The Islamic University of Gaza

Deanship of Research and Graduate Studies

Master of of Crisis and Disaster Management

الجامعـــــــة الإســـــلامية بغـزة

عمادة البحث العلمي والدراسات العليا

ماجستيـــــر إدارة الأزمات والكوارث

The Role of Risk Management in Achieving Sustainable Development within the Radiation Departments at Governmental Hospitals in the Gaza Strip

دور إدارة المخاطر في تحقيق التنمية المستدامة داخل أقسام الأشعة التابعة للمستشفيات الحكومية – قطاع غزة

By

Ahmed S. Al-hana

Supervised by

Prof. Dr. Nizam M. El-Ashgar **Dr. Yasser S. Al-Ajerami**

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Crisis and Disaster Management

April / 2019

إقـــــرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

The Role of Risk Management in Achieving Sustainable Development within the Radiation Departments at Governmental Hospitals in Gaza Strip

دور إدارة المخاطر في تحقيق التنمية المستدامة داخل أقسام الأشعة التابعة للمستشفيات الحكومية – قطاع غزة

أقر بأن ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وأن هذه الرسالة ككل أو أي جزء منها لم يقدم من قبل الاخرين لنيل درجة أو لقب علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

I understand the nature of plagiarism, and I am aware of the University's policy on this.

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted by others elsewhere for any other degree or qualification.

Student's name:	أحمد سعيد الهنا	اسم الطالب:
Signature:	احمد الهنا	التوقيع:
Date:	27/4/2019	التاريخ:

بسم الله الرحمن الرحيم

الجامعة الإسلامية بغزة

The Islamic University of Gaza

عمادة البحث العلمي والدراسات العليا

هاتف داخلي: 1150

الرقم Ref ج س غ/35/

التاريخ Date 2019/05/25م

نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة عمادة البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ **احمد سعيد مصطفى الهنا** لنيل درجة الماجستير في كلية **العلوم**/ برنامج إدارة **الأزمات والكوارث** وموضوعها:

دور إدارة المخاطر في تحقيق التنمية المستدامة داخل اقسام الاشعة التابعة للمستشفيات الحكومية - قطاع غزة

The Role of Risk Management in Achieving Sustainable Development within the Radiology Departments at Governmental Hospitals in the Gaza Strip

وبعد المناقشة التي تمت اليوم **السبت 20 رمضان 1440**هـ الموافق **2019/05/25**م الساعة **الحادية عشرة صباحاً**، في **قاعة اجتماعات كلية العلوم** اجتمعت لجنة الحكم على الأطروحة والمكونة من:

أ. د. نظام محمود الأشقر	**مشرفاً ورئيساً**	....
د. ياسر العجرمي	**مشرفاً**	....
د. عبد أحمد الشكري	**مناقشاً داخلياً**	....
د. أحمد نجم	**مناقشاً خارجياً**	....

وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في **كلية العلوم/برنامج إدارة الأزمات والكوارث**.

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله تعالى ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق،،،

عميد البحث العلمي والدراسات العليا

أ. د. مازن إسماعيل هنية

P.O. Box 108, Rimal, Gaza, Palestine Tel: +970 (8) 264 4400 هاتف Fax: +970 (8) 264 4800 فاكس ص.ب. 108 الرمال. غزة. فلسطين

public@iugaza.edu.ps www.iugaza.edu.ps

التاريخ: ٩/٤/2019م	الرقم العام للنسخة 3107562	اللغة	E	ماجستير ☒	دكتوراه ☐

338

الموضوع/ استلام النسخة الإلكترونية لرسالة علمية

قامت إدارة المكتبات بالجامعة الإسلامية باستلام **النسخة الإلكترونية** من رسالة

للطالب/ احمد سعيد مصطفى الصفا

رقم جامعي: 120171440 قسم: ادارة الازمات والكوارث كلية: العلوم

وتم الاطلاع عليها، ومطابقتها بالنسخة الورقية للرسالة نفسها، ضمن المحددات المبينة أدناه:

- تم إجراء جميع التعديلات التي طلبتها لجنة المناقشة.
- تم توقيع المشرف/المشرفين على النسخة الورقية لاعتمادها كنسخة معدلة ونهائية.
- تم وضع ختم "عمادة الدراسات العليا" على النسخة الورقية لاعتماد توقيع المشرف/المشرفين.
- وجود جميع فصول الرسالة مجمَّعة في ملف (WORD) وآخر (PDF).
- وجود فهرس الرسالة، والملخصين باللغتين العربية والإنجليزية بملفات منفصلة (PDF +WORD)
- تطابق النص في كل صفحة ورقية مع النص في كل صفحة تقابلها في الصفحات الإلكترونية.
- تطابق التنسيق في جميع الصفحات (نوع وحجم الخط) بين النسخة الورقية والإلكترونية.

ملاحظة: ستقوم إدارة المكتبات بنشر هذه الرسالة كاملة بصيغة (PDF) على موقع المكتبة الإلكتروني.

والله ولي التوفيق،

توقيع الطالب ....

إدارة المكتبة المركزية

Abstract

Radiation departments play an effective and important role in hospitals in the early diagnosis of disease, as well as treatment. Radiation dose, over load work, equipment damage, risks from external factor and high voltage electricity have adversely effects on both employees and patients. On the other hand, risk management seek to identify, assess and prioritize risks to control of resources to reduce the likelihood and impact of unfortunate events or to limit opportunities. The aim of this study was assessing the role of risk management in achieving sustainable development within the radiation departments of six main government hospitals in Gaza Strip.

Triangulated study design was used. For the quantitative part; 150 of Radiation Technologists and Radiologist completed questionnaires with 91.33% response rate. The researcher used matrix of risks to assess the risks impact on the employees. Census study conducted on all Radiation Technologists and Radiologists at six major governmental hospitals in Gaza Strip. In addition, four key informant interviews with radiation departments heads and managers were conducted. A pilot study was carried out prior to the implementation of the questionnaires. 30 copies of the questionnaire were distributed appropriately to the respondents from the target group and the results of the pilot study were combined with the overall results of the respondents.

The researcher interviewed directly 150 participants (76.6% males; 90.5% married; 68.6% younger than 40; 80.3% had bachelor's degrees; 15.3% had a master's degree; 79.6% radiation technologist and 81% had permanent work). Findings revealed that 63.5% of Radiation Technologists and Radiologists having Thermoluminescence Dosimeters, but only 38.7% notified of reading it.

The results of the study in the field of "risk management" revealed that the result of RII was (61.33%), Test-value =-4.28, and P-value=0.001 which is smaller than the level of significance α=0.05. The sign of the test is negative, so the mean of this group is significantly smaller than the test value (2). In other words, there is no risk management within the radiation departments of the six major hospitals in GS. Where Regarding to "Sustainable Development" field, the result of RII was (92.33%), Test-value = 44.60, and P-value=0.001 which is smaller than the level of significance α=0.05. The sign of the test is positive, so the mean of this group is significantly greater than the test value (2). So, the respondents totally agreed about the importance of sustainable development.

Furthermore, the results of the ANOVA test showed that the variances of the groups are not significantly different (the groups are homogeneous). Thus, there are no statistically significant differences due to educational level and years of experience at the level of $\alpha \leq 0.05$ toward the role of risk management in achieving sustainable development.

In the light of these findings, the study recommended the establishment of a specialized committee on risk management to facilitate the provision of radiation services in a sustainable manner.

Keyword: Risk Management, Radiation Departments, Sustainable Development.

ملخص الدراسة

تلعب أقسام الأشعة دورًا فعالًا وهامًا في المستشفيات في التشخيص المبكر للمرض، وكذلك العلاج. جرعات الإشعاع، الحمل الزائد، تلف المعدات، مخاطر العوامل الخارجية والكهرباء عالية الجهد لها آثار سلبية على كل من الموظفين والمرضى. من ناحية أخرى، تسعى إدارة المخاطر إلى تحديد وتقييم وترتيب أولويات المخاطر للسيطرة على الموارد وتقليل احتمالية وتأثير الأحداث المؤسفة أو للحد من فرص وقوعها.

تهدف هذه الدراسة إلى تقييم دور إدارة المخاطر في تحقيق التنمية المستدامة داخل أقسام الإشعاع في ست مستشفيات حكومية رئيسية في قطاع غزة.

استخدام الباحث التصميم الثلاثي للدراسة. اولاً: الجزء الكمي، حيث تم توزيع 150 استبانة على كل من تقنيي الإشعاع وأخصائي الأشعة وكانت نسبة الاستجابة 91.33 ٪. ثانياً: استخدم الباحث مصفوفة المخاطر لتقييم المخاطر التي تؤثر على الموظفين. ثالثاً: أجريت أربع مقابلات مع رؤساء أقسام الإشعاع ومدير الدائرة الفنية في وزارة الصحة. أجري الباحث دراسة تجريبية قبل تنفيذ الاستبيانات، حيث تم توزيع 30 نسخة من الاستبيان بشكل مناسب على المجيبين من المجموعة المستهدفة وتم الجمع بين نتائج الدراسة التجريبية والنتائج الإجمالية للمستجيبين.

كما أجرى الباحث مقابلات مباشرة مع 150 مشاركًا (76.6٪ ذكور؛ 90.5٪ متزوجون؛ 68.6٪ أصغر من 40 عام؛ 80.3٪ حاصلون على درجة البكالوريوس؛ 15.3٪ حاصلون على درجة الماجستير؛ 79.6٪ تقني إشعاع و81٪ موظفين دائمين). كشفت النتائج أن 63.5 ٪ من تقنيي الأشعة وأخصائي الأشعة لديهم جهاز لقياس جرعة التعرض الاشعاعي، ولكن 38.7 ٪ فقط منهم أعلموا بقراءتها الدورية.

كما كشفت نتائج الدراسة في مجال "إدارة المخاطر" عدم توفر إدارة للمخاطر داخل أقسام الإشعاع في المستشفيات الستة الرئيسية في قطاع غزة. وفيما يتعلق بمجال "التنمية المستدامة"، اتفق المشاركون بشكل كامل على أهمية التنمية المستدامة.

بالإضافة الى ذلك اظهرت نتائج اختبار ANOVA، ان المجموعات في عينة الدراسة لا تختلف اختلافًا كبيرًا (المجموعات متجانسة). لذلك، لا توجد فروق ذات دلالة إحصائية بسبب المستوى التعليمي وسنوات الخبرة على مستوى $0.05 \leq \alpha$ نحو دور إدارة المخاطر في تحقيق الاستدامة داخل اقسام الاشعة التابعة لوزارة الصحة في قطاع غزة.

وفي ضوء هذه النتائج، أوصت الدراسة بإنشاء لجنة متخصصة في إدارة المخاطر لتسهيل تقديم خدمات الإشعاع بطريقة مستدامة.

الكلمات المفتاحية: إدارة المخاطر، أقسام الاشعة، التنمية المستدامة.

Dedication

To each one of the individuals who helped me in my way towards progress,

To the spirit of my dad,

To my caring mother, who merits my incredible love and regard for her unending penance and giving,

To my beloved wife, without her help, comprehension and support I could never have had the capacity to finish this voyage,

To my valuable little daughter, Braai and to my dear children, Mohammed and Saied, whose grins give me solidarity to proceed in the midst of the hardest conditions,

To every one of my siblings and sister,

To every one of my companions and partners.

Ahmed S. Al Hana

Acknowledgment

Praise be to God who gave me the strength and ability to complete this humble thesis. Also, I strongly acknowledge the contribution of the real individuals who supported me throughout this study. This thesis will not be accomplished without the help and support of these supportive and dedicated individuals.

I owe my sincere thanks and gratitude to the academic supervisor, Prof. Dr. Nizam M. El-Ashgar and Dr. Yasser Al Ajrami, who have spent a lot of time, knowledge, effort and patience in supervising this research and encouraging me to do my best.

I would like to thank all academic and administrative employees at the Master of Crisis and Disaster Management, Islamic University–Gaza for their guidance and collaboration.

I would like to say thank you to Dr. Abdul Rahman Al Shukri and Dr. Ahmed Najim for their help and comprehensive recommendations in evaluating the validity of the study tools.

Special thanks and appreciation are sent to my friends and colleagues Maher Suleiman, Hesham Ahmed, Rafat Ahmed, Abeer Ayoob, Abd Alkader Abu Hashim, Islam al Khateib for their special and valuable support.

I would like to thanks all radiation employees who participated in this study for their cooperation and participation in this study.

Ahmed S. Al Hana

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACR	American College of Radiology
ALARA	As Low As Reasonably Achievable
ANOVA	Analysis of Variance
ASRT	American Society of Radiologic Technologists
CT	Computed Tomography
ESR	European Society of Radiology
GS	GS
HWH	Healthcare Without Harm
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IFRC	International Federation of Red Cross
IISD	International institute for sustainable development
ISO	International Organization for Standardization
IRMI	International Risk Management Institute
KII	Key Informant Interview
MEM	Major Emergency Management
MoH	Ministry of Health
mSv	Milli Sievert
MRI	Magnetic Resonance Imaging
NDT	Nondestructive Testing
NGOs	Non-Governmental Organizations
OHSA	Occupational Health and Safety Act
PCBU	Person Conducting A Business or Undertaking
PCBS	Palestinian Central Bureau of Statistics
RCR	The Royal College of Radiologists
RII	Relative Importance Index
RSNA	Radiological Society of North America
RT	Radiologic Technologist
SD	Sustainable Development
SPSS	Software Statistical Package of Social Science
TLD	Thermoluminescence Dosimeter
QC	Quality Control
UNCED	United Nations Conference on Environment & Development
UNHR	United Nations for Human Rights
UNRWA	United Nations Relief and Works Agency
UPS	Uninterruptible Power Supply
WB	West Bank
WHO	World Health Organization
WHS	Work Health and Safety

Chapter 1

Introduction

Chapter 1

Introduction

1.1 Background

After the discovery of x-rays by Rontgen in 1895, increasing immersion was achieved in the modalities of medical imaging. This progress facilitates the discovery and characterization of various diseases within the human body (Krupinski, 2008).

Radiography or radiology is a photographic process used to depict anatomical structures. Instead of visible light, radiography uses x-ray energies that penetrate the body. These energies are absorbed at different rates with different tissue densities and are particularly effective for bone and dense tissue imaging (Siegel, 2008).

Furthermore, radiology services are now the main tool for diagnosis of many diseases and have an important role in monitoring treatment and predicting outcomes. Radiation service can include methods based on both ionizing and non-ionizing radiation, covering conventional radiation, fluoroscopy, nuclear medicine, computerized tomography, mammography, interventional radiology, bone density measurement, ultrasound and Magnetic Resonance Imaging (Pereira, 2015).

The field of radiation is rapidly evolving due to technological advances and the globalization of health care. This continuous development will have a significant impact on quality of care and delivery of services. Risk is an opportunity or possibility of a loss or a negative event that may cause injury to patients or medical practitioners. This will push to consider some approaches that are used in risk management in radiology. Thus, risk management in radiology is essential in the protection of patients and radiologists, medical regulation in terms of capital and broadening the organization's medical reputation with patients (Craciun, 2015).

1.2 Problem statement

Gaza Strip is one of the largest overcrowded geographical area in the world, this requires a doubling of services adapted to the population growth (PCBS, 2018). Radiation departments plays an effective and important role in hospitals in the early diagnosis of disease, as well as treatment. There are international standards and regulations determine the exposure dose for employee and patient, this dose must be minimum as much as possible, to reduce the risks and harmful effects of ionizing radiation on the health. The Israeli siege imposed on GS impact significantly on medical imaging services. Also, a significantly increase in breakdowns of radiation equipment's resulting from overload work and scarcity of resources. This adversely effects on both employees and patients.

The GS also suffers from a severe economic crisis that has a clear impact on the services provided at governmental hospitals, especially the radiation departments, which increases the risks to employees and patients within the radiation departments. The effects of the economic crisis have led to complex radiation problems. This is reflected on the quantity and quality of outputs (ESR, 2015).

Based on direct contact with MoH, there is ambiguity in the concept of plans development and sustainable development within the radiation departments in the course of rapid technological development to raise the level of radiation prevention and reduce risk. Furthermore, little attention, follow-up and monitoring for risks and occupational safety compared with the international standards are reported in the GS.

1.3 Justifications of the study

The Ministry of Health (MoH) is the main provider of radiology services in Palestine, the number of radiation procedures in MoH hospitals were 654,616 procedure in 2017 which increased by 7.7% compared to 2016 by 81% of the total medical imaging services in hospitals in Gaza Strip (GS). These services are represented in the following: conventional radiography 504,709, Computed Tomography (CT) 34,904, Magnetic Resonance Imaging (MRI) 8,159, Fluoroscopy 4,023 and others 13073. Palestinian MoH observed a significant increase in medical imaging services in GS between 2008-2017 (MoH, 2017).

The risks and harmful effects of ionizing radiation as a result of excessive and unjustified use of radiation protection methods in addition to increasing population density and poor health status in GS made this study important in order to reduce the risk of radiation and maintain the health and safety of employees and patients and protect generations coming from this risk, including the right to secure medical services particularly during crisis situations.

Through literature reviewing, there is no previous study was reported about risk management in achieving sustainable development within the radiation departments of governmental hospitals in GS. Risk management is very important particularly in GS, which is politically instable, suffering poverty, and low health resources. The current study will try to assess the role of risk management in achieving sustainable development within the radiation departments at governmental hospitals.

1.4 General objective

The overall aim of this study is to assess the role of risk management in achieving sustainable development within the radiation departments at governmental hospitals in GS.

1.4.1 Specific objectives of the study

1. To assess the available risk management within radiation departments at governmental hospitals.
2. To Explore the existence of criteria for medical imaging practice at governmental hospitals to reduce the risk of radiation exposure.
3. To assess possibilities of sustainable development in the radiation departments at MoH.

1.5 Study Questions

1. Is the available risk management effective within the radiation departments of government hospitals?
2. Is there any criteria for the practice of medical imaging in public hospitals to reduce the risk of exposure to radiation?
3. Are there sustainable development prospects in the radiation departments of the MoH?

1.6 Context of the study

This study conducted at radiation departments at the six main governmental hospitals in GS. Therefore, it is worthwhile to understand the circumstance that contributes in forming the Palestinian health care system's features and their effect on the Palestinian population. The researcher represented some background information about the demographical context, Palestinian population, political that may interact with each other's to influence the health situation and health care services in Palestine.

1.6.1 Demographic context of Palestine

Palestine is an Arab country, somewhat small and the total surface area of authentic Palestine is about 27,000 square kilometers. Israel occupied Palestine in 1948, and after the war in 1967, the remaining part was geographically isolated (the West Bank and the Gaza Strip). The historic borders of Palestine are surrounded by Lebanon, Syria, Jordan, Egypt and the Mediterranean (Appendix 1) (Abu-lughod, 1971). The total area of the GS(365 Km²) and West Bank (5655 Km²) is about 6,020 Km² which represents 22% of historical Palestine area with total population, living in is about 4,682,467 people (1,943,398 in GS and 3,008,770 in the WB) with population density 778 capita per Km2 (PCBS, 2017).

1.6.2 Demographic context of GS

The GS is a limited real estate parcel, situated on the south of Palestine on the bank of Mediterranean Sea (Appendix 2). Its length from Rafah in the south to Beit-Hanoon in the north estimates 50 kilometers in length and 5-12 kilometer wide. GS is overcrowded region with population number 1,943,398 inhabitant and with population density of 5,239 inhabitants/Km²(PCBS, 2017).

The GS is divided into five governorates: North Governorate (362,772 inhabitants); Gaza Governorate (625,824 inhabitants); Mid-zone Governorate (264,455 inhabitants); Khan-Younis Governorate (314,393 inhabitants); and Rafah Governorate (225,538 inhabitants) (PCBS, 2017).

1.6.3 Palestinian health care system

Health care framework in Palestine is intricate, because health service in Palestine is divided into five major health care providers: two public providers (the MoH and the Ministry of Interior – Military medical services), various private providers (medical clinics, hospitals) and various Non-Governmental Organizations (NGOs) (the United Nations Relief and Works Agency-UNRWA and other local NGOs). The primary providers (MoH) is operating 25 hospitals and 448 Primary health care facilities, 394 in WB and 54 in GS ((PCBS, 2017).

The fundamental jobs and duties of the MoH as indicated by the Palestinian Public Health Law is giving, directing and overseeing the provision of health care in Palestine.

Additionally, MoH is responsible about managing the health care services in coordination with various partners, upgrading health advancement to improve the health status, supporting human resources in health segment, overseeing and disseminating health data, and others (MoH, 2015).

1.6.4 Governmental hospital service

MoH is the essential provider of secondary care in the GS. It is in charge of 13 hospitals all through the five governorates and the number of hospitals beds in the GS is around 2186 and the percentage of hospitals beds per 1000 capita is about 1.3 (MoH, 2015). The average rate of hospitals occupancy in GS is about 88%. The shaky Palestinian political circumstance increases the load on the health care services in Gaza.

Six main governmental hospitals provided with radiological departments presenting health care services in GS. Full description about these hospitals (hospital area, employees, RTs and beds number) is given in (Appendix 3).

1.7 Definitions of terms

1.7.1 Risk

The traditional definition of risk consolidates three components: it begins with a potential event and after that joins its likelihood with its potential seriousness. A high-risk occasion would have a high probability of happening and a serious effect in the event that it really happened. In this way, the Risk is defined as an opportunity or probability of danger or bringing loss or damage (ISO, 2017).

However, the concept of medical risk is the danger of loss or a negative impact that may make damage to patients or medical employees at hospitals(Messano, 2014).

1.7.2 Risk management

Risk management refers to a planned arrangement of exercises and strategies used to manage an organization and control the numerous dangers that may influence its capacity to accomplish goals. The term risk management additionally alludes to the program used to oversee risk. This program covers risk management standards, risk management structure and risk management procedure (ISO, 2017).

Risk management in the medical filed refers alludes to the different methodologies that medical staff and experts coordinate to decrease risk (Robinson, 1999).

In addition, risk management is a set of activities that plan, organize, direct, evaluate and implement, which involve reducing the risk of injury to patients and employees, as well as damage to property or financial loss in the health care facility (McGraw-Hill, 2002).

1.7.3 Sustainable development

Sustainable development has been defined in various perspectives, yet the most habitually cited definition is related to our common future, otherwise called the Brundtland Report: "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (IISD, 2018).

1.7.4 Governmental hospitals

Public hospitals are hospitals that provide emergency and reception services and include all medical specialties and the study here focuses on Governmental hospitals, the six major hospitals are (Al-Shifa hospital, European Gaza hospital, Indonesia hospital, Shohada Al-Aqsa hospital, Nasser hospital, and Abu Yousef Al Najjar hospital).

1.7.5 Radiation department

Department includes imaging modalities such as General Radiology, Ultrasound, Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and Fluoroscopy. The Department also provides a comprehensive diagnostic and therapeutic Interventional Radiology Service.

Chapter 2

Conceptual Framework

and

Literature Review

2. Conceptual Framework and Literature Review

In this chapter, the researcher will illustrate the study‘s conceptual framework which reveals the main domains required for risk management steps and how to achieve sustainability and protection of the human (Figure 2.1). The chapter provides a comprehensive review of related studies.

Conceptual Framework

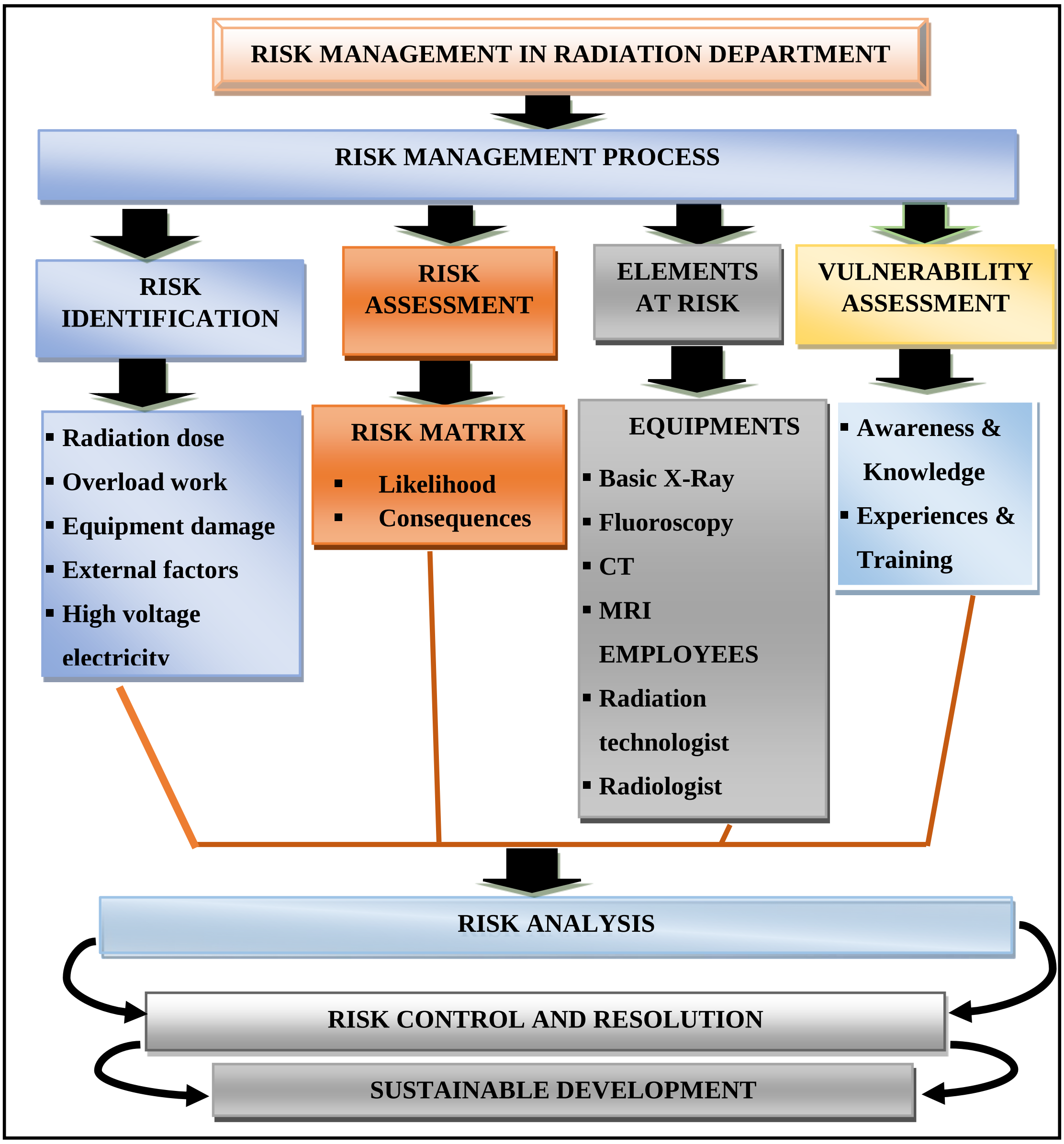


Figure (2.1): Conceptual framework

(self-developed)

The Conceptual framework is considered a fundamental component in the scientific research. It guides the research process, organizes the work and makes the research results meaningful. The framework of this ponder was outlined by the researcher based on the broad literature of the accessible writing around the risk management. The review aimed at identifying, clarifying and establishing data based and ascertain strengthen and weakness points in the current risk management.

