ASSESSMENT OF SAFETY CULTURE FOR OCCUPATIONAL RADIATION PROTECTION IN MEDICAL PRACTICES: A CASE STUDY OF PARIRENYATWA GROUP OF HOSPITALS, HARARE, ZIMBABWE

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CHAPTER ONE

INTRODUCTION

1.1.Background to the Study

Although highly beneficial, the use of ionizing radiation and nuclear technologies poses risks to workers, the public and the environment. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reported that medical occupational exposure contributes 75% of the 9.6 million workers exposed to artificial sources of radiation (UNSCEAR; 2016). This is attributed to the widespread medical applications of the technologies that include dental radiology; diagnostic radiology (general X-ray, Computed Tomography, Mammography, bone densitometry); Interventional radiology (fluoroscopy, angiography); Radiotherapy and Nuclear Medicine (diagnosis and treatment). The exposure emanates from practices and interventions, where the former involves normal operations while interventions seek to reduce the existing radiation exposure, in emergency situations (IAEA, 2015).

Occupational radiation hazards/ effects in medical practitioners were observed first observed among early radiologists with some suffering from severe skin burns and ultimately cancer and as Kang (2015) points out, only within a year of the discovery of X-rays by William Roentgen in 1895, the first case of occupational exposure was reported, appearing as a skin burn in the United States, followed by reports of radiation damages to the hands and fingers from several countries such as the UK and Germany. The International Commission for Radiological Protection (ICRP) was formed in 1925 by practitioners seeking to find ways of reducing the effects of radiation on workers, among others (Clarke and Valentin; 2009). This marked the beginning of coordinated, international efforts to find solutions to address the occupational exposure challenges. The ICRP publishes recommendations that include occupational protection based on evidence from research.

International / intergovernmental organisations have complimented the initiatives by ICRP and have developed mechanisms for implementation of recommendations at national level. Following the Hiroshima and Nagasaki bombings ,the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was formed by General Assembly resolution 913 (X) of 3 December 1955, with a mandate to undertake broad reviews of the sources of ionizing radiation and its effects on human health and the environment (UNSCEAR, 2008). As such, the Committee thoroughly reviews and evaluates global and regional exposures to radiation, evaluating evidence of radiation-induced health effects in exposed groups, including radiation workers and survivors of the atomic bombings in Japan. Its reports provide the scientific foundation used, inter alia, by the relevant agencies of the United Nations Common System in formulating international standards for protection of the public and of workers against ionizing radiation

Concerned with the growing effects of radiation among workers, the International Labour Organisation (ILO) coordinated tripartite engages featuring representatives of government, labour and employers who came up with Convention No. 115 and Recommendation N0. 114 in 1960 for the protection of workers against ionizing radiations as a way of ensuring governments develop a framework consisting of laws, regulations, codes and appropriate standards for occupational radiation protection. (Lindell; 1996).

Similarly, the World Health Organization (WHO) embarked on the Global Initiative on Radiation Safety in Healthcare Settings in 2008, highlighting the risk radiation poses on medical practitioners. WHO (2008) identifies workers in fluoroscopically guided interventional radiology and molecular imaging techniques (nuclear medicine) as being at greater exposure risk and with a higher chance of developing of cataracts due to the high sensitivity of the eye.

The International Atomic Energy Agency (IAEA) has been instrumental in developing safety standards related to occupational protection and championing the agenda of safety culture. The highest level of the safety standards issued by IAEA, the Safety Fundamentals (SF-1) contains 10 principles that member states are mandated to ensure in order to ensure acceptable levels of radiation safety/protection for workers, the public and the environment. Principle 3 of the Safety Fundamentals addresses the need to foster s strong safety culture, stating that "Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks; and …a safety culture that governs the attitudes and behaviour in relation to safety of all organizations and individuals concerned must be integrated in the management system. Safety culture includes:

—Individual and collective commitment to safety on the part of the leadership, the management and personnel at all levels;

—Accountability of organizations and of individuals at all levels for safety;" (IAEA, 2008)

The term "Safety Culture" came to the fore during the review of the Chernobyl nuclear accident of 1986 where the International Nuclear Safety Advisory Group (INSAG) constituted by the IAEA defined it as "that assembly of characteristics and attitudes in organisations and individuals which established that as an overriding priority nuclear safety issues receive the attention warranted by their significance" (INSAG; 1991). Similarly, Thompson (2015) defines safety culture as "a part of the overall culture of the organization and is seen as affecting the attitudes and beliefs of members in terms of health and safety performance." Boughaba, Chabane and Ouddai (2014) highlight the tripartite interaction between people (psychological factors), jobs (behavioural factors), and the organization (situational factors) in shaping the safety culture of an organization. Ultimately, safety culture is linked to safety performance and there has been an increased interest from high-risk industries in the concept as a means of potential accident reduction associated with routine and emergency work situations.

Several authorities in the subject matter highlight a number of different factors which underline safety culture but the most commonly measured are management commitment to safety, safety policies, safety rules and procedures, workers' involvement and safety behaviour, training, communication, and incentives (Taylor, 2010). Traditional safety performance measures have relied on some form of accident or injury data, while contemporary approaches have incorporated safety-related behaviours such as safety compliance and safety participation (Boughaba, et al 2014). Ghahramani (2017) further contends that lagging indicators such as frequency, severity, and costs of accidents and injuries have been dominant in safety assessments. However, these metrics are retrospective focusing on safety outcomes and measuring the failures of safety programmes hence the emerging trend of leading indicators such as hazard identification, safety training and audits, which all contribute to the overall safety culture of an organization (ibid). Just ensure that your discussion on culture leans more to issues of radiation

Occupational radiation exposure can be either acute or chronic, where the former refers to exposure to high radiation doses over a short period of time thereby leading to deterministic radiation effects. On the other hand, chronic exposure involves exposure to low doses over a prolonged period and can result in stochastic effects. The onset of stochastic effects which include cancer, leukaemia and hereditary defects that may occur long after an employee has retired (Kamiya et al, 2015). A cohort study of 308 000 workers in the nuclear and radiation industry who were exposed to low radiation doses in France, United Kingdom and United

States of America revealed that 17 597 of the 66 632 known deaths at the end of the follow-up were due to cancers (Richardson et al 2015). This supports the assertions that chronic exposure to radiation in workers increases the relative risk of cancer mortality.

The IAEA has been advocating for strengthening of safety culture in all institutions with radiation exposure risk in order to reduce the likelihood of stochastic effects. Singer et al (2003) identify key components of safety culture as safety leadership, management involvement in safety, a focus on systems, employee involvement, as well as data collection and reporting, among others.

High reliability environments such as nuclear power plants, aviation and health need strong safety culture in order to reduce accidents and injuries that may result in injuries and fatalities (Mohammadfam et al, 2012). It is therefore essential for this study to establish the level of safety culture of an institution in order to recommend appropriate interventions, where needed.

1.2.Statement of the Problem

Medical practices are considered high- risk where the consequences of mistakes/ errors can compromise both patient and worker safety. As such, developing and fostering a positive safety culture is a good management strategy to improve safety performance. It is generally agreed that the concept of “safety first” is not as inherent in hospitals as compared to other sectors such as manufacturing and mining industries (*reference*). As such a culture for safety has to be deliberately introduced and sustained over a period of time.

The institution under research, Parirenyatwa Group of Hospitals (PGH) is the largest referral institution in the country with extensive use of radiation technologies ranging from dental, diagnostic, interventional, nuclear medicine and radiotherapy. Based on the IAEA Categorization of Radioactive Sources (2005), high energy accelerators and high dose rate brachytherapy sources used for cancer treatment at PGH present the greatest safety risk in the country. The hospital has over 120 workers in these departments facing a high risk of radiation exposure either directly or indirectly. These include radiographers and x-ray operators, medical physicists, radiologists, oncologists and registrars (students), oncology nurses as well as maintenance engineers and technicians. Additionally, a number of radiography and medical students receive clinical training at the institution and are also at risk of radiation exposure.

It is therefore expected that the institution should have developed a strong safety culture that will ensure that occupational exposure will not lead to deterministic effects while still in active employment or the onset of stochastic effects like cancer after employees have retired. Further, the absence of a strong safety culture can lead to accidents and incidents that can be costly to the organisation.

This should be demonstrated with the availability of clear organisational policies and strategies to address the safety risks of radiation as well as a system of reporting and documenting incidences for continual improvement and fostering a strong safety culture.

A preliminary search of policies, and incident reports at the institution has not yielded any positive feedback thereby raising a number of questions one of which being "could the absence of documented incidents and accidents be a result of high levels of operational safety?" or a poor safety culture where incidents go unreported and there are no mechanism to learn from them?

The research therefore seeks to assess the level of safety culture at the institution as benchmarked by the requirements of the international safety standards**.**

1.3. Objectives of the Study

1.3.1. General Objectives

To assess the strength of existing radiation safety culture at PGH focused on the examination of systems, policies, practices and attitudes related to radiation safety.

1.3.2. Specific Objectives

The specific objectives of the study were:

- To examine differences in safety culture variables among departments;
- To determine the attitudes and level of worker participation in the development and implementation of radiation safety policies and procedures;
- To analyse the existing culture for radiation risk management at the hospital; and
- To evaluate leadership and management practices for radiation safety;

1.4. Justification of the Study

Parirenyatwa Group of Hospitals has extensive use of radiation in radiology, radiotherapy and nuclear medicine departments. Although this is highly beneficial, it also results in occupational exposure to workers in those departments with a risk of both deterministic effects that can arise due to acute radiation exposure and stochastic effects such as cancer and hereditary defects due to chronic exposure to low doses. The absence of a strong safety culture increases the relative risk of hazardous effects to radiation workers at the hospital. Due to the outlined risks, the International Basic Safety Standards developed by IAEA has requirements for all users of ionizing radiation to establish, maintain, assess and improve their safety culture by implementing sound organizational safety management systems that will result in reduced radiation exposure, and incidents.

The study will be beneficial to a number of stakeholders/ interested parties. It will provide a synopsis of the existing level of safety culture and performance of various variable that can serve as a basis for Parirenyatwa Group of Hospitals policy and management decisions. On the other hand, the study will raise the level of safety culture awareness among workers which will assist them to either maintain or reinforce positive attitude contributing to their safety.

Further, the findings will enlighten regulators with a responsibility for safety on the prevailing level of safety culture in order for them to plan and make informed interventions, should they be needed.

Lastly, the study will help sharpen the research skills for the researcher and lay the ground-work for further academic research at higher levels in the subject area as well as add to the existing body of knowledge on safety culture with a particular emphasis on medical exposure control, which is a diversion to the commonly researched patient safety culture in medical practices.

1.5.Study Area

The research will be conducted at the Parirenyatwa Group of Hospitals located in Harare, the capital city of Zimbabwe. It is found in the area 17.8121° South to 31.0427° East covering 400 000 m^2, nestled between Josiah Tongogara Street to the west, Leopold Takawira Avenue to the south and Mazowe Avenue to the north. Figure 1.2, below shows the map of the institution.

