

# Factors Related to the Implementation of X-Ray Radiation Safety Management in the Radiology Unit in East Kalimantan, Indonesia

Sri Warsuni Almas, Yuly Peristiowati, Ratna Wardani

Masters Program of Public Health, Strada Institute of Health Sciences, Indonesia

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## ABSTRACT

**Background:** The hospital is a complex public health service and a research center for medicine. The wider the function of a hospital, the more complex the equipment and facilities available. One of the specialist supporting medical services in hospitals is radiology using X-ray machines. The use of diagnostic radiology X-rays in Indonesia continues to grow. The aim of the study was to determine the factors that influence the implementation of X-ray radiation safety management in the Radiology Work Unit of the Province of East Kalimantan.

**Subjects and Method:** An observational study with a cross-sectional design was conducted in Radiology Working Unit, East Kalimantan Province in October 2022. A total of 173 respondents were selected using proportional random sampling. The dependent variable is the implementation of X-ray radiation safety management. The independent variables are man, money, method, material and machine. The data were collected using a questionnaire, and analyzed using a linear regression test.

**Results:** Man ( $b= 0.49$ ;  $p<0.001$ ), money ( $b= 0.20$ ;  $p= 0.007$ ), method ( $b= 0.47$ ;  $p<0.001$ ), material ( $b= 0.23$ ;  $p= 0.002$ ), and machine ( $b= 0.11$ ;  $p= 0.050$ ) have effects on the implementation of X-ray radiation safety management in radiology work units.

**Conclusion:** Man, money, method, material, and machine significantly influence the implementation of X-ray radiation safety management in radiology work units.

**Keywords:** management, X-ray radiation safety.

### Correspondence:

Sri Warsuni Almas. Masters Program of Public Health, Strada Institute of Health Sciences. Jl. Manila 37, Kediri 64123, East Java, Indonesia. Email: sriwarsuni99@gmail.com. Mobile: +62 822-5455-3137.

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## BACKGROUND

Occupational Health and Safety (K3) is an instrument that prevents work accidents from workers, companies, the environment, and the surrounding community (Fairusiyah & Widjasena, 2016). Protection in an OSH system involves several elements, namely management, labor and also the work

environment. This is useful for minimizing the occurrence of work-related accidents and work-related illnesses so that the workplace becomes safe, efficient so that productivity increases (Utami, 2019). In Government Regulation Number 50 of 2012 concerning guidelines for the implementation of the Occupational Safety and Health management

system, it states that Occupational Health and Safety (K3) efforts must be held in every workplace, especially in areas with high health hazards and are easily exposed to disease and have a minimum number of employees. 100 people. The use of nuclear technology develops in line with the development of many other technologies. The field of industry and health is the main or main field in the utilization of the latest nuclear technology.

The use of radiation is necessary for therapy and the use of radiopharmaceuticals in medicine is a nuclear application in the health sector, while in the industrial sector is the use of radiation for radiography, gauging and also logging (Utami, 2019). The hospital is a complex public health service and also a research center for medicine. The wider the function of a hospital, the more complex the equipment and facilities available. Hospitals have great potential for danger, this risk can endanger hospital visitors, patients and also medical personnel. Hospitals have a very high potential for work accidents. Hospitals in Indonesia are growing rapidly, both in terms of quantity and medical technology. The results of the 1988 National Safety Council (NSC) report estimated that accidents in hospitals were 41% greater than workers in other industries. Cases that often occur include needle stick injuries (NSI), back pain, sprains, scratches or cuts, burns, infectious diseases and others (Firnando et al., 2020)

Considering the large radiation hazard potential in the use of X-rays, safety is an important factor so as to minimize the risks due to work in radiology installations and the impact of radiation on radiation workers. To prevent this, it can be done by implementing aspects of radiation safety management where radiation safety is an action taken to protect patients, workers and members of the public from radiation hazards. A similar study conducted by Utami (2019) explained

descriptively that the application of 5M management in the radiology room really needs to be implemented as a control mechanism for the performance of both nurses and other health workers in the radiology room to ensure that health management and work safety have been implemented to provide services. quality and prioritizing patient safety in accordance with regulations in the hospital.

Judging from the importance of implementing occupational safety management, this study aims to determine the factors that influence the implementation of X-ray radiation safety management in the Radiology Work Unit of East Kalimantan Province.