The researcher illustrated the role of risk management through risk assessment and emergency plan to achieve sustainable development within the departments of radiation. Each field consists of a number of variables that affect the subject of the research. The study is hopeful to assess the role of risk management and to assess the current status of these areas and make recommendations for sustainable development.

2.1 Risk management

2.1.1 Introduction

A recent review of literature on risk management has shown numerous sees that the fast development of administrations, the globalization of wellbeing care and the imbalance between workload and workforce are few of the variables which will debilitate health service benchmarks as well as patient safety (Olisemeke, 2014).

Additionally, the risk management and development of radiology is primarily developed to help and protect patients, employees members and the entire organization (ESR, 2015).

Risk management is to identify, evaluate and prioritize risks followed by the facilitated and financial application of assets to diminish the probability, affect and dangers of disastrous occasions or to restrain opportunities. The objective of Risk management is to guarantee that uncertainty does not misshape the endeavor of business objectives. (Abudulnabi, 2018).

Several risk management guidelines have been created and developed by many institutes and agencies, including the Project Management Institute, the National Institute of Standards and Technology, the Actuarial Societies, and the ISO Standards. The strategies, definitions and destinations shift incredibly depending on whether the risk management strategy is within the setting of venture administration, security, designing, mechanical forms, portfolios, actuarial valuations or public health and safety and security. Hazard administration in ISO 31000 was too characterized as "the effect of uncertainty on targets" (Abudulnabi, 2018).

Risk management permits radiologists to concentrate on risk mitigation measures. This guarantees that medical personnel follow appropriate and important conventions and rules for risk lessening in radiation departments (RCR, 2017).

2.1.2 Risk management process

Concurring to the standard ISO 31000 Risk Management Standards and Rules on Usage(ISO, 2017). the process of risk management comprises of a few steps as takes after:

1. Identification.
2. Risk assessment.
3. Risk analysis.
4. Risk control and resolution.

2.1.2.1 Risk Identification

The first step in risk assessment is to identify risks. In identifying risks, the group considers all things and occasions inside the project from the viewpoint of diverse risk categories and distinguishes those that are likely to have a noteworthy negative affect on the project. The team then considers the potential consequences if a risk occurs. Keep in mind that if the risk is associated with one or more risks, that is, if the risks have dependencies, good practice prescribes that the relevant risks should be assessed together (Cervone, 2006).

The chosen method of risk identification may depend on culture, occupational practices and compliance. Selection methods are created from templates or templates are developed to determine the source, problem, or event. Common risk identification methods are:

Target-based risk identification: organizations and extend groups have destinations. Any event that will jeopardize the accomplishment of a partial or total objective is distinguished as a risk.

Scenario-based risk identification: Within the analysis scenario, diverse scenarios are created. Scenarios may be elective ways to attain an objective, or an analysis of the interaction of forces in. Any event that causes an undesirable situation is defined as a risk.

Definition of classification-based risks: The risk-based classification could be a breakdown of potential risk sources based on classification and best practice knowledge, a survey is compiled. Answers to questions reveal risks.

Common Risk Checks: In many organizations, lists of known risks are available. Each risk in the list can be checked for application on a given position.

Risk mapping: This approach combines the above methods by including at-risk resources, threats to those resources, and adjustment factors that may increase or reduce the risks and consequences that you wish to avoid. Creating a matrix under these headings allows for a variety of ways. One can start with resources and consider the threats to them and their consequences. Instead, one can start with threats and examine the resources that may affect them, or one can start with the consequences and determine which set of threats and resources will be shared (Abudulnabi, 2018).

According to the University of Western Sydney in the identification of risks, the Work Health and Safety Act of 2011 (the WHS Act) and legislation in New South Wales require a person conducting a business or undertaking (PCBU), in consultation with employees, to identify all potentially harmful things or situations. In general, risk is likely to be found in the following;

- Physical work environment.
- Equipment, materials or materials used.
- Tasks and performance of work.
- Design and management of work (Western Sydney University, 2015).

In order to identify risks, it is recommended that:

(1) Accidents / past incidents are checked to see what happened and whether the accident / incident can occur again.

(2) Employees should be consulted to see what they consider safety issues, i.e. ask employees to learn about the risks close to the killings they have encountered as part of their work. Sometimes a survey or questionnaire can help employees provide information about workplace hazards,

(3) Inspecting or examined work areas or work sites to see what is happening now. Specific risks should be documented to allow for further action. The work

environment, tools and equipment should be examined in addition to the tasks and procedures should be examined for risks to WHS.

(4) Information about equipment (e.g., plant, operating instructions) and material safety data sheets is reviewed to identify relevant safety precautions.

(5) Welcome to creative thinking about what can happen from mistakes, i.e., the serious event that can happen here (Western Sydney University, 2015).

2.1.2.1.*1* Radiation dose

Radiation dosage isn't like medication. A dose of radiation isn't the same as a dosage of medicine. Moreover, radiation dose has numerous shapes and incorporates such as: absorbed dose, equivalent dose and effective dose. In expansion to, there are several quantities in which dose is measured (e.g., mGy, mSv) (RSNA, 2018).

The most important aspect of medical radiation science is to understand the safe utilize of ionizing radiation, the related radiation risk and its outcome on the conclusion result of diagnosis and treatment (Shah, 2011). Radiation exposure for a long period of time (years) produces random impacts. There is no level of radiation exposure threshold can be said beneath it certainly that cancer or hereditary impacts will not happen. The multiplying of radiation dose doubles the risk of cancer or hereditary impact (Briggs-Kamara, 2013).

It is difficult to assess genetic risks among human users occurring in descendants of exposed individuals. Physical effect such as leukemia and solid tumor has a latent period of few years to 40 years. Since these effects are not produced immediately, the radiographer becomes more confident about excessive exposure to radiation. In our part of the world, radiographers' knowledge of radiation protection is weak. Most radiologists had little knowledge of radiation protection principles and procedures. This lack of knowledge is harmful to themselves and the general population (Khan, 2011).

Therefore, the knowledge of the radiographer regarding optimal techniques, radiation dose and radiation protection measures is important to reduce radiation exposure to himself and to the population in general (Khan, 2011).

Occupational dose limits:

Occupational exposure to any radiation employee shall be monitored to the extent that it does not exceed the following limits:

1. Effective dose of 20 mSv per year for five consecutive years.
2. An effective dose of 50 mSv in one year.
3. An equivalent dose of 150 mSv per eye. An equivalent dose of 500 mSv for limbs and skin in one year (Supreme Council for Environment and Natural Reserves, 2002)

2.1.2.1.*2* Overload work

At the current study the overload work means an increase in the number of radiological tests provided by employees in radiation departments during limited periods of work.

Tomic defined workload as the perceived pressure due to the amount of work and task heaviness (Tomic, 2008). Whereas Holden et al. characterize workload as the relationship between the work requests that are set on the worker given a indicated sum of time and assets. Workload shows the degree to which the work is saddling in terms of mental exertion, complexity of work and speed of work (Holden, 2011).

The fast development of services, the globalization of health care and the imbalance between the workload and the labor force are some of the factors that may threaten health service standards as well as patient safety (Olisemeke, 2014).

A recent study conducted by (Watanabe and Yamauchi, 2018) within the impact of quality of overtime work on nurses' mental health and work engagement the comes showed nurses typically worked overtime due to a pressure to conform, high workload and to enhance self-development. Automatic additional time work illustrated a negative impact on mental health and work engagement at both the ward and person level, though intentional extra minutes work applied an advantageous impact on wellbeing (Watanabe, 2018).

The workload has been found to be the most common indicator of fatigue, lack of participation and the dehumanization of patients by health care employees. It was also a major cause of dissatisfaction between health care providers and support employees, and was found to affect employees decisions regarding leaving or remaining in employment (Shirom, 2010).

2.1.2.1.*3* Equipment damage

The equipment are the medical machines which perform for medical imaging such as (conventional radiography, fluoroscopy, computed tomography) and the damage means a failure in this equipment prevents it from providing its own service.

Furthermore, radiological equipment has a specific lifecycle, resulting in unavoidable collapse and reduced or lost image quality, making the equipment useless after a certain period of time. Equipment condition is also affected by its use and maintenance (ACR, 2013).

The Canadian Association of Radiologists adopts general rules on the life cycle of different types of equipment based on their use, which are classified into three categories (high, medium and low) based on the number of tests per year, as shown in the table (2.1)

Table (2.1): Medical imaging equipment life expectancy guidance (utilization and age related)

Device type (analogue or digital)	**Device life expectancy based on utilization: HIGH-MID-LOW**	**Utilization based on exams/year**		
		HIGH	**MID**	**LOW**
Radiography, general	10-12-14	>20,000	10,000-20,000	<10,000
Radiography, mobile	10-12-14	>6,000	3,000-6,000	<3,000
R/F fluoroscopy (conventional/remote)	8-10-12	>4,000	2,000-4,000	<2,000
CT scanner	8-10-12	>15,000	7,500-15,000	<7,500
MRI scanner	8-10-12	>8,000	4,000-8,000	<4,000

(Canadian Association of Radiologists , 2013)

Since older equipment has a high risk of failure and breakdown, this can lead to critical delays in diagnosing and treating the patient. In addition, old equipment can cause safety problems for both the patient and the doctor (European Commission , 2012).

The operating costs of the old equipment will be high compared to the new equipment, and sometimes maintenance will be impossible if spare parts are not available. Technical or functional obsolescence may cause deterioration in the functionality of radiology devices (US National library of medicin, 2014).

The European Society of Radiology (ESR) is promoting the use of up-to-date equipment, especially in the context of the Euro Safe Imaging Campaign, as the use of up-to-date equipment will improve quality and safety in medical imaging (ESR , 2014).

Equipment up to 5 years old is known to reflect the current state of technology and provide opportunities for economically reasonable upgrade measures. Equipment between 6 and 10 years old is still usable if properly maintained, but requires the development of alternative strategies. Equipment older than 10 years is no longer a modern equipment and must be replaced. It is recommended to have at least 60% of the equipment installed in radiology sections up to 5 years old. Age must be 30% of the age of 6 to 10 years, while more than 10% of the equipment must be greater than 10 years (ECCR, 2009).

2.1.2.1.*4* External factors

There are a number of external factors that may have a negative impact on the radiation departments. The researcher studied the most impact factors such as the blockade imposed on the GS and the energy crisis, fuel and repeated Israeli aggressions.

The siege on the GS is the main reason for the weakness of the health system, in addition to the negative effects on the health and development system, where the health sector suffers from the problems of lack of medicines, medical supplies and spare parts for medical devices (Deba, 2017).

Furthermore, frequent fluctuations in power supply and interruption of long hours have put hospital patients at risk, such as intensive care, cardiac care, operating theaters, neonatal incubators and dialysis units. In addition, it causes a lot of medical equipment to be malfunctioned and disrupted (WHO, 2015).

The MoH in Gaza has been forced to take some emergency measures because of the blockade, reducing public health services, including surgical operations in some hospitals, and halting the provision of some basic health services such as dental clinics, public clinics and outpatient clinics. In many clinics and other sections of the sector hospitals, including surgeries, a large part of the services of laboratory examinations, medical imaging, laparoscopic surgery, pathology, orthopedics and neurology, and reduction of health services in some primary health care departments and hospitals (Barsh, 2017).

In addition, GS has been subjected to constant Israeli attacks. The most severe of these attacks occurred in 2008, 2012 and 2014, which had a significant impact on the hospitals and health service providers, which was adversely affected by the increase in the number of injuries and the increase in the number of radiological tests conducted and the employees in the radiation departments were exhausted and the radiation equipment was consumed.

In addition, there was an increase in the number of radiation tests carried out with the start of the "March of Return" on the date of 30 March 2018, where the tests were provided to about 13631 wounded were treated in public hospitals until August 12, 2018, according to the statistics of the MoH in Gaza (MOH, 2018).

2.1.2.1.5 High voltage electric

A high voltage power supply is an imperative component of an X-ray generation system. When we say high voltage supply, we need to differentiate from that of commercial electricity. Commercial electricity is commonly accessible as 110 volts, 220 or 440 volts. X-ray system require exceptionally tall voltages commonly within the run from 5 kilovolts (kV) to as much as 400 kV or more (NDT, 2018).

At dawn on Thursday, December 28, 2017, a fire broke out in the radiation department of Al-Shifa Medical Complex in Gaza City, causing considerable damage, without causing any injuries. Ayman al-Sahabani, director of the reception and emergency department at Al-Shifa Medical Complex, said that the fire that broke out in the radiation department due to the UPS explosion was controlled (Sawa News, 2107).

2.1.2.2 Risk assessment process

One thing for risk assessment is to identify and diagram a long list of (potential) issues, but it could be an essentially different matter to undertake to address them. Typically, where risk evaluation comes into play. The primary step in risk evaluation is to identify risks. In identifying risks, the group considers all things and occasions inside the project from the point of view of distinctive risk categories and identifies those that are likely to have a critical negative affect on the project. The group at that point considers the potential results in the event that risk happens. For illustration, in a computerized imaging extend based on vendor-supplied program, delays in conveyance of the computer program are considered a potential hazard, and the potential result is the delay of numerous, in case not all, of the consequent venture assignments. Be beyond any doubt that in case the hazard is related with one or more dangers, that's , on the off chance that the dangers have conditions, great hone forces that the related dangers ought to be surveyed together as one (Cervone, 2006).

The risk assessment comprises four stages:

1. Establishing the context.

2. Hazard Identification.

3. Risk Assessment.

4. Recording potential hazards on a risk matrix (MEM, 2010).

2.1.2.2.*1* Establishing the Context

The purpose of this stage is to describe the characteristics of the area in which the risk is assessed, as this will affect both the likelihood and impact of the major emergency. The creation of a local / regional context allows for a better understanding of the vulnerability of the region and its ability to respond to emergencies. The team conducting the risk assessment should take into account the national, regional and local contexts that affect the primary emergency management in their region. Results should be recorded in a series of short data. To help, the team should consider the relevant aspects of its region, taking into account possible emerging and future trends, as well as the current situation. It would also be appropriate for the group to establish linkages with entities that could provide information / inputs relevant to the risk assessment process. These can include bodies such as the Environmental Protection Agency (EPA) and the Health and Safety Authority (HSA) (MEM, 2010).

2.1.2.2.*2* Hazard identification

The purpose at this stage is to review and observe general risks for each specific risk, the elements of the community at risk should be identified. Both the threats to society and their possible impact point must emerge from this stage (MEM, 2010).

2.1.2.2.*3* Risk assessment

The next stage is to study the overall risks posed by these risks. Risk assessment begins by examining the impact of specific risks on life and health, in addition to radiation equipment. Probability should also be taken into account and the resulting judgment should be recorded in the risk matrix in the next stage (MEM, 2010).

The purpose at this stage is to determine the nature of the harm that may result from the hazard, the severity of that harm and likelihood of this occurring by using risk matrix.

2.1.2.2.*4* Recording Potential Hazards on a Risk Matrix

The reason at this arrange is to risk assessment is considered through a five by five matrix, consequences and likelihood scales are utilized to display risk assessment comes about. The method requires the result from the risk assessment to be recorded and inserted within the box judged to be most appropriate for the functional area under consideration and after that, the risk assessment work out records, in a readily presentable format:

- **Consequences:** The affect of a risk and the negative results that would result.
- **Likelihood:** The probability of the risk happening.

To place a risk in the risk assessment matrix, the typical classifications used are:

A. consequences

- ***Negligible*:** Risks that bring no real negative consequences, or pose no significant threat to the employee or department.
- ***Minor*:** Risks that have a small potential for negative consequences, but will not significantly impact overall success.

- ***Moderate***: Risks that could potentially bring negative consequences, posing a moderate threat to the employee or department.
- ***Major***: Risks with substantial negative consequences that will seriously impact of the employee or department.
- ***Extreme***: Risks with extreme negative consequences that could cause the death or severely impact daily operations of the department. These are the highest-priority risks to address (Smartsheet, 2018).

B. Likelihood

- ***Rare***: Extremely rare risks, with almost no probability of occurring.
- ***Unlikely***: Risks that are relatively uncommon, but have a small chance of manifesting.
- ***possible***: Risks that are more typical, with about a 50/50 chance of taking place.
- ***Likely***: Risks that are highly likely to occur.
- ***Almost certain***: Risks that are almost certain to manifest. Address these risks first (Smartsheet, 2018).

2.1.2.2.5 Risk Matrix

Table (2.2) is An explanatory table showing the content of the risk matrix that the researcher will use in the current study (Risk = likelihood × Consequences).

Table (2.2): risk matrix

REF / ID	RISK TYPE	RISK DESCRIPTION	RISK consequences	RISK LIKELIHOOD	IMPACT LEVEL
	RADIATION DOSE		Negligible	Rare	LOW
	OVERLOAD WORK		Minor	Unlikely	MEDIUM
	EQUIPMENT DAMAGE		Moderate	Possible	HIGH
	EXTERNAL FACTORS		Major	Likely	VERY HIGH
	HIGH VOLTAGE ELECTRIC		Extreme	Almost certain	Catastrophic

Low risk	Manage by routine procedures
Medium risk	Manage by specific monitoring or audit procedures
High risk **Very high risk** **Catastrophic risk**	This is serious and must be addressed immediately. The magnitude of the consequences of an event, should it occur, and the likelihood of the event occurring, are assessed in the context of the effectiveness of existing strategies and controls.

(Australian Guidelines for the Prevention and Control of Infection in Health Care (NHMRC), 2010).

2.1.2.3 Elements at risk

2.1.2.3.1 Equipment

A. Basic X-Ray

Known as ordinary radiography is the utilize of x-rays to imagine the inner structures of a patient. X-Rays are a frame of electromagnetic radiation, created by an x-ray tube. The x-rays are passed through the body and captured behind the patient by a detector; film delicate to x-rays or a computerized detector. There's a variation in retention of the x-rays by distinctive tissues inside the body, thick bone retains more radiation, whereas delicate tissue permits more to pass through. This change produces differentiate inside the picture to provide a 2D representation of all the structures inside the persistent (WHO, 2018).

B. Fluoroscopy

Fluoroscopy is an imaging modality that uses x-rays to allow real-time visualization of body structures. During fluoroscopy, x-ray beams are continually emitted and captured on a screen, producing a real-time, dynamic image. This allows for dynamic evaluation of anatomy and function. High density contrast agents may be introduced into the patient to allow for greater differentiation between structures (WHO, 2018).

The uses of fluoroscopy include positioning of orthopedic implants during surgery, catheters and pacemakers, viewing the movement of contrast agents, such as barium, through the body and studying the movement of parts of the body. Through fluoroscopy an X-ray beam is passed through the body but instead of being registered on film, the image is displayed on a fluorescent screen. Modern versions digitize the image using ‘flat panel’ detector systems, which reduce the radiation dose required (Jonas, 2011).

C. Computed tomography CT

CT is considering an imaging modality that utilizes x-ray photons for image production, with digital reconstruction. The CT scanner essentially consists of an x-ray tube and detectors. The x-ray tube produces an x-ray beam that passes through the patient. This beam is captured by the detectors and reconstructed to create a two- or three-dimensional image (WHO, 2018).

For a CT scan the radiation exposure is higher than for a conventional radiography examination. But on the other hand, a CT scan delivers additional information (Jonas, 2011).

D. Magnetic resonance imaging MRI

MRI systems use a powerful magnetic field and radiofrequency pulses to produce detailed images of the body’s structures as cross-sectional images or slices without exposing the patient or employees to ionizing radiation (Jonas, 2011).

2.1.2.3.2 Employees

A. Radiologic technologists

Radiologic technologists (RTs) are the medical personnel who perform diagnostic imaging examinations and administer radiation therapy treatments. They are educated in anatomy, patient positioning, examination techniques, equipment protocols, radiation safety, radiation protection and basic patient care. They may specialize in a specific imaging technique such as bone densitometry, cardiovascular-interventional radiography, computed tomography, mammography, magnetic resonance imaging, nuclear medicine, quality management, and general radiography. Also, they perform imaging examinations are responsible for accurately positioning patients and ensuring that a quality diagnostic image is produced. They work closely with radiologists, the physicians who interpret medical images to either diagnose or rule out disease or injury (ASRT, 2015).

RTs should complete at least two years of formal education in an accredited hospital-based program or a two- or four-year educational program at an academic institution and should pass a national certification examination (ASRT, 2015).

B. Radiologist

Radiologists are medical doctors that specialize in diagnosing and treating injuries and diseases using medical imaging (radiology) procedures (exams/tests) such as X-rays, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine (NM), Positron Emission Tomography (PET) and Ultrasound (US) (ACR, 2018).

According to American college of radiology radiologists complete at least 13 years of training, including medical school, a four-year residency, and most often, an additional one- or two-year fellowship of very specialized training, such as radiation oncology, pediatric radiology, or interventional radiology. They are certified by the American Board of Radiology, and they have exacting requirements for continuing medical education throughout their practicing years (ACR, 2018).

2.1.2.4 Vulnerability

A condition or predisposition. It applies to individuals, groups of individuals or communities, but it can be used also when referring to structures, etc. And vulnerability can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard. The concept is relative and dynamic. Vulnerability is most often associated with poverty, but it can also arise when people are isolated, insecure and defenseless in the face of risk, shock or stress (IFRC, 2018).

In addition; vulnerability can be defined as the manifestation of the inherent states of the system that can be subjected to a natural hazard or be exploited to adversely affect that system (Aven, 2011).

In the current study, the researcher defines the vulnerability as the lack of knowledge and awareness among the employees in the radiation sections of the risks identified in the study, in addition to the lack of protection and prevention tools and the weakness of the diagnostic radiology equipment.

A. Awareness& knowledge

There's significant underestimation of dose and cancer risk from radiation examinations, which may possibly lead to imperfect risk assessment. Also, the excessive or unwarranted examinations posing noteworthy radiation risk to the patient and radiation employees. It is additionally, the obligation of radiologists to reply the patient's concerns and at the same time to give information of radiation risks to their clinical colleagues (Ramanathan, 2015).

B. Training & experiences

Training and experiences play an imperative role within the efficiency of radiation department and to the expertise of RT in work. Training is the most reason behind all the success accomplished by any service or discovery or activity , which interpret the advance or failure of any community is responsible for the success of any organization or any institution (Goldstein, 2002).

All organizations employing people need to train and develop their staff. Most organizations are aware of this condition and are investing efforts and other resources in training and development. This investment can take the form of recruitment of specialized staff in training and development and payment of salaries to staff undergoing training and development. Investment in training and development requires the acquisition and maintenance of assets and equipment (Goldstein, 2002).

2.1.3 Risk analysis

Risk analysis is a standard use of accessible information to identify risks and assess risks to people, property and the environment. Risk analysis is always a proactive approach in the sense that it deals exclusively with potential accidents. This can be contrasted with accident investigation, a reaction approach looking for causes and circumstances of incidents that have already occurred (Jensen, 2002).

Furthermore, Risk analysis starts with a detailed study of specific risk issues. The objective is to collect sufficient risk data to judge the likelihood that it will occur and to influence the cost, performance and schedule in case of risk. Risk analyzes are often based on detailed information that may come from the following:

Comparisons with comparable systems, studies related to lessons learned, experience, results from tests and model development, information from engineering or other models, specialist and expert judgment, examination of plan and related reports, modeling and simulation, and affectability analysis of alternatives (Conrow, 2003).

2.1.4 Risk control and resolution

Risk control is synonymous with loss control. The technique of reducing the frequency or severity of losses with training, safety and security measures (IRMI, 2018).

This Arrangement is fundamental because it would be difficult, if not inconceivable, to supply a arrange for managing with each conceivable hazard in each step of the venture. With each risk assigned a risk factor value, the staff now has a roadmap for mitigating project risk by developing emergency plans only for the tasks that have the highest risk factor. In most projects, the run the show of thumb is that the group ought to center its hazard resolution efforts on the beat 20 percent of the identified risks, but this is not a significant-and-fast rule. Risk resolution may need to be more extensive and applicable (Cervone, 2006). Adaptable planning is the foundation on which nonstop risk appraisal is built. In spite of the fact that the project director does not want to be continually changing course in reaction to each event, it is pivotal to adapt and alter plans as new information becomes available (Cervone, 2006).

2.2 Sustainable development

2.2.1 Overview

Sustainable development is one of the objectives of national policies in all countries of the world and has a clear impact on the environment and natural resources and on the future of human development in general, and thus there is a relationship between sustainable development and the environment. Hospitals are fertile ground for these relations; Therefore, it is necessary to manage the risks of hospitals in a safe and sound manner to prevent the occurrence of pollution and the spread of diseases and wasting energies.