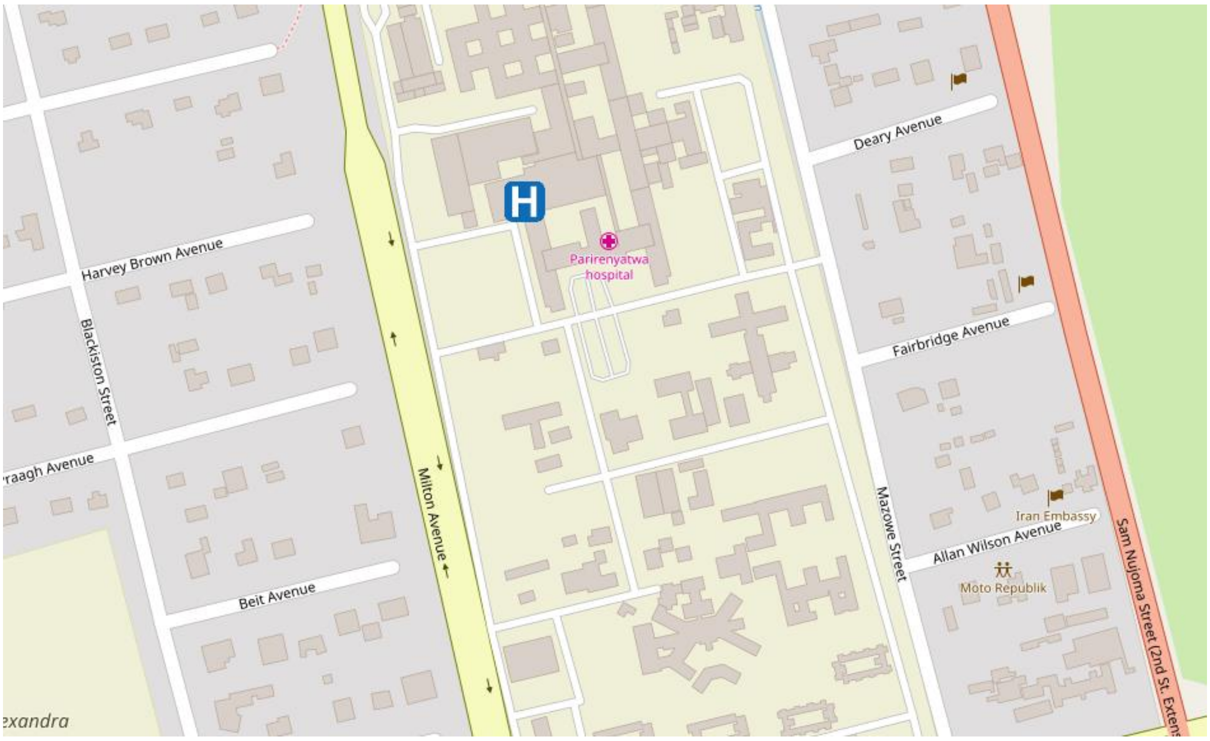

Figure 1.1: Map showing location of Parirenyatwa Group of Hospitals, Harare

The Institution is a grouping of hospitals covering various specialities such as maternity (Mbuya Nehanda), ophthalmology (Sekuru Kaguvi), psychiatry (Annex unit) and the main hospital, with a total bed capacity of 1800 and employee count of 2000. Its development has undergone various phases, starting off as a small hospital in 1890 before transforming into a group of hospitals in 1974 then known as Andrew Flemming hospital. It was later renamed to its present day name on attaining independence after Dr Samuel Parirenyatwa, a hero of the armed struggle.

The hospital is government by an act of parliament, the Health Services Act [Chapter 15:16] which gives it's a semi-autonomous status. The affairs of the hospital are superintended by a board of directors chaired by the Executive Chairman who is also the Group Chief Executive Officer. The board reports to the health services board under the Ministry of Health and Child Care. As a semi-autonomous entity, the hospital has powers to establish its policies and procedures as long as they are not *ultra-vires* national statues and government policies. It is capable of suing or being sued in its own capacity. Funding is by way of statutory appropriations in the national budget, fees and levies on its services as well as donations from well-wishers. Its employees are on government payroll and pension and compensation schemes.

The hospital is also a university teaching hospital encompassing the University of Zimbabwe's College of Health Sciences, providing clinical practice for medical students in various specialities. This research will focus of the radiology (X-Ray), radiotherapy, nuclear medicine, engineering units which involve radiation technologies.

1.6. Conceptual Framework

While understanding that there are various models for safety culture, this study employees a framework infusing components advocated by the IAEA and other scholars such as Guldenmund, 2010 considering four thematic areas as indicated in figure 1.2, below focusing on leadership and management for safety, employee involvement and participation in safety as well as the radiation safety risk assessment framework. The performance of these metrics will be assessed at an organisational level as well as at departmental level with comparisons to examine any differences among user department.

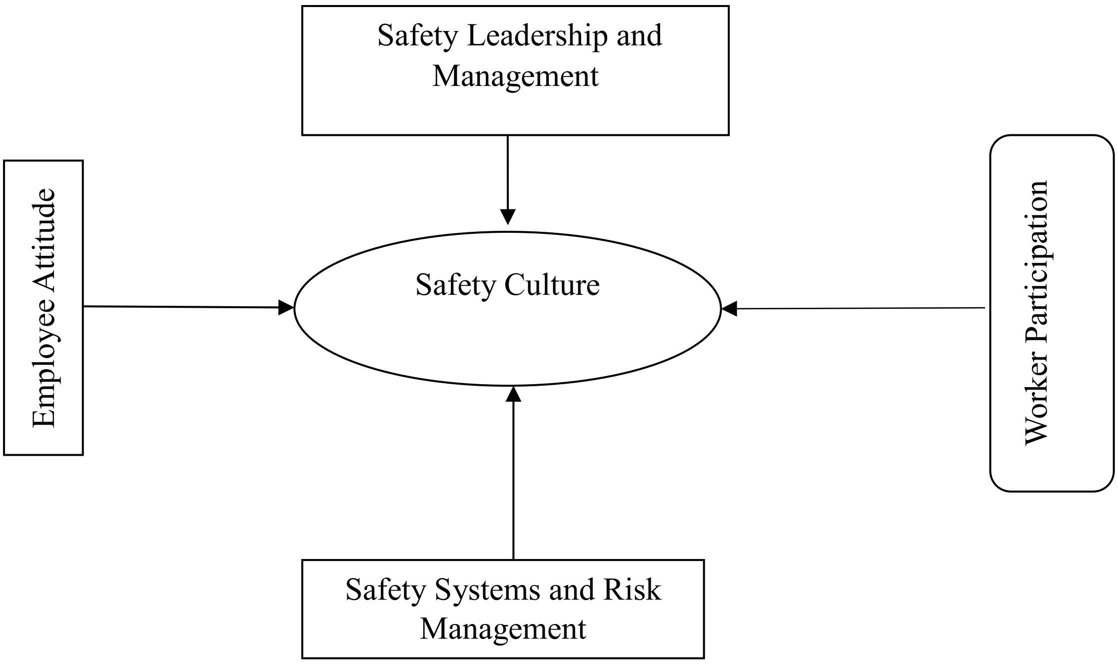

Figure 1.2: Conceptual Framework of the Study

1.7. Limitations of the Study

The study of safety culture requires a lengthy period of to collect data and the use of more qualitative methods to reveal the underlying issues affecting identified attributes. Due to time, resource and competence constraints. This study employed questionnaires, interviews and observations. The researcher had prior access to applicable international standards and regulatory reports used in the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents an overview of the concepts of organisational and safety culture as well as looking at their relationship. It explores the model and characteristics of safety culture, highlighting the advantages of strong safety culture.

2.2. Radiation and Occupational Risk

Radioactive sources are beneficially used in various applications that include medicine, industry, research, education, and agriculture. Similarly, medical applications of radiation are also varied and they range from diagnosis of diseases using X-rays or Computed Tomography (CT), interventional radiology, nuclear medicine application, to treatment of cancers using external beam therapy or brachytherapy in radiotherapy centres. Balwinder, Jaspreet, and Amritpa (2013) (cited in Nassef and Kinsara, 2017, p.2) opine that there is marked increase in the use of radiation for medical diagnosis and treatment purposes due to a combination of improved health services and an aging population around the world.

The use of ionizing radiation and nuclear technologies presents risks to workers, the public and the environment, with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reporting that medical occupational exposure contributes 75% of the 9.6 million workers exposed to artificial sources of radiation (UNSCEAR; 2016). Harmful radiation effects in medical practitioners were observed first observed among early radiologists with some suffering from severe skin burns and ultimately cancer. Kang (2015) points out that the first case of occupational exposure was reported only within a year of the discovery of X-rays by William Roentgen in 1895, appearing as a skin burn in the United States. This was followed by reports of radiation damages to the hands and fingers from several countries such as the UK and Germany.

Industry professionals formed the International Commission for Radiological Protection (ICRP) way back in 1925 seeking to find ways of reducing the effects of radiation on workers, among others (Clarke and Valentin; 2009). This marked the beginning of coordinated, international efforts to find solutions to address the occupational exposure challenges.

The ICRP published the first recommendations on occupational protection against X-rays and radium for medical professionals in 1928, which noted that ‘The effects to be guarded against are injuries to superficial tissues, derangements of internal organs and changes in the blood’ (IXRPC, 1928). These recommended workers to be afforded prolonged holidays and limitation of working hours as protection measures.

Concerned with the growing effects of radiation among workers, the International Labour Organisation (ILO) coordinated tripartite engages featuring representatives of government, labour and employers who came up with Convention No. 115 and Recommendation N0. 114 in 1960 for the protection of workers against ionizing radiations as a way of ensuring governments develop a framework consisting of laws, regulations, codes and appropriate standards for occupational radiation protection. (Lindell; 1996).

Similarly, the World Health Organization (WHO) embarked on the Global Initiative on Radiation Safety in Healthcare Settings in 2008, highlighting the risk radiation poses on medical practitioners. WHO (2008) identifies workers in fluoroscopically guided interventional radiology and molecular imaging techniques (nuclear medicine) as being at greater exposure risk and with a higher chance of developing of cataracts due to the high sensitivity of the eye.

2.3. Occupational Radiation Exposure effects

The International Nuclear Workers Study (INWORKS) whose findings have been reported by Leuraud et al (2015) presents the most recent scientific evidence and basis for the protection of workers exposed to seemingly low doses over a period of time. The study comprised of workers from the United Kingdom (UK), France, and the United States of America (USA) forming a cohort that was placed under personal monitoring for external exposure to radiation with personal dosimeters and followed up for up to 60 years after exposure (ibid). The study revealed an increased relative risk of leukaemia mortality, providing strong evidence of positive associations between leukaemia and chronic low low-dose radiation exposure, typical of occupational exposure. Medical workers are also exposed to low doses of external γ-rays or x-rays, hence the study highlights the importance of adherence to the basic principles of radiation protection in order to optimise worker protection and reduce exposures to as low as reasonably achievable (ALARA principle).

Similarly, Liu JJ, Freedman DM, Little MP, et al (2014) reportedly observed after a cohort study of 90 268 USA radiological technologists (radiographers) that the leukaemia risk was doubled for those who had worked for more than 30 years compared to those who had worked for less than 10 years.

2.4. Radiation Risk Management

Noting the risk posed by radiation exposure, ICRP set out to establish and maintain a system and standards for medical, occupational, environmental radiation protection as well as controls against radiological exposures during accidents but without unduly limiting the beneficial uses from technologies (Nassef and Kinsara, 2017). Since its establishment , the ICRP provides research based recommendations in terms of the effective and equivalent radiation dose limits to various body organs , including for extremities and eye lenses (ICRP, 1990). These recommendations have been adopted and further translated into safety standards by various international bodies that include ILO, WHO and IAEA. The IAEA publishes International Basic Safety Standards (BSS) for protection against ionizing radiation.

According to Valentin (2002), the ICRP Publication 60 of 1990 introduced a system of protection premised on three pillars *viz* justification of practice, optimization of protection and limitation of individual doses. The principle of justification of practice is anchored on ensuring that any planned exposure to radiation should provide a net benefit to the user. According to the IAEA Safety Fundamental Principles (2008), justification takes into consideration several aspects that include social and economic factors and in most cases decisions relating to such benefits and risks are taken at the highest levels of government.

The principle of optimization of protection requires that persons exposed to radiation be afforded the highest level of protection to reduce doses to as low as reasonably achievable (ALARA). This can be achieved through a number of initiatives that include periodic risk assessments, application of good practices and common sense to avoid risks as far as practicable, as well as enforcement of regulatory requirements (IAEA, 2008).