## SUBJECTS AND METHOD

### 1. Study Design

This study uses a quantitative design with observational analytic research methods with a cross-sectional approach. This was carried out in October 2022 at the Radiology Work Unit, East Kalimantan Province.

### 2. Population and Sample

The population is all radiographers in the East Kalimantan Province Radiology Work Unit with a total of 307 respondents. The sample in this study were radiographers of radiology as many as 173 respondents with proportional random sampling.

### 3. Study Variables

**Independent variables:** point man, money, methods, material and machine factors.

**Dependent variable:** implementation of X-ray radiation safety management.

**4. Operational Definition of Variables**  
**Implementation of X-ray radiation safety management** is an action taken to protect patients, workers, members of the public, and the environment from radiation hazards. This can be measured using an observation sheet.

**Man** is a human resource owned by the organization, either giving directions or carrying out work in the field of radiation. This is measured using a questionnaire.

**Money** is related to how much money must be provided to finance labor salaries, the tools needed and must be purchased and how much results an organization will achieve in implementing X-ray radiation safety. This is measured using a questionnaire.

**Method** is an organizational effort in implementing X-ray radiation safety. This can be known by researchers using a questionnaire.

**Material** is the ability of human resources to utilize materials or infrastructure. This is measured using a questionnaire.

**Machines** are infrastructure facilities that can assist HR in carrying out their duties. This can be measured using an observation sheet

**5. Data Analysis**

This research was conducted using univariate, bivariate, and multivariate analysis. Univariate analysis was used to describe the distribution of respondents. Multivariate

analysis was performed using a linear regression test.

**SUBJECTS AND METHOD**

**1. Sample Characteristics**

From the table below it can be seen that Table 1 shows the results of the characteristics of the research subjects based on age, gender, years of service, last education, position, work space, employment status and participation in survey meter use training. In the age category of respondents, it was found that most of the respondents were less than the average age (32 years), namely 101 respondents (58.4%). The gender of the respondents was mostly male, namely 87 respondents (50.3%). The working period of most of the respondents was less than 10 years, namely 109 respondents (63.0%). In the education category, almost all of the respondents were Diploma education, namely 159 respondents (91.9%). The status of almost half of the PNS respondents is 63 respondents (36.4%). In the variable participation in the survey meter usage training, almost all of the respondents had never attended training, namely 139 respondents (80.3%).

**Table. 1 Characteristics of Sample**

Characteristic	Categories	Total (n)	Persentase (%)
<b>Age</b>	≤ mean (32 years)	101	58.4
	> mean (32 years)	72	41.6
<b>Gender</b>	Male	87	50.3
	Female	86	49.7
<b>Years of Service</b>	< 10 years	109	63
	≥ 10 years	64	37
<b>Background Education</b>	Diploma 3	159	91.9
	Diploma 4	7	4
<b>Employment status</b>	Bachelor Degree	7	4
	Regional contractors	24	13.9
	Honorarium	14	8.1
	Regional public service agency	55	31.8
<b>Training</b>	Civil servant	63	36.4
	Private	17	9.8
	Never	139	80.3
	Ever	34	19.7

Table 2 shows the results of the characteristics of the research variables, namely point man, point money, point method, point

material, point machine and implementation of X-ray radiation safety management. Most of the respondents had the appropriate point

man, namely 131 respondents (75.7%). In the point money variable, most of the respondents have the appropriate category, namely 149 respondents (86.1%). The point method is mostly appropriate, namely 149 respondents (86.1%). Most of the respondents at the material point have the appropriate category,

namely 173 respondents (91.9%). Most of the point machines have appropriate categories, namely 93 respondents (53.8%). At the point of implementing X-ray radiation safety management, most of the respondents were in the appropriate category, namely 152 respondents (87.9%).