The Sustainable Development Strategy for the Health, Public Health and Welfare System 2014-2020 was propelled in January 2014. It depicts the vision for a sustainable health and care framework by decreasing carbon outflows, securing natural assets, and planning communities for extraordinary climate occasions and advance sound ways of lifestyles and environments. The challenge is how to proceed to make strides health and well-being and to supply quality care presently and for future eras inside accessible budgetary, social and natural assets. Understanding these challenges and creating plans to realize moved forward health and well-being and the proceeded arrangement of quality care is at the heart of sustainable development (Sustainable Development Unit, 2016).

2.2.2 Concepts of sustainable development

A literature review of the multidisciplinary on sustainable development uncovers a need of a comprehensive theoretical system for understanding sustainable development and its complexities (Jabareen, 2008).

The definition of sustainable development in the Webster Dictionary is a development that uses natural resources without allowing them to be depleted or destroyed in whole or in part (webster dictionary, 2019).

The World Health Organization identified the relationship between sustainable development and human beings as "Individuals at the heart of sustainable development concerns, are entitled to a healthy and productive life in concordance with nature" (WHO, 2002).

In addition to the definition of the third creator at the United Nations Conference on Environment and Development, which was held in Rio in 1992, it is necessary to achieve the right to development so as to achieve the highest growth equal to the developmental and environmental needs for both present and the future generation (UNCED, 1992).

The term sustainability belongs originally to the field of environment, alluding to an ecosystem's potential for subsisting over time, with nearly no change. When the thought of improvement was included, the concept would now not be looked at from the point of see of the environment, but from that of society and the capital economy (Reboratti, 1999).

It is secure to state that there's not a single, commonly acknowledged concept of sustainable development, how to measure it, or even less on how it ought to be promoted. There are two perspectives for the subject. On one hand, we have the ecologists' see that associates sustainability with the conservation of the status and work of environmental systems. On the other hand, we have economists that consider that sustainability is approximately the support and change of human living benchmarks. Sustainable development has been characterized in numerous ways, but the foremost as often as possible cited definition is from Our Common Future, moreover known as the Brundtland Report: "Sustainable development is development that meets wants of the present without compromising the capacity of future generations to meet their possess needs" (Brundtland, 1987).

A study was conducted by Maria Gerali et. al (2015) about sustainable development in healthcare by implementation of the concept of sustainable development in the establishment of "Green Hospital". the study show that the strategic planning of a Green Hospital can cause significant changes such as: Energy saving – Green development – Environment protection; Improvement of provided services to citizens; Saving of financial resources. Hence, endeavors ought to be made to save energy and cash within the clinics through sustainable development projects. At long last, the Green Hospital has the potential to supply improved therapeutic results for patients and more wonderful and comfortable working environment for employees (Gerali, Paikopoulou, & Servitzoglou, 2015).

One notable example for sustainable development in healthcare is Healthcare Without Harm (HWH). HWH notes that the huge scale of the healthcare sector worldwide suffers from unsustainable practices such as poor waste management, the use of harmful chemicals, and dependence on contaminating technologies have a major negative impact on the health of individuals and the environment. The main objective of HWH is to 'transform the healthcare sector worldwide, without compromising patient safety or care, so that it is ecologically sustainable and no longer a source of hurt to public health and the environment'' (Ling, 2012).

After literature review of the multidisciplinary on sustainable development, the most concept related to the current study is: the concept of Brundtland Report 1987.

Chapter 3
Materials and Methods

3. Materials and Methods

3.1 Introduction

This chapter discusses the methodology used in this research. The methodology used for the completion of this study uses the following techniques: information on research plan / strategy, population size, sample size, data collection technique, questionnaire design and development, statistical data analysis, content validity and pilot study. The methodology in academic research should describe the mechanism for answering research questions; justify empirical design; and clarify the analysis of results. This chapter explains the materials used and prepares them in the research, explains the calculations made to analyze the results, and mentions the statistical tests.

3.2 Research Strategy

Research strategy is the general plan for how data is collected, how it is collected, and how results are analyzed. The selected research plan will affect the type and quality of the data being collected (Ghauri & Gronhaug, 2010).

To evaluate the role of risk management in achieving sustainable development within the radiation departments at governmental hospitals in GS (triangulation design). a quantitative and qualitative survey approach has been adopted. The questionnaire was chosen as research technique to measure objectives, and the risk matrix was used to assess the impact of risks on employees. Finally, interviews of well-prepared key informant interviews (KII) were selected as a qualitative method of data collection.

3.3 Research Framework

This study employed qualitative and quantitative data. The researcher designed the research by Seventh main steps as described below.

First step: Theme Identification (Problem definition)

It was initiated to define the problem, set the objectives and develop the research plan.

Second step: Literature Review

Many references have been reviewed including journals, conferences, books, official reports and websites. The literature on the role of risk management in achieving sustainable development provided the theoretical basis to develop the research framework.

Third step: Pilot Study

The pilot study includes two parts. The first part was undertaken by consulting 7 experts in the field of the risk management, and radiology to pre-test the survey and subsequently modified before a final version was produced. After this, the second part was accomplished by making analysis trial using some of the radiation employees sample at the Indonesian hospital for validation before the main survey. The questionnaire was modified based on the results of the pilot study and the final list of questions was adopted to be used for the study.

Fourth step: The Main Survey

In this step of the survey, a quantitative and qualitative approach were utilized as the main components in the study. A purposive sampling strategy was used to ensure meaningful statistical analysis, which included disseminating the questionnaire to particular individuals who have experience in the research topic. Unlike random studies, which purposely incorporate a differing cross segment of ages, backgrounds and societies, the thought behind purposive examining is to concentrate on individuals with specific characteristics who are more able to help with this inquire about subject. The questionnaire was designed in one form and distributed to: RT and radiologist working at radiation departments in GS governmental hospitals.

Fifth step: Results and Discussion

Data collected were analyzed utilizing both descriptive and inferential tools of statistical software Statistical Package for Social Science (SPSS version 22).

Sixth step: Conclusion and Recommendations

The final phase of the research included the conclusions and recommendations.

Seventh step: Documentation

The final phase of the research included formatting, editing the final text, and spelling and grammatical review in order to be easy to read and understand.

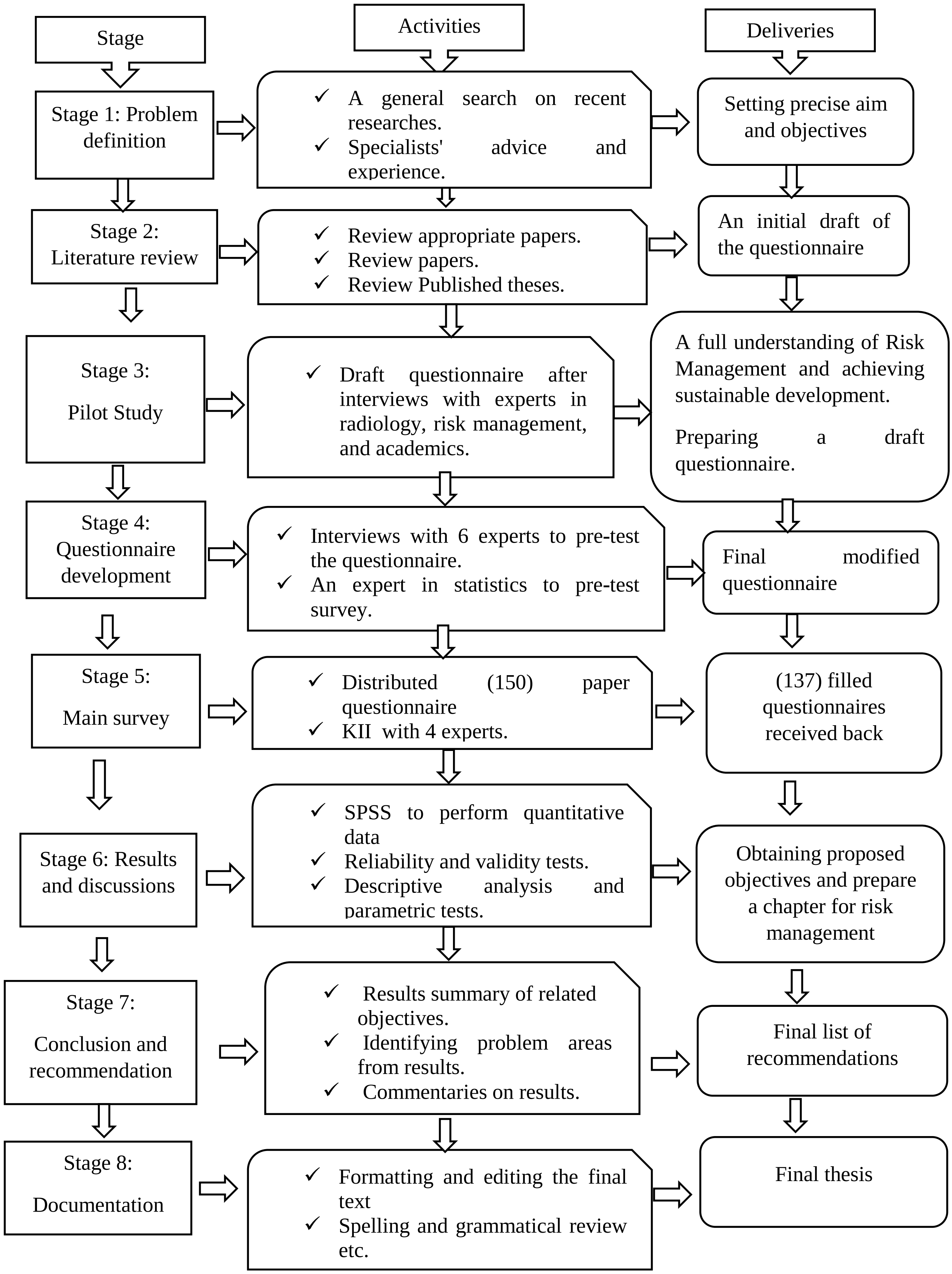


Figure (3.1): Framework of the research methodology

(self-developed)

3.4 Setting of the study

The research was carried out in GS in Palestine, which consists of five governorates: Northern governorate, Gaza governorate, the mid zone governorate, Khan Younis governorate and Rafah governorate.

3.5 Study period

The research was conducted five months from of October 2018 to the end of March 2019. The research started in October 2018 after the proposal was approved. At the end of November 2018, the literature review was continued till the finalizing of research. The questionnaire distribution and collection were completed in the beginning of February 2019. The analysis, discussion, conclusions and recommendations were completed in the end of April 2019.

3.6 Study Population

The target population were the RT and radiologist working in radiation departments at the six major hospitals in GS which include (227 employees).

3.7 Sample size

The following statistical equation (3.1) was used to determine the sample size

$$X = Z^2 \times p \times (1 - p)$$

$$n = \frac{NX}{((N-1)E^2 + X)}$$

Where:

Z: (1.96 for 95% C.I)

P: (0.50 used for “n” needed)

n: Sample size

N: Population size =227

E: Maximum Error of estimation (0.05)

$$X = 1.96^2 \times 0.5 \times (1 - 0.5) = 0.9604$$

$$n = \frac{NX}{((N-1)E^2 + X)}$$

$$= \frac{227 \times 0.9604}{((227-1)(0.05)^2 + 0.9604))} \qquad (3.1)$$

$$\cong 143$$

Based on the above equation, the required sample size was 143 employees.

Purposive sample was chosen as the type of sample. The purposive sampling technique is a type of non-probability sampling that is most effective when there is a limited number of people that have expertise in the area being researched (Dolores Ma. Tongco C. , 2007). In addition, Purposive sampling can be used with both qualitative and quantitative research techniques. The inherent bias of the method contributes to its efficiency, and the method will remain strong when it is tested against random probabilities. The choice of purposive sample is essential for the quality of information collected; in this way, the quality and efficiency of the source must be ensured (Dolores Ma. Tongco C. , 2007). 150 copies of the questionnaire were distributed to radiation technologist and radiologist working in radiation departments in GS hospitals. Each respondent took about 15 to 20 minutes to fill out the questionnaire. 137 copies of the questionnaire were returned from the respondents and completed for quantitative analysis. The total of 137 questionnaires were satisfactory completed, making the total response rate (137/150) *(100) = 91.33%. Personal delivery for the whole sample helped to increase the rate of response and thus the representation of the sample.

3.8 Eligibility criteria

3.8.1 Inclusion criteria

All radiation departments at the six main governmental hospitals that are already exist and provide medical imaging and diagnosis services for patients. Also, all permanent and contract employees RTs and radiologist at the selected radiology services will be included in the current study.

3.8.2 Exclusion criteria

In the current study, the researcher excluded all volunteers and trainers either from RTs, radiologist. Also, the researcher excluded other risks that were not identified in the study.

3.9 Ethical and administrative considerations

The study approval was received from Islamic University- Gaza. In addition, formal letters were sent through the university to official MoH directorates, where the title of the research and the name of the researcher were mentioned (Appendix 4). The official MOH directorates were formally contacted to obtain their approvals to conduct the study at MoH hospitals (Appendix 5).

A complete explanatory form for each questionnaire (the title, purpose and other relevant information) was attached. The right to participate or not, the confidentiality, and the anonymity of the data collected have been fully preserved and respected (Appendix 6).

3.10 Data Collection procedure

This research was chosen the questionnaire to be the approach of collecting data. Using questionnaire consider the easiest and the fastest approach to collecting data and is more precise in processing and analyzing the data (Appendix 7 and 8). The second type of data collection was risk matrix developed by the researcher based on international standards for risk assessment (Australian Guidelines for the Prevention and Control of Infection in Health Care "NHMRC", 2010) (Appendix 9). The KII were used as a third data collection method. Semi structured, open-ended statements were performed and filling the matrix (Appendix 10). Four experts were selected for in-depth interviews to drill down the quantitative data. It should be noted that the interviews were conducted in Arabic and then translated into English.

3.11Questionnaire design and contents

Questionnaires were set of questions utilized to elicit from radiation employees a wide cluster of objective data as well as subjective data about their thoughts and perceptions. Questionnaires are an effective data collection mechanism that provide the researcher with the information required. The questionnaire was at first designed based on the broad literature review of previous studies.

The questionnaire was provided with a covering letter clarifying the purpose of the study, the way of responding, the aim of the research and the security of the data in order to encourage a high response. In Appendix 7 and 8 there exist a copy of the questionnaire in both Arabic and English languages.

The questionnaire included multiple choice questions which are used widely in the survey. The variety in these questions points to meet the research destinations and objectives, and to collect all the necessary data that can support the results, discussion and recommendations in the research. The questionnaire structure divided into three parts: (i) Personal information about the respondents (ii) Risk Management within the Radiation departments at Governmental Hospitals in the GS, (iii) Sustainable development. The following are explanation of each part of these parts.

3.11.1 Personal information about the respondents

This is the first section in the questionnaire and aimed to determine the characteristics of the respondents. This section consists of 30 questions: name of hospital, gender, age, place of residence, social status, certificate, employment, years of experience, job title and job description.

3.11.2 Risk Management within the Radiation departments at Governmental Hospitals in the GS

The second section contains 26 questions, which seek information about the availability of risk management at radiation departments. These questions have been selected after a well review of previous studies on the subject.

3.11.3 Sustainable development

The third section contains 32 questions designed to determine the importance of sustainable development. After answering the first part that related to general information about the respondents. The respondents were asked to rate each item in each of the second and third fields on a rating scale (three-point Likert scale) that required a ranking (1-3), where 1 represented "Disagree", 2 represented "Don’t know", and 3 represented "Agree".

The numerical rating scale (three-point Likert scale) was chosen to format the questions of the questionnaire with some common sets of response categories called quantifiers (they reflect the intensity of the particular judgment involved) (Naoum, S. G. , 2007). Those quantifiers were used to facilitate understanding as shown in Table (3.1).

Table (3.1): The used quantifiers for the rating scale (the three-point Likert scale) in each field of the questionnaire

Item	Disagree	Don't Know	Agree
Code	1	2	3

The first draft of the questionnaire was revised through three main stages, which are: the face validity, pre-testing the questionnaire in order to ensure all kinds of errors that are associated with survey research are reduced, and pilot study. With each stage, the questionnaire was revised and refined more and more. Regarding details of each stage, it will be discussed in the following parts.

3.12 Face validity

Face validity was critical to see whether the questionnaire shows up to be valid or not. It was a "common sense" appraisal by specialists within the field of hazard administration, and radiology as well as specialists in statistics. The survey was displayed to 6 specialists by hand conveyance and by mail at diverse periods for assessing the validity of the questionnaire. Numerous valuable and critical adjustments and comments were made and taken into thought for the questionnaire.

3.13 Pretesting the questionnaire

Pretesting is a very important tool in survey research. It is a necessary step to ensure all errors that are associated with survey research are mitigated and taken away. It significantly contributes to improving the quality of data. Pretesting is implemented on a small sample of respondents from the target population. After the pilot test, the respondents were asked a series of questions regarding the survey as well as the process of data collection during a debriefing session. These debriefing sessions can help to explore any problem with the questionnaire design leading to ambiguity of words, misinterpretation of questions, inability to answer a question, sensitive questions, along with many other problems associated with the questionnaire as well as the process of handling the survey. The pre-testing was conducted in two phases. The first stage of the pre-testing resulted about with a few alterations to the wording of a few words within the questions, in expansion to including more clarification to a few items to guarantee the understanding of the question. The questionnaire was adjusted based on the comes about of the primary stage of the pre-testing. After that, the second stage was actualized and it was adequate to ensure success of the questionnaire, where there were no any inquiries or comments from any professional and all were clear. According to that, questions became to be clear to be answered in a way that helps to achieve the target of the study and to start the phase of the pilot study.

3.14 Pilot study

After the success of the second stage of the pretesting of the questionnaire, a trial run on the questionnaire was done before circulating it to the entire sample to get valuable responses and to identify zones of possible shortcomings (Thomas, Weirs, 2011). Baker (1994) noted that "a pilot study is regularly utilized to pretest or attempt out a research instrument, he included that a pilot study is an initial investigation to deliver data that will be essential when planning a future trial or study. For illustration, a pilot may be utilized to:

1. In the experimental study, the researcher may try a number of alternative measures and then identify those measures that produce the clearest results for the main study.
2. A preliminary test of hypotheses leading to the testing of more accurate hypotheses in the main study is permitted. This may change some hypotheses, drop some of them, or develop new hypotheses.
3. The researcher is often provided with ideas, methods and evidence that you may not expect before the pilot study. These ideas and clues increase the chances of obtaining clearer results in the main study.
4. Allows a thorough examination of planned statistical and analytical procedures, giving you an opportunity to evaluate the usefulness of the data. May be able to make the necessary adjustments in data collection methods, thus analyzing data in the main study more efficiently.
5. Can greatly reduce the number of unexpected problems because you have the opportunity to redesign parts of your studies to overcome the difficulties revealed by the pilot study.
6. It may save a lot of time and money. Unfortunately, many research ideas that look good, do not pay off when they are already implemented. The pilot study provides sufficient data for the researcher to determine whether the main study should continue.

7. Especially for students: If the researcher is a student planning to continue after a master's degree, the master's thesis may sometimes serve as a pilot study of the subsequent research to be conducted as part of the doctoral program (Baker, T.L. , 1994).

There are few published guidelines on the size of the pilot study. General guidelines, such as the use of 20% of the sample required for a full study, may not be sufficient to achieve such objectives as assessing the adequacy of devices or providing statistical estimates for a larger study (Melody, A., and Hertzog, 2008).

The pilot sample size depends on the actual sample size. Typically, a sample of 30 to 50 people is sufficient to determine any major errors in the system (Thomas, Weirs, 2011). Accordingly, 30 copies of the questionnaire were distributed appropriately to respondents from the target group. All copies have been compiled, encoded and analyzed through a Statistical Package for the Social Sciences IBM (SPSS). The tests were conducted as follows:

1. The statistical validity of the questionnaire/ criterion-related validity.
2. Reliability of the questionnaire by Half Split method and the Cronbach's coefficient Alpha method.

3.15 Statistical validity of the questionnaire

In quantitative research, validity is the extent to which the study is measured using a specific instrument that you specify for measurement. To ensure the validity of the questionnaire, two statistical tests must be applied. The first test is criterion-related/internal validity test, which measures the correlation coefficient between each element in the field and the entire field. The second test is structure validity test, which was used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the entire questionnaire. It measures the correlation coefficient between one field and all fields of the questionnaire that have the same level of a similar scale (Weir, 2011) and (Garson, 2013).

3.15.1 Internal validity test

Internal consistency of the questionnaire was measured by the scouting sample (the sample of pilot study), which consisted of 30 questionnaires. It was done by measuring the correlation coefficients (Pearson test) between each item in one field and the whole field (Weir, 2011) and (Garson, 2013). Table (3.2) and Table (3.3), show the correlation coefficient and p-value for each field items. As shown in the Tables (3.2) and (3.3) the P-values are less than 0.05, so the correlation coefficients of each field are significant at α= 0.05. Also, it is obvious that all correlation coefficient values were positive, which means that there are direct relations between the examined factors. Thus, it can be said that the items of each field are consistent and valid to be measured what it were set for.

3.15.1.1 Internal validity of the first section: Risk Management

Table (3.2) shows the correlation coefficient and P-value for each item. As shown in Table (3.2) the P-values are less than 0.05, so the correlation coefficients of each field are significant at α= 0.05. Thus, it can be said that the items of each field are consistent and valid to be measured what it were set for.

Table (3.2): The correlation coefficient between each paragraph/item in the field of Risk Management and the whole field.

#	Paragraph	correlation coefficient	p-value
1.	You have formal system of Risk management in radiation department.	0.425	0.001 *
2.	There is a section / committee responsible for identifying, monitoring and controlling radiology risks.	0.643	0.001 *
3.	The radiation department have internal guidelines / rules and concrete procedures with respect to the risk management system.	0.516	0.001 *
4.	The radiation department have in place an internal control system capable of dealing with newly recognized risks arising from changes in environment, etc.	0.574	0.001 *
5.	The radiation department have in place a regular reporting system regarding risk management for senior officers and management	0.505	0.001 *
6.	The manager responsible to review and identify the risk management systems, guidelines and risk reports.	0.420	0.001 *
7.	The radiation department have contingency plans against disasters and accidents.	0.450	0.001 *
8.	Radiation department complies with the standards of the International Protection Committee.	0.479	0.001 *
9.	Supervisors / regulators able to assess the true risks inherent in radiation department.	0.589	0.001 *
10.	There is a separation of duties between those who generate risks and those who manage and control risks.	0.500	0.001 *
11.	The radiation department have tools and procedures for protection of employee.	0.548	0.001 *

#	Paragraph	correlation coefficient	p-value
12.	Your Radiation department determines your protection requirements to reduce radiation risks.	0.564	0.001 *
13.	Review and approve control process take place periodically.	0.502	0.001 *
14.	There is a disclosure about radiation risk in the annual report.	0.584	0.001 *
15.	The Radiation department has a system to evaluate the causes of overworked work quantitatively.	0.577	0.001 *
16.	Department of Radiology adopted and utilized guidelines for protection employees.	0.691	0.001 *
17.	Radiation exposure limits for employees are set and monitored.	0.634	0.001 *
18.	The radiation department have in place a system for managing problems.	0.546	0.001 *
19.	Radiation department often measures occupational risk.	0.533	0.001 *

3.15.1.2 Internal validity of the second section: Sustainable development

Table (3.3) shows the correlation coefficient and p-value for each field. As shown in Tables (3.3) the P-values are less than 0.05, so the correlation coefficients of each field are significant at α= 0.05. Thus, it can be said that the items of each field are consistent and valid to be measured what it were set for.

Table (3.3): The correlation coefficient between each paragraph/item in the field of sustainable development and the whole field.

#	Paragraph	correlation coefficient	p-value
1.	Economic development is necessary for sustainable development.	0.693	0.001 *
2.	Improving people's health and opportunities for a good life contribute to sustainable development.	0.611	0.001 *
3.	A good clinical examination of the condition of the patient and the need for radiographic imaging helps to reduce the randomness and congestion on the sections of radiation, which helps in the sustainability of the service.	0.601	0.001 *
4.	The acquisition of modern and computerized equipment to reduce effort and time helps to sustainability	0.722	0.001 *
5.	A culture where conflicts are resolved peacefully through discussion in radiation department is necessary for sustainable development.	0.452	0.001 *
6.	Sustainable development demands that we humans reduce all sorts of (Risk).	0.600	0.001 *
7.	Connecting radiation departments in government hospitals and non-governmental hospitals to a computerized network that allows for follow-up and achieves sustainable development.	0.480	0.001 *
8.	The organization of specialized courses on a continuous basis for employees in the departments of radiation allows for the	0.563	0.001 *

#	Paragraph	correlation coefficient	p-value
	development of the quality of work and sustainability.		
9.	Radiation maintenance technicians receive advanced courses to repair emergency faults and maintain the safety of devices contributes to sustainability.	0.631	0.001 *
10	To achieve sustainable development, all the people must have access to good radiology awareness.	0.530	0.001 *
11	To achieve sustainable development, radiation departments must treat their employees in a fair way.	0.615	0.001 *
12	Preserving department equipment's is necessary for sustainable development.	0.825	0.001 *
13	Having respect rights of protection of other in your department is necessary for sustainable development.	0.776	0.001 *
14	Sustainable development requires equitable distribution, for example a periodic follow-up of equipment and ways of protecting employees.	0.671	0.001 *
15	Wiping out risk associated with radiation departments is necessary for sustainable development.	0.682	0.001 *
16	Sustainable development demands to organize number of courses (courses include for example, radiation protection, good practices, emergency management).	0.776	0.001 *
17	Sustainable development demands that radiology employees understand how the equipment's functions and maximum work loud for each machine.	0.766	0.001 *
18	For sustainable development, occupational radiation dose must be reduced.	0.708	0.001 *
19	For sustainable development, radiology employees need to be educated in how to protect themselves against radiation risk.	0.698	0.001 *
20	I think that risk management could be educated in how to work sustainably.	0.685	0.001 *
21	I think that we who are alive now should make sure that people in the future will be as well off as we are today.	0.573	0.001 *
22	I think the MOH has a responsibility to reduce the use of radiation by raising awareness among communities.	0.672	0.001 *
23	Using more X-ray resources than we need does not threaten people's health or medical prospects in the future.	0.641	0.001 *
24	I think that we need stricter laws and regulations to protect our self from excess radiation dose.	0.572	0.001 *
25	I think it is important to put emergency plan that ensure business continuity during emergency incidences.	0.500	0.001 *
26	I think that it is important to do something about problems which have to do with overload work.	0.601	0.001 *
27	I think the government should provide financial assistance to encourage risk management to make the workplace safe.	0.480	0.001 *
28	I think that the government should make all its decisions on the basis of sustainable development.	0.754	0.001 *
29	I think that the government should be using building back better approach when renewing or reconstruction by using safety standards and sustainability.	0.629	0.001 *
30	I think there is strong relation between risk management and achieving sustainable development.	0.666	0.001 *

3.15.2 Structure validity test

Structural validity is the second statistical test used to test the validity of the entire questionnaire. It measures the correlation coefficient between one field and all other fields of the questionnaire that have the same level of rating scale (three-point Likert scale) (Weir, 2011) (Garson, 2013). As shown in Table (3.4), the significance values are less than 0.05. Thus, it can be said that the fields are valid to be measured what it were set for to achieve the main aim of the study.

