buleleng, serta mengevaluasi efektivitas pelayanan dan penerapan Kesehatan dan Keselamatan Kerja (K3) bagi pekerja radiasi. Jenis penelitian ini menggunakan metode penelitian kualitatif deskriptif dengan melakukan observasi secara langsung, wawancara dengan 10 informan dan dokumentasi. Hasil penelitian menunjukkan bahwa Instalasi Radiologi RSUD Kabupaten Buleleng terbagi menjadi Radiologi Central dan Radiologi IGD, yang menghadapi sejumlah kendala dalam proses pelayanan akibat desain dan tata letak yang kurang optimal, seperti alur pasien yang tidak efisien dan ruangan yang kurang ergonomis. Penerapan K3 Radiologi telah sesuai dengan regulasi yang berlaku. Beberapa inovasi atau perubahan desain dan tata letak telah diajukan kepada pihak manajemen rumah sakit, namun pelaksanaannya belum bisa diwujudkan saat ini.

Kata kunci: *Desain, Tata Letak, Efektivitas, Kesehatan, Keselamatan Kerja*

INTRODUCTION

A hospital is a health service institution that provides comprehensive individual health services that provide inpatient, outpatient and emergency services (Panjaitan et al., 2020; Marbun et al., 2022; Amran et al., 2022). According to Law No. 44, 2009, a hospital is a health service institution for the community with its own characteristics influenced by the development of health science, technological advances, and the socio-economic life of the community which must continue to be able to improve services that are of higher quality and affordable to the community in order to achieve the highest level of health. Hospitals have an important role and function for the welfare of the community (Dione 2017; Tambaip et al., 2023). In carrying out its activities, hospitals are required to have a high level of effectiveness and efficiency, so they need to be supported by adequate supporting facilities and infrastructure in order to optimize the activities that occur in them (Astuti, 2018; Budo et al., 2020; Fadilla, 2021). Design is the process of planning, creating, and implementing an object or system with a specific purpose. Design involves selecting certain elements, such as form, function, and aesthetics to achieve the desired results (Irawan & Tamara, 2013; Aulia et al., 2023). Layout is a part of facility design that focuses on the arrangement of physical elements. Physical elements can be in the form of work equipment, tables, buildings, and so on to support the smooth service process (Arif, 2017; Martiana & Aman, 2018; Sinta, 2019; Waruwu, 2022). Layout is the arrangement of equipment that creates an efficient, safe, and ergonomic work area. A work area with a layout that has good design principles will produce a high level of efficiency.

Hospital buildings and infrastructure must meet the requirements for building and environmental planning as well as the requirements for hospital buildings and infrastructure. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 40 of 2022, one of the requirements for building and environmental planning in question is the design of the hospital which includes the layout of buildings and the layout of the space in the building must consider zoning based on the level of risk of disease transmission, zoning based on privacy and zoning based on the proximity of the relationship between the functions of the service space. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 56 of 2014, the design of the use of space in a building must be effective in accordance with the service functions. Hospital services are divided into several sub-sections, one of which is the medical support section, including the radiology installation. In addition to the availability of adequate facilities, infrastructure and diagnostic support equipment, the layout of the radiology installation room is one of the things that needs to be considered for the smooth and effective service to patients (Satoto, 2009; Dwipasari, 2019). According to the Indonesian Minister of Health Regulation No. 24 of 2020, buildings and infrastructure that serve clinical radiology services must be easily accessible from the emergency room, outpatient and other service facility sections and meet radiation protection requirements in order to meet the Radiology K3 standards. Radiology Occupational Health and Safety (K3) is a procedure used to protect patients, workers, the community and the environment from the dangers of radiation (Fairusiyyah et al., 2016; Utami, 2019; El-Matury et al., 2021). Given the potential high risk of radiation in the use of x-rays, the radiology K3 factor is very important to minimize the risks arising from working in radiology installations and the impact of radiation on workers' radiation (Monita, 2021; Oemiati & Umar, 2021; Dari et al., 2023; Sari et al., 2023).