The last principle on limitation of doses requires the establishment of measures for controlling doses to radiation worker, and the public in order to ensure that no individual bears an unacceptable risk of harm (IAEA, 2008). The ICRP recommended annual effective dose limits of 20millisieverts (mSv) and 1MSv for occupational and public exposure, respectively have been internationally adopted and translated into national legislation of several countries for regulatory control.

Safety culture is one such long-term, sustainable factor in the optimization of protection as it encompasses various aspects such as policies and procedures, as well as planning and implementation of exposure controls (Valentin 2002).

2.5. Organizational Culture

An analysis of the safety culture concept cannot be divorced from a look at organisational culture where as argued by Nordén-Hägg (2010) it is birthed. The concept of organisational culture has evolved since the 1950s with different themes and its application to various fields (Clarke, 2006). When considering the meanings of "culture" it is useful to note the contributions of Brigges (1992) cited in Choudhry et al (2007) pointing out a number of differences between the term as used by anthropologists and as applied to organizations by management consultants and other technical experts. It should be noted that the latter have over-simplified the concept to such an extent it has lost much of its connection to the usages in the former (ibid). Silla, Navajas and Koves (2017) refers to the definitions of organizational culture by Deal and Kennedy (1982) "the way we do things around here" and by Smircich, (1983), "as shared symbols, rituals, beliefs, stories, ideologies, values, practices, knowledge, or artefacts".

With no widely accepted definition, this research settled for the organisational culture definition adopted from Schein (2010: p.18) "a pattern of shared basic assumptions learned by a group as it solved its problems of external adaptation and internal integration, which has worked well enough to be considered valid and, therefore to be taught to new members as the correct way to perceive, think, and feel in relation to those problems".

Organisational culture also referred to as corporate culture exists in "all types of organizations whether private, public, non-profit and government organisations with subcultures manifesting as occupational groups in an organisation that have their own specific values and norms. Further, Schein (2010) identifies micro-cultures describing them as existing within "small, intelligible units cutting across occupational groups". The importance of a thorough examination of organisational culture will help to answer a number of questions related to safety culture such as “Where does work safety fit into an organisation’s culture?”; “Is the management of work safety different from other areas of management such as accounting, marketing and sales?”

A study conducted by Blewett and Shaw over a 3- year period on Australian small and medium enterprises revealed that the style of management of health and safety in the workplace was a reflection of the strategic focus of the organisations involved (Blewett 2011). It identified that safety performance could be categorised in three ways, *viz* proactive, reactive and transitional as a result of various internal and external factors (ibid).

Similarly, Westrum (2004) who defined culture as “the organisation’s pattern of response to the problems and opportunities it encounters”, found a predictive relationship between organisational culture and safety. In the analysis, Westrum identified three categories of organisational culture; pathological which focusses on personal needs, bureaucratic focusing on departmental needs and generative that focussed on the organisation’s mission (Westrum, 2004).

Kimbrough and Componation (2009) further argue that researches have revealed the presence of links between organisational culture and risk management. This is supported by a correlation of the results of an organisational culture survey that looked at the differences in the implementation of enterprise risk management between traditional, rule-bound or mechanistic approaches and organic-style cultures that are defined by strong leadership and employee participation. The results indicated that organisations with organic approaches to risk management progress more effectively than the mechanistic counterpart.

2.6. Safety Culture

Safety culture as a term gained prominence in the aftermath of the Chernobyl accident, in 1986 being introduced by the International Nuclear Safety Group (INSAG) set up by the International Atomic Energy Agency (IAEA) to investigate the causes of the disaster that claimed 31 lives and resulted in the release of radioactivity into the environment in a report (IAEA, 1988; Gibbons, 2007; Bergh, 2011; and Taylor, 2010). The INSAG report indicated that the adverse events were mostly preventable (Flin, 2007 cited in Haghighi et al, 2016) and went on to define safety culture as “the personal dedication and accountability of all individuals engaged in any activity which has a bearing on the safety of nuclear power plants” (IAEA/INSAG, 1989). The concept was further developed in a subsequent INSAG report in 1991 being redefined as ”an assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance” (IAEA/ INSAG, 1991 p.1).

An analysis of the definition by Choudhry *et al*. (2007) draws two conclusions, the first being that it refers to both good safety attitudes and good safety management as well as that safety has the highest priority in a good safety culture which is typical of nuclear plant safety issues. However, this has since been extended to cover other high reliability organizations in aviation, medical, oil and gas industries where the risk of an accident has serious consequences to life, health, property and environment (Halligan and Zecevic, 2010).

The Health and Safety Executive (HSE) in the United Kingdom (UK) defined the term as ‘‘the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization’s health and safety management” (Kaafarani et al., 2009). Further, HSE suggests safety culture is influenced by a number of factors such as employee involvement in safety decisions and programmes, training and competence of employees, effectiveness of communication, compliance with legal and regulatory requirements, organisational learning as well as management commitment and leadership style (Blewett, 2011).

Taghdisi (2009) argues that organizations that promote and maintain a strong safety culture encourages all level individual employees and groups to be actively involved and accountable in predicting, and managing risks and threats, developing and enhancing safety.

2.6.1. The Components of a Safety Culture

Various models have been proposed to explain components of safety culture. These include the Bandura (1986) model reviewed by Cooper (2000) which consists of three interrelated components of safety culture, being the psychological, behavioural and situational aspects. Psychological aspects of a safety culture refer how people in an organisation feel about their safety and safety management systems, which affect individual and group values, attitudes and perceptions of safety (ibid). Similarly, behavioural aspects of are concerned with what individuals in an organisation do such as safety-related activities, actions and managements' commitment to safety. Lastly, the situational aspects refer to the organizational policies, procedures, structures, management systems, control and communication systems (HSE, 2005; and Canso, 2008). The model is presented in figure 2.1, below:-

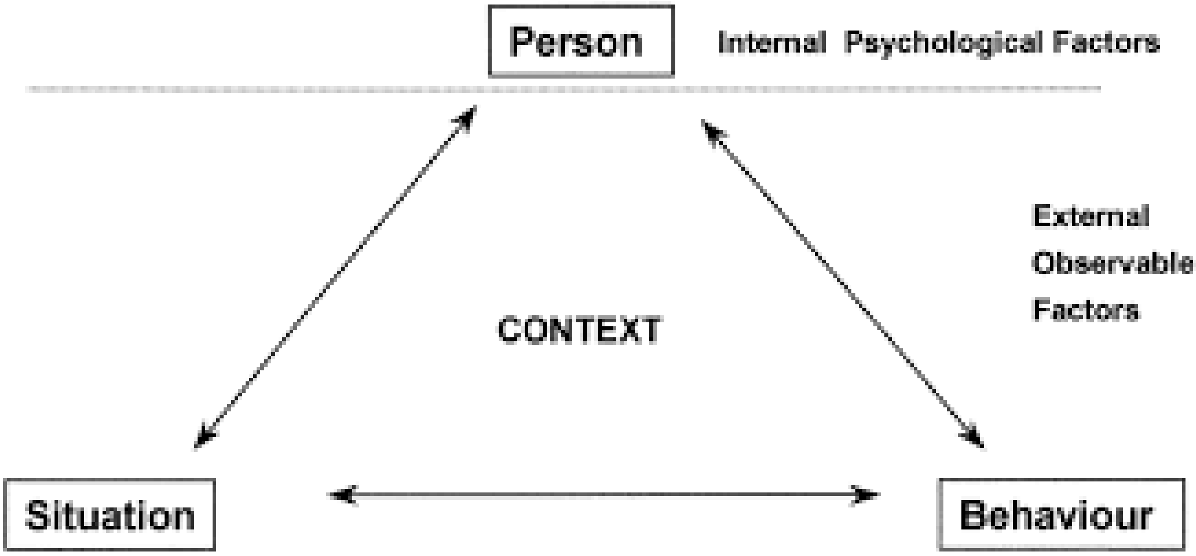

Figure 2.1: Bandura Model of Reciprocal Determinism

Another safety culture framework was proposed by Guldenmund (2010), based on Schein's (1992) model of organizational culture. Based on the model, safety culture consists of basic assumptions that are surrounded by layers of espoused values and artefacts as illustrated in figure 2.2, below. The evaluation of espoused values and artefacts can be achieved quantitatively as they are considered to be less stable than the core of basic assumptions.

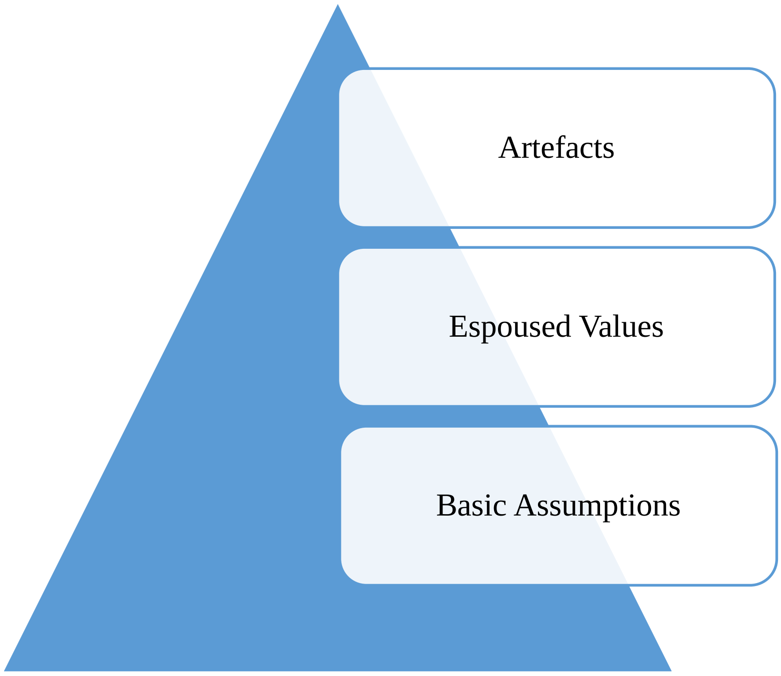

Figure 2.2: Guldenmund (2010) Model of Safety Culture

2.6.2. Safety Sub-Cultures

Another viewpoint on safety culture was proposed by Reason (1997 and supported by Hudson, (1999) and Canso (2008) in which safety culture is a product of a number of sub-cultures ultimately resulting in informed culture. These are just culture, flexible culture, reporting culture and learning culture based in a number of distinct characteristics as illustrated in figure 2.3, below.

2.6.2.1.Just Culture

Canso (2008) explains a just culture as one in which trust and justice is held in high esteem and employees are motivated and rewarded for availing relevant safety information based on a clear understanding of the acceptable and unacceptable safety behaviours in an organization. Employees are encouraged to report errors of any magnitude without fear of victimization, blame or punishment despite the circumstances involved (Reason, 199.7). Similarly, rewards are used to cultivate a positive safety behaviour.

2.6.2.2.Reporting Culture

The presence of a reporting culture is identified by the willingness of employee to report their own errors and near-misses and it is related to the trust built around the just culture discussed above. On the contrary, employees will not voluntarily report their errors and near-misses if believe/ suspect or know that management will blame or punish them (Reason, 1997 cited in Bergh, 2011). (Reason, 1997). A number of factors have been identified as influencing the success or failure of a report culture by Reason (1997) and they include confidentiality or anonymity of the system, ease of reporting, reasonable immunity against disciplinary action as well as feedback, among others.