Table (3.4): Structure validity of the questionnaire.

Fields	Spearman correlation coefficient	P-value
Risk Management	**0.731**	*** 0.001**
Sustainable Development	**0.698**	*** 0.001**

3.16 Reliability of the Research

Reliability of an instrument is the degree of consistency in which the tool measures the attribute that is supposed to be measured. The test is repeated for the same sample of persons on two occasions and the results obtained are compared by the reliability factor calculation. For most purposes, reliability coefficients are higher than 0.7. Two weeks to two months are recommended between the two tests. Given the complex conditions faced by the contractors at the time of the questionnaire distribution, it was difficult for them to answer the questionnaire twice in a short period of time. The researchers overcame this difficulty by using the Cronbach alpha factor through the SPSS program.

Cronbach's Coefficient Alpha

This method is used to measure the reliability of the questionnaire between each field and the mean of all fields of the, questionnaire. The normal value of Cα alpha for the Cronbach coefficient ranges between 0.0 and +1 and the higher value reflects a higher degree of internal consistency (Garson, 2013) (Field, 2009). As shown in Table (3.5), the Cronbach's coefficient alpha (Cα), was calculated for each field, as well as all fields together. The general reliability for all items equals 0.849. This range is considered high, where it is above 0.7. Thus, the result ensures the reliability of the questionnaire.

Table (3.5): Cronbach's Coefficient Alpha for reliability (Cα)

Fields	Cronbach's Alpha (Cα)
Risk Management	0.850
Sustainable Development	0.873
All items	**0.849**

3.17 Final amendment to the questionnaire

After piloting, the questionnaire was adopted and distributed to the whole sample. The questionnaire was provided with a covering\explaining letter that presents the purpose of the study, the security of the information in order to encourage a high response, and the way of responding. The original questionnaire was developed in English. English language questionnaire is attached in (Appendix 8). Based on the belief of the researcher that the questionnaire would be more effective and easier to be understood for all respondents if it is in Arabic (native language); hence, the questionnaire was translated to Arabic language, which is attached in (Appendix 7).

3.18 Quantitative data analysis

Quantitative methods have been adopted in the current research. Quantitative methods of data analysis can be of great value to a researcher trying to show value and value resulting from a wide range of qualitative data. The main advantage is that the quantitative analytical approach provides a way to separate a large number of confusing factors that often obscure the main quantitative results. Statistical methods play a prominent role in most research based on analysis of quantitative data by converting ordinal data into digital scale data using a digital scale as mentioned earlier. This method helps to derive better results and to link them with previous research findings to show variation and progress. Statistical analysis helps the researcher determine the degree and accuracy of the data and information contained in the study. Summer results can be reported in terms of numbers with a certain degree of confidence (Field, 2009).

3.19 Measurements

Data analysis was performed using IBM SPSS Statistics (version 22). The following quantitative measures were used to analyze the data:

3.19.1 Frequencies and Relative frequency

Frequency (f): the number of times a score occurs.

Relative frequency (rel. f): the proportion of time the score occurs.

3.19.2 Measures of central tendency (mean), and measurement of dispersion (standard deviation)

A measure of central tendency: a number called a measure of central tendency can represent a center or middle of a set of data values. The mean, medium and mode can be used as a tool for measuring the central direction.

A measure of Dispersion: one simple measure of dispersed is standard deviation, it is a statistic that tells you how dispersed, or spread out, data values are, which portrays the typical difference (or deviation) between a data value and the mean.

3.19.3 Relative Important Index

The ranks of all factors were determined by utilized the relative importance index method (RII). and the relative importance index was computed by the following equation (3.2) (Sambasivan,M.; and Soon, Y.W., 2007):

$$\bar{X}_W = \frac{\sum W}{AN} = \frac{3n_3 + 2n_2 + 1n_1}{3N} \qquad (3.2)$$

Where:

W = the weighting given to each factor by the respondents (ranging from 1 to 3)

A = the highest weight (i.e. 3 in this case)

N = the total number of respondents

The RII value had a range from 0 to 1 (0 not comprehensive), the higher the value of RII, the more effect of the attribute. In any case, RII doesn't reflect the relationship between the different attributes. As such analysis does not give any important results with respect to understanding the clustering impacts of the similar items and the predictive capacity, more analysis is required utilizing advanced statistical methods.

3.19.4 Normal distribution

Normal distribution approximates numerous natural phenomena so well. It has been created into a standard of reference for numerous probability issues (Field, 2009).

When the data are not normal, they lead to inappropriate results, so the parametric statistical tests regularly assume that the data have a normal distribution. The normal state was assessed by applying the central limit theory, which is defined as when the samples are large (more than 30), Sample distribution will take the form of normal distribution in any case of the sample population from which the sample was selected (Field, 2009).

Accordingly, the data collected from the natural distribution search are tracked, where the sample size is N = 137 and therefore parametric tests should be used.

3.19.5 Homogeneity of variances.

The equal variances across samples represented the homogeneity of variance, there are some of statistically tests such as analysis of variance which indicate to assume that the variances are equal across groups or samples. Where the assumption of homoscedasticity (homogeneity of variance) simplifies mathematical and computational treatment. Levene's test (Levene, Howard , 1960) is used to verify the assumption that k samples have equal variances (Field, 2009).

3.19.6 One sample t test

Test utilized to decide on if the mean of a paragraph was essentially different from a test value 2 (Middle value of Likert scale). The sign of the test value indicates whether the mean is significantly greater or smaller than test value 2. If the P-value (Sig.) is smaller than or equal to the level of significance $\alpha = 0.05$ then the mean of a paragraph was significantly different from a test value2. On the other hand, if the value that the P-value (Sig.) is more than the level of significance $\alpha=0.05$, then the mean a paragraph is insignificantly different from a test value 2.

3.19.7 Independent sample t test

The test was used to examine whether there was a statistically significant difference between two means among the respondents.

3.19.8 One-way Analysis of Variance (ANOVA)

The test was used to examine whether there was a statistically significant difference between several means among participants (more than two groups).

3.19.9 Scheffe's method for multiple comparisons.

The Scheffé method applies to the set of estimates for all possible discrepancies between a factor level, not just the marital differences taught by the Scheffe method.

3.19.10 Pearson's correlation coefficient "product moment correlation coefficient".

Measure the linear correlation between two variables.

3.20 Summary

This chapter portrayed the detailed adopted methodology of the research. It included the essential research framework for the study, details of research period, location, population, and sample size. The questionnaire plan was point by point counting the introductory draft that was altered and refined through pilot study. Quantitative data analysis strategies, which include factor analysis, reliability test, and Pearson correlation analysis, were designed to be applied by the instruments of SPSS. For the purposes of testing the research validity, reliability, and adequacy of methods used in analysis, different statistical tests were used and explained in details. All the statistical tests confirmed the reliability and the validity of the questionnaire.

Chapter 4

Results and Discussion

4. Results and discussion

4.1 Introductions

This chapter analyzes and discusses the results collected from the surveys of the employees of the radiation departments. A total of 137 completed copies were returned, representing a true response rate of 91.33%. Quantitative data was analyzed using IBM Version 22 (SPSS) including descriptive and inferential statistical tools. This chapter includes general information about the respondents, the quantitative analysis of the questionnaire, and finally the summary framework of the results.

4.2 General information about the respondents

Participants in the questionnaire were RT and radiologists working in radiation departments in GS hospitals.

The results in Table (4.1) showed that most of the participants were young people between the ages of 30 and 40 years (55.5 %) and this indicates that they are newly employed in these jobs. And the Shifa Hospital has the largest number of RTs and radiologists (34.3%) because it covers the largest population in the General Service category. Furthermore, the result showed that the number of males is about three times that of females working in radiation departments. The researcher attributed this to the level of awareness of both the Ministry of Health and females with the risk of radiation, especially during pregnancy, which makes them move away from such a job.

In addition to, the results showed that the study sample varied in terms of residence for employees. It included the five governorates with a close percentage to know the degree of awareness of the risks and the importance of sustainable development at the level of the GS in full.

Finally, the results showed that the social status of most employees in the sample was married and had a higher risk of radiation, especially in the reproductive period.

Table (4.1): General information of the respondents (n = 137).

Variable	Frequency (F)	Percent (%)
Hospital		
Indonesia	19	13.9
El Najar	5	3.6
European	22	16.1
Nasser	31	22.6
Al Aqsa	13	9.5
Al Shifa	47	34.3
Age		
20 to less than 30	18	13.1
30 to less than 40	76	55.5
40 to less than 50	30	21.9
50 to 65	13	9.5
Gender		
Male	105	76.6
Female	32	23.4
Place of residence		
North Gaza	22	16.1
Gaza City	30	21.9
Mid-zone	31	22.6
Khan-younis	40	29.2
Rafah	14	10.2
Social status		
Single	13	9.5
Married	124	90.5

The results in Table (4.2) showed that most of employees have an experience in working within the radiation departments for more than 10 years (62.7 %), indicating their adequate knowledge of risks of the radiation department. This indicates that they have an experience and proficiency in protection and continuity in work in a sustainable manner. A study was conducted by (Paloniemi, 2006) about experience, competence and workplace learning aimed to examine employees' conceptions of the meaning of experience in job competence and its development in workplace context. The finding of the study showed the importance given to experience in efficiency and learning in the workplace. Staff also appreciate work experience as their primary source of competence, and the extent of learning through experiences has been emphasized (Paloniemi, S., 2006).

In addition, the results showed that a significant number of employees in the MoH radiation departments do not have special TLD to measure the dose of radiation exposure during work. This percentage is close to the percentage of those with less than

10 years of experience. There is also a large proportion of employees in the sections of radiation are not informed of readings of the amount of radiation exposure periodically. These values increase risk percentages and give a bad indication about crisis management and sustainable development.

That took in consideration when interviewing to know why the TLD are not provided to employees and not being informed of the periodic reading. When asking the head of technical departments Mr. Ibrahim Abbaas regarding availability of TLDs, he replied that for more than 15 years, the radiation departments were not equipped with such equipment and all employees after 2007 did not get TLDs. He also said, the responsibility for this lack of performance is related to the Power Authority in Gaza. The Power Authority does not have a device to read (TLD) and they send these (TLD) for reading to west bank, as a result of political circumstances in Gaza. In addition, there is a difficulty in sending these devices because the Israeli side refuses to enter it.

Table (4.2): qualification and experience for employees

Educational level	**Frequency (F)**	**Percent (%)**
Diploma	5	3.6
Bachelor Deg.	110	80.3
Master Deg.	21	15.3
Doctorate	1	0.7
Employment Type		
Permanent	111	81.0
Contract	26	19.0
Years of experience		
Less than 5	15	10.9
5 – 10	36	26.3
11 – 15	48	35.0
More than 15	38	27.7
Job title		
Manager	3	2.2
Head of Department	23	16.8
Head of Division	12	8.8
Employee	99	72.3
Job description		
Radiation technologist	109	79.6
Radiologist	28	20.4
Having TLD badge		
Yes	87	63.5
No	50	36.5
Are you notified of your TLD?		
Yes	53	38.7
No	84	61.3

4.3 Analysis of Risk Management

4.3.1 Is the available risk management effective within the radiation departments of government hospitals?

To answer this question related to the effectiveness of risk management, the descriptive statistics, i.e. means, standard deviations (SD), t-value (two tailed), probabilities (P-value), relative importance indices (RII), and finally ranks were established.

Table (4.3) showed that the Paragraph *"Your Radiation department determines your protection requirements to reduce radiation risks"* was ranked in the first position by the respondents under this group with relative importance index equals (81.27%), Test-value = 5.99, and P-value = 0.001 which is smaller than the level of significance (α= 0.05). The sign of the test is positive, so the mean of this paragraph is significantly greater than the test value (2). This result illustrates that there is an agreement by respondents about this paragraph. The researcher attributed the high response rate for this paragraph to providing radiation sections radiation prevention tools, especially those made of lead, in addition to the use of lead barriers in the radiation rooms. Also, radiation sections provide occupational dosimeters (TLD) as protection requirements to reduce radiation risks.

The Paragraph *"Supervisors / regulators able to assess the true risks inherent in radiation department"* was ranked in the second position by the respondents under this group with relative importance index equals (81.00%), Test-value = 5.92, and P-value = 0.001 which is smaller than the level of significance α= 0.05. The sign of the test is positive, so the mean of this paragraph is significantly greater than the test value (2). This result illustrates that there is agreement by respondents about this paragraph. The researcher attributed the high percentage in the second paragraph in Table (4.3) to the consensus of a large number of respondents about the importance of having a responsible person performing the risk identification and management procedures in scientific and administrative ways. Therefore, the respondents considered that the task of identifying risks in the radiology sections is not the responsibility of the employees in the diagnostic field whether RT or radiologist.

There is also agreement from the respondents in the paragraphs 3, 4, 5 and 6. The researcher attributed the consent of the respondents to these paragraphs to the degree of awareness among the employees in the radiation departments about the risk of radiation exposure, the importance of having a specialized committee for risk management in radiation departments in general and the importance of the role of directors of radiation departments in identifying these risks and treatment, where they have a great responsibility in the safety of employees. On the other hand, the researcher attributed the existence of an agreement regarding the existence of an emergency plan in the radiation sections to the political conditions in the GS due to the siege and the repeated Israeli attacks, in addition to the extreme weather and the climatic changes that have occurred in the country in the last few years.

Respondents did not know about paragraphs 7, 8 and 9. The researcher attributed this result to the absence of a clear risk management policy based on international standards for risk reduction, especially radiological exposure to employees, as well as the absence of a management or committee responsible for identifying and controlling radiation risk.

The paragraph *"The radiation department have in place an internal control system capable of dealing with newly recognized risks arising from changes in environment, etc."* was ranked in the last position by the respondents under this group with relative importance index equals (44.04%), Test-value = -12.87, and P-value = 0.001 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is negative, so the mean of this paragraph is significantly smaller than the test value (2). This result illustrates that members of the study sample do not agree with this paragraph. The researcher attributed this finding to the absence of risk management specialists who are able to identify the risks actually present in the radiation sections, as well as the risks that may threaten these sections from outside hospitals or due to environmental or other changes.

There is also disagreement on the paragraphs 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19. A consensus of the employees in the radiation departments of the six major hospitals in the GS indicates the absence of risk management in these sections and the identification of risks to employees, in addition to the failure to follow up and control the impact of these risks or follow directions that can provide prevention and protection of employees to mitigate some of these risks and not to report on risks to employees on an annual and periodic basis.

The researcher conducted KII with number of radiation heads departments belong to the hospitals of MoH in the GS. The selection was conducted according to the experience and the years of the service in the field of diagnostic radiology.

The KII, revealed that there is a lack of risk management section in these departments. Also, the KII showed that there is a consensus among the departments heads regarding the importance of these risks which were specified in this study. In addition, the study showed that these risks have a great effect on the health and safety of employees in the radiation departments.

Furthermore, all the departments heads agreed that the most dangerous risk is the ionizing radiation, because it has a negative effect especially without taking protective and safety procedures.

Table (4.3): RII's and test values for field of (Risk Management)

#	Statement	Mean	Std. Dev	RII (%)	T value	P value Sig.	Rank
1.	Your Radiation department determines your protection requirements to reduce radiation risks.	2.44	0.86	81.27	5.99	0.001 *	1
2.	Supervisors / regulators able to assess the true risks inherent in radiation department.	2.43	0.84	81.00	5.92	0.001 *	2
3.	The radiation department have tools and procedures for protection of employee.	2.42	0.89	80.54	5.48	0.001 *	3
4.	The radiation department have contingency plans against disasters and accidents.	2.41	0.84	80.29	5.72	0.001 *	4
5.	There is a separation of duties between those who generate risks and those who manage and control risks.	2.35	0.84	78.19	4.81	0.001 *	5
6.	The manager responsible to review and identify the risk management systems, guidelines and risk reports.	2.20	0.89	73.48	2.68	0.008*	6
7.	Department of Radiology adopted and utilized guidelines for protection employees.	2.01	0.95	66.91	0.09	0.929	7
8.	Review and approve control process take place periodically.	1.97	0.94	65.69	-0.36	0.716	8
9.	There is a section / committee responsible for identifying, monitoring and controlling radiology risks.	1.93	0.94	64.23	-0.91	0.367	9
10.	Radiation department often measures occupational risk.	1.81	0.94	60.47	-2.24	0.027*	10
11.	The radiation department have internal guidelines / rules and concrete procedures with respect to the risk management system.	1.59	0.80	53.04	-5.98	0.001 *	11
12.	The Radiation department has a system to evaluate the causes of overworked work quantitatively.	1.55	0.83	51.58	-6.37	0.001 *	12

#	Statement	Mean	Std. Dev	RII (%)	T value	P value Sig.	Rank
13.	There is a disclosure about radiation risk in the annual report.	1.48	0.67	49.39	-9.12	0.001 *	13
14.	Radiation exposure limits for employees are set and monitored.	1.47	0.79	48.91	-7.93	0.001 *	14
15.	Radiation department complies with the standards of the International Protection Committee.	1.47	0.69	48.91	-9.08	0.001 *	15
16.	The radiation department have in place a system for managing problems.	1.45	0.65	48.42	-9.82	0.001 *	16
17.	The radiation department have in place a regular reporting system regarding risk management for senior officers and management	1.42	0.68	47.20	-10.02	0.001 *	17
18.	You have formal system of Risk management in radiation department.	1.38	0.72	45.99	-10.10	0.001 *	18
19.	The radiation department have in place an internal control system capable of dealing with newly recognized risks arising from changes in environment, etc.	1.32	0.62	44.04	-12.87	0.001 *	19
All statements		**1.84**	**0.42**	**61.33**	**-4.28**	**0.001 ***	

Regarding the whole paragraphs of “Risk Management” field, the RII equals (61.33%), Test-value =-4.28, and P-value=0.001 which is smaller than the level of significance α=0.05. The sign of the test is negative, so the mean of this group is significantly smaller than the test value (2). The respondents totally disagree about the field of risk management, and this is evidence that there is a problem in the management of risks in the radiation departments in GS hospitals (Table 4.3).

For risk management in facilities using radiation sources, the first step is to identify the risks and then conduct risk assessment. In order to achieve the required safety levels and to continuously enhance safety for operators, a potential risk assessment must be carried out. A risk assessment can identify vulnerable areas where more resources can be allocated for safety (Pandey, 2016).

The results indicate that the radiation departments determine the protection requirements of the employees to reduce the risk of radiation. This is because the radiation departments provide personal protective equipment from radiation such as protective devices made of lead as a mean of protection without working to reduce the doses of radiation that employees may be exposed to it at times of work is due to increased daily working pressure. Furthermore, the tools do not provide the full protection for the employees as well as the quality control process don't take place periodically. This is explained by the lack of consent of the respondents on complies of radiation department with the standards of the International Radiation Protection Committee.

On other hand, the results showed that there are no radiation exposure limits for employees are set and monitored, through the KII the heads of radiation departments correlated the much more exposure to the radiation with increasing radiation tests. i.e. there is a positive relation between the number of tests and exposure time. Also, all the heads of departments attributed the continuous breaking down of radiation devices to the pressure of work and continuous cutting off the electricity as these devices are not provided with unit power supply. Simply, we can say that there is a relation between devices damage and work pressure and continuous cutting off the electricity.

On the other hand, the heads of radiation departments considered the most dangerous risk, which needs a management, is the ionizing radiation. Besides, to manage this risk, there should be a clear policy to manage the threats which contain prevention and awareness raising and limiting the radiation checks through suitable clinical examination. And when regarding to risk of radiation dose, the Radiation Protection Bureau Health in Canada set some guides for public health policy after workshop conducted in at 12 July 2005 as radiation dose risk model as following:

linear no threshold (LNT) hypothesis;

- There is no safe level of radiation exposure.
- All exposure carries some level of risk.
- The risk is directly proportional to the exposure.

In addition, the radiation risk has been recommended by ICRP as the following:

For each Sievert of exposure to radiation in the general population, risk of fatal cancer is 5% (5 cases per 100 people). Therefore at 1 mSv the fatal cancer risk is: 50 cases per 1 million people (Moir, 2005).

Furthermore; the radiation departments do not have an internal control system capable of dealing with newly recognized risks arising from changes in the environment, etc. Therefore, there is no special vision for the radiation departments to develop a plan or program to achieve continuity during any emergency event that can occur.

Regarding to the vocational safety standards, the views varied among the heads of departments. Some of them stated that there are no safety and they attributed this lack to the absence of a committee to follow up all risks, which affects the vocational safety of the employees of radiation departments. Also, they attributed this lack to the absence of continuous censorship for prevention and safety to guarantee the continuation of the work.

While, when asking the heads of departments concerning the existence of instructions to deal with risks among the workers for the vocational safety, some of them stated that there are no instructions related to this field and there is no specification and paying attention to these risks which were specified in this study. Also, there is a default among some employees caused a huge fire in the department of CT instrument in the Al Shifaa Hospital as a result of electrical fault which leaded to a complete stop inside the department.

Furthermore, the KII showed a clear lack of performance in conducting the meetings to discuss the means of prevention and safety and evaluating the real situation. Besides, there is neither awareness system nor courses to raise the awareness among the employees. The heads of the departments attributed this lack of performance to the absence of the coordination between the MoH and the Power Authority and the lack of logistics in the departments of radiation.

Finally, the results showed that there is no define or detection for the risks at radiation departments that could be threat the employees and work continuity, in other word there is no risk management within the radiation departments of the six major hospitals in GS. This anomaly may be attributed to: lack of a committee specialized in risk management operations in radiation departments that has the responsibility for identifying, evaluating, analyzing and prioritizing risks from the administrative side. Furthermore, there is no formal risk management system or even problem management which act as a guideline to protect the employees and ensure the continuity of work, so without risk management that covers all of its stages at radiation departments it's difficult to achieve sustainable development.

4.3.2 The Risk Management Policy is issued in the Radiation department through the following management level

The results in Table (4.4) show that (27.9%) of the sample members said that the risk management policy in the radiation departments is issued by the MoH, (30.2%) said that the risk management policy in the radiation departments is issued by Power Authority, (40.3%) said that issued by hospital management, while the remaining percentage (1.6%) said that such policies are issued by specialized external agencies.

The researcher attributed the high rate of respondents' tendency to choose hospital administration as the body responsible for implementing the risk management policy because to it is the responsibility of the hospital administration to follow up periodically and continuously to maintain the employees and to continue the work through the development of a risk management policy by identifying risks and evaluating them and prioritizing dealing with them and coordination with the MoH and Power Authority.

Table (4.4): Frequency and percentage of administrative level issued by the Risk Management Policy

Management level	Frequency	Percent (%)
MOH	36	27.9
Power Authority	39	30.2
Hospital management	52	40.3
External specialized agencies	2	1.6

4.3.3 Issuing Reports of Radiation department

There are many reports issued by the departments of radiology and there are other reports are not issued, Table (4.5) shows the nature of reports issued and other not issued as follow:

- (13.9%) of the respondents said that the radiation departments are issuing a radiation dose risk report.
- (52.6%) of the respondents said that the radiation departments are issuing overload work risk report.
- (79.6%) of the respondents said that the radiation departments are issuing equipment damage risk report.
- (64.2%) of the respondents said that the radiation departments are issuing external factor risk report (power cuts, Israeli attacks, political crises, etc.

- (24.1%) of the respondents said that the radiation departments are issuing high voltage electric risk report.

These results exhibited that the radiation departments at all six major hospitals have the same role in dealing with risks identifying. In addition, it was recorded that the most common reports issued by the radiation departments were about the risk of equipment damage, and this may attribute to avoiding service down at the department.

As shown in Table (4.5) a large proportion of employees in the radiation departments believe that many reports concerning the risk of overload work and occupational safety are not issued, including reports of high voltage electric risk. This calls on the officials and heads of departments attention and accuracy in the issuance of these reports in order to maintain the safety of employees and ensure continuity of work and achieving of sustainability.

On the other hand, the lowest percentage of reports were about the risk of radiation dose. The researcher attributed this attitude to the absence of radiation dosimeters (radiation dose measurement) received by the employees during the working time. Also, the dose is not measured periodically as shown in Table 4.5.