Buleleng District General Hospital (RSUD) is a general hospital owned by the Buleleng district government with the status of a type B Hospital that has been fully accredited and is one of the teaching hospitals in the Bali area. The location of Buleleng District Hospital is very strategic and easy to reach because it is located in the center of the densely populated city of Singaraja. Buleleng District Hospital is supported by various adequate services including 21 outpatient services (polyclinics) and 21 inpatient rooms and several other types of supporting facilities. One type of medical support service available is radiology services with an average number of visitors per month of ±

3,000 people. To enter the panoramic examination room, patients must first go through the conventional DR radiology examination room, so if there is a patient in the conventional DR room, the patient who will undergo a panoramic examination must wait first, and vice versa. Meanwhile, the conventional DR examination room is often used for examinations that use contrast media such as HSG, fistulography and so on which require a long time. This certainly affects the effectiveness of services in the radiology installation, especially for patients who will be examined in the conventional DR room and panoramic room. In addition, the connecting door of the conventional DR and panoramic examination rooms has a size that is not optimal, making it difficult for patients who enter using wheelchairs.

METHODS

This study uses a descriptive qualitative research type with a case study approach (Sugiono, 2016). This study was conducted on March 21 - March 26, 2024, located at the Radiology Installation of Buleleng Regency Hospital. The subjects in this study were 10 informants consisting of three radiographers, one Radiation Protection Officer (PPR), one radiologist, one radiology nurse, one radiology administration officer and three radiology patients/visitors. The object of this study is the design and layout of the room in the Radiology Installation of Buleleng Regency Hospital. In analyzing this data, the author used a descriptive qualitative analysis technique. This qualitative data analysis began with direct observation of the design and layout of the room in the Radiology Installation of Buleleng Regency Hospital and conducting interviews with competent informants and documenting the data needed in this study. The author processed the data by reducing the data and using an open coding system to obtain conclusions.

RESULTS

The Radiology Installation of Buleleng District Hospital is divided into 2, namely the central unit and the Emergency Installation. For central access, it is close to the polyclinic, registration counter, and lab. For radiology, the Emergency Installation is certainly close to the emergency unit, pharmacy and lab too. The layout is very easy to access. In general, access to radiology is quite easy even though there are several inpatient rooms that are located or further from other rooms because Buleleng District Hospital is quite large so that there are several rooms that are quite far away but can still be easily accessed to the radiology installation.

Figure 1. Central Radiology Floor Plan & Emergency Room Radiology Floor Plan

If in terms of design, the first is in the Emergency Installation section because the design is quite winding and the corridor is narrow, usually Emergency Installation patients who come queue with a bed so that access in and out is slightly hampered. While in the central, in terms of design, the panoramic room is located at the back and does not have its own entrance access so that to enter the panoramic room you must go through the conventional room II (Doctor's room) first, so when there are panoramic patients and patients who are being worked on in the Doctor's room (contrast

examination patients) then the obstacle is that the panoramic patient must wait for the patient in the Doctor's room to finish first. Actually, there is another option, namely panoramic patients enter through the USG room but back again if there are patients in the USG and the Doctor's rooms at the same time, then the panoramic patient must wait first. There are no serious obstacles, but currently the obstacle is when patients from the VVIP room use a large bed, it is rather difficult to enter the examination room, so the patient must be moved to a smaller stretcher because the obstacle is the wall/corridor to enter the conventional radiology room of the Emergency Installation which is too small/narrow in terms of its layout. At this time, the problem is in the USG service room because the room is quite narrow, the area is very limited so that for a stretcher that is quite large in size, it is difficult to enter, so we have to make more efforts so that the stretcher/patient bed that is large in size can enter the examination room.

The impact of the constraints is on patient care because of the extra effort required by nurses and assistants in the USG room to get patients into the room so that the time becomes longer although it is not too significant. Maybe more on the USG door which is often scratched and slightly damaged because it is very close to inserting the stretcher. Then the constraints for the doctor, sometimes the examination position on patients with large stretchers and close to the radiology room so that the examination position is less ergonomic and can cause back pain in examinations that take a long time with an uncomfortable position so that sometimes it causes complaints for the examining doctor. The impact of the existing constraints is such as delays in service because for panoramic examinations, the examination does not require patient preparation so that the patient should be able to be done immediately but because the location of the room is at the back and does not have its own door access, the patient must wait first because there is a patient in the Doctor's room and the USG room at the same time so that the patient cannot be examined. However, officers will continue to try so that when there is a gap or even though there is already a patient in the USG and the doctor has not started the examination, the panoramic patient is still attempted to be able to enter the panoramic room so that the patient does not wait too long.