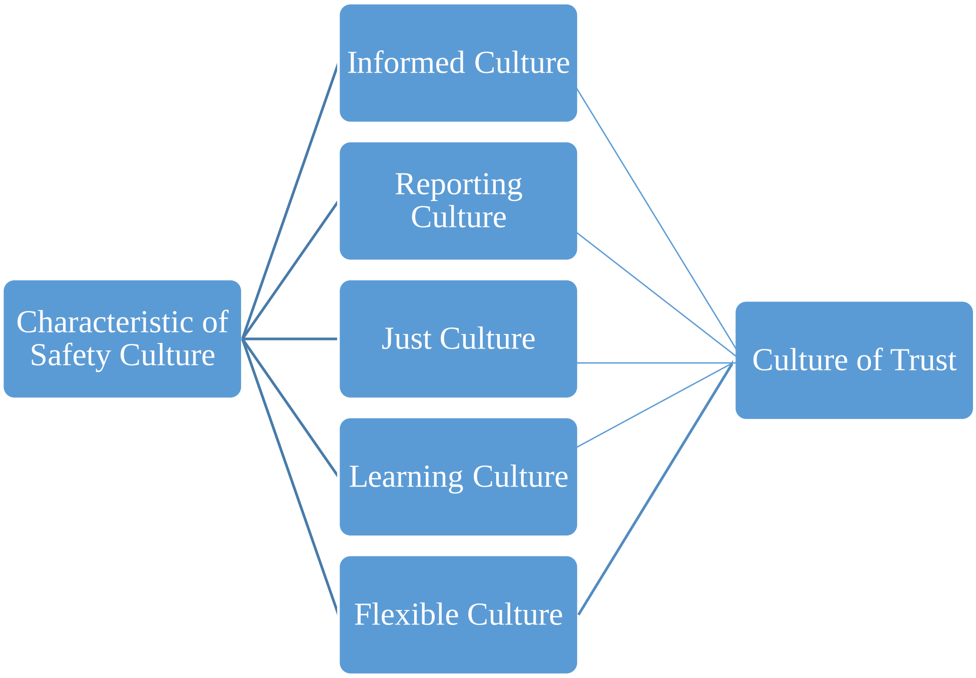

Figure 2.3: Reason (1997) Safety Culture Model

2.6.2.3.Flexible Culture

The ability of a culture to adapt to varying situations/ circumstances signifies the existence of a flexible culture. This is especially important for organizations to be prepared to adjust in times of crises which may require changes in decision-making processes (Canso, 2008).

2.6.2.4.Learning Culture

A learning culture is characterised by the willingness and consistency of an organization to review reports of errors, near-misses and accidents and drawing the right conclusions and lessons that can be used to strengthen its safety systems. The culture is highly dependent on a reporting culture which provides an input for analysis and resulting in lessons learned (Reason, 1997).

2.6.2.5.Informed Culture

Reason (1997) equates an informed culture to a safety culture which is based on all the other sub-cultures discussed above. It is achieved when an organization is able to attain sufficient knowledge about the human, technical, organizational, and environmental factors influencing on the safety its system. (Hudson, 1999; and Canso, 2008). Senior management of such an organization that has an informed culture work to promote a culture that enables its employees to understand the risks and hazards of their work (Canso, 2008).

2.6.3. Safety Culture Characteristics and Attributes

Safety culture has a number of characteristics and IAEA (2008) and Taylor (2010) identify five common characteristics which are: safety as a clearly recognised value; clear leadership for safety; clear accountability for safety; integration of safety into all activities and that safety is learning-driven. Further, Taylor (2010) avers that the measure of the strength of a safety-culture against the characteristics is determined by the safety attributes associated with each of the characteristics.

2.6.3.1.Overriding Safety Priority

Safety as a clearly recognised value is demonstrated by safety being given an overriding priority in an organization. This means that management ensures that safety policies and procedures are developed and complied with at all the times and decisions made show that safety is considered above production. (Taylor, 2010; and HSE, 2005). In addition, organizational safety values should be clearly communicated to all employees so as to develop a consistent understanding and shared safety beliefs. This can be achieved through adequate documentation and effective communication (Mattison, 2015).On the other hand, individuals in the organization exhibit safety consciousness which is acceptable by others. This can be seen by a questioning attitude, openness to report errors and near-misses so that the organization can learn from them. Dekker (2007) affirms that a just culture needs to be cultivated by the establishment and implementation of a blame tolerant, ‘just’ culture policy and an events and near-miss reporting system. Further, the allocation of resources should reflect the safety priority in the organization in the form of equipment procurement and maintenance, suitably qualified and experienced human resources.

2.6.3.2.Safety Leadership

Senior management in an organization should demonstrate a clear commitment to safety and behave as role models and mentors reflecting and refereeing to the organisational safety values. (Taylor, 2010; Butler and Park, 2005). Managers should put safety priorities ahead of production, encouraging safe behaviour and attend to unsafe behaviours. In addition, safety leadership should be visible with managers responsible for the development and implementation of employee safety-training, take a lead in emergency drills, and participate in initiatives seeking solutions to safety issues (ibid). Managers should stop work tasks in compromising safety which can be identified by regular visits and interactions with employees during their course of normal work. Management walk-abouts provide managers with opportunities to make safety behaviour observations, and initiate related discussions with employees, which helps to cultivate an environment of trust. Further, Taylor (2010) highlights that management ought to actively involve employees in safety decisions, encourage open dialogue and provide feedback.

2.6.3.3.Accountability for Safety

A good safety culture is reflected by clear accountability for safety in an organization, with clearly defined and understood safety roles and responsibilities. As such, all staff visibly demonstrate that they are responsible for their own and colleagues safety through their attitude and behaviours. This can be supported by management ensuring that safety responsibilities are well defined in employee job descriptions as well as supported by clear internal regulations and procedures to promote compliance. On the other hand, the organization should demonstrate overall accountability for safety by meeting legal and regulatory safety requirements (Tronea, 2014; Bernard, 2014 and Taylor, 2010).

2.6.3.4.Safety Integration

Management has a mandate to ensure that safety is integrated into all activities in the organisation and this is reflected in a number of ways. This includes management establishing a process is in place to ensure independent safety review of operations to identify any good practices or gaps to enhance safety performance. Further, management ensures that all relevant safety documentation, quality processes and procedures are developed and user friendly. Additionally, Taylor (2010) advocates for strict observance of safety margins from designers and manufacturers of equipment and ensure that operators maintain strict adherence.

2.6.3.5.Learning Driven Safety

Safety driven learning is preceded by the development of reporting and just cultures that encourage individuals in an organisation to bring to the attention of management and co-workers their own mistakes, incidents and near-misses. As Bernard (2014) asserts, there is need for a questioning attitude across all functional levels to ensure that critical safety issues are identified and discussed. Further, an organisation needs to establish a system of collecting operating feedback, tracking the performance of safety indicators as well as conducting periodic internal and external safety assessment. The results of the initiatives should be systematically evaluated in order to draw lessons to enhance safety. This includes designing training programmes to address individual competences including leadership for continuous improvement (ibid).

2.7. Benefits of a Good Safety Culture

The benefits of a good safety culture have been outlined through a number of studies conducted since the Chernobyl accidents, all of which are focused on reducing accidents and impact on safety (Bergh, 2011). Hudson (1999) declared that a good safety culture has a direct bearing on an organization's bottom line as it results in increased productivity matched by a reduction of costs in the long run. Taylor (2010) highlights some of the benefits, which include among others:-

- Increasing the efficiency of employees due to increased competencies and safety confidence, reduction personnel;
- Increasing the effectiveness in the use of resources;
- A demonstration to the employees that their organisation cares for their well-being;
- Upholding a positive corporate image due to reduced incidents and injuries; and
- Helping to manage a business risk for a viable long-term enterprise

2.8. Methods for Evaluating Safety Cultures

Various methodologies have been proposed for measuring safety culture variables and as Bergh (2011) found out, there is no one single method that has been accepted by all scholars. In-depth safety culture assessments require a triangulation of both quantitative and qualitative methods although basic assessments can be achieved by employing pure quantitative approaches (Canso, 2008). The HSE (2005) recommends that data collection should include employee attitude surveys, and a combination of qualitative methods such as observations, focus groups, interviews, and document analysis, among others. A review of the various studies revealed a few common themes which include: safety management systems, individual responsibility and involvement. Work environment as well as management attitudes and action (Clarke 2000). Another study by Guldenmund (2010) came up with six focus areas being: safety arrangement, risk, management, procedures, training and work pressure.

Schein (2010) advises researchers to make ethical considerations in safety culture assessments for the insider and outsider to take into account especially committing to confidentiality, and prevention of harm to the participants.

2.9. Summary

This chapter explored the importance of radiation technologies in many fields including human health as well as the associated risks to workers. A number of initiatives by international organizations to mitigate radiation occupational exposure were highlighted culminating into the current dispensation of the promotion of safety culture. An overview of organisational culture was presented together with the evolution of the concept of safety culture, focusing on its characteristic, attributes and sub-cultures. The last section gave an overview of some of the benefits of a good or strong safety culture and approaches in conducting assessments.

CHAPTER THREE

Research Methodology

3.1. Introduction

Any attempts to determine the safety culture strength of an organization or entity need to be based with credible data measuring the performance of the critical metrics that contribute to safety culture. Such valid and reliable data requires the use of an appropriate research design that can capture all the critical components for decision making. This chapter lays out the methodology used in this study following the “research onion” adopted from Saunders, Lewis, and Thornhill (2012). It explores, with justification, the research philosophy adopted, highlighting the ontological and epistemological positions taken and the associated research approach, strategy and data collection methods.

3.2. Research Philosophy

The research was based on the positivist research philosophy also called the scientific method. According to Grix (2004), the choice of the underlying research philosophy brings to the fore the ontological and epistemological assumptions held about the reality. The positivist stance taken assumed that reality is objective and the researcher will be able to determine the prevailing safety culture at PGH by employing predominantly quantitative methods without being involved in the work routine to as advocated by phenomenologists (Saunders, Lewis, and Thornhill; 2012).

Consequently, the research adopted a positivist epistemological stance, which equates legitimacy with science and scientific methods of inquiry with the assumption that that the world is objective, existing independently of those who seek to know it, researchers (Scott and Usher, 2011). The positivism stance is based on "hard data", in the form of numbers and figures instead of qualitative information which as Jerie (2013) argues, this data is untainted by the interpretive and meaning-endowing processes of the researcher.

3.3. Research Design

The study was an exploratory cross-sectional survey based, employing predominantly quantitative methods for data collection. Cross-sectional surveys are meant to find out the prevalence of a phenomenon, in this case the safety culture, by taking a cross-section of the population of users and they are useful in obtaining an overall 'picture' at the particular time of the study (Kumar ;2011). Therefore this study design was appropriate for the current research meant to provide a picture of the prevailing radiation safety culture at PGH.

Unlike longitudinal designs that require a prolonged period of data collection, cross-sectional studies are quick as data is collected at one point in time, hence it is cheaper and provides an opportunity for prompt interventions based on research findings. As Gall, Borg and Gall (2003) point out, the design does not suffer from a drop-out as participants are interviewed only once. Although the disadvantage is that the design can only infer association, and not causation as argued by Sedwig (2014), it is appropriate for this study as it is the first study of radiation safety culture at the institution hence the need to focus on prevalence before an in-depth look into the underlying causes.

3.4. Research Approach

The study employed predominantly quantitative methods that were augmented by a mix of qualitative methods for the collection of data used to reach conclusions on the strength of the radiation safety culture at PGH. The conclusions reached were based on the performance of the metrics identified in the theoretical framework presented and illustrated in figure 1.1. The approach adopted took into consideration the weakness of a purely quantitative approach which is largely descriptive and lacks in-depth analysis as advocated for by De Lisle (2011) who urges positivists to accept the link between knowledge and the knower, hence the need to infuse qualitative techniques in quantitative research.

This position referred to as critical proposed by McEvoy and Richards (2006), which ultimately develops deeper levels of explanation and meaning for the study, benefiting from the methodological triangulation. Taylor (2010) points out that the development of organisational characteristics such as safety culture and their supporting attributes can be a long and iterative process that involves establishment, implementation and assessment of various procedural and behavioural strategies to efficiently achieve set goals. These safety culture attributes are either visible or elicit-able hence the need to employ both qualitative and quantitative methods.