**Table. 2 Characteristics of study variables**

Characteristic	Categories	Total (n)	Percentage (%)
<b>Point man</b>	Inappropriate (< mean (34))	42	24.3
	Appropriate (≥ mean (34))	131	75.7
<b>Point money</b>	Inappropriate (< mean (56))	24	13.9
	Appropriate (≥ mean (56))	149	86.1
<b>Point method</b>	Inappropriate (< mean (76))	24	13.9
	Appropriate (≥ mean (76))	149	86.1
<b>Point material</b>	Inappropriate (< mean (61))	14	8.1
	Appropriate (≥ mean (61))	159	91.9
<b>Point machine</b>	Inappropriate (< mean (34))	80	46.2
	Appropriate (≥ mean (34))	93	53.8
<b>X-ray safety implementation</b>	Inappropriate (< mean (20))	21	12.1
	Appropriate (≥ mean (20))	152	87.9

**2. Bivariate Analysis**

Table 3 is the result of bivariate analysis using the Pearson correlation test. There is a positive relationship between point man (r= 0.73; p<0.001), point money (r= 0.21; p=0.004),

point method (r= 0.53; p<0.001), point material (r= 0.19; p= 0.010), and point machine (r= 0.39; p < 0.001) with the application of X-ray radiation safety management in radiology work units.

**Table 3. Tabulation of man, money, method, material and machine cross points on the implementation of X-ray radiation safety management in radiology work units.**

Factors	r	p
Man	0.73	< 0.001
Money	0.21	0.004
Method	0.53	< 0.001
Material	0.19	0.010
Machine	0.39	< 0.001

**3. Multivariate analysis**

Table 4 is the result of multivariate analysis which was performed using a linear regression test. The results of the linear regression analysis showed an Adjusted R Square number of 0.521, which means that this study could explain 52.10% of the influence of the variables in the study (man, money, method, material and machine) on the implementation of X-ray radiation safety management in radiology work units. The results show that

point man (b= 0.49; p<0.001), point money (b= 0.20; p= 0.007), point method (b= 0.47; p<0.001), point material (b= 0.23; p=0.002), and point machine (b=0.11; p=0.050) has an effect on the implementation of X-ray radiation safety management in radiology work units. Multivariate analysis showed that the variable that most influenced the implementation of X-ray radiation safety management in radiology work units was point man with (b=0.49; p<0.001).

**Table 4. Results of Multivariate Analysis of the Influence of Factors Associated with the Implementation of X-Ray Radiation Safety Management in Radiology Work Units.**

Variable	Unstandardized Coefficient		Standardized Coefficient	P
	b	SE	β	
Man	0.22	0.03	0.50	<0.001
Money	0.10	0.04	0.21	0.007
Method	0.14	0.03	0.47	<0.001
Material	0.10	0.03	0.24	0.002
Machine	0.07	0.04	0.12	0.050
Adjusted R <sup>2</sup> = 52.1%				

**DISCUSSION**

**1. The effect of man on radiation safety**

Human Resources (Personnel) are the key to the success of radiodiagnostic and imaging services in hospitals. Basically radiology activities must be carried out by officers who have adequate educational qualifications and experience and obtain or have the authority to carry out activities in the field for which they are assigned or responsible (Irawan B and Putri Z, 2021).

Kepmenkes No.1014 of 2008, the radiology installation of a type C hospital consists of 1 radiology specialist, 2 radiographers/tools, 1 radiation protection/PPR officer, 1 medical physicist, 1 electromedical staff, 1 nurse and 2 administrative staff and darkroom staff. From the results of Utama et al.'s research. (2018) shows that planning the number of human resource needs must be in accordance with the workload in the work unit. A shortage of labor will result in excessive workload, and vice versa, excess labor will result in unproductive use of working time. The results showed that the needs of nurses in the radiology room had been met.

The implementation of radiation protection training needs to be carried out. So that, radiation workers including radiologists, radiation protection officers, medical physicists, and radiographers are aware of

nuclear laws and regulations, developments in radiation sources in the use of nuclear power, the biological effects of radiation, principles of radiation protection and safety, equipment measure radiation, and act in an emergency that is in accordance with radiological developments. So that it can support efforts to use nuclear power with a high level of safety (Dianasari & Koesyanto, 2017).

**2. The effect of money on radiation safety**

Nurse performance is influenced by several indicators, one of which is job satisfaction. Job satisfaction obtained will affect the attitude of nurses in work where the work will be completed as well as possible. Job satisfaction is also often associated with receiving work wages. Robbins stated that if wages are given fairly according to job demands, individual skill levels and community wage standards, it is likely to result in satisfaction for workers, especially radiographers (Buanawati, 2019).