For central radiology, almost all rooms are connecting doors and access from the admin to the conventional room is close because sometimes as radiographers we also double as admins so that access to cooperation between officers to work on patients is quite easy because we do not need far access to other examination rooms so that it is quite productive for us as radiation workers in carrying out work. While in the Emergency Installation radiology, the conventional room and CT-Scan are very close so that the productivity of radiation workers is assessed in terms of design is quite good. It is very important because a good room design will make work more effective and more patient flow so that it is easier, more effective and more efficient. The design of the radiology room greatly affects the productivity of radiation workers such as in the Emergency Installation guard room, the design is less efficient because there is no adequate air circulation and only relies on exhaust fans. The following Emergency Installation CT-Scan room is too far into the conventional exposure/operator room so that the operator room is very narrow, but it can still be accessed in and out by officers.

The layout of the equipment is quite appropriate, but for the position of the Emergency Installation CT Scan gantry facing north so that the mobility of patients using stretchers is slightly hampered because when the patient's bed enters it is slightly hampered by the gantry head, the position should be directly facing the entrance so that it is more effective. The layout of radiology equipment or radiology machines can affect the productivity of radiation workers, both radiographers, nurses, and doctors. For the position of the panoramic machine which is very close to the east wall so that when the cephalometric examination is carried out there are obstacles from several parts, namely the panoramic machine does not rotate optimally according to its function.

For the implementation of K3 in radiology, it already exists, such as the building area is in accordance with the standards of the Minister of Health Regulation No. 24 of 2020, then the thickness of the walls has been adjusted using radiation protection made of pb

or concrete with a thickness of 30 cm or equivalent to 0.2 mm pb. Then we have also arranged a separator between the operator's room and the action room. In the action room, there is pb glass which will later be used to monitor the patients inside, so workers still feel safe while working. Occupational health and safety for radiation certainly already exists, we conduct routine exposure tests, but there are slight obstacles in the Emergency Installation radiology because the room is on the ground floor of the building so for the guard room there is no ventilation there, there is only a small exhaust fan.

Feeling quite safe because in addition to the room that is always tested, every radiation worker is also equipped with a TLD and so far, the TLD test results are still safe, so personally the employees also feel safe. Employees already feel safe working in the radiology installation of Buleleng District Hospital because in terms of security and safety it is quite good and usually there are periodic health checks for radiology officers. As a radiation worker, they feel safe because they have been tested for suitability of wall leaks, pb glass leaks, doors and x-ray equipment has also been tested and calibrated periodically.

Innovation and changes in the design of the radiology room layout have certainly been submitted to the management, but again, the results that will be carried out by the management depend on the hospital's finances and of course if it is done, it should not hinder services, so it takes quite a long time to make revisions to the design and layout changes of the radiology room at Buleleng District Hospital. For innovation and changes, there have been none because we see the aspect of hospital financing and seen from the effectiveness of workers, it has also been running normally until now so that there have been no significant obstacles. However, if later there are certain innovations or changes, they will be discussed with radiation officers and related hospital parties. For now, there have been no changes to the design and layout of the radiology room at Buleleng District Hospital, although previously it was planned to make changes to the building but it has not been realized at this time, but there has been a renovation to replace the old roof to improve safety for workers.

The radiology installation at Buleleng District Hospital is divided into two parts, namely Central Radiology and Emergency Installation Radiology. Central Radiology is located in the northern part of the hospital, close to the laboratory and easily accessible from the outpatient clinic and inpatient room. Meanwhile, Emergency Installation Radiology is located in the western part of the hospital, close to the emergency unit and operating room. The Radiology Installation Building at Buleleng District Hospital meets the provisions of Minister of Health Regulation No. 24 of 2020 and BAPATEN Regulation No. 4 of 2020 by having a patient waiting room, administration room, examination room, operator room, radiologist room, and standard equipment. The spatial arrangement has been designed to facilitate patient access from various units, as well as minimize the risk of radiation exposure for visitors and officers with a clear separation between the public area and the radiation officer's work area.