Quantitative methods employed are based on questionnaire surveys aimed at collecting hard data on the safety culture attributes that will be analysed and presented in the form of graphs, tables and numeric values. This will be augmented with in-depth interviews with management of the hospital to get an understanding of the deep-sited safety attributes of the organisation, particularly the management approach using open-ended questionnaires. In addition, observations will be made during visits to the relevant departments as well as a search for relevant secondary data sources that can help to answer the research questions.

3.5. Research strategy

This research adopts the exploratory research strategy , which as Kumar (2011) points out is ideal in situations where little information is available about the study focus hence it will be necessary to explore further in order to gain insights and/or understanding. This is ideal for this current study as very little information has been found on the state or strength of the radiation safety culture at PGH that can help researcher and scholars to reach informed conclusions. This study has no intention to provide solutions to the problems identified but the results can be used for further conclusive research in future. Dudovsky (2013) argues that exploratory research has great flexibility and adaptability to change and can potentially save time and resources. However, its limitations include that the modest sample size to be used in the study may not adequately represent the target population hence the danger of making inaccurate conclusions.

3.6. Study Population and Sampling Frame

The study population for this study, defined by Babbie (2007: p.189) “as the aggregation of elements from which a representative portion to be studied”, comprises all hospital staff in radiology, radiotherapy and engineering departments which are the user departments of radiation technologies at the institution. It is made up of medical doctors, nurses, radiographers, medical physicists, nurses, and support staff such as nurse aides, cleaners and security. Additionally, trainees/ students currently attached to the units form part of the population. The distribution of the population per department is indicated in table 3.1 below.

The study population is heterogeneous on the basis of the technologies used in the different departments, which may affect the approach of individuals to safety and ultimately impact on radiation safety culture. Workers in the radiotherapy department use high energy technologies with a greater risk of radiation exposure and the impact thereof, compared to those in radiology. It is therefore important to segregate the population in order to note any variations between the different strata.

3.6.1. Sampling

The research adopted a stratified random sampling selection for the survey participants with representatives of the different departments making up the study sample. As highlighted by Proctor (2003), sampling is adopted in research as in most cases the populations of interest are too large to work, thereby presenting cost, time and resources constraints. Therefore sampling makes the research manageable, and cost effective, while enhancing the accuracy of findings by accelerating the speed of primary data collection and processing (Brown; 2006).

The stratified random sampling technique employed falls under probability sampling which according to Babbie (2007) affords every member of the population an equal chance of being selected into the study sample. This creates a highly representative sample with numerous advantages that include absence of systematic and sampling bias as well as increased reliability of findings, which easily offsets the disadvantage of time and effort required as compared to non-probability sampling.

Stratified random sampling will be used in order to ensure representation of all the departments of interest in the study, in a proportionate manner to the whole population. The technique is advantageous in that it can result in more precise estimates in a case where there is homogeneity within strata and heterogeneity between strata (Dudovskiy; 2013). This will take into consideration the heterogeneity brought about by the different radiation risks that the employees in the different departments/sections are presented to, which nonetheless contributes to the overall organisational safety culture. Conversely, the technique is complex, taking more time and requires prior knowledge of the strata membership.

3.6.2. Sample Size and Distribution

A sample size of 44 will be used based on the formula proposed by Krejcie and Morgan (1970) and corrected using the Cochran's (1977) correction formula. This study adopted a 99% confidence interval and 2.5% confidence level. This implies that the researcher seeks 99% certainty that the responses to survey questions are accurate and willing to accept a margin of error of +/- 2.5%.

A proportionate stratified sampling technique was employed resulting in the following sampling distribution indicated in table 3.1, below.

Table 3.1: Population and Sample Distributions among Departments

Department	Population	Sample Size
Radiology (X-Ray)	32	15
Radiotherapy	54	25
Engineering	8	4
Total	**94**	**44**

3.7. Methods of Data Collection

Primary and secondary data will be collected using a number of methods that include questionnaire survey, interviews, direct observation and secondary data source searches. Primary data collection will be done using surveys, observation and in-depth interviews with selected participants. Secondary data collection will involve a review of the hospital policy documents, annual and other reports as well as a search of any relevant publications.

Furthermore, the nature of data required for the study necessitates that both qualitative and quantitative data gathering instruments are used. Quantitative data is gathered using close-ended questionnaires during survey, while for qualitative data open-ended questionnaires, observation and in-depth interviews will be employed. The use of different techniques is meant to capitalise on the strength of the techniques and improve on the validity of the findings.

3.7.1. Questionnaire Survey

A survey questionnaire will be used to collect the required data for the assessment of radiation safety culture at the hospital and ensure that the set research objectives are met. This technique was chosen for its numerous advantages that include convenience of data gathering, low cost and time requirements, as well as high objectivity, among others.

Following the guidelines by Burgess (2001) and Leung (2001), a self-administered, structured and close- ended questionnaire has been developed, paying particular attention to the length of the instrument, as well as the order and relevance of questions. The instrument has a short introduction on the objective of the study and provides assurance for confidentiality of responses. The instrument is divided into five parts aimed at collecting information on the demographic characteristics of respondents, employment history, radiation safety policies, leadership and management for safety culture as well as employee perception to safety. These traits are envisaged to help answer the research question raised and lead the researcher to arrive at informed and credible conclusions.

The questions designed are written in clear and simple terminology in order for the respondents to answer without ambiguity. Further, instructions will be provided on the number of boxes to be ticked for each section. The instrument uses a mix of the dichotomous and Likert scales for the responses, with the former applied to questions on gender and identification of managers or supervisors or those individuals that have received relevant training. The Likert scale adopted has four options that are: strongly agree, agree, disagree and strongly disagree. This is a deviation from the five point scale advocated by other researchers which includes a neutral option as the study needs to come up with a defined position and for respondents to avoid the comfort of being neutral.

A pilot survey or pre-testing of the questionnaire will be undertaken with a few respondents drawn from the institution and the regulator for radiation safety to gauge the usefulness of the instrument, check for ambiguity, response time so as to help reframe should there be a need based on the responses. Overall, this is aimed at improving the validity of the data collection instrument.

3.7.2. Interviews

Interviews will be conducted to solicit the views of managers and supervisors of the various department included in the study as well as central administration such as Quality Assurance and Operations. Additionally, senior managers at the regulatory body will be interviewed to get their views on the state of the safety culture at the institution against the international safety standards or best practices. Interview guides will be prepared with relevant questions in order to control the direction of the interview and avoid diverting to issues that may not be valuable for the current study. The questions will be close-ended in order to allow the respondents to fully express their opinions. The method will be used to enable the researcher to get in-depth information that could reveal some of the underlying issues identified through the survey. This triangulation strategy is known to improve validity of findings.

3.7.3. Observations

Direct observation will also be employed where the researcher will try and identify the various elements that are critical to safety culture such as the use of appropriate personal protective clothing, monitoring badges, availability of warning signs, notices and procedure manuals on areas with known radiation dangers. Although the technique is known to be highly subjective, the data gathered will be used to validate that gathered using the two other techniques. A checklist will be prepared of items that the researcher will be looking out for.

3.7.4. Secondary Data Sources

A review of the organisation's policies and annual reports will be done to assess the coverage of radiation safety culture issues. Further, reports will be searched from the International Atomic Energy Agency, and World Health Organisation repositories for any relevant reports as well as those from national regulators such as Radiation Protection Authority of Zimbabwe and NSSA.

3.8. Data Analysis and Presentation

Quantitative data will be analysed using SPSS and MS Excel to establish trends proportions, frequencies, and measures of central tendency among others. Chi-Squared tests will be employed to investigate if any differences between departments are not due to chance. The findings will be presented in the form of graphs, charts and tables.

3.9. Validity and Reliability

Validity defined by Bracht and Glass (2013) as the extent to which the results of an experiment/survey can be generalised from the sample that participated in it to the larger population. This validity will be ensured through triangulation of data collection techniques. Survey findings will be validated by interviews, observation and secondary data sources. Further, triangulation will be achieved by collecting the data across the various departments of the hospital that use radiation technologies and considering all categories of the hospital staff from managers, general workers and other professionals.

3.10. Relevance

The study is highly relevant to the institution and the national regulators as little research has been done in the area of radiation safety culture in the country despite the increased applications across various socio-economic sectors. There are international safety standards relevant to the application of radiation for peaceful uses that individual countries that are member states of the International Atomic Energy Agency (IAEA) are supposed to adapt at national level. Therefore, the results will assist the hospital to review its radiation safety and risk management systems, policies and procedures to strengthen safety culture. Similarly, the regulators may be able to review and strengthen the framework and policies for the improvement radiation safety culture for all applications.

3.11. Ethical Consideration

A number of considerations were made during the study, which include obtaining permission for the study from the hospital senior management following consultations with heads of affected departments. Similarly, authority to conduct the study was granted by the University and the guidance of the supervisor was followed. All survey respondents had informed consent with no cohesion used to force them to answer any part of the questionnaire. The researcher will ensure that none of the respondents are harmed during the survey. A commitment was made to keep the responses confidential. This was done being mindful of a number of red flags that have been raised over unethical research conduct some of which have resulted in injury to human populations. Such examples include the testing of unproven medicines on unsuspecting patients. Ruan (2005) implores on researcher to uphold highest ethical and professional conduct during studies.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1. Response Rate

The questionnaire survey achieved a response rate of 91.9% as indicated in table 4.1 below. The distribution of responses from the targeted departments at the hospital shows that HEM registered 100% while the X-Ray and Radiotherapy departments had 86.7% and 92% due to the practice of shift work leading to failure to locate some of the recipients of questionnaires during collection.

Table 4.1: Survey Response Rate

Department	Questionnaires Distributed	Questionnaires Returned	Percentage Response
X- Ray	15	13	86.7%
Radiotherapy	25	23	92%
Hospital Equipment Maintenance	4	4	100%
Overall	**44**	**40**	**90.9%**

Source: Primary Data

The achieved response rate is acceptable as it is above the 60% threshold advocated for by Yin (2010) needed for the replicability of the methodology and acceptable reliability and validity.

4.2. Demographic, Educational and Employment Data Analysis

4.2.1. Gender

The survey collected data on the gender of respondents for correlation during analysis of safety culture traits, presented in table 4.2, below. Overall, the survey respondents constituted of 37.5% males and 62.5% females. Further analysis of the gender distribution among the departments is presented in table 4.3 which shows that HEM had 100% male respondents while in the X-Ray department there were 38.5% males and 61.5% females. The Radiotherapy respondents were 26.1% males and 73.9% females.

Table 4.2: Gender Distribution

Table 4.2: Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	15	37.5	37.5	37.5
	Female	25	62.5	62.5	100.0
	Total	40	100.0	100.0	

Source: Primary Data

Table 4.3: Gender Distribution by Department

Department	Males	Females
X-Ray	38.5	61.5
Radiotherapy	26.1	73.9
HEM	100	0.00

Source: Primary Data

4.2.2. Education Qualifications

The results show that the majority of respondents possess a university degree with 70% having a Bachelors' degree while 12.5% hold a Masters' degree in the relevant work of operation. Additionally, 7.5% of the respondents only went up to secondary school, while 10% hold other qualifications such as being 25% each for Post Basic Diploma in Nursing and Diploma in Radiography, as well as 50% with a National Certificate in Instrumentation and Control. These results are consistent with expectations of personnel working in the target departments made up of Medical Doctors, Engineers and Medical Physicists who have a least a Bachelors' degree qualification. Other professionals such as Radiographers, and Nurses have qualifications ranging from certificates, diplomas and degrees while some of the support staff such as security and cleaners may have secondary education.

4.2.3. Duration of Service

The survey results indicated that the participants have a varied duration at the institution. As indicated in Figure 4.1 below, only 27.5% of the respondents have less than one year at the hospital and those with a tenure of between 1 and 5 years account for 32.5% while 17% have been with the hospital for more than 10 years.