Table (4.5): Frequency and percentage of reports

#	Report type	Yes (Issued)		No (Do not issue)	
		F	%	F	%
1.	Radiation dose risk report	19	13.9	118	86.1
2.	Overload work risk report	72	52.6	65	47.4
3.	Equipment damage risk report	109	79.6	28	20.4
4.	External factor risk report (power cuts, Israeli attacks, political crises, etc.)	88	64.2	49	35.8
5.	High voltage electric risk report	33	24.1	104	75.9

4.3.4 Use of Radiation departments for Risk Prediction Models

There are many prediction models that the radiation departments can use to manage and predict risks as shown in Table (4.6) the results summarized as following:

- (7.3%) of the respondents said that the radiation departments use the risk prediction model related to the radiology dose risk.
- (32.1%) of the respondents said that the radiation departments use the risk prediction model related to o overload work risk.

- (66.4%) of the respondents said that the radiation departments use the risk prediction model related to equipment damage rate risk.
- (32.1%) of the respondents said that the radiation departments use the risk prediction model related to external factor risk.

As shown in Table (4.6) a large proportion of employees in the radiation departments believe that there is a significant shortfall in the use of the risk prediction models, and this is attributed to the lack of a clear and formal risk management policy for such models.

Table (4.6): Frequency and percentage of use of prediction models

#	prediction models	Yes (Uses)		No (not used)	
		F	%	F	%
1.	Radiation dose risk	10	7.3	127	92.7
2.	Over loud work risk	44	32.1	93	67.9
3.	Equipment damage rate risk	91	66.4	46	33.6
4.	External factor risk (Power cuts, Israeli attacks, political crises, etc.)	44	32.1	93	67.9
5.	High voltage electric risk	21	15.3	116	84.7

4.3.5 The regular risk management technique that used in radiation department

The radiation department usually uses techniques related to risk management and these techniques are as follows in Table (4.7).

As shown in Table (4.6) a large proportion of the employees in the radiation departments believe that there is a difference in the techniques used as risk management, where the results showed no use of radiation dose risk management technique. Where the percentage of exile for each of the (10- day rule) was 78.1% (appendix 13) and ICRP approach was 80.3% (appendix14).

While a large proportion of the employees in the radiation departments believe that the techniques of number of cases / times used significantly as a means to reduce excessive radiation exposure of employees and reduce the risk of overload work, where the respondent's rate was 80. 3% and the occupational safety standards are used, but with lesser percentage (64.2%) (appendix15).

In addition, the results showed that the risk of equipment damage is handled by medical engineers by a large percentage reached to 75.9% as a technique to reduce this risk and ensure continuity of work. While the technique of the duration of equipment has a lower percentage (32.8%). and the researcher here refers to the intervention of other factors such as frequent power outages and over loud work and misuse which negatively effect on life span of machines.

While, the results showed that the risk of external factors such as irregularity of electricity, Israeli attacks, political crises, …etc. are treated in alternative ways according to respondent's perception by a large percentage reached to 76.6%. For example, the irregularity of electricity suffered by the GS since 2007, where the power outage reaches 12 hours. Sometimes, generators are used as a means of continuing work and providing medical services to patients. While in case of Israeli aggressions and political crises, alternative hospitals are used by transferring injuries cases and patients to other hospitals. Actually, this what happened in the Israeli aggression in 2014 when the medical services in Abu Yousef al-Najjar Hospital were stopped. On the other hand, the results showed that most radiation departments in the six main government hospitals rely on a contingency plan for continuity of work as a way to deal with the risk of external factors. Where the percentage of approval of respondents with 72.3%. where, these plans are developed for the continuation of services within the sections of radiation and were linked to an emergency plan that includes all sections of the hospital.

Finally, the results showed that the risk of high voltage electricity that should be handled by protection approach by a large percentage reached to 76.6%. This technique used to protect employees from electric shock accident and the protection of the devices from the occurrence of electrical contact causing the failure of these devices. In a line, there was an electrical shock accident happened in the Department of CT scan at Shifa Hospital and led to a complete cessation of service on 28th, December 2017.

While a lower percentage (35.0%) of the employees in the radiation departments believe that the engineering technique is used for management the risk of high voltage electricity. This calls on officials and heads of departments to pay attention to engineering intervention to prevent electrical accidents, as it is the engineers of the medical apparatus who install the electrical equipment and supplies in order to maintain the safety of employees and ensure continuity of work and sustainability.

Table (4.7): Frequency and percentage of risk management technique used in the radiation departments

#	Type of risk	Approach(technique)	Yes (Uses)		No (not used)	
			F	%	F	%
6	**Radiation dose risk**	10 - day rule approach	30	21.9	107	78.1
		ICRP approach	27	19.7	110	80.3
7	**Over loud work risk**	Number of case/ Time	110	80.3	27	19.7
		Occupational safety standards	88	64.2	49	35.8
8	**Equipment damage risk**	Engineering approach	104	75.9	33	24.1
		Time Duration	45	32.8	92	67.2
9	**External factor risk (Power cuts, Israeli attacks, political crises, etc.)**	Alternatives approaches	105	76.6	32	23.4
		Emergency plan	99	72.3	38	27.7
10	**High voltage electric risk**	Engineering approach	48	35.0	89	65.0
		Protection approach	105	76.6	32	23.4

4.3.6 The Radiation department has a documented risk management policy

The results in Table (4.8) show that (9.5%) of the respondents said that the radiation departments have a documented risk management policy, while the majority (90.5%) said that don't have a credible risk management policy in the six main government hospitals included in the study sample. The researcher attributed this to overload work, which reflects increased exposure to radiation and increased risk of damage to equipment.

Table (4.8): Frequency and percentage of use of forecasting models

Does your radiation department have a documented risk management policy?	**Frequency**	**Percent (%)**
Yes	13	9.5
No	124	90.5
Total	137	100.0

4.3.7 Responsible for the implementation of risk management policy

The results in Table (4.9) show that (13.9%) of the respondents believe that the head of the department is responsible for risk management within the radiation departments, (6.6%) believe that specialists are responsible for risk management within the radiation departments, (9.5%) believe that MoH is responsible for risk management within the radiation departments, (9.5%) believe that the Energy Authority is responsible for risk management within the radiation departments, while (60.6%) believe that no one are implementing risk management policies within the radiation departments. These results indicate that there is no specific entity implementing the risk management policy. The researcher attributes the previous results to the absence of a documented policy that manages these risks as shown in Table (4.8).

While, when asking the heads of radiation departments regarding a mechanism to specify the risks inside the departments, the results showed that there is no specification to these risks because there is no committee to evaluate and supervise on these risks. Also, there is no committee to manage these risks. In another context, the results of KII showed that all heads of departments are not responsible for any accident which could cause a harm to the employees. These accidents could occur as a result of neglecting principle of taking a suitable procedure for prevention, and all the heads of departments showed that all the employees have a knowledge with radiation risky. The most important is that the section provided them with radiation protection equipment. therefore, the researcher reached to a conclusion that the lack for these committees caused an obstacle to achieve the sustainable development which aimed to protect the workers and continuity of the work.

On contrary, the head of technical department in MOH confirmed that there is a specification for these risks in the departments of radiation, but there are failures among the employees and heads of departments in avoiding these threats. Also, the head technical department at MOH, Mr. Ibrahim Abbaas denied the existence of a specialized administration to manage these risks. This shortage urged to the lack of logistics in the MOH.

On the other hand, the results of KII showed that there is no periodic medical tests (checks) to the employees of radiation departments as a result of the lack of a program to explain the mechanism and quality of tests to assess the effects of these radiation on the employees. Significantly, the heads of departments showed that any employee has an ability to conduct a Complete Blood Count (CBC) test in order to ensure his health without knowing the mechanisms of work to these tests and its results which could be accepted.

Table (4.9): Frequency and percentage of responsible for the implementation of risk management policy.

Responsible	Frequency	Percent (%)
Head of department	19	13.9
Specialist	9	6.6
MOH	13	9.5
Energy Authority	13	9.5
No one	83	60.6
Total	137	100.0

4.4 Analysis of Sustainable Development

4.4.1 Have you heard of the notion of Sustainable Development?

The results in Table (4.10) show that (75.2%) of respondents have heard about the concept of sustainable development, while (24.8%) didn't hear about that concept. It is clear that majority of employees in the radiation departments of the six main government hospitals included in the study sample have heard about the concept of sustainable development, which enhances the objectives of the question and the importance of sustainable development and the possibility of achieving it.

Table (4.10): Frequency and percentage of heard of the notion of sustainable development

heard of the notion of Sustainable Development	F	%
Yes	103	75.2
No	34	24.8
Total	137	100.0

4.4.2 If yes, in what connection have you heard of Sustainable Development?

The results in Table (4.11) show that majority of those who have heard about the concept of sustainable development have heard it through the Internet, institutions and hospitals.

Table (4.11): Frequency and percentage of connection heard of Sustainable Development

Item	F	%
Hospital	16	15.5
Through an association	24	23.3
On TV	13	12.6
From friends	3	2.9
In the newspapers	3	2.9
On Radio	1	1.0
Via the internet	43	41.7
Total	103	100.0

4.4.3 Importance of sustainable development

This section seeks information about the importance of sustainable development. To answer this question related to the importance of sustainable development, some statistic parameters were studied include: a descriptive statistic, i.e. means, standard deviations (SD), T-value (two tailed), probabilities (P-value), relative importance indices (RII), and finally ranks were established.

Table (4.12) showed that the paragraph "*A good clinical examination of the condition of the patient and the need for radiographic imaging helps to reduce the randomness and congestion on the sections of radiation, which helps in the sustainability of the service*" was ranked in the first position by the respondents under this group with relative important index equals (98.30%), Test-value = 44.06, and P-value = 0.001 which is smaller than the level of significance $\alpha = 0.05$. The sign of the test is positive, so the mean of this paragraph is significantly greater than the test value (2). This result illustrates that there is agreement by respondents about this paragraph.

The researcher attributed the high rate of response in this paragraph to the importance of clinical examination of the patient where the identification of radiation images required for diagnosis more accurately and this reduces the re-imaging, which limits the number of tests performed by employees in the sections of radiation and consequential reduction of radiation exposure to them. This indicates the awareness of employees in the radiation sections about the risk of radiation exposure and helps to protect themselves and preserve the radiation equipment, which ensures continuity of work and achieve sustainable development.

The paragraph *"Having respect rights of protection of other in your department is necessary for sustainable development"* was ranked in the second position by the respondents under this group with relative important index equals (97.81%), Test-value = 43.98, and P-value = 0.001 which is smaller than the level of significance α= 0.05. The sign of the test is positive, so the mean of this paragraph is significantly greater than the test value (2). This result illustrates that there is agreement by respondents about this paragraph.

The researcher attributed the high response rate in this paragraph to the importance of protecting the rights of other employees in the radiation departments in compliance with the principles of human rights (guideline 13), which states as follows:

Responsibility for respect for human rights requires that businesses:

- To avoid causing or contributing to the harmful effects of human rights through their activities and to address such effects when they occur;
- To seek to prevent the adverse effects of human rights that are directly related to their operations, products or services in the context of their commercial relations, even when they do not contribute to such effects (UNHR, 2012).

Where compliance with these principles ensures the protection of personnel in the radiology sections and thus the achievement of sustainable development.

Furthermore, there is also agreement on all paragraph related to the importance of sustainable development.

The paragraph *"Using more X-ray resources than we need does not threaten people's health or medical prospects in the future"* was ranked in the last position by the respondents under this group with relative important index equals (45.01%), Test-value = -10.66, and P-value = 0.001 which is smaller than the level of significance α= 0.05. The sign of the test is negative, so the mean of this paragraph is significantly smaller than the test value (2). This result illustrates that members of the study sample disagree with this paragraph.

The researcher attributed the reasons for the disagreement with this paragraph to overload working which may lead to increase exposure to radiation and increase in the depletion of radiation equipment. Furthermore, increases the possibility of equipment damage and interruption of service, which is an obstacle to achieving sustainable development in radiation departments.

Regarding the whole paragraphs of "*Sustainable Development*", the RII equals (92.33%), Test-value =44.60, and P-value=0.001 which is smaller than the level of significance $\alpha=0.05$. The sign of the test is positive, so the mean of this group is significantly greater than the test value (2). The respondents totally agree about the importance of sustainable development Table (4.12). The researcher attributed this to the fact that they work in a similar work environment and all of them need reforms and developments that will support sustainable development. This result ensures the need of professional protection of employees, the maintenance of equipment and the sustainability of work.

According to the results achieving sustainable development clearly requires the following:

1. The good clinical examination of the patient's condition and the need for radiography are necessary to reduce the randomness and congestion of the radiation sections, and the excessive exposure to radiation, which helps sustained the service.
2. Respect rights of protection of others at the radiation department is necessary for sustainable development.
3. For sustainable development, radiology employees need to be educated in how to protect themselves against radiation risk.
4. Preserving department equipment's is necessary for sustainable development.

The KII showed that there is a consensus among heads of departments that the MoH has a policy towards sustainability in providing the service in the radiation departments through developing a computerized web. This computerized web sends the X-ray images and dispensing with the chemical materials that used in image processing. In line, there is a problem revealed in some departments as a result of breaking down some of radiation devices. After all, the heads of departments agreed on the existence of a default in the MoH with updating and renewing these devices in addition to saving spare part as well as. The interviews showed that many radiation devices have stopped in working for more than a year and this hinders providing the services in some hospitals.

Finally, when asking the heads of radiation departments regarding the impediments to sustainable development, they stated that there is an attempt to achieve sustainability in the service as it is basic in diagnosing the diseases. Also, they cannot initiate more departments because of the difficulty of political and economic circumstances. In addition, there is no clear development plan to implement risk management policy in the MOH, as the ministry current accreditation depends on projects submitted by donors.

Table (4.12): RII's and test values for field of (sustainable development)

#	Statement	Mean	Std. Dev	RII (%)	T value	P value Sig.	Rank
1.	A good clinical examination of the condition of the patient and the need for radiographic imaging helps to reduce the randomness and congestion on the sections of radiation, which helps in the sustainability of the service.	2.95	0.25	98.30	44.06	0.001 *	1
2.	Having respect rights of protection of other in your department is necessary for sustainable development.	2.93	0.25	97.81	43.98	0.001 *	2
3.	For sustainable development, radiology employees need to be educated in how to protect themselves against radiation risk.	2.93	0.28	97.81	39.53	0.001 *	3
4.	I think the government should provide financial assistance to encourage risk management to make the workplace safe.	2.93	0.28	97.81	39.53	0.001 *	4
5.	The acquisition of modern and computerized equipment to reduce effort and time helps to sustainability	2.93	0.29	97.57	37.69	0.001 *	5
6.	Sustainable development demands to organize number of courses (courses include for example, radiation protection, good practices, emergency management).	2.93	0.29	97.57	37.69	0.001 *	6
7.	I think that the government should make all its decisions based on sustainable development.	2.93	0.26	97.57	41.56	0.001 *	7
8.	Preserving department equipment's is necessary for sustainable development.	2.92	0.27	97.32	39.47	0.001 *	8
9.	I think that risk management could be educated in how to work sustainably.	2.92	0.30	97.32	36.07	0.529	9
10	Wiping out risk associated with radiation departments is necessary for sustainable development.	2.91	0.32	96.84	33.30	0.001 *	10
11	I think it is important to put emergency plan that ensure business continuity during emergency incidences.	2.91	0.36	96.84	29.31	0.001 *	11
12	I think that the government should be using building back better approach when renewing or reconstruction by using safety standards and sustainability.	2.91	0.32	96.84	33.30	0.001 *	12
13	Sustainable development demands that radiology employees understand how the equipment's functions and maximum work load for each machine.	2.90	0.30	96.59	34.57	0.001 *	13

#	Statement	Mean	Std. Dev	RII (%)	T value	P value Sig.	Rank
14	I think that it is important to do something about problems, which have to do with overload work.	2.90	0.33	96.59	32.11	0.001 *	14
15	For sustainable development, occupational radiation dose must be reduced.	2.89	0.34	96.35	31.02	0.001 *	15
16	Improving people's health and opportunities for a good life contribute to sustainable development.	2.88	0.34	96.11	30.02	0.001 *	16
17	The organization of specialized courses on a continuous basis for employees in the departments of radiation allows for the development of the quality of work and sustainability.	2.88	0.38	96.11	26.87	0.001 *	17
18	Sustainable development requires equitable distribution, for example a periodic follow-up of equipment and ways of protecting employees.	2.88	0.34	96.11	30.02	0.001 *	18
19	I think there is strong relation between risk management and achieving sustainable development.	2.88	0.37	96.11	28.31	0.001 *	19
20	Sustainable development demands that we humans reduce all sorts of (Risk).	2.87	0.36	95.62	28.23	0.001 *	20
21	I think that we who are alive now should make sure that people in the future will be as well off as we are today.	2.87	0.42	95.62	24.39	0.001 *	21
22	Economic development is necessary for sustainable development.	2.86	0.39	95.38	26.05	0.001 *	22
23	Connecting radiation departments in government hospitals and non-governmental hospitals to a computerized network that allows for follow-up and achieves sustainable development.	2.86	0.41	95.38	24.86	0.001 *	23
24	To achieve sustainable development, radiation departments must treat their employees in a fair way.	2.84	0.44	94.65	22.27	0.001 *	24
25	To achieve sustainable development, all the people must have access to good radiology awareness.	2.81	0.49	93.67	19.23	0.001 *	25
26	A culture where conflicts are resolved peacefully through discussion in radiation department is necessary for sustainable development.	2.71	0.54	90.27	15.22	0.001 *	26
27	I think that we need stricter laws and regulations to protect our self from excess radiation dose.	2.62	0.75	87.35	9.70	0.001 *	27
28	I think the MOH has a responsibility to reduce the use of radiation by raising awareness among communities.	2.17	0.94	72.26	2.10	0.038*	28
29	Radiation maintenance technicians receive advanced courses to repair emergency faults and maintain the safety of devices contributes to sustainability.	1.96	0.81	65.21	-0.63	0.529	29
30	Using more X-ray resources than we need does not threaten people's health or medical prospects in the future.	1.35	0.71	45.01	-10.66	0.001 *	30
All statements		**2.77**	**0.20**	**92.33**	**44.60**	**0.001 ***	

4.5 Opinion of respondents about the Role of Risk Management and Sustainable Development.

4.5.1 The differences in the opinion due to qualification level

One-way Analysis of variance (ANOVA) test were used to find whether there were statistically significant differences between opinions of respondents or not.

According to the results of the test showed in Table (4.13), the P-value for the Levene's test is greater than 0.05 in each field. Thus, the variances of the groups are not significantly different (the groups are homogeneous). Regarding to F- test, the significance values for each field are not significant (P-value > 0.05). Thus, there are no statistically significant differences due to educational level at the level of $\alpha \leq 0.05$ toward the role of risk management in achieving sustainable development within the radiology departments at governmental hospitals in GS. The current results indicate that neither risk management nor sustainable development are considered in radiation department.

Table (4.13): One-way ANOVA results regarding educational level of employees

Factor	Test of Homogeneity of Variances		F-test	P-value (Sig.)
	Levene Statistic	P-value (Sig.)		
Risk Management	0.326	0.722	1.174	0.325
Sustainable Development	1.272	0.284	2.609	0.057

4.5.2 The differences in the opinion due to years of experience

ANOVA was used to test the differences among opinions of respondents with respect to their years of experience (Less than 5, 5 – 10 years, 11 – 15 years, and More than 15 years). According to the results of the test showed in Table (4.14), the P-value for the Levene's test is greater than 0.05 in each field. Thus, the variances of the groups are not significantly different (the groups are homogeneous). Regarding to F- test, the significance values for each field are not significant (P-value > 0.05). Thus, there are no statistically significant differences due to years of experience at the level of $\alpha \leq 0.05$

toward the role of risk management in achieving sustainable development within the radiology departments at governmental hospitals in the GS.

Table (4.14): One-way ANOVA results regarding years of experience of employees

Factor	Test of Homogeneity of Variances		F-test	P-value (Sig.)
	Levene Statistic	P-value (Sig.)		
Risk Management	1.322	0.270	0.278	0.841
Sustainable Development	1.741	0.174	1.254	0.274

4.6 The outcome of the researcher's findings from the questionnaire and KII result:

- The final results of the questionnaire indicated that the radiation departments determined the protection requirements of the employees to reduce the risk of radiation. This was confirmed by the results of interviews conducted by the researcher. Where, the results of KII showed that all heads of departments said that the sections provided the employees with radiation protection equipment.
- The results of the questionnaire and interviews with heads of radiation departments were in agreement in terms of the absence of a committee specialized in risk management operations in the radiation departments that has the responsibility for identifying, evaluating, analyzing and prioritizing risks from the administrative side. In other word, there is no risk management within the radiation departments of the six main hospitals in Gaza Strip.
  On contrary, the head of technical department in MoH confirmed that there is a specification for these risks in the departments of radiation, but there are failures among the employees and heads of department in avoiding these threats.
- The results of the questionnaire showed that the hospital management is responsible for issuing the risk management policy in the radiation departments more than the other administration.

- The results of the questionnaire showed that radiation departments don't complies with the standards of the International Protection Committee. This was confirmed by the results of interviews conducted by the researcher. Where, the results of KII showed that some of heads departments attributed this lack of safety standards to the absence of a committee to follow up all risks that affect the vocational safety of the employees of radiation departments. Also, they attributed this lack to the absence of continuous censorship for prevention and safety to ensure work continuity.
- The results of the questionnaire showed that radiation departments don't measures occupational risks. On the other hand, the results of KII showed that there is no periodic medical tests (checks) to the employees of radiation departments as a result of lack of a program to explain the mechanism and quality of tests, that may show the effects of these radiation on the employees.
- The results of the questionnaire showed that a large number of employees in radiation departments of the MoH do not have a special TLD to measure the dose of radiation exposure at work. This result is close to the percentage of those with less than 10 years of experience. Also, a large proportion of the workers in the radiation departments are not informed with the periodic exposure to radiation.
- The results of the questionnaire showed that radiation departments don't measures occupational risks. In the same context, the result of KII showed that there are no periodic medical tests to the employees of radiation departments as a result of lack a program to explain the mechanism and quality of tests, that may show the effects of these radiation on the employees.
- The results of the questionnaire showed the agreement of the majority of employees in the radiation departments for the importance of sustainable development. As well as, there is a consensus among heads of departments that the MoH has a policy to move towards sustainability in providing the service in the radiation departments. But there are some of impediments to sustainable development because of the difficulty of political and economic circumstances. In addition, there is no clear development plan to implement risk management policy in the MoH, as the Ministry current accreditation depends on projects submitted by donors.

4.7 Risk Management in the light of these findings

4.7.1 Risk Management

Initially, the risk management and development of radiology is primarily developed to help and protect patients, employees members and the entire organization (ESR, 2015).

Risk management is to identify, assess and prioritize risks followed by the coordinated and economic application of resources to reduce the likelihood, impact and threats of unfortunate events or to limit opportunities. The goal of risk management is to ensure that uncertainty does not distort the endeavor of business objectives (Abudulnabi, 2018).

Risk management allows radiologists to focus on risk mitigation measures. This ensures that medical personnel follow appropriate and relevant protocols and guidelines for risk reduction in radiation departments (RCR, 2017).

In the following, the researcher will illustrate the key areas required for risk management steps and how we can achieve sustainability and human protection through risk identification, risk assessment, risk analysis, matrix for prioritizing risks and how to deal with them. In addition, the researcher will illustrate some of the methods, standards and recommendation for business continuity and employee's safety.

4.7.1.1 Risk Identification

The first step in risk management is to identify risks. In identifying risks, the researcher considered all risks and events within the radiation departments from the perspective of different risk categories and then started to identify those that are likely to have a significant negative impact on the employees and department. The researcher then considered the potential consequences if a risk occurs.

The chosen method of risk identification may depend on culture, occupational practices and compliance. Selection methods are created from templates or templates are developed to determine the source, problem, or event (Western Sydney University, 2015).

By reviewing the literature in addition to the work experience of the researcher in the field of diagnostic radiation, he identified the most risks that may be exposed to employees in the departments of radiation and have a negative impact on the continuity of work.

1. Radiation dose
2. Overload work
3. Equipment damage
4. External factors
5. High voltage electricity

4.7.1.2 Risk assessment process

The next stage is to study the overall risks posed by these risks is risk assessment which begins by examining the impact of specific risks on life and health, in addition to radiation equipment. Probability should also be taken into account and the resulting judgment should be recorded in the risk matrix in the next stage (MEM, 2010).

The purpose at this stage is to determine the nature of the harm that may result from the hazard, the consequences of that harm and likelihood of this occurring by using risk matrix.

Through the depth interviews conducted by the researcher with a number of heads and directors of the radiation departments, to estimate the effects of these risks and possibility of recurrence within one year.

During the interviews, the researcher used a five-step scale to describe both consequences and likelihood as follows:

A. Consequences: The impact of a risk and the negative consequences that would result (Table 4.15).

Table (4.15): The impact of a risk and the negative consequences.

Consequences	Negligible	Minor	Moderate	Major	Extreme
Scale	1	2	3	4	5

B. Likelihood: The probability of the risk occurring (Table 4.16).

Table (4.16): The probability of occurrence.

Likelihood	Rare	Unlikely	possible	Likely	Almost certain
Scale	1	2	3	4	5

4.7.1.2.*1*Risk Matrix

The purpose at this stage for risk assessment is considered through (Risk = likelihood × Consequences) matrix. The process requires the outcome from the risk assessment to be recorded and inserted in the box judged to be most appropriate for the functional area under consideration. Table (4.17) shows the degree of severity of risk for each hazard identified in advance based on the consequences and likelihood.

Table (4.17): The severity of risk, which may occur.