The design and layout of the Radiology Installation room of Buleleng District Hospital has several obstacles to the patient service process, including disrupting mobility and service efficiency because the access to the panoramic examination room is winding, narrow and does not have its own entrance door, making it difficult for patients using wheelchairs and patients must enter through the conventional examination room II or the USG examination room. The position of the panoramic-cephalometric machine close to the wall causes some parts of the panoramic machine not to rotate optimally according to its function. The narrow access to the USG and conventional examination rooms in the IGD and the position of the CT Scan gantry in the Emergency Installation close to the entrance make it difficult to mobilize patients using large beds. In addition, circulation in the radiographer's duty room is inadequate because it only relies on a small exhaust fan. Constraints in the panoramic examination room have an impact on service delays. Access to the winding and narrow room is also

an obstacle if there are patients using wheelchairs, so that non-cooperative patients must be carried by their families.

Patient mobility that is hampered by narrow room access and inappropriate placement of work equipment can disrupt the effectiveness and efficiency of services. Officers who should be responsive to patients become less effective due to narrow access so that when there is a patient with a large bed, it takes more time to move the patient to a smaller stretcher. Good design and layout not only improve patient comfort and safety, but also allow radiation workers to work effectively and efficiently. The uneven contour of the hospital land and the layout of the Emergency Installation radiology room which is located at the ground level resulted in the design of a radiographer's duty room that did not have adequate air circulation and only relied on a small exhaust fan becoming an obstacle to radiation worker productivity. Poor air circulation can cause heat and humidity buildup, which ultimately affects the comfort and health of officers. Uncomfortable and unhealthy workspace conditions can result in fatigue, decreased concentration and increased risk of long-term health problems. A room with good air circulation will ensure sufficient fresh air flow, reduce the risk of spreading infection and keep the room temperature stable. The importance of good room design is not only limited to aesthetics, but also includes aspects of the health and comfort of officers. Therefore, paying attention to the design and layout of the radiographer's duty room and ensuring adequate air circulation are important steps in creating a conducive working environment and supporting the productivity of radiation workers.

The implementation of Occupational Health and Safety (OHS) in Radiology at the Radiology Installation of Buleleng District Hospital includes the thickness of the walls covered with radiation protection made of Pb or concrete, arranging the separator between the examination room and the operator, conducting regular tests on the suitability and leakage of walls, doors, and Pb glass, radiation workers equipped with TLD radiation measuring instruments and periodic health checks for radiology officers. The implementation of Occupational Health and Safety (OHS) in Radiology reviewed in terms of the design and layout of the Radiology Installation of Buleleng District Hospital has met the radiation safety and security standards according to BAPETEN regulations and Permenkes No. 24 of 2020 (Damayanti et al., 2022). Radiation workers who are equipped with TLDs and undergo periodic health checks further strengthen the commitment to the safety and operational efficiency of the radiation environment. The results of the TLD tests of the workers did not exceed the Dose Limit Value (NBD) so that the workers felt safe in carrying out their duties in the radiation environment. Several innovations or changes in design and layout have been proposed by the radiology team to the hospital management to improve the K3 aspects of Radiology and the effectiveness of radiation workers, but they cannot be realized at this time due to considerations regarding hospital financing aspects and services in the radiology department which are still running normally.

CONCLUSION

The Radiology Installation of Buleleng District Hospital is divided into Central Radiology and Emergency Radiology Installation. Central Radiology is located in the north, close to the laboratory, outpatient clinic and inpatient room. Meanwhile, Emergency Radiology Installation is located in the north, close to the emergency unit and operating room. Several obstacles were found in services at the Radiology Installation of Buleleng District Hospital due to less-than-optimal design and layout, such as narrow access to several examination rooms and inadequate air circulation for the radiographer's guard room design. These obstacles affect the comfort and productivity as well as the effectiveness of services to patients. The implementation of K3 Radiology at the Radiology Installation of Buleleng District Hospital has been in accordance with radiation safety and security standards. Radiation protection facilities, routine room suitability and leak tests and periodic health checks for radiation workers demonstrate a strong commitment to worker safety and health. Several innovations or

changes in design and layout have been submitted to the hospital management, but their implementation has not been realized at this time. Hospital management must consider several things related to the design and layout that have been submitted, such as improving access to examination rooms to facilitate patient and staff mobility, optimizing the placement of radiology machines to ensure maximum functionality and reduce operational obstacles. Improve air circulation in the radiographer's duty room by adding larger vents or exhaust fans to ensure worker comfort and health. Implement flexible room design to allow for future adjustments without disrupting ongoing services and involve radiologists in the planning process to obtain constructive input and ensure that all changes meet operational needs and safety and comfort standards.

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