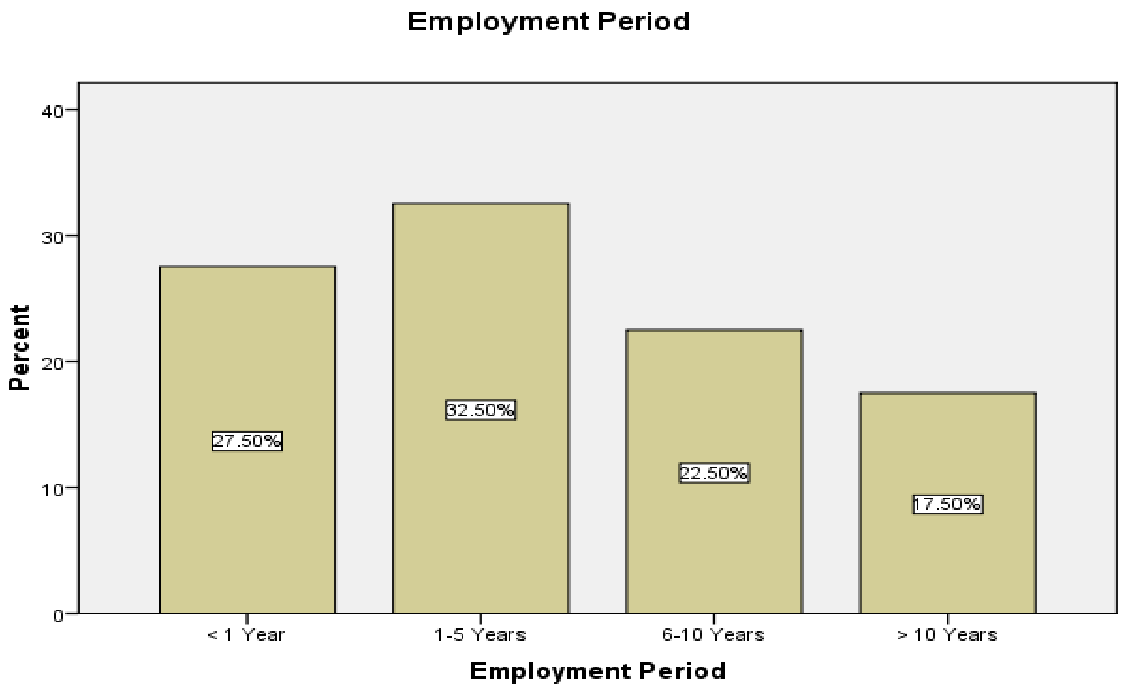

Figure 4.1: Distribution of respondents' duration of employment
Source: Primary Data

4.3. Radiation Risk Management

Interviews conducted with the Heads of Department for X-Ray and Radiotherapy as well as Chief Radiographer and Radiation Safety Officer (RSO) for Radiotherapy revealed that the hospital does not have a radiation safety policy document. The departments are guided by a Radiation Protection Programme prepared in fulfilment of regulatory requirements from the Radiation Protection Authority of Zimbabwe (RPAZ). It was further revealed that the hospital has established a Radiation Safety Committee mandated to develop relevant policies, procedures, and systems to manage the radiation risk in line with national and international safety requirements.

4.3.1. Safety Induction

The survey sought to establish the implementation of safety induction as a measure of managing the radiation risk at the institution. The results presented in table 4.4 indicate that 40% of the respondents went through safety induction before they began their jobs at the hospital, leaving 60% who plunged in without induction.

Table 4.4: Safety Induction Before Work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	40.0	40.0	40.0
	No	24	60.0	60.0	100.0
	Total	40	100.0	100.0	

Source: Primary Data

The departmental cross-tabulation indicates that a greater proportion in the X-Ray department did not receive induction with only 2 out of 13 (15.4%) having gone through induction. HEM had an equal proportion of respondents inducted and those not while in Radiotherapy 12 out of 23 respondents representing 52.2% underwent radiation safety induction before commencing work.

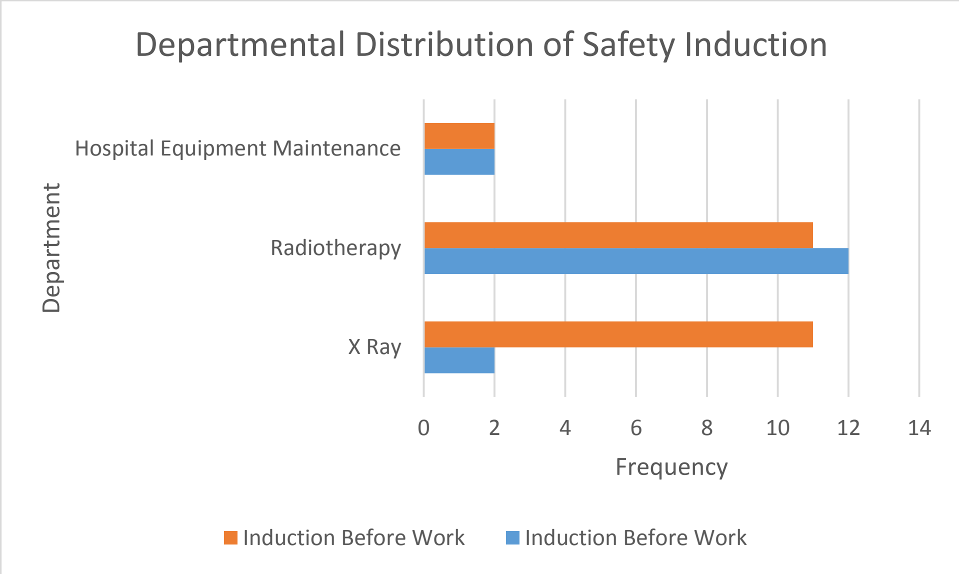

Figure 4.2: Departmental Distribution of Induction

A Chi-square test to check whether the conduct of induction for new workers before commencing work with radiation technologies was influenced by the department of work was done at 95% Confidence Interval (5% Significance Level)

Hypothesis 1: Association between Department and Induction

Ho*: There is no association between Department and Induction before Work*

H1*: There is an association between Department and Induction before Work*

Table 4.5 Chi-square test: Association between Department and Induction before Work

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.869^a	2	.088
Likelihood Ratio	5.292	2	.071
Linear-by-Linear Association	3.516	1	.061
N of Valid Cases	40		

Source: Primary Data

Decision

The p –value from the SPSS output of 0.088 is more than 0.05 thus we accept H_0 while rejecting H_1 and conclude that there is no association between Department and the conduct of Induction before Work.

Therefore, none of the departments under study had a deliberate programme for the induction of new staff before commencing work.

4.3.2. Formal Radiation Safety Training

The survey showed that 40% of the respondents have undergone formal radiation safety training initiated by the hospital since joining service, while 60% have not received any formal radiation safety training as shown in figure 4.3, below.

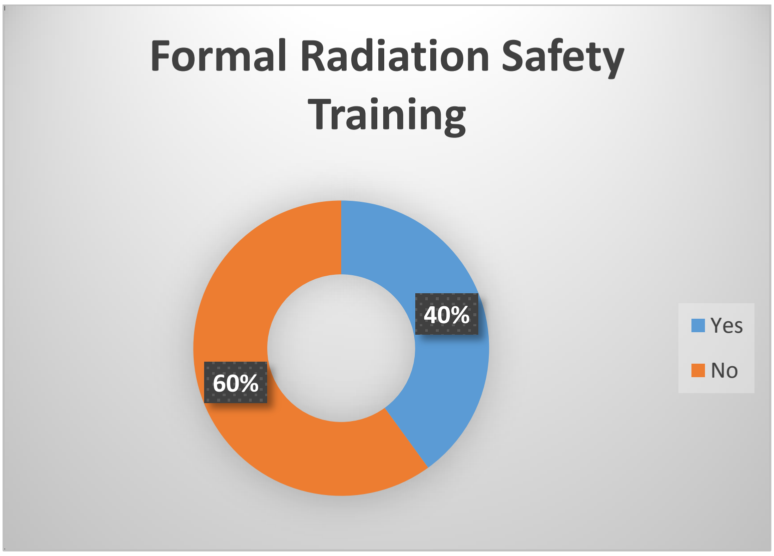

Figure 4.3: Radiation Safety Training Responses

A cross-tabulation by department indicates that a greater proportion of training has been realized in the Radiotherapy where 10 of the 23 respondents have been trained representing 43%, followed by X-Ray with 38% while HEM has the least at 25%, depicted in figure 4.4, below.

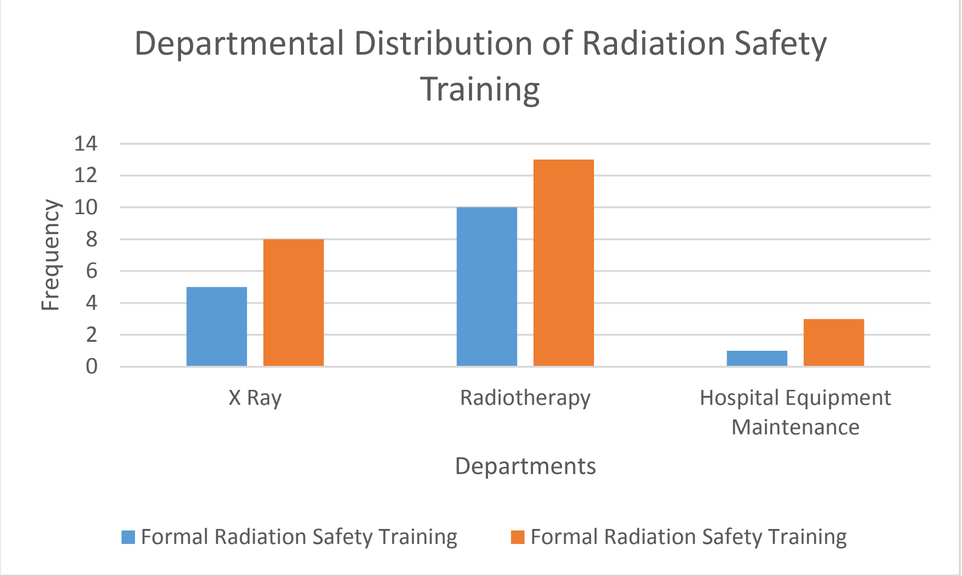

Figure 4.4: Departmental Distribution of responses on radiation safety training

Source: Primary Data

4.3.3. Radiation Safety Briefings

The survey results presented in figure 4.5 below, indicate that 47.5% of the respondents have taken part in a radiation safety briefing over the past 12 months at the hospital.

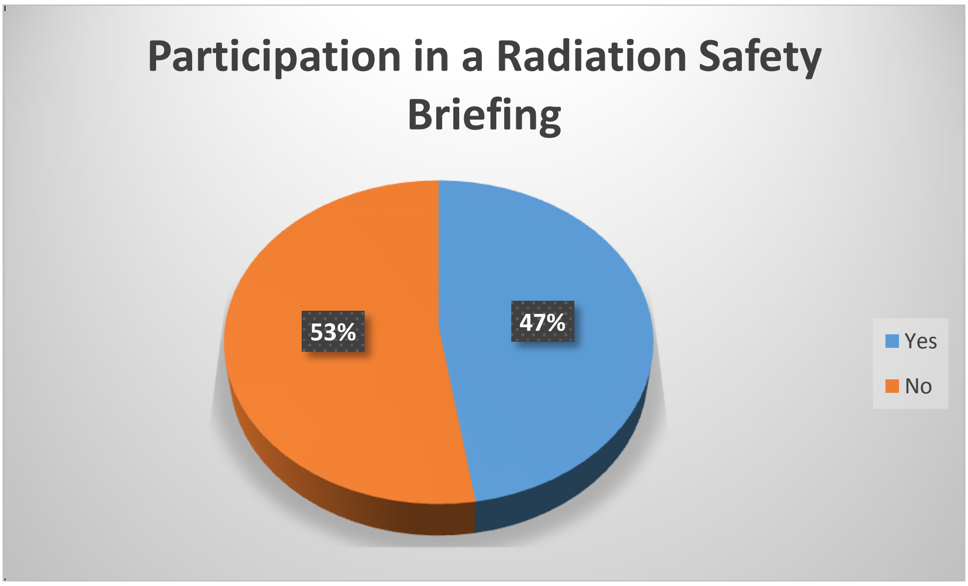

Figure 4.5: *Responses to participation in Radiation safety briefing over past 12 months*

Departmental distribution of briefings indicates that a greater proportion was recorded in the HEM with 75% while X-Ray and Radiotherapy departments had 53.8% and 39.1%, respectively as indicated in table 4.6, below.