Likelihood		Consequences				
		Negligible	Minor	Moderate	Major	Extreme
	Rare					
	Unlikely				8 High voltage electric	
	Possible				12 Equipment damage	
	Likely				16 Radiation dose	
	Almost certain		10 Overload work	15 External factors		

After conducting the risk matrix for each risk, the researcher conducted a matrix that included all the risks identified in order to determine the degree of threat and prioritize the control and treatment processes. Table (4.18) illustrates a matrix that included all the risks identified and show the impact level for each risk. Table (4.19) shows the factors by a score, and color for each score that indicate the degree of impact level and Table (4.20) illustrates the impact level for the risk and its control degree.

Table (4.18): Matrix of all the risks and the impact level for each risk.

RISK TYPE	RISK DESCRIPTION	RISK CONSEQUENCES	RISK LIKELIHOOD	IMPACT LEVEL
RADIATION DOSE		Major	Likely	HIGH
OVERLOAD WORK		Minor	Almost certain	MEDIUM
EQUIPMENT'S DAMAGE		Major	Possible	MEDIUM
EXTERNAL FACTORS		Moderate	Almost certain	HIGH
HIGH VOLTAGE ELECTRIC		Major	Unlikely	LOW

Table (4.19): The risk factors by a score and its color that indicates the degree of impact level.

Risk factors	Score
Very low	1 – 4
Low	5 – 9
Medium	10 – 14
High	15 – 20
Very high	21 – 25

Table (4.20): *The impact level for the risk and its control degree.

Low risk	Manage by routine procedures
Medium risk	Manage by specific monitoring or audit procedures
High risk **Very high risk** **Catastrophic risk**	This is serious and must be addressed immediately. The magnitude of the consequences of an event, should it occur, and the likelihood of the event occurring, are assessed in the context of the effectiveness of existing strategies and controls.

***(Australian Guidelines for the Prevention and Control of Infection in Health Care (NHMRC), 2010)**

4.7.1.2.2Elements at risk

Are the most vulnerable. In this study, the researcher focuses on the employees in the radiation departments, as well as the radiological equipment at the six main governmental hospitals in GS. These risks are illustrated in Figure (4.1).

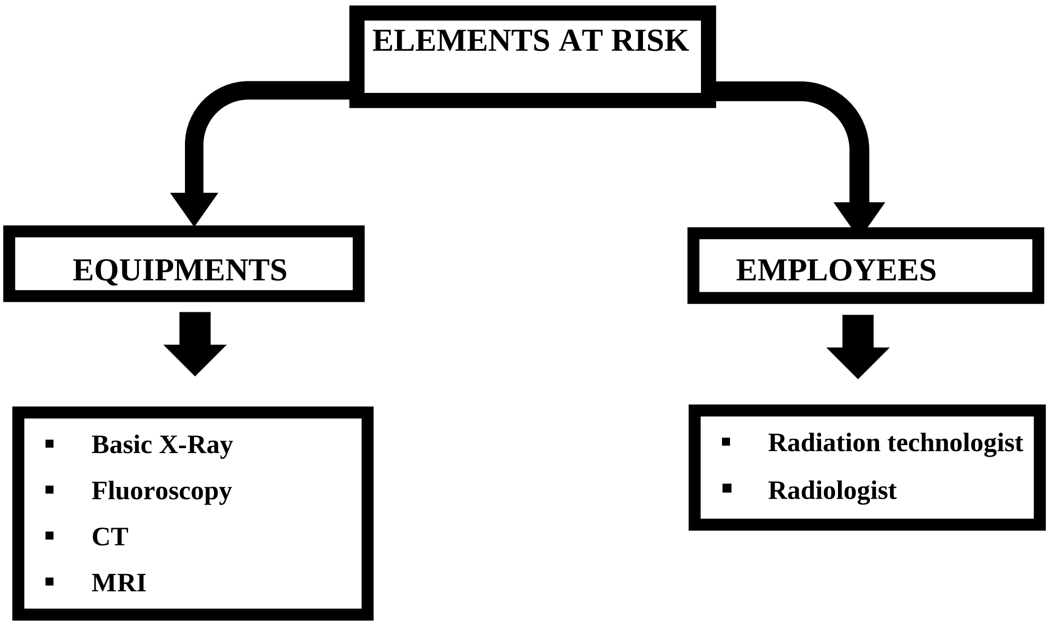


Figure (4.1): The elements of risk at the radiation departments

(self-developed)

4.71.2.*3* Vulnerability

In the current study, the researcher defined vulnerability as the lack of knowledge and awareness among the employees in the radiation departments of the risks identified in the study. In addition, the lack of protection and prevention tools and the weakness of the diagnostic radiology equipment were considered and analyzed.

The results of the questionnaire and interviews revealed that there is a severe shortage in the subject of radiation protection because there are insufficient protective devices and measuring devices for radiation dose. The work overload increases the exposure of employees to radiation and threat radiation equipment plus to external threat factors.

Thus, the radiation departments suffer from fragility at the level of employees and equipment that may affect on the continuity of work and safety of employees, and cause a barrier to sustainable development.

4.7.1.3 Risk analysis

According to the risk assessment across the risk matrix, there are high risks that have a serious impact on the health and safety of employees in the departments of radiation, as well as their impact on the continuity of work and the provision of radiographic service. As evidenced by the results of interviews that a relationship between these risks may increase impact each other.

The risk matrix showed that the highest risk of radiation sections was the risk of radiation dose and risk of external factors, with a difference in the consequences of risk and likelihood of risk. On the other hand, although the risk consequences of the radiation dose are higher than the risk of external factors, but they are equal in terms of the importance of the risk, because the recurrence of the risk of external factors was greater than the recurrence of radiation exposure, and this does not mean equal in terms of risk to the safety of employees and continuity of work. When prioritizing risk management, the risk of radiation exposure is more prioritized than the risk of external factors.

Moreover, the risk matrix was equal to both the risk of work pressure and equipment damage in the radiation sections in terms of the importance of risk, with a difference in the consequences of risk and likelihood of risk. On the other hand, although the risk consequences of the equipment damage are higher than the risk of overload work, because the consequences of the risk of equipment damage was greater than the consequences of the risk of overload work, and this does not mean equal in terms of risk to the safety of employees and continuity of work. When prioritizing risk management, the risk of overload work is more prioritized than the risk of equipment damage.

The priority of the risk of overload work was obtained from the results of the interviews showed that there is a positive relationship between increased overload work and increase radiation exposure and a positive relationship between increased overload work and the increase of the likelihood of damage equipment.

Finally, the risk matrix showed that the least impact of the risk was high-voltage electricity risk. The consequences of this risk are great, but the frequency of occurrence of the risk was small and the researcher attributed this to the results of the questionnaire. Where the results showed that the departments of radiation used methods of prevention of this risk. In order to manage risk, management priorities must be prioritized for all identified risks according to risk analysis and their relationship with each other. As in the following hierarchy (4.2)

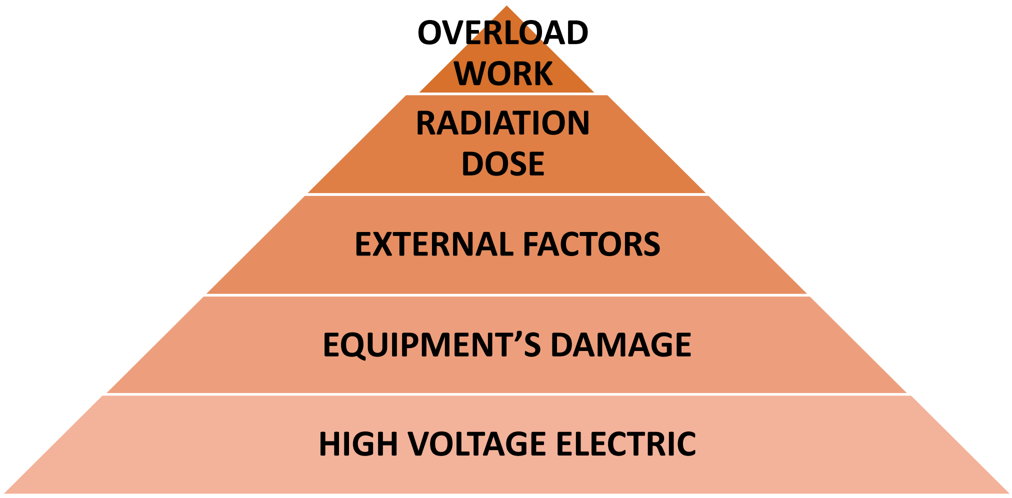


Figure (4.2): Hierarchy of the priorities for risks to be controlled

(self-developed)

The top of the pyramid represents the danger of great priority because of its impact on other risks, while the bottom of the pyramid represents the risk of low priority because of the scarcity of occurrence.

4.7.2 Risk Control and Resolution to achieving sustainable development

4.7.2.1 Risk of overload work

The risk of overload work was considered to be the highest priority and needed to be managed to reduce this risk and the consequent risks such as increased radiation exposure and equipment damage, it is necessary to develop viable solutions in order to preserve the safety of employees and ensure continuity of work in all circumstances.

According to the results of the questionnaire, which showed the view of the majority of respondents about reducing the pressure of work through a good clinical examination may limit the increase of the work of radiation tests. And through the work of the researcher in one of the sections of radiation studied by the study, it must be set a protocol to examine the radiation through:

1. Make a file for each patient to be archived in order to reduce the frequency of radiographic imaging during outpatient review.
2. The establishment of a computer network between hospitals to reduce radiographic re-imaging when moving between hospitals.
3. Forming a committee of specialists in order to raise awareness about the dangers of radiation and its negative consequences.
4. Specialized courses for doctors in order to determine the best radiological positions of imaging, which help diagnosis without asking for more than a radiological image.
5. Determine the number of cases that the radiologist and the RT will perform the examination in one working day.
6. Establishment of radiation rooms of a size and number commensurate with the population density in each region.
7. Adopting occupational safety standards for radiation imaging, applying them in all radiation departments and forming a specialized committee to monitor their implementation.

4.7.2.2 Risk of radiation dose

The risk of radiation exposure is a recognized risk in the departments of radiation because of its clear threat to human health, whether in the short and long term. Therefore, specialized strategies should be used to prevent occupational radiation as much as possible through:

- A strategy that depends on the balance of the risks and benefits of radiation for imaging to reduce exposure to radiation.
- Apply some of the factors by which the dose of exposure to radiation can be reduced such as:
  1. **Time:** The absorbed radiation dose is directly proportional to the exposure period of a person to the radiation source. So, the reducing exposure period to half will reduce radiation exposure by half.
  2. **Distance:** The dose of absorbed radiation is inversely proportional to the distance, and according to the reverse squared law, when the distance between the source of radiation and a person is doubled, the absorbed dose decreases and reaches 25% of the basic dose.
  3. **Protection shields**: Protective shields reduce radiation exposure through the use of shields and barriers made of lead material, where it absorbs the radiation leaking from the device as well as secondary radiation completely or reduce its energies (Metwally, 2015).
- Use the philosophy of allowing only a reasonable amount of damage by using the concept of (ALARA) which mean As Low As Reasonably Achievable (Metwally, 2015).
- Radiologists should ensure that they receive appropriate training on any new technique to reduce the dose resulting from repeated radiographs. As part of the Organization's risk management policy, adequate funding must be made available for all additional training required (European Society of Radiology, 2007).
- Radiation departments should adopt basic radiation protection standards, such as ICRP standards.

4.7.2.3 Risk of external factors

There are a number of external factors that may have a negative impact on the radiation departments. The researcher studied the most impact factors such as the blockade imposed on the GS and the energy crisis, fuel and repeated Israeli aggressions.

To control these risks, a contingency plan should be developed for hospitals in general. This plan includes radiation sections. Also, the plan should include the following:

- Coordination between governmental hospitals close to each other, if any, or with private hospitals, in order to continue to provide radiation services during times of Israeli attacks or the disruption of radiological devices.
- Coordination with suppliers of radiation equipment to provide continuous spare parts and periodically check equipment to determine their efficiency.
- Coordinating with the supporting institutions and donors to replace the old equipment with modern equipment and constantly updating the programs.
- Coordination with the fuel companies to provide quantities needed to operate the generators at all times, especially the times of Israeli closures and lack of fuel.
- Providing alternatives to electric power either using generators or solar energy, which ensures the continuation of the work of equipment during the power outages.
- Providing UPS devices for each device separately to prevent power outages of radiation equipment in order to preserve the safety of the devices and non-re-tests of radiography, which reduces radiation exposure of employees.

4.7.2.4 Risk of equipment damage

The equipment are the medical machines which perform for medical imaging such as (conventional radiography, fluoroscopy, computed tomography) and the damage means a failure in this equipment prevents it from providing its own service.

As evidenced from the results of the interview, there is a direct relationship between increasing the number of daily radiation tests and increasing the likelihood of damage to radiation equipment. In addition, there is the effect of external factors such as sudden power outages, which caused damage to some radiation equipment.

To control these risks, a safety mechanism must be put in place to reduce equipment overload by reducing overload working pressure and providing UPS equipment to keep the equipment running at a sudden power outage. Radiation departments should create a paper to record the errors and repeated alerts that appear on the equipment in order to facilitate repairs and updates.

To control these risks, periodic updating of radiation equipment should be made to avoid the risk of damage to this equipment. Where the European Society of Radiology (ESR) is promoting the use of up-to-date equipment, especially in the context of the EuroSafe Imaging Campaign, as the use of up-to-date equipment will improve quality and safety in medical imaging (ESR, 2014).

In addition to, equipment up to 5 years old is known to reflect the current state of technology and provide opportunities for economically reasonable upgrade measures. Equipment between 6 and 10 years old is still usable if properly maintained, but requires the development of alternative strategies. Equipment older than 10 years is no longer a modern equipment and must be replaced. It is recommended to have at least 60% of the equipment installed in radiology sections up to 5 years old. Age must be 30% of the age of 6 to 10 years, while more than 10% of the equipment must be greater than 10 years (European Coordination Committee of the Radiological, 2009).

4.7.2.5 Risk of high voltage electricity

It is known that the radiation equipment needs high voltage electricity for the operation, where the work of electrical wiring during the design period of the sections of radiation, and this requires the adoption of special engineering specifications that provide protection to employees, so that these extensions are covered by means of protection and far from accessible to employees and patients. In addition, signs, warning signs and alarms are placed indicating the danger of electricity Figure (4.3).

Figure 4.3: Symbol for the danger of electricity

(Electrical Safety forum, 2019)

There are some guidelines to avoid high voltage electricity hazards:

1. Preview the fittings continuously while working.
2. Ensure the presence of insulation materials on the devices.
3. Isolating high pressure devices from other devices, and not allowing non-specialists to access them.
4. The removal of flammable substances (gases, chemicals, etc.) from the locations of electrical appliances for fear of fires.
5. Refrigeration of some electrical devices with appropriate fluids to reduce their temperature, and not to expose electrical devices and components to moisture, dust and gases.
6. Provide appropriate fire extinguishing equipment and distribution to cover all work places, especially hazardous ones (Arab British Academy for Higher Education, 2019).

Chapter 5

Conclusion and Recommendations

5. Conclusion and Recommendations

5.1 Conclusion

The risks management are essential for safety provision for employees and preserving equipment at all radiation departments. Qualified employees and appropriate management increase safety, productivity and quality of services provided to patients. This study was carried out to assess the role of risk management within radiation departments at governmental hospitals in Gaza Governorates and possibilities of achieving of sustainable development. This study may provide guidance to the decision makers in order to manage the risks of radiation departments. The researcher utilized an observation, analytical cross-sectional design with a triangulated approach. (quantitative and qualitative survey approach has been adopted). A self-developed questionnaire were chosen as research technique to measure objectives. In addition, key informants' interviews were used as qualitative part to enhance and strengthen quantitative results. Personal delivery for the whole sample helped to increase the rate of response and thus the representation of the sample. The high response rate (91.33%) ensured subjects interesting and high validity of the study findings.

Human resources were assessed in the current study based on several questions through face-to-face interviews with RTs and radiologists at government hospitals and through a personal interview with some heads of radiation departments and head of the technical department at the MoH. Three-quarters of RTs and radiologists were male, 55.5% were under 40 years of age, 81% were permanent employees with a bachelor's degree and 15.3% have master's degrees, more than 60% of employees have more than 10 years' experience, 63.5% of them have TLDs, 38.7% notified of reading it. Comparing between radiation departments capacities of the six major hospitals, Al-Shifa Hospital has the largest employees' number because it covers the largest demographic area in the GS. Significant risks on employees was remarked in all radiation departments at governmental hospitals, especially due to overload of work and possibility of exposing to ionizing radiation.

The availability of risk management, existence of criteria for medical imaging practice and possibilities of sustainable development were checked based on arbitrated questionnaire filled in six governmental hospitals. In addition, interviews were held with a number of departments heads and the director of the technical department at the

MoH in order to obtain more accurate and in-depth information about the objectives of the study, as well as in order to obtain estimates of the probability of the occurrence of the risks and the degrees of influence. The researcher benefited from them in the work of risk matrix, which helped in the assessment and analysis of risks, and prioritization of dealing with them by administrative methods.

5.1.1 Risk management

Regarding risk management, the results indicate that the radiation departments do not provide full protection for employees and the quality control process is not performed periodically. Moreover, radiation departments do not comply with the standards of the International Commission on Radiation Protection, as there are no restrictions on radiation exposure to employees that are controlled and monitored.

Furthermore; the radiation departments do not have an internal control system capable of dealing with newly recognized risks arising from changes in the environment, etc. Therefore, there is no special vision for the radiation departments to develop a plan or program to achieve continuity during any emergency event that can occur.

Finally, there is no definition or detection for the risks at radiation departments that could be threat the employees and the work continuity, in other words, there is no risk management within the radiation departments of the six major hospitals in GS. So, without risk management that covers all of its stages at radiation departments it's difficult to achieve sustainable development.

- Concerning to the level of administration responsible for issuing risk management policy in radiation departments, the tendency to choose hospital administration as the body responsible for implementing the risk management policy more than any another department.
- With regard to the issuance of the reports of the radiation departments, it has been noted that the most common reports issued by radiation departments relate to the risk of equipment damage. On the other hand, the proportion of reports about the risk of radiation dose was lower.
- Respecting to the use of risk prediction models, there is a significant lack of use of risk models in radiological sections was reported.

- With regard to the regular risk management technique that used in radiation department, the techniques of number of cases / times used significantly as a means to reduce excessive radiation exposure of employees and reduce the risk of work overload. In addition, the risk of equipment damage is handled by medical engineers as a technique to reduce this risk and ensure continuity of work. While, the risk of external factors such as irregularity of electricity, Israeli attacks, political crises, …etc. are treated in alternative ways. Sometimes, generators are used as a means of continuing work and providing medical services to patients. While in case of Israeli aggressions and political crises, alternative hospitals are used by transferring injuries cases and patients to other hospitals. On the other hand, the most radiation departments in the six main government hospitals rely on a contingency plan for continuity of work as a way to deal with the risk of external factors. Finally, the high-voltage electricity risks were dealt with through the protection approach by insulation and coverage.
- Finally, with respect to the implementation of the risk management policy, there is no reliable risk management policy and no entity implements risk management policies within the radiation departments. So, there is no definition or detection for the risks at radiation departments that could be threat the employees and work continuity. In other words, there is no risk management within the radiation departments of the six major hospitals in GS. Simply, without risk management that covers all of its stages at radiation departments it's difficult to achieve sustainable development.

5.1.2 Sustainable development

Regarding to sustainable development at radiation departments, more than three-quarters of respondents have an idea about concept of sustainable development from different places, most of them through the Internet.

Education of the radiation employees how to protect themselves against radiation risk, and good clinical examination of the patient's condition and the need for radiography are necessary to reduce the randomness and congestion of the radiation sections, and the excessive exposure to radiation. Also, respect rights of protection of others at the radiation department, and preserving of department equipment is necessary for sustainable development.

The majority of employees in the radiation departments agreed on the importance of sustainable development. As well as, there is a consensus among heads of departments that the MoH has a policy to move towards sustainability in providing the service in the radiation departments. But there are some of impediments to sustainable development because of the difficulty of political and economic circumstances. In addition, there is no clear development plan to implement risk management policy in the MoH, as the Ministry current accreditation depends on projects submitted by donors.

5.2 Recommendations

The current study presents important findings that deserve careful consideration and response from decision makers. The researcher strongly recommends that consideration should be given to accommodate the study in future improvement initiatives. Based on the study results, findings and conclusions, the researcher suggests the following recommendations for radiation employees, policy makers and future research studies towards risk management and protection of employees and the sustainability of radiation services at governmental hospitals in GS.

5.2.1 Recommendations for radiation employees

- It is apparent that awareness of this issue is minimal in the radiation departments. Therefore, it is imperative that education with respect to risks management should be introduced in all undergraduate courses, not only the health concerns, but also the legal issues associated with work at radiation departments. Also, heads of departments should provide further training in the workplace with respect to occupational safety and international radiation protection standards (Appendix 14 and 15).
- Development of specific training programs or courses to encourage RTs and radiologists to comply with TLDs usage standards for periodic monitoring of radiation exposure ratios.
- Regular monitoring and review of radiation departments in terms of equipment efficiency, electrical network and necessary protective supplies.
- Undoubtedly, educating radiation employees at governmental hospitals in GS about potential risks and prevention techniques should be a critical element in their training.

- Radiation employees should be familiar with how the equipment works and carry the maximum work of each equipment to achieve sustainable development.

5.2.2 Recommendations for policy makers

- It is necessary to form new committee specialized in risk management to monitor the risks in the radiation departments, and develop contingency plans to facilitate the provision of radiation services and ensure the continuity of work at the times of emergency.
- It is necessary to form national committee specialized to apply radiation protection criteria according to IRCP or IAEA standards (Appendix 14).
- Coordination between the MoH and the Energy Authority for the periodic inspection of radiology equipment and radiation rooms to prevent the occurrence of leakage of radiation.
- Providing UPS devices and use of solar energy to prevent power outages from radiation equipment in order to ensure the safety of equipment and continuity of work.
- Updating radiation equipment periodically to avoid sudden breakdowns.
- Establishment of a mechanism to be implemented within the hospitals of the MoH through which doctors are informed about the good clinical examination and determine the required examination accurately, which helps in the diagnosis of the patients and limits the number of radiation tests and consequently reduce the work overload.
- The radiation departments should issue a timely report. While, administrators and department heads must be attentive and accurate in issuing risk reports in order to maintain employees safety, ensure business continuity and achieve sustainability.
- The government must take all its decisions on the basis of sustainable development, especially when establishing new radiation departments.
- The MoH and radiation departments should organize a number of courses (courses include for example, radiation protection, good practices and emergency management) to achieve sustainable development through protection of both employees and radiation equipment, and ensuring business continuity.

- Working on linking the radiation departments at governmental hospitals with each other's and with non-governmental hospitals with a computer network that enables patient follow-up and achieving sustainable development.

5.2.3 Recommendations for future research studies

- Conducting similar study for other risks impact the radiation departments at governmental hospitals such as risk of infection, contamination, ...etc.
- Conducting similar study for emergency management in radiation departments at governmental hospitals to deal with the current emergency events.
- The researcher recommend following radiation employees at governmental hospital in the future (follow up studies) to provide further understanding to the role played by risks management in achieving sustainable development and business continuity.

The Reference List

Abudulnabi, H. M. (2018). *THE APPLICATION OF RISK MANAGEMENT IN BUILDINGS PROJECTS IN LIBYA.* india: Allahabad-211007.

Abu-lughod, I. (1971). *The Transformation of Palestine.* Evanston: North-Western University Press.

ACR. (2013). *Practice guidelines and technical standards*. Retrieved 12 3, 2018, from American College of Radiology: http://www.acr.org/Quality-Safety/Standards-Guidelines

ACR. (2018). *Practice Management Quality Informatics / What Is a Radiologist?* Retrieved sep 04, 2018, from American College of Radiology: https://www.acr.org/Practice-Management-Quality-Informatics/Practice-Toolkit/Patient-Resources/About-Radiology

Arab British Academy for Higher Education. (2019, march 3). *Occupational safety of electricity hazards*. Retrieved from https://www.abahe.uk/occupational-safety-enc/66912-occupational-safety-risks-of-electricity.html

ASRT. (2015). *careers-in-radiologic-technology*. Retrieved February 07, 2018, from Who Are Radiologic Technologists?: https://www.asrt.org/main/careers/careers-in-radiologic-technology/who-are radiologic-technologists

(2010). *Australian Guidelines for the Prevention and Control of Infection in Health Care (NHMRC).* Australia: National Health and Medical Research Council (NHMRC).

Aven. (2011). On some recent definitions and analysis frameworks for risk, vulnerability, and resilience. Risk Analysis. *International Journa*, pp. 515-522.

Baker, T.L. . (1994). *Doing Social Research (2nd Edn.).* New York: McGraw- Hill Inc.

Barsh, A. A. (2017). *Israeli Policies and their Repercussions for the Health Sector in the Palestinian Territories (1994 – 2014).* gaza: Al Azhar university.

Briggsb Kamara M. A., Okoye P. C. , and Omubo-Pepple V. B. (2013, 4 1). Radiation safety awareness among patients and radiographers in three hospitals in Port Harcourt. *american journal of scientific and industrial research*, pp. 83-88.

Briggs-Kamara M. A., O. P.-P. (2013). Radiation safety awareness among patients and radiographers in three hospitals in Port Harcourt . *Am J Sci Ind Res* , pp. 83-88.

Brundtland. (1987). What is sustainable development. *Our common future*, pp. 8-9.

Canadian Association of Radiologists . (2013). *Lifecycle guidance for medical imaging equipment in Canada*. Retrieved 12 2, 2018, from http://www.car.ca/uploads/standards%20guidelines/CAR-LifecycleGuidance-MainReport-e_20131127.pdf

Cervone, H. F. (2006). Project risk management. *International digital library perspectives*, pp. 256-262.

Conrow, E. H. (2003). *Effective risk management: Some keys to success.* Vancouver, Canada: AIAA, Reston.

Craciun, H. M. (2015, 7 6). Risk management in radiology departments. *World journal of radiology*, p. 134.