Theory of Work Adjustment states that job satisfaction is a function of the relationship between the driving system of the work environment and individual needs. The relationship begins when the individual shows the ability or expertise that allows him to respond to the work needs of a work environ-



ment. On the other hand, the work environment provides certain incentives or rewards such as salary, status, personal relationships, and others in relation to individual needs.

If the individual fulfills the job requirements then the employee will be considered as satisfactory workers. Therefore financial compensation affects job satisfaction (Hertati et al., 2021). According to Robbins, employees want a wage (salary) system to be seen as fair based on job demands, individual skill levels, and community wage payment standards, most likely to result in satisfaction (Robbins & Judge, 2013).

### **3. The effect of methods on radiation safety**

In carrying out their duties in the radiology room, nurses must carry out nursing care with a model that is adjusted to standards. Nursing care is a series of nursing practice activities with a five-stage approach to the nursing process. Documentation of nursing care is a record that can be verified legally, contains a collection of information collected by nurses as responsibility for the services that have been provided, which contains all information for standards of nursing care and nurses can get into legal trouble if they do not complete nursing care documentation. The nurse should really know as stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 269/MEN-KES/PER/III/2008 concerning Medical Records that the nurse is one of the health workers who is responsible for the contents of the medical record as a document that has legal value in the form of evidence writing of the services provided to patients (Zavihatika et al., 2020).

According to Mubarak (2012) education plays an important role in determining the quality of life of someone who will acquire knowledge and apply it, the higher the education, the higher the quality of things that do not know to know. Researchers assume that

education affects the implementation of tasks. With almost all D3 radiology education, the attitude of the respondents in carrying out their duties had an effect on the weighing of patients on the guard shift.

### **4. The effect of material on radiation safety**

Radiation safety is an effort made to create conditions in such a way that the effects of ionizing radiation on humans and the environment do not exceed the specified limit values (Anggraeni, 2020). Based on the regulation of the Nuclear Energy Supervisory Agency (BAPETEN) Number 3 of 2013. Radiation protection is carried out to reduce the damaging effects of radiation due to radiation exposure, it is a must to realize radiation safety. The Dose Limit Value (NBD) for radiation workers may not exceed 20 mSv (millisievert) per year on average for 5 consecutive years and 50 mSv in a certain year, while the NBD for members of the public may not exceed 1 mSv in 1 year. Monitoring of the radiation dose received by radiation workers is carried out using a film badge or a Thermoluminescence Dosimeter (TLD) badge, and a calibrated direct reading dosimeter (BAPETEN, 2013).

Radiological safety aspects are given high priority in the use of radiology because in principle unwanted radiation exposure to the human body will have a negative effect on health. One of the requirements for safety standards is the thickness of the room walls so that radiation leakage from inside the facility does not exceed a predetermined limit value, in this case the walls of the room will act as a radiation shield (Utami, 2019).

### **5. The effect of machine on radiation safety**

Regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia Number PER.08/MEN/VII/2010 concerning Personal Protective Equipment states

that Personal Protective Equipment, hereinafter abbreviated as PPE, is a tool that has the ability to protect a person whose function is to isolate part or all of the body from potential hazards. hazard in radiology installations. In accordance with this regulation, employers are required to provide PPE for workers or laborers in the workplace. The PPE must comply with the Indonesian National Standard (SNI) or applicable standards and must be provided by employers free of charge. In addition, employers/caretakers are required to announce in writing and put up signs regarding the obligation to use PPE in the workplace (Mindola et al., 2021).

Radiation can cause damage to body tissue cells and genetic damage, mutations in reproductive cells. The body is at risk for the effects of radiation due to radiation exposure both in the whole body and only in certain or local parts of the body. No matter how low the radiation dose, there is always the potential for a risk or probability of a stochastic effect in the form of damage to the biological system where in a relatively long period of time it will grow and develop into malignant or cancerous tissue. Meanwhile, the deterministic effect in the form of cell death due to radiation exposure which changes tissue function occurs due to exposure to radiation above the threshold dose sometime after exposure (Tsapaki, 2020).

#### **AUTHOR CONTRIBUTION**

Sri Warsuni Almas acts as the lead researcher who selects topics, collects data, analyzes data, and writes publication manuscripts. Yuli Peristiwati and Ratna Wardani acted as research members who assisted in preparing the publication manuscript.

#### **CONFLICT OF INTEREST**

There was no conflict of interest in the study.

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