Table 4.6: Departmental Distribution for radiation safety briefing(s)

Department	% Attended briefing(s)	% Did not attend briefing(s)
X-Ray	53.8	46.2
Radiotherapy	39.1	60.1
HEM	75.0	25.0

Source: Primary Data

4.3.4. Development and Implementation of the Radiation Protection Programme

The survey sought to establish the level of awareness and involvement of employees in the development of the radiation protection programme (RPP), which is the guiding policy document for safety in the various departments of the hospital. The results as show that only 40% of the respondents are aware of the existence of the RPP, while 60% expressed ignorance of the same.

Analysis of the responses to establish the departmental trends on the level of awareness of the RPP indicate higher awareness in the Radiotherapy department at 47.8% as compared to the 30.8% and 25% recorded from the X-Ray and HEM departments, respectively.

Table 4.7: Employee Participation in Development of the Radiation Protection Programme

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	12.5	12.5	12.5
	No	35	87.5	87.5	100.0
	Total	40	100.0	100.0	

Source: Primary Data

As indicated by table 4.7 above, only 12.5% of the respondents were involved in the development of the radiation protection programme.

Further correlation was conducted on the relationship between participation in the development of the RPP and level of awareness as indicated in table 4.8, below;

Hypothesis 2: *Relationship between participation in development of the RPP and RPP awareness.*

H_0: There is no relationship between employee participation in development of the RPP and level of awareness;

H_1: There is a relationship between employee participation in the development of the RPP and level of awareness;

Table 4.8 Correlation: Employee participation in development of RPP and Level of awareness

		Participation in development of RPP	Employee awareness of RPP
Participation in development of RPP	Pearson Correlation	1	.463
	Sig. (2-tailed)		.003
	N	40	40

Source: Primary Data

The results of the 2- tailed Pearson Correlation analysis at 99% confidence level showed that there is a positive, slightly weak and statistically insignificant relationship between employee participation in the development of the RPP and the level of awareness on the RPP in the organization **[r=-0.463, p>0.01 (p=0.03)].** Therefore, it implies that there is no relationship between the two variables and the low awareness level could be due to other problems.

4.4. Leadership and Management for Radiation Safety

Interviews with respective heads of department and sections revealed that the responsibility for radiation safety is vested in the HOD. However, some delegated responsibility is on the departmental RSO, a position mandatory under Section 16 of the Radiation Protection Act [Chapter 15:15] for all users of ionizing radiation. Organisational Structure.

Perception on the effectiveness of management to deal with safety was assessed through a number of questions in which workers in the departments were asked to provide an opinion regarding safety priority, confidence in management's handling of safety concerns and responsiveness to safety concerns, among others.

4.4.1. Safety as an Overriding Priority

Responses to the opinions of the employee on the prioritization of safety over work schedule indicate that 20% strongly agreed that safety has an overriding priority while 35% agreed. Cumulatively, 55% of the respondents believe that heir management prioritizes safety over work schedules. However, a significant proportion of 45% does not share the same views with 32.5% disagreeing while 12.5% strongly disagree with the assertion.

An analysis of the departmental distribution of the sentiments as presented in table 4.9, below indicate that 53.8% of the respondents in the X-Ray department do not believe that safety has an overriding priority in their work, compared to have 43.8% and 25% from Radiotherapy and HEM, respectively sharing similar views.

Table 4.9: Departmental distribution of perception of safety as an overriding priority

Department	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
X-Ray	15.4	30.8	30.8	23.0
Radiotherapy	13.0	43.3	34.8	0.9
HEM	75.0	0.0	25.0	0.0
Percentage Contribution	**20.0**	**35.0**	**32.5**	**12.5**

Source: Primary Data

Correlation analysis was made to test the relationship between induction before work and employee perception of safety as an over-riding priority.

Hypothesis 3: Correlation between induction and safety as an overriding priority

H_0: There is no relationship between Induction before work and Perception of Safety as an Overriding Priority;

H_1: There is a relationship between Induction before work and Perception of Safety as an Overriding Priority

Table 4.10- Correlation: Induction before work and Perception of Safety as an Overriding Priority

		Induction before work	Safety as an Over-riding Priority
Induction before Work	Pearson Correlation	1	.271
	Sig. (2-tailed)		.090
	N	40	40

Source: Primary Data

The indicated the existence of a positive, weak and statistically insignificant relationship between induction before work and employee perception that safety has an overriding priority in the organization **[r=-0.271, p>0.01 (p=0.09)].** Therefore, it implies that there is no relationship between the two variables and the poor safety perception is due to other reasons.

4.4.2. Adherence to Safety Rules

When asked if management encourages employees to work in accordance with safety rules at all times, 20% of the respondents strongly agreed and a further 55% agreed while 20% disagreed and 5% strongly disagreed. These results are depicted in table 4.11.

Table 4.11: Responses on Management encouraging following safety rules

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	8	20.0	20.0
Agree	22	55.0	75.0
Disagree	8	20.0	95.0
Strongly Disagree	2	5.0	100.0
Total	40	100.0	

Source: Primary Data

The departmental distribution of the opinions which indicate that the highest proportion agreeing that management encourages adherence to safety requirements is in the X-Ray

Department where 84.6% agree consisting of 23.1% strongly agreeing and 61.5% agreeing. 21.7% of the respondents in the Radiotherapy Department do not believe that their management encourages adherence with safety requirements all the time and a further 9% strongly disagree. In HEM, 75% of respondents agree that management encourages them to abide by safety rules all the times.

A test of association (Chi-square) was conducted to establish whether management's encouragement on adherence to safety rules was determined by department of work.

Hypothesis 4: Association between Department and Management Encouragement to Adhere to Safety Rules.

H_0: There is no association between Department and Management encouragement to adhere to safety rules

H_1: There is association between Department and Management encouragement to adhere to safety rules

Table 4.12- Chi-Square Test: Association between Department and Encouragement to adhere to safety rules

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.885[a]	6	.559
Likelihood Ratio	5.333	6	.502
Linear-by-Linear Association	.089	1	.765
N of Valid Cases	40		

Source: Primary Data

Decision

The p –value from the SPSS output of 0.559 is more than 0.05 thus we accept H_0 while rejecting H_1 and conclude that there is no association between Department and Management encouragement to adhere to safety rules at all times.

Therefore, management is all departments are consistent in encouraging adherence to safety rules to safeguard employees and patients.

4.4.3. Provision and Access to Radiation Safety Information

The survey sought to collect respondents' opinion on whether their management provides the necessary safety information to the workers. A total of 55% agreed made up of 10% that strongly agreed, while 45% of the respondents did not agree as indicated in figure 4.6, below.

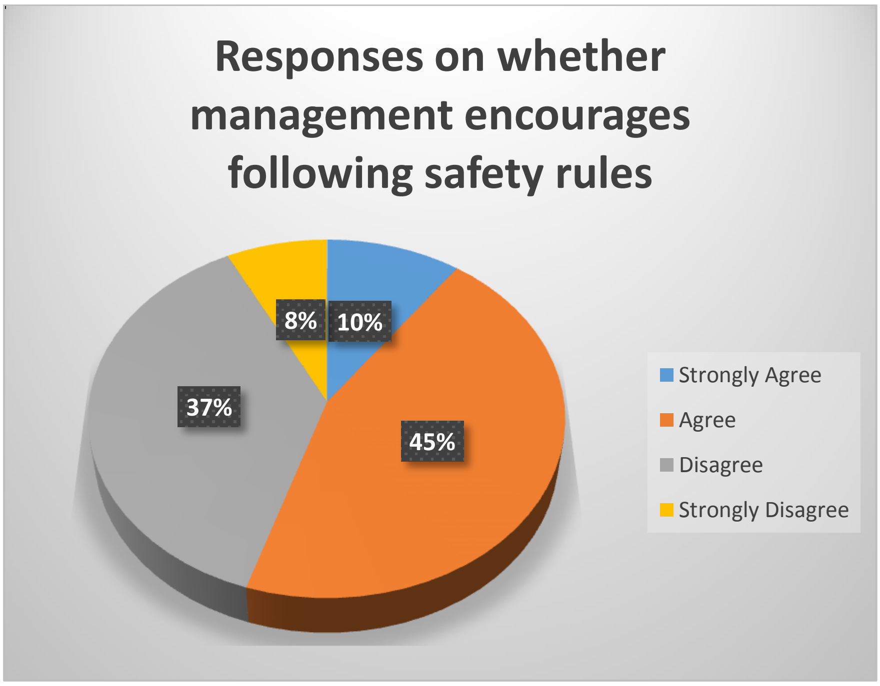

Figure 4.6: Responses on whether management provides relevant safety information all the time.

Consequent departmental analysis as presented in table 4.13, below, indicate that a strong positive opinion was found in the X-Ray and HEM departments with a total of 69.2% and 75%, respectively contrasted to Radiotherapy department where 56.5% of respondents did not agree that their management made available the relevant safety information all the time.

Table 4.13: Departmental analysis on perception that management provides relevant safety information all the time.

Department	Strongly Agree	Agree	Disagree	Strongly Disagree
X-Ray	15.4	53.8	30.8	0.0
Radiotherapy	8.0	34.5	43.5	13.0
HEM	0.0	75.0	25.0	0.0

Percentage Contribution	10.0	45.0	37.5	7.5

Source: Primary data

4.4.4. Employee Confidence in Management's ability to deal with Radiation Safety

Confidence in Management's ability to deal with radiation safety was measured among the respondents and it revealed that 52.5% of the respondents do not believe that their management has the ability to address radiation safety issues.

Table 4.14: Confidence in management ability to deal with radiation safety

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	7	17.5	17.5
Agree	12	30.0	47.5
Disagree	18	45.0	92.5
Strongly Disagree	3	7.5	100.0
Total	40	100.0	

The distribution across departments as presented in figure 4.7 indicates that 58.5% of the respondents in the Radiotherapy department are not confident in the ability of their management to effectively address safety issues. The lack of confidence is 50% and 46% in the X-Ray and HEM departments, respectively.

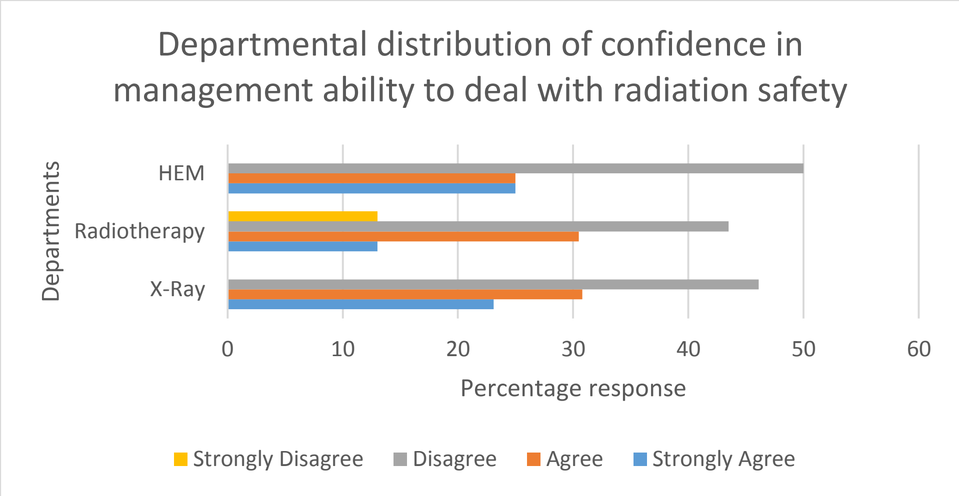

Figure 4. 7: Departmental Cross tabulation on confidence in management's ability to deal with safety

Correlation analysis was conducted to establish the relationship between employee induction before work and perception on management's ability to deal with radiation safety and the results are shown in table 4.15, below.