Deba, N. H. (2017). *The repercussions of the Israeli siege on the Gaza Strip from the social point of view.* gaza: Gaza Center for Studies and Strategies.

Dolores Ma. Tongco C. . (2007). *Purposive Sampling as a Tool for Informant Selection Department of Botany.* Manoa: University of Hawai`i .

Electrical Safety forum. (2019). Retrieved from Electrical Safety Symbols Explained: https://www.electrical-safety-forum.com/electrical-safety-symbols

ESR . (2014). *Eurosafe Imaging* . Retrieved 12 4, 2018, from http://www.eurosafeimaging.org/

ESR. (2015). *Insights into imaging*, pp. 141-155.

ESR. (2015, 6 28). *Risk management in Radiology in Europe.* Retrieved 11 30, 2018, from The European Society of Radiology: http://www.myesr.org/html/img/pool/ESR_2006_IV_Riskmanagement_Web.pdf

European Commission . (2012). *Criteria for acceptability of medical radiological equipment used in diagnostic radiology, nuclear medicine and radiotherapy*. Retrieved 12 3, 2018, from Radiation protection no. 162: http://ec.europa.eu/energy/nuclear/radiation_protection/

European Coordination Committee of the Radiological. (2009). Retrieved 12 3, 2018, from Age profile 2009, Diagnostic medical imaging devices: http://www.cocir.org/site/fileadmin/Publications_2009/new_members_ws_-_del._3_-_cocir_age

European Society of Radiology. (2007). *Risk Management in Radiology in Europe.* Austria: European Society of Radiology.

Field, A. . (2009). *Discovering Statistics Using SPSS, 3rd Edition.* SAGE Publications Ltd.

Garson, G. D. . (2013). *Testing statistical assumptions.* NC: Statistical Publishing Associates.

Gerali, M., Paikopoulou, D., & Servitzoglou, M. . (2015, 4 2). Sustainable Development in Healthcare. *International Journal of Reliable and Quality E-Healthcare (IJRQEH)*, pp. 31-38.

Ghauri, P. N., & Gronhaug, K. . (2010). *Research Methods in Business Studies, 4th Edition.* New York: Financial Times Prentice Hall.

Goldstein. (2002). *Training in Organizations: Needs Assessment, Development and Evaluation.* Wadsworth: Belmont.

Holden, R. J. (2011). A human factors framework and study of the effect of nursing workload on patient safety and employee quality of working life. *BMJ quality & safety*, pp. 15-24.

IAEA. (2019, march 21). *pregnant women*. Retrieved from https://www.iaea.org/resources/rpop/.../radiology/pregnant-women

ICRP. (2011). Annals of the ICRP. In O. C.-B. Madan M Rehani, *Radiological protection in fluoroscopically guided procedures performed outside the imaging department* (pp. 22-33). ICRP.

IFRC. (2018). *disaster-management / What is vulnerability* . Retrieved sep 05, 2018, from International Federation of Red Cross : http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/what-is-a-disaster/what-is-vulnerability/

IISD. (2018). *sustainable-development*. Retrieved 9 18, 2018, from International institute for sustainable developement: https://www.iisd.org/topic/sustainable-development

IRMI. (2018). *International Risk Management Institute*. Retrieved sep 05, 2018, from risk control: https://www.irmi.com/term/insurance-definitions/risk-control

ISO. (2017, 7). *ISO 31000*. Retrieved 9 16, 2018, from ISO 31000: http://praxiom.com/iso-31000-terms.htm

Jabareen. (2008). A new conceptual framework for sustainable development. Environment. *development and sustainability*, pp. 179-192.

Jensen, U. (2002). Probabilistic risk analysis. *foundations and methods.*

Jonas. (2011). *types-of-medical-imaging*. Retrieved April 18, 2018, from Understanding Medical Radiation.: http://www.medicalradiation.com/types-of-medical-imaging/imaging-using-x-rays/computed-tomography-ct/

Khan A. R., &. S. (2011). *Knowledge of Radiographiers about radiation protection procedures.* PeshawarPakistan: Journal of Postgraduate Medical Institute vol. 20.

Krupinski E., J. (2008). *Evaluation Of Medical Imaging Systems.* Medical Physics.

Levene, Howard . (1960). Robust tests for equality of variances. *In Ingram Olkin; Harold Hotelling; et al. Contributions to Probability and Statistics: Essays in Honor of Harold Hotelling* (pp. 278–292). Stanford University Press.

Ling, T., Pedersen, J. S., Drabble, S., Celia, C., Brereton, L., & Tiefensee, C . (2012). *Sustainable Development in the National Health Service (NHS).* UK: RAND EUROPE.

McGraw-Hill. (2002). *medical- dictionary*. Retrieved 9 17, 2018, from Concise Dictionary of Modern Medicine: http// medical-dictionary.thefreedictionary.com

Melody, A., and Hertzog. (2008). *Considerations in determining sample size for pilot studies.* Research in Nursing and Health 31 (2).

MEM. (2010, JANUARY). *A GUIDE TO RISK ASSESSMENT IN MAJOR EMERGENCY MANAGEMENT.* Retrieved from A Framework for Major Emergency Management: mem.ie/wp-content/uploads/2015/.../A-Guide-to-Risk-Assessment.pdf

Messano, G. D. (2014). Past and present of risk management in healthcare. *SANITÀ PUBBLICA*, pp. 421-427.

Metwally, S. (2015). *X - ray benefits and risks.* Riyadh: King Abdulaziz City for Science and Technology.

MoH. (2015). *annual report of hospital in the gzaz strip.* palestin: Palestine health information system.

MoH. (2017). *Annual report of hospital in the Gaza Strip.* Gaza, Palatine: Palestine health information system.

MoH. (2018). *Special report on the Israeli aggressions against participants in the peaceful return marches.* gaza: ministry of health.

Moir, Deborah. (2005, july 12). workshop on guiding public health policy in areas of scientific. *radiation pratection*.

Naoum, S. G. . (2007). *Dissertation research and writing for construction students, 2nded.* Oxford: Butterworth-Heinemann.

NDT. (2018). *Nondestructive Testing /Radiography/xraygenerators*. Retrieved novamber 2, 2018, from EducationResources: https://www.nde-ed.org/EducationResources/HighSchool/Radiography/xraygenerators.htm

Olisemeke B, C. Y. (2014, 6 27). The effectiveness of service delivery initiatives at improving patients' waiting times in clinical radiology departments: a systematic review. *Journal of digital imaging*, pp. 751-778.

OSHA. (2019, march 22). *GuideOSHA.* Retrieved from https://www.osap.org/page/GuideOSHA

Paloniemi, S. (2006). Experience, competence and workplace learning. *Journal of workplace learning*, pp. 439-450.

Pandey, A., Singh, M., Sen, A., Rane, D. M., & Sonawane, A. U. (2016). *Risk Assessment andManagementof Radiation Safety in Industrial Applications of Ionizing Radiation.* India : Radiological Safety Division, Atomic Energy Regulatory Board, Niyamak Bhavan, Anushakti Nagar, Mumbai 400094.

PCBS. (2015). *Population, Housing units, Building and Establishment.* Ramallah-Palestine: Palestinian Central Bureau of Statistics.

PCBS. (2017). Ramallah-Palestine: Palestinian Central Bureau of Statistics.

Pereira A., V. L. (2015). Solutions in radiology services management. In *a literature review* (pp. 298–304). Radiol Bras.

Ramanathan. (2015). Radiation awareness among radiology residents, technologists, fellows and staff: where do we stand?. *Insights into imaging*, pp. 133-139.

RCR. (2017, 1 10). *Good practice guide for clinical radiologists.* Retrieved 11 30, 2018, from The Royal College of Radiologists: http://www.rcr.ac.uk/docs/radiology/pdf/BFCR(12)1_GoodPractice.pdf

Reboratti. (1999). Territory, scale and sustainable development. *Sustainability and the social sciences*, pp. 207-209.

Robinson, P. J. (1999). Variation between experienced observers in the interpretation of accident and emergency radiographs. *The British journal of radiology*, pp. 323-330.

RSNA. (2018, May 15). *Radiological Society of North America*. Retrieved 10 23, 2018, from radiologyinfo.org: https://www.radiologyinfo.org/en/info.cfm?pg=safety-hiw_09

Sambasivan,M.; and Soon, Y.W. (2007, 5 25). Causes and effects of delays in Malaysian construction industry. *International Journal of Project management*, pp. 517-526.

Sawa News. (2107, 12 28). *palsawa*. Retrieved from https://palsawa.com/post/138179/

Shah A. S., B. N. (2011). *Assessment of radiation protection awareness levels in medical radiation science technologists-a pilot survey.* Peshawar-Pakistan: Journal of Postgraduate Medical Institute V 21.

Shirom, A. N. (2010). Work hours and caseload as predictors of physician burnout: the mediating effects by perceived workload and by autonom. *Applied Psychology*, pp. 539-565.

Siegel. L, .. B. (2008). *Va Design Guide Radiology Service.* Department of veterans affairs veterans' health administration facilities management office.

Smartsheet. (2018, 12 27). *All the Risk Assessment Matrix Templates You Need*. Retrieved from Smartsheet: https://www.smartsheet.com/all-risk-assessment-matrix-templates-you-need

Supreme Council for Environment and Natural Reserves. (2002, march 15). *radiation protection.* Retrieved from Instructions for work in the field of radiation and radiation doses: www.iaea.org/inis/collection/NCLCollectionStore/_Public/39/008/39008901.pdf

Sustainable Development Unit. (2016). Retrieved from Sustainable development in the health and care system e Health Check 2016: https://www.

sduhealth.org.uk/policy strategy/reporting/sustainable-development-inhealth-and-care report-2016.aspx

Thomas, S.J., Weirs (2011). (2004). *Using Web and paper questionnaires for data-based decision-making From design to interpretation of the results.* India: Corwin.

Tomic, W. &. (2008, 1 29). Existential fulfillment and burnout among principals and teachers. *Journal of beliefs & values*, pp. 11-27.

UNCED. (1992, June 7). *United Nations Conference on Environment & Development Rio de Janerio, Brazil, 3 to 14 June 1992.* Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

UNHR. (2012). *corporate responsibility for respect for human rights, explanatory guide.* Geneva: United nations.

US National library of medicin. (2014, 9 18). *Renewal of radiological equipment* . Retrieved 12 4, 2018, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4195838/

Watanabe, K. Y. (2018). The effect of quality of overtime work on nurses' mental health and work engagement. *Journal of nursing management*.

webster dictionary. (2019, 2 7). *webster dictionary*. Retrieved from merriam webster: https://www.merriam-webster.com/dictionary/sustainable

Weir, C. J. (2011). *Language Testing and Validation: An Evidence-Based Approach. Research and Practice in Applied Linguistics.* Palgrave Macmillan: Basingstoke.

Western Sydney University. (2015). *Hazard Identification, Risk Assessment and Control Procedure.* Retrieved 12 1, 2018, from Western Sydney University: https://www.westernsydney.edu.au/__data/assets/pdf_file/0020/12917/12917_Hazard_Identification,_Risk_Assessment_and_control_Procedure.pd

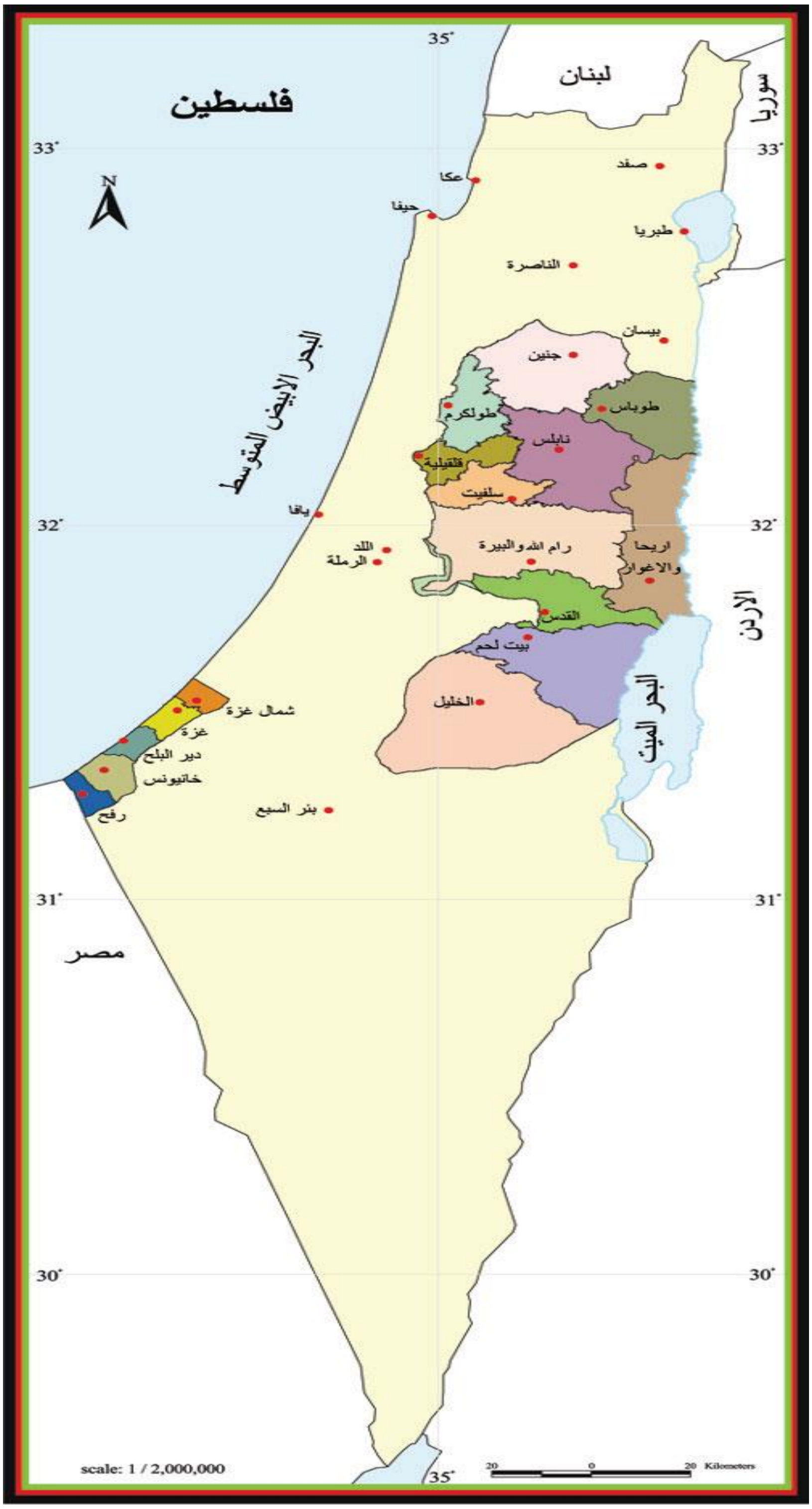
WHO. (2002). *Health and Sustainable Development Key Health Trends.* 1211 Geneva 27, Switzerland: World Health Organization.

WHO. (2015). *Health conditions in the Occupied Palestinian Territory, including East Jerusalem, and in the occupied Syrian Golan.* Geneva: Sixty-eighth World Health Assembly.

WHO. (2018). *Imaging Modalities, Diagnostic imaging.* Switzerland: Avenue Appia 1211.

Appendix

Appendix (1): Map of Palestine



From (PCBS, 2017)

Appendix (2): Location map of Gaza Strip

Appendix (3): distribution of six main governmental hospital in the GS (MoH, 2018).

Item / Hospital	Governorate	Establishment	Employees No.	Radiologists No.	RTs No.	Beds No.
Al- Shifa	Gaza	1946	1892	21	52	470
Nasser	Khan Younis	1960	994	5	29	330
European Gaza	Khan Younis	2000	878	13	30	261
Indonesia	North	2015	440	5	21	110
Shohda Al-Aqsa	Mid Zone	2001	593	6	26	261
Abu Yousef Al Najjar	Rafah	2000	322	3	16	49

Appendix (4): Islamic University approval latter

بسم الله الرحمن الرحيم

الجامعة الإسلامية غزة

The Islamic University of Gaz

FACULTY OF SCIENCE — كلية العلوم

Ref: ج س غ/35/...

Date: 2019/1/29

الأخ الفاضل/ د. رامي العبادلة حفظه الله...

مدير عام تنمية القوى البشرية بوزارة الصحة

السلام عليكم ورحمة الله وبركاته..

الموضوع / تسهيل مهمة

بداية تهديكم عمادة كلية العلوم بالجامعة الإسلامية بغزة أطيب تحياتها، ونرجو من سيادتكم التكرم بتسهيل مهمة الباحث/ **أحمد سعيد مصطفى الهنا** تخصص ماجستير (إدارة الأزمات والكوارث) في الحصول على المعلومات اللازمة لإتمام رسالة الماجستير، وذلك لغرض البحث العلمي.

شاكرين لكم حسن تعاونكم معنا...

عميد كلية العلوم

أ.د. أسعد يوسف أسعد

Appendix (5): MoH approval latter

State of Palestine
Ministry of Health

دولة فلسطين
وزارة الصحة

الموضوع: تسهيل مهمة الباحث/ أحمد الهبا

السلام عليكم ..

محمد ابراهيم محمد العرساوي

Appendix (6): Explanation about the study to the participants

Islamic University-Gaza

Deanship of Graduate Studies

Sciences Department

Disaster and crisis management Master Program

عزيزي المشارك / عزيزتي المشاركة

احيط سيادتكم علما أنني اجري دراسة علمية بغرض استكمال متطلبات الحصول على درجة الماجستير في إدارة الازمات والكوارث من الجامعة الإسلامية بغزة، وهذه الدراسة بعنوان:

دور إدارة المخاطر في تحقيق التنمية المستدامة داخل اقسام الاشعة التابعة للمستشفيات الحكومية في قطاع غزة

The Role of Risk Management in Achieving Sustainable Development within the Radiation departments at Governmental Hospitals in the GS

كما يسعدني مشاركتكم الكريمة في الإجابة على أسئلة الاستبانة مع التأكيد على ان المعلومات ستبقى سرية ولهدف البحث العلمي فقط لذلك لا داعي لذكر الأسماء، علماً بأنه من حق المشارك الامتناع عن إجابة أي سؤال او رفض المشاركة.

مع خالص تحياتي ،،،،،،

الباحث	المشرفون
احمد سعيد الهنا	أ. د / نظام الاشقر
0598882579	د. / ياسر العجرمي

Appendix (7): The Arabic language questionnaire

استبيانة

اولا: أسئلة عامة

معلومات شخصية:

اسم المستشفى:.........................

التاريخ:...../...../........

العمر: .... سنة **الجنس:** ذكر ☐ انثى ☐

محل الاقامة: شمال غزة ☐ مدينة غزة ☐ الوسطى ☐ خان يونس ☐ رفح ☐

الحالة الاجتماعية: أعزب/ آنسة ☐ متزوج/ة ☐ منفصل/ة ☐ أرمل/ة ☐

الدرجة العلمية:

دبلوم ☐

بكالوريوس ☐

ماجستير ☐

دكتوراه ☐

غير ذلك ☐

نوع التوظيف:

تعيين ثابت ☐

عقد خاص ☐

تطوع ☐

سنوات الخبرة: اقل من 5 سنوات ☐ من 5 الى 10 سنة ☐ من 11 الى 15 سنة ☐

أكثر من 15 سنة ☐

المسمى الوظيفي : مدير ☐ رئيس قسم ☐ رئيس شعبة ☐ موظف ☐

طبيعة العمل: طبيب أشعة ☐ أخصائي تصوير طبي ☐

هل لديك جهاز قياس الاشعة الشخصي (TLD): نعم ☐ لا ☐

هل يتم إعلامك بقراءات (TLD) الخاص بك: نعم ☐ لا ☐

متى كانت اخر قراءة لجهاز (TLD): ☐

ثانيا: إدارة المخاطر

يسعى هذا القسم للحصول على معلومات حول أهمية إدارة المخاطر في أقسام الأشعة **(أرجو التكرم بوضع إشارة √ وضع اسفل الخيار الذي يصف الوضع في مؤسستك بشكل أفضل).**

السؤال	لا أوافق	لا أعلم	أوافق
1. يتوفر نظام رسمي لإدارة المخاطر في قسم الأشعة.			
2. توجد هناك إدارة / لجنة مسؤولة عن تحديد ومراقبة مخاطر الإشعاع.			
3. تتوفر لدى قسم الأشعة إرشادات / قواعد داخلية وإجراءات محددة فيما يتعلق بنظام إدارة المخاطر.			
4. يوجد لدى قسم الأشعة نظام تحكم داخلي قادر على التعامل مع المخاطر المعترف بها حديثًا الناشئة عن التغيرات في البيئة، إلخ.			
5. يتبع قسم الأشعة نظام إبلاغ منتظم حول إدارة المخاطر لكبار المسؤولين والإدارة.			
6. إذا كانت إجابتك نعم (سؤال 5)، فهل يقوم قسم الأشعة الخاص بك بإعداد هذه التقارير: يوميا ☐ أسبوعي ☐ شهري ☐ غير ذلك (يرجى التحديد)			
7. مدير القسم هو المسؤول عن مراجعة وتحديد نظم إدارة المخاطر والمبادئ التوجيهية وتقارير المخاطر.			
8. أقسام الأشعة لديها خطط طوارئ ضد الكوارث والحوادث.			
9. يتوافق قسم الأشعة مع معايير لجنة الحماية الدولية للطاقة الذرية.			
10. المشرفون / المسؤولين هم القادرون على تقييم المخاطر الحقيقية الكامنة في قسم الأشعة.			
11. هناك فصل في الواجبات بين أولئك الذين يولدون المخاطر والذين يديرون ويسيطرون على المخاطر.			
12. قسم الأشعة لديه أدوات وإجراءات لحماية الموظف.			
13. يحدد قسم الأشعة الخاص بك متطلبات الحماية الخاصة بك للحد من مخاطر الإشعاع.			
14. تتم مراجعة عملية التحكم والموافقة على إجراءات الحماية بشكل دوري.			
15. يشمل التقرير السنوي لأقسام الاشعة على مخاطر الإشعاع وحوادث العمل.			
16. قسم الأشعة لديه نظام لتقييم أسباب زيادة ضغط العمل.			
17. توجد في اقسام الاشعة مبادئ توجيهية معتمدة لحماية العاملين في القسم.			
18. يتم تحديد ومراقبة حدود التعرض للإشعاع للموظفين.			
19. أقسام الأشعة لديها خطط لتطوير نظام لإدارة المخاطر وتقليل الحوادث.			
20. يتم قياس وتحديد المخاطر المهنية في اقسام الاشعة. إذا كانت إجابتك اوافق، يرجى وضع دائرة حول الفترة الصحيحة: يوميا ☐			

أسبوعي ☐ شهري ☐ سنويا ☐			
21.تصدر سياسة إدارة المخاطر في أقسام الأشعة من خلال المستوى الإداري التالي: •وزارة الصحة ☐ •سلطة الطاقة ☐ •إدارة المستشفى ☐ •الوكالات المتخصصة الخارج ☐			

	22. يقوم قسم الأشعة بإصدار التقارير التالية على فترات منتظمة:	**نعم**	**لا**
1	تقرير مخاطر الجرعة الإشعاعية		
2	تقرير مخاطر العمل المتزايد		
3	تقرير مخاطر تلف المعدات		
4	تقرير مخاطر العوامل الخارجية (انقطاع الكهرباء، الاعتداءات الإسرائيلية، أزمات سياسية..... الخ)		
5	تقرير مخاطر الكهرباء عالية الجهد المغذية للأجهزة		
6	آخرى		

	23. هل يستخدم قسم الأشعة أي نموذج للتنبؤ بالمخاطر ...؟	نعم	لا
1	خطر الجرعة الإشعاعية		
2	خطر العمل المتزايد		
3	خطر ضرر المعدات		
4	خطر العوامل الخارجية (إنقطاع الكهرباء، الاعتداءات الإسرائيلية، أزمات سياسية..... الخ)		
5	خطر الكهرباء عالية الجهد		

	24. ما هي تقنية إدارة المخاطر التي يستخدمها قسم الأشعة بانتظام؟	نعم	لا
1	خطر الجرعة الإشعاعية • نهج (10 - day rule) • نهج (IRPC مفوضية الحماية الدولية من الاشعة) • غير ذلك (وضح)		
2	خطر العمل المتزايد • عدد الحالات / الوقت • معايير السلامة المهنية • أخرى.		
3	خطر ضرر المعدات • نهج هندسي • مدة تشغيل زمنية • اخرى		
4	خطر العوامل الخارجية (انقطاع الكهرباء، الاعتداءات الإسرائيلية، أزمات سياسية..... الخ) • نهج البدائل • خطة طوارئ • اخرى		
5	خطر الكهرباء عالية الجهد • نهج هندسي • نهج وقاية • اخرى		
25	هل يوجد لدى قسم الأشعة الخاص بك سياسة موثقة لإدارة المخاطر؟		

26. من الذي ينفذ سياسة إدارة المخاطر داخل قسم الاشعة الذي تعمل به؟

- رئيس القسم ☐
- متخصص في هذا المجال ☐
- وزارة الصحة ☐
- سلطة الطاقة ☐
- غير ذلك (الرجاء التوضيح) ________________

ثالثا: التنمية المستدامة

1. هل سمعت من قبل بمفهوم التنمية المستدامة؟

نعم ☐ لا ☐

2. إذا كانت الإجابة نعم، فبأي وسيلة سمعت عن التنمية المستدامة؟ هناك عدة خيارات ممكنة هنا:

في المستشفى ☐ من خلال مؤسسة ما ☐ في الاذاعة المرئية ☐

من صديق ☐ في صحف الاخبار ☐ في الاذاعة المسموعة ☐

في المنزل ☐ بواسطة الانترنت ☐

غير ذلك (حدد بوضوح) ....