Hypothesis 5: Correlation between employee induction and perception on management's ability to deal with radiation safety.

H_0: There is no relationship between employee Induction before Work and perception of Management's ability to deal with Radiation Safety

$H_{1:}$ There is a relationship between employee Induction before Work and perception of Management's ability to deal with Radiation Safety

Table 4.15 Correlation: Induction before Work and Management's ability to deal with Radiation Safety

		Induction Before Work	Confidence in Management's ability to deal with Radiation Safety
Induction Before Work	Pearson Correlation	1	-0.012
	Sig. (2-tailed)		0.942
	N	40	40

Source: Primary Data

The results showed that there is a negative, very weak and statistically insignificant relationship between Induction before Work and Confidence in management's ability to deal with radiation safety **[r=-0.012, p>0.01 (p=0.942)].** This implies that there is no relationship between the two variables.

4.4.5. Management Responsiveness to identified Radiation Safety Concerns

Management response to identified safety problems is another key indication of safety culture. The opinion of respondents shows that only 2.5% strongly agree that their management is swift in addressing identified radiation safety concerns with a further 42.5% in agreement. However the remaining 55% hold a contrary belief with 12.5% strongly disagreeing that management is very responsive in addressing such challenges as depicted in table 4.16, below.

Table 4.16: Management ensures that identified safety problems are addressed timeously

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	1	2.5	2.5	2.5
	Agree	17	42.5	42.5	45.0
	Disagree	17	42.5	42.5	87.5
	Strongly Disagree	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

Source: Primary Data

The responsiveness metric was measured against departments as well and table 4.17 shows that the greatest disagreement was in the Radiotherapy department where 65.2% of the respondents disagree with a further 21.7% strongly disagreeing. The least disagreement came from HEM where 75% of the respondents believe their management is swift to respond to safety concerns.

Table 4.17: Departmental Distribution on Management's Responsiveness

Department	Strongly Agree	Agree	Disagree	Strongly Disagree
X-Ray	8.0	46.0	46.0	0.0
Radiotherapy	0.0	34.8	43.5	21.7
HEM	0.0	75.0	25.0	0.0
Percentage Contribution	2.5	17	17	5

A Chi-square test was run to check whether the challenges to management's responsiveness are confined to some particular departments or are an organisational phenomenon. The results are presented in table 4.18, below.

Hypothesis 6: Association between Department and Management responsiveness to identified radiation safety concerns

H_0: There is no association between Department and Management responsiveness to identified radiation safety concerns;

H_1: There is association between Department and Management responsiveness to identified radiation safety concerns;

Table 4.18-Chi-Square: Association between department and management responsiveness to identified radiation safety concerns

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.464[a]	6	.280
Likelihood Ratio	9.357	6	.154
Linear-by-Linear Association	.422	1	.516
N of Valid Cases	40		

Decision

The p –value from the SPSS output of 0.28 is more than 0.05 thus we accept H_0 while rejecting H_1 and conclude that there is no association between Department and Management responsiveness to identified radiation safety concerns. Therefore, the perception that management is not very responsive is shared among all departments.

4.4.6. Employee involvement in Safety Decisions

The survey as indicated in table 4. 19 revealed that 47.5% of the respondents agree that management at the hospital involves employees when making safety-related decisions while 52.5% believe to the contrary. A further analysis of the distribution across the three departments shows a balance of opinions in HEM with 50% each in agreement and disagreement while 65.2% of respondents in the Radiotherapy department believe that management makes arbitrary safety decisions without involving employees.

Table 4.19: Employee Involvement in Safety Decisions

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	7	17.5	17.5
Agree	12	30.0	47.5
Disagree	17	42.5	90.05
Strongly Disagree	4	10.0	100.0
Total	40	100.0	

Source: Primary Data

4.4.7. Blaming of employees after accidents

The inquiry on whether management blames employees in the case of accidents revealed that 55% of the respondents do not agree while 45% agree that management blames employees when an accident occurs. As depicted in table 4.20 below, 25% respondents in HEM, 38.5% in X-Ray and 42.2% in Radiotherapy departments believe that management blames its employees when accidents occur.

Table 4.20: Departmental Distribution of Perceptions of Blaming in case of accidents

Department	Strongly Agree	Agree	Disagree	Strongly Disagree
X-Ray	15.4	23.0	46.2	15.4
Radiotherapy	17.4	34.8	34.8	13.0
HEM	25.0	0.0	50.0	25.0
Percentage Contribution	17.5	27.5	40.0	15.0

A Chi-square test was run to check whether the perceptions of management blaming employees when accidents occur are confined to some particular departments or are an organisational phenomenon. The results are presented in table 4.21 below.

Hypothesis 7: Association between Department and perceptions of Management blaming employees when accidents occur.

H_0: There is no association between Department and perceptions of Management blaming employees when accidents occur.

H_1: There is association between Department and perceptions of Management blaming employees when accidents occur.

Table 4.21 Chi-Square: Association between department and perception of management blaming employees when accidents occur.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.504[a]	6	.868
Likelihood Ratio	3.513	6	.742
Linear-by-Linear Association	.005	1	.941
N of Valid Cases	40		

Source: Primary Data

Decision

The p –value from the SPSS output of 0.868 is more than 0.05 thus we accept H_0, reject H_1 and conclude that there is no association between Department and perceptions of

Management blaming employees when accidents occur.

4.5. Employee Attitude and Participation in Radiation Safety

4.5.1. Understanding Radiation Safety Goals

The research sought to establish whether the employees understood the radiation safety goals of their organization or department. Responses presented in table 4.22 indicate that 72.5% of the employees understand the safety goals while the remaining 27.5% do not.

Analysis of the strait by department in figure 4.8 below, shows that Radiotherapy contributes a greater proportion of employees that understand the radiation safety goals with 8 out of 12 that strongly agreed and 9 out of 17 that agreed. However, the department still had 6 out of 23 respondents who do not understand the safety goals.

Table 4.22: Responses on employees Understanding Radiation Safety Goals

		Frequency	Percent	Cumulative Percent
Valid	Strongly Agree	12	30.0	30.0
	Agree	17	42.5	72.5
	Disagree	10	25.0	97.5
	Strongly Disagree	1	2.5	100.0
	Total	40	100.0	

Source: Primary Data

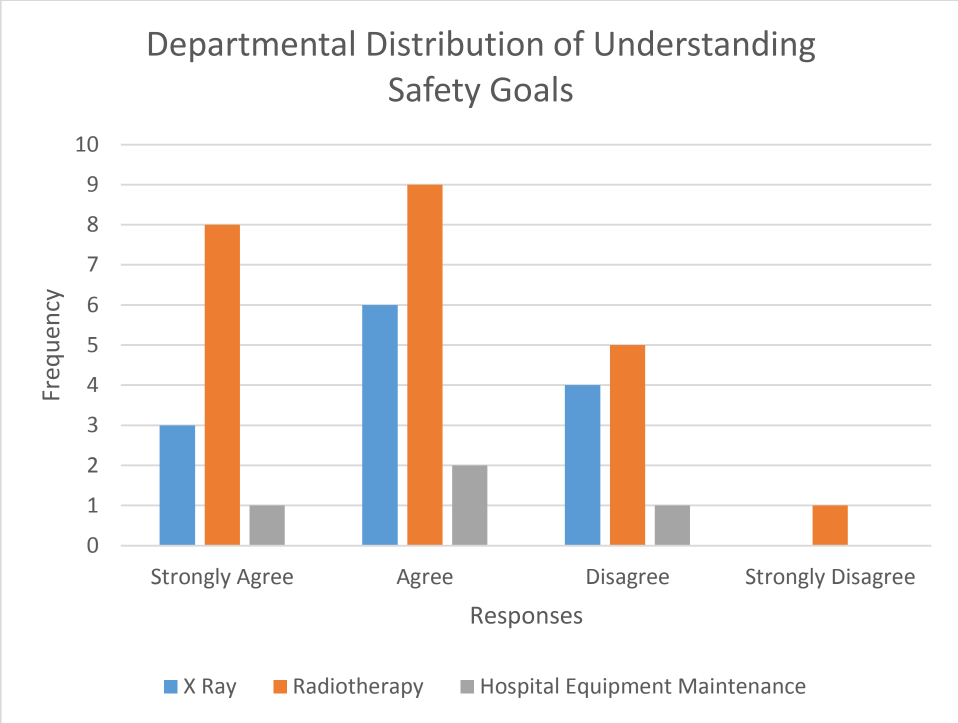

Figure 4.8: Departmental Distribution of Understanding Safety Goals

4.5.2. Adequacy of Training

When quizzed if they felt that they have been adequately trained to work with radiation technologies, the survey indicates that 60% of the employees affirmed that they are well trained to work safely with radiation, equally distributed among the two response categories (strongly agree and agree). Conversely, 40% of the respondents believe that they do not have the requisite training to work safely with radiation as indicated in figure 4.9, below.

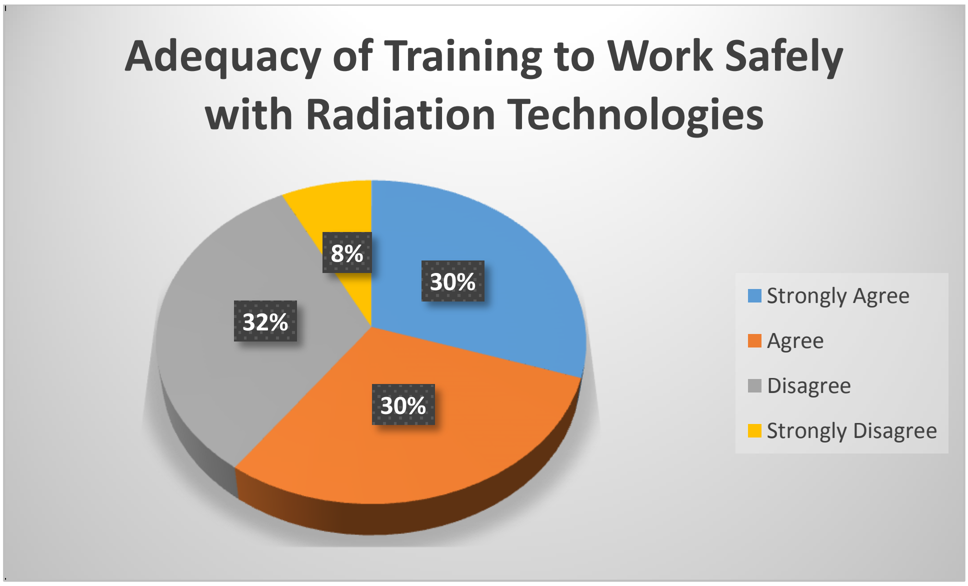

Figure 4.9: Responses to adequacy of training to work safely with radiation

The perception distribution across the departments as presented in figure 4.10 indicates that 50% of respondents in HEM do not believe that they are well trained to handle radiation. Radiotherapy has the highest proportion of respondents who are confident that their training adequately prepared them to work with radiation.