يسعى هذا القسم للحصول على معلومات حول أهمية التنمية المستدامة **(أرجو التكرم بوضع إشارة √ وضع اسفل الخيار الذي يصف الوضع في مؤسستك بشكل أفضل).**

السؤال	لا اوافق	لا اعلم	اوافق
1. تعتبر التنمية الاقتصادية ضرورية للتنمية المستدامة.			
2. إن تحسين صحة الناس والفرص المتاحة لحياة كريمة يسهم في التنمية المستدامة.			
3. فحص سريري جيد لحالة المريض والحاجة للتصوير الاشعاعي يساعد على تقليل العشوائية والازدحام على أقسام الإشعاع، مما يساعد في استدامة الخدمة.			
4. الحصول على معدات حديثة ومحوسبة لتقليل الجهد والوقت يساعد على الاستدامة.			
5. ثقافة حل الخلافات سلميا من خلال المناقشة في قسم الأشعة أمر ضروري للتنمية المستدامة.			
6. التنمية المستدامة تتطلب منا خفض جميع أنواع المخاطر والحوادث داخل قسم الاشعة.			
7. توصيل أقسام الأشعة في المستشفيات الحكومية والمستشفيات غير الحكومية بشبكة محوسبة تسمح بالمتابعة وتحقيق التنمية المستدامة.			
8. إن تنظيم دورات متخصصة على أساس مستمر للعاملين في اقسام الاشعة يسمح بتطوير نوعية العمل والاستدامة.			
9. يتلقى فنيو صيانة اجهزة الاشعة دورات متقدمة لإصلاح الاعطال الطارئة والحفاظ على سلامة الأجهزة و التي تساهم في الاستدامة.			
10. لتحقيق التنمية المستدامة، يجب على جميع افراد المجتمع الحصول على الوعي الجيد بمخاطر الاشعة.			
11. لتحقيق التنمية المستدامة، يجب على أقسام الأشعة التعامل مع موظفيها بطريقة عادلة.			
12. المحافظة على معدات القسم أمر ضروري للتنمية المستدامة.			
13. إن احترام حقوق حماية الآخرين من مخاطر الاشعة في اقسام الاشعة ضروري لتحقيق التنمية المستدامة.			

السؤال	لا اوافق	لا اعلم	اوافق
14. تتطلب التنمية المستدامة توزيعا عادلا، مثل (المتابعة الدورية للمعدات وطرق حماية الموظفين).			
15. القضاء على المخاطر المرتبطة بأقسام الأشعة أمر ضروري للتنمية المستدامة.			
16. تتطلب التنمية المستدامة تنظيم عدد من الدورات، وتشمل الدورات التدريبية على سبيل المثال (الحماية من الإشعاع، والممارسات الجيدة، وإدارة حالات الطوارئ).			
17. تتطلب التنمية المستدامة أن يفهم موظفين قسم الأشعة وظائف الجهاز وأقصى طاقة تحمل لكل جهاز.			
18. لتحقيق التنمية المستدامة، يجب تخفيض جرعة الإشعاع المهني.			
19. لتحقيق التنمية المستدامة، يحتاج العاملون في قسم الأشعة إلى التثقيف حول كيفية حماية أنفسهم من مخاطر الإشعاع وحوادث العمل.			
20. تعليم إدارة المخاطر يسهم في العمل على نحو مستدام.			
21. أعتقد أنه ينبغي علينا الآن التأكد والعمل من اجل الاجيال القادمة في المستقبل من حيث استهلاك الموارد وحفظ حقهم في المستقبل وانهم سيكونون في وضع جيد كما نحن اليوم.			
22. أعتقد أن وزارة الصحة تتحمل مسؤولية الحد من استخدام الإشعاع عن طريق رفع الوعي بين المجتمعات.			
23. استخدام المزيد من موارد اقسام الأشعة أكثر مما نحتاج إليه لا يهدد صحة الناس أو آفاقهم الطبية في المستقبل.			
24. أننا بحاجة إلى قوانين وأنظمة أكثر صرامة لحماية أنفسنا من جرعة الإشعاع الزائدة.			
25. أن وضع خطة الطوارئ التي تضمن استمرارية العمل خلال حالات الطوارئ تسهم لحد كبير في اعمال التنمية المستدامة.			
26. أعتقد أنه من المهم القيام بشيء ما بشأن المشاكل التي لها علاقة بزيادة ضغط العمل.			
27. يجب على الحكومة أن تقدم المساعدة المالية لتشجيع إدارة المخاطر لجعل مكان العمل اكثر آمنًا.			
28. ينبغي على الحكومة اتخاذ جميع قراراتها على أساس التنمية المستدامة.			
29. يجب على الحكومة أن تستخدم نهج إعادة البناء بشكل أفضل عند التجديد أو إعادة البناء باستخدام معايير السلامة والاستدامة.			
30. أعتقد أن هناك علاقة قوية بين إدارة المخاطر وتحقيق التنمية المستدامة.			

Appendix (8): The English language questionnaire

QUESTIONNAIRE

1. GENERAL

Personal Information

Name of hospital: ....

Job Date: …../......../……….

Age by years: …………….

Gender:
Male ☐
Female ☐

Place of residence:
North Gaza ☐ Gaza City ☐ Mid-zone ☐
KhanYounis ☐ Rafah ☐

Social status:
☐ Single
☐ Married

Certificate:
Doctorate ☐
Master's degree ☐
Bachelor's degree ☐
Diploma ☐
Other: ……….......... ☐

Employment:
☐ Permanent
☐ Contract
☐ Volunteer

Total years of experience: less than 5 y ☐ from 5 to 10 ☐ from 11 to 15 ☐ more than 15 y ☐

Job Title:

Manager ☐ Head Of Department ☐
Head Of Division ☐ Employee ☐

Job Description: Radiation Technologist ☐ Radiologist ☐

Total years of experience: ☐

Having TLD badge: ☐ Yes ☐ No

last reading time: ☐

Are you notified of your TLD readings: ☐ Yes ☐ No

2. RISK MANAGEMENT

This section seeks information about importance of risk management at radiation departments (can you please circle the number that best characterizes the situation in your organization).

Question	Disagree	No opinion	Agree
1. You have formal system of Risk management in radiation department.			
2. There is a section / committee responsible for identifying, monitoring and controlling radiology risks.			
3. The radiation department have internal guidelines / rules and concrete procedures with respect to the risk management system.			
4. The radiation department have in place an internal control system capable of dealing with newly recognized risks arising from changes in environment, etc.			
5. The radiation department have in place a regular reporting system regarding risk management for senior officers and management.			
6. If your answered yes (Q5), does your radiation department prepares these reports on: ▪ Daily ☐ ▪ Weekly ☐ ▪ Monthly ☐ ▪ Other (please specify) ___________________			
7. The manager responsible to review and identify the risk management systems, guidelines and risk reports.			
8. The radiation department have contingency plans against disasters and accidents.			
9. Radiation department complies with the standards of the International Protection Committee.			
10. Supervisors / regulators able to assess the true risks inherent in radiation department.			

Question	Disagree	No opinion	Agree
11. There is a separation of duties between those who generate risks and those who manage and control risks.			
12. The radiation department have tools and procedures for protection of employee.			
13. Your Radiation department determines your protection requirements to reduce radiation risks.			
14. Review and approve control process take place periodically.			
15. There is a disclosure about radiation risk in the annual report.			
16. The Radiation department has a system to evaluate the causes of overworked work quantitatively.			
17. Department of Radiology adopted and utilized guidelines for protection employees.			
18. Radiation exposure limits for employees are set and monitored.			
19. The radiation department have in place a system for managing problems.			
20. Radiation department often measures occupational risk. If your answered yes, please circle the right period: ▪ Daily ☐ ▪ Weekly ☐ ▪ Monthly ☐ ▪ Quarterly ☐ ▪ Yearly ☐			
21. The Risk Management Policy is issued in the Radiology sections through the following management level • MOH • Power Authority • Hospital management • External specialized agencies • Other (*please specify below)* ______________________________			

22. Does the radiation department produce the following reports at regular intervals?

		Yes	No
1	Radiation dose risk report		
2	Over loud work risk report		
3	Equipment damage risk report		
4	External factor risk report (Power cuts, Israeli attacks, political crises, etc.)		
5	High voltage electric risk report		
6	Other ________________		

23. Does the radiation department use any model to predict risk …?

		Yes	No
1	Radiation dose risk		
2	Over loud work risk		
3	Equipment damage rate risk		
4	External factor risk (Power cuts, Israeli attacks, political crises, etc.)		
5	High voltage electric risk		

24. What is the risk management technique your radiation department regularly utilizes?

		Yes	No
1	Radiation dose risk ▪ 10 - day rule approach ▪ IRPC approach ▪ Others ____________		
2	Over loud work risk ▪ Number of case/ Time ▪ Standardized occupational approach ▪ Others ______________		

3	Equipment damage risk ▪ Engineering approach ▪ Duration ▪ Others ________________		
4	External factor risk (Power cuts, Israeli attacks, political crises, etc.) ▪ Alternatives approaches ▪ Emergency plan ▪ Others _____________		
5	High voltage electric risk ▪ Engineering approach ▪ Protection approach ▪ Others ______________		

		Yes	**No**
25.	Does your radiation department have a documented risk management policy?		

26. Who implements the risk management policy?

☐ Head of department

☐ Specialist

☐ MOH

☐ Energy Authority

☐ Other (Please specify) _______________

3. Sustainable development

1. **Have you heard of the notion of Sustainable Development?**

☐ Yes ☐ No

2. **If yes, in what connection have you heard of Sustainable Development? Several alternatives are possible here:**

☐ In hospital.
☐ From friends
☐ In your home
☐ Through an association
☐ In the newspapers
☐ Via the internet
☐ On TV
☐ On Radio

☐ Other, state which……………….

This section seeks information about importance of sustainable development (can you please circle the number that best characterizes the situation in your organization)

Question	Disagree	No opinion	Agree
1. 1.Economic development is necessary for sustainable development.			
2. 2. Improving people's health and opportunities for a good life contribute to sustainable development.			
3.A good clinical examination of the condition of the patient and the need for radiographic imaging helps to reduce the randomness and congestion on the sections of radiation, which helps in the sustainability of the service.			
4.The acquisition of modern and computerized equipment to reduce effort and time helps to sustainability			
5.A culture where conflicts are resolved peacefully through discussion in radiation department is necessary for sustainable development.			
6.Sustainable development demands that we humans reduce all sorts of (Risk).			
7.Connecting radiation departments in government hospitals and non-governmental hospitals to a computerized network that allows for			

Question	Disagree	No opinion	Agree
follow-up and achieves sustainable development.			
8.The organization of specialized courses on a continuous basis for employees in the departments of radiation allows for the development of the quality of work and sustainability.			
9.Radiation maintenance technicians receive advanced courses to repair emergency faults and maintain the safety of devices contributes to sustainability.			
10.To achieve sustainable development, all the people must have access to good radiology awareness.			
11.To achieve sustainable development, radiation departments must treat their employees in a fair way.			
12.Preserving department equipment's is necessary for sustainable development.			
13.Having respect rights of protection of other in your department is necessary for sustainable development.			
14.Sustainable development requires equitable distribution, for example a periodic follow-up of equipment and ways of protecting employees.			
15.Wiping out risk associated with radiation departments is necessary for sustainable development.			
16.Sustainable development demands to organize number of courses (courses include for example, radiation protection, good practices, emergency management).			
17.Sustainable development demands that radiology employees understand how the equipment's			

Question	Disagree	No opinion	Agree
functions and maximum work loud for each machine.			
18.For sustainable development, occupational radiation dose must be reduce.			
19.For sustainable development, radiology employees need to be educated in how to protect themselves against radiation risk.			
20.I think that risk management could be educated in how to work sustainably.			
21.I think that we who are alive now should make sure that people in the future will be as well off as we are today.			
22.I think the MOH has a responsibility to reduce the use of radiation by raising awareness among communities.			
23.Using more X-ray resources than we need does not threaten people's health or medical prospects in the future.			
24.I think that we need stricter laws and regulations to protect our self from excess radiation dose.			
25.I think it is important to put emergency plan that ensure business continuity during emergency incidences.			
26.I think that it is important to do something about problems which have to do with over loud work.			
27.I think the government should provide financial assistance to encourage risk management to make the workplace safe.			
28.I think that the government should make all its decisions on the basis of sustainable development.			
29.I think that the government should be using building back better approach when renewing or reconstruction by using safety standards and sustainability.			
30.I think there is strong relation between risk management and achieving sustainable development.			

Appendix (9): Template for Risk matrix

REF / ID	RISK TYPE	RISK DESCRIPTION	RISK consequences	RISK LIKELIHOOD	IMPACT LEVEL	TRIGGER
			Negligible	Rare	LOW	
			Minor	Unlikely	MEDIUM	
			Moderate	possible	HIGH	
			Major	Likely	VERY HIGH	
			Extreme	Almost certain	Catastrophic	

Low risk	Manage by routine procedures
Medium risk	Manage by specific monitoring or audit procedures
High risk **Very high risk** **Catastrophic risk**	This is serious and must be addressed immediately. The magnitude of the consequences of an event, should it occur, and the likelihood of the event occurring, are assessed in the context of the effectiveness of existing strategies and controls.

(Australian Guidelines for the Prevention and Control of Infection in Health Care (NHMRC), 2010)

Appendix (10): Key informant interview- English

The first part

1. Is there a risk management system within the radiation department?

2. Is there a risk definition that may affect the radiation department and business continuity?

3. Are there occupational safety standards and periodic monitoring that provide protection and prevention and ensure continuity of work within the radiation sections?

4. Are there clear guidelines and a code accessible to employees to deal with risks and occupational safety.

5. Are there periodic reviews and meetings that discuss safety and prevention, implementation of guidance and assessment of the status quo.

6. Is there a periodic health examination for the employees of the radiation department and what is the period?

7. Why are there no TLDs devices for some employees, in addition to not being informed of readings periodically?

8. If there is a shortening and the occurrence of some injuries and disruption to work in the radiation department, from your point of view of the person or entity responsible for it?

9. Is there a policy adopted by the MOH for the promotion and sustainability of the services provided by the radiation departments?

The second part

To prepare the risk matrix, the following percentages for each risk identified should be known. Note, the ratio is calculated in a year.

The first risk: radiation exposure

1. What is the likelihood of radiation exposure by employees? (1 to 5)

2. What is the degree of risk due to continuous exposure to radiation without the use of prevention tools or procedures or due to a defect in the means of prevention? (1 to 5)

The second risk: overload of work

1. What is the degree of increase in the work volume (number of tests) than the normal rate? (1 to 5)

2. What is the degree of the effects of increasing the volume of work that may be reflected on the energy and health of employees? (1 to 5)

Third risk: damage and malfunction of equipment and devices in the radiation department

1. What is the likelihood of faults in the X-ray equipment? (1 to 5)

2. What is the severity of the effects of malfunctions in the radiation department? (1 to 5)

The fourth risk: the risk of external factors such as power outages, Israeli attacks, political unrest, etc.

1. What is the likelihood of the risk of external factors affecting the radiation department? (1 to 5)

2. What are the effects of these factors on business continuity and employee safety? (1 to 5)

The fifth risk: high voltage electricity feeder devices in the radiation department.

1. What is the percentage of accidents resulting from high-voltage electricity feeding devices in the radiation department? (1 to 5)

2. What is the percentage of the effects of high voltage electrical accidents? (1 to 5).

Appendix (10): Key informant interview- Arabic

الشق الاول

1. هل يتوفر نظام لإدارة المخاطر داخل اقسام الاشعة؟
2. هل هناك تحديد للمخاطر التي قد توثر على العاملين في قسم الاشعة وعلى استمرارية العمل؟
3. هل هناك معايير للسلامة المهنية ومراقبة دورية توفر الحماية والوقاية وتضمن استمرار العمل داخل اقسام الاشعة؟
4. هل هناك ارشادات واضحة ومدونة في متناول العاملين للتعامل مع المخاطر والسلامة المهنية.
5. هل هناك مراجعات دورية ولقاءات تناقش سبل السلامة والوقاية وتنفيذ الارشادات وتقييم الوضع القائم.
6. هل يوجد فحص صحي دوري للعاملين في أقسام الأشعة وماهي فترته الزمنية.
7. ما سبب عدم وجود أجهزة قياس التعرض الاشعاعي لدى بعض الموظفين بالإضافة الى عدم ابلاغهم بالقراءات بشكل دوري؟
8. إذا كان هناك تقصير وحدوث بعض الإصابات وتعطل للعمل في اقسام الاشعة فمن وجهة نظرك من الشخص او الجهة المسؤولة عن ذلك؟
9. هل هناك سياسة متبعة لدى وزارة الصحة من اجل الرقى والاستدامة في الخدمات التي توفرها اقسام الاشعة؟

الشق الثاني

لإعداد مصفوفة المخاطر لابد من معرفة النسب التالية لكل خطر تم تحديده. ملاحظة النسبة تحسب تقديريا في العام الواحد.

الخطر الأول: الاشعة المؤينة

1. ما هي نسبة تكرار التعرض للأشعة من قبل العاملين؟ (من 1 الى 5)
2. ماهي درجة الخطورة نتيجة التعرض المستمر للأشعة دون استخدام أدوات وإجراءات الوقاية او نتيجة وجود خلل في وسائل الوقاية؟ (من 1 الى 5)

الخطر الثاني: زيادة ضغط العمل

1. ما هي درجة زيادة حجم العمل (عدد الفحوصات) عن المعدل الطبيعي؟ (من 1 الى 5)
2. ما هي درجة الاثار المترتبة عن زيادة حجم العمل والتي قد تنعكس على طاقة وصحة العاملين؟ (من 1 الى 5)

الخطر الثالث: تلف واعطال المعدات والأجهزة في قسم الاشعة

1. ما هي نسبة تكرار الأعطال الحاصلة في معدات قسم الاشعة؟ (من 1 الى 5)
2. ما هي شدة الاثار المترتبة عن حدوث اعطال في أجهزة قسم الاشعة؟ (1 الى 5)

الخطر الرابع: خطر العوامل الخارجية مثل انقطاع الكهرباء، الاعتداءات الإسرائيلية، الاضطرابات السياسية، الخ.

1. ماهي نسبة تكرار مخاطر العوامل الخارجية المؤثرة على اقسام الاشعة؟ (من 1 الى 5)
2. ما هي نسبة الاثار المترتبة عن هذه العوامل على استمرارية العمل وسلامة العاملين؟ (من 1 الى 5)

الخطر الخامس: الكهرباء عالية الجهد المغذية للأجهزة في قسم الاشعة.

1. ما هي نسبة الحوادث الناتجة عن الكهرباء عالية الجهد المغذية للأجهزة في قسم الاشعة؟ (من 1 الى 5)
2. ما هي نسبة الاثار المترتبة عن حوادث الكهرباء عالية الجهد؟ (من 1 الى 5)

Appendix (11): Questionnaire review experts

NO.	Name	Location
1	Dr. Ahmed Nejim	Al- Azhar university- Gaza
2	Dr. Ehab Nasser	Al- Azhar university- Gaza
3	Dr. Alaa Musalim	University of Science and Technology - Khan Yunis
4	Dr. Abd al Rahman al Shokri	Islamic university- Gaza
5	Mr. Maher Suliman	MOH
6	Mr. Hesham Ahmed	MOH
7	Mr. Rabea Awad	Statistical analyst, Privet sector

Appendix (12): Characteristics of the key informants

NO.	Name	Location	Position	Experiences
1	Mr. Ibrahim Abaas	MOH	Manager of the Technical Department at the MOH	More than 20 years
2	Mr. rafaat Ahmed	MOH	Medical imaging director	More than 20 years
3	Mr. Ahmed Abu Daan	MOH	Medical imaging director	More than 20 years
4	Mr. Abd al salaam Abu Shamali	MOH	Medical imaging director	More than 20 years

Appendix (13): 10-day rule

What is the ten-day rule and what is its status?

It is important for radiology facilities to have procedures to determine the pregnancy status of female patients of reproductive age before any radiological procedure that could result in a significant dose to the embryo or fetus. The approach is not uniform in all countries and facilities. One approach is the 'ten-day rule,' which states that "whenever possible, one should confine the radiological examination of the lower abdomen and pelvis to the 10-day interval following the onset of menstruation."

The original proposal was for 14 days, but this was reduced to 10 days to account for the variability of the human menstrual cycle. In most situations, there is growing evidence that a strict adherence to the "ten-day rule" may be unnecessarily restrictive (IAEA, 2019).

Appendix (14): ICRP

14.1 General principles of radiation protection

- **Time:** distance and shielding (T,D,S) form the key aspects of general protection principles as applicable to the situations within the scope of this document. Time: minimize the time that radiation is used (it can reduce the radiation dose by a factor of 2 to 20 or more). This is effective whether the object of minimization is fluoroscopy time or the number of frames or images acquired.
- **Distance:** increasing distance from the x-ray source as much as is practical (it can reduce the radiation dose by a factor of 2 to 20 or more).
- **Shielding:** use shielding effectively. Shielding is most effective as a tool for employees protection. Shielding has a limited role for protecting patients ‘body parts, such as the breast, female gonads, eyes and thyroid in fluoroscopy (with exception of male gonads).

Justification: The benefits of many procedures that utilize ionizing radiation are well established and well accepted both by the medical profession and society at large. When a procedure involving radiation is medically justifiable, the anticipated benefits are almost always identifiable and are sometimes quantifiable. On the other hand, the risk of adverse consequences is often difficult to estimate and quantify. In the Publication 103, Commission stated as a principle of justification that ―Any decision that alters the radiation exposure situation should do better than harm (ICRP, 2007a). The Commission has recommended a multi-step approach to justification of the patient exposures in the Publication 105 (ICRP, 2007b). In the case of the individual patient, justification normally involves both the referring medical practitioner (who refers the patient, and may for example be the patient 's physician/surgeon) and the radiological medical practitioner (under whose responsibility the examination is conducted).

Optimization: Once examinations are justified; they must be optimized (i.e. can they be done at a lower dose while maintaining efficacy and accuracy). Optimization of the examination should be both generic for the examination type and all the equipment and procedures involved. It should also be specific for the individual, and include review of whether or not it can be effectively done in a way that reduces dose for the particular patient (ICRP, 2007b).

14.2 Requirements for the facility

Each x-ray machine should be registered with appropriate state database under the overall oversight of national regulatory authority. During the process of registration and authorization, the authority will examine the specifications of the machine and the room where it is going to be used in terms of size and shielding. There are safety requirements for x-ray machines that are provided by the international organizations such as International Electrotechnical Commission (IEC) and International Standards Organization (ISO). In many countries, there are national standards for x-ray machine which are applicable. These considerations are aimed at protection of the employees and members of the public who may be exposed. The process will also include availability of qualified employees. There are requirements for periodic quality control (QC) tests for constancy check and performance evaluation. Periodic QC testing of fluoroscopy equipment can provide confidence of equipment safety and its ability to provide images of optimal image quality. If a machine is not working properly it can provide unnecessary radiation dose to the patient and images that are of poor quality.

14.3 Specific aspects of employees protection

Shielding

- **Lead apron:** The foremost and most essential component of personal shielding in an x-ray room is the lead apron that must be worn by all those present in the X-ray room.

- **Ceiling suspended shielding:** Ceiling suspended screens that contain lead impregnated in plastic or glass are very common in interventional radiology and cardiology suits. Shielding screens are very effective as they have lead equivalence of 0.5 mm or more and can cut down x-ray intensity by more than 90%.
- **Mounted shielding:** These can be table mounted lead rubber flaps or lead glass screens mounted on pedestal that are mobile. Lead rubber flaps should be used as they provide effective attenuation being normally impregnated with 0.5 mm lead equivalence.

In addition, leaded glass eye wears of various types are commonly available. There are also clip-on type eye shields which can be clipped to the spectacles of the employees and full-face shields that also function as splash guards. Leaded eyewear should have side shields to reduce the radiation coming from the sides. The use of these protection devices is strongly recommended.

14.4 Individual monitoring

Individual monitoring of persons occupationally exposed to ionizing radiation using film, thermoluminescent dosimeter (TLD), optically stimulated luminescence (OSL) badge or other appropriate devices is used to verify the effectiveness of radiation control practices in the workplace. An individual monitoring programme for external radiation exposure is intended to provide information for the optimization of protection and to demonstrate that the employees ‘s exposure has not exceeded any dose limit or the level anticipated for the given activities. As an effective component of a program to maintain exposures as low as reasonably achievable, it is also used to detect changes in the workplace and identify working practices that minimize doses. The Commission had recommended in 1990 a dose limit for employees of 20 mSv per year (averaged over defined 5-year period; 100 mSv in 5 years) and other limits. However, all reasonable efforts to reduce doses to lowest possible levels should be utilized. Knowledge of dose levels is essential for utilization of radiation protection actions.

In addition to the individual monitoring, it is recommended in these installations, to use indirect methods to estimate radiation levels at the workplace using passive or electronic dosimeters (e.g. Dosimeters attached to the C-arm) to allow the estimation of occupational doses to the professionals not using regularly their personal dosimeters (ICRP, 2011).

Appendix (15): Occupational Safety and Health Act

The Occupational Safety and Health Act of 1970 (OSHAct) was passed to prevent employees from being killed or seriously harmed at work. The law requires that employers provide their employees with working conditions that are free of known dangers. The Act created the Occupational Safety and Health Administration (OSHA), which sets and enforces protective workplace safety and health standards. OSHA also provides information, training and assistance to employees and employers.

To help assure a safe and healthful workplace, OSHA also provides employees with the right to:

- Receive information and training about hazards, methods to prevent harm, and the OSHA standards that apply to their workplace. The training must be in a language you can understand;
- Observe testing that is done to find hazards in the workplace and get test results;
- Review records of work-related injuries and illnesses;
- Get copies of their medical records;
- Request OSHA to inspect their workplace; and
- Use their rights under the law free from retaliation and discrimination (OSHA, 2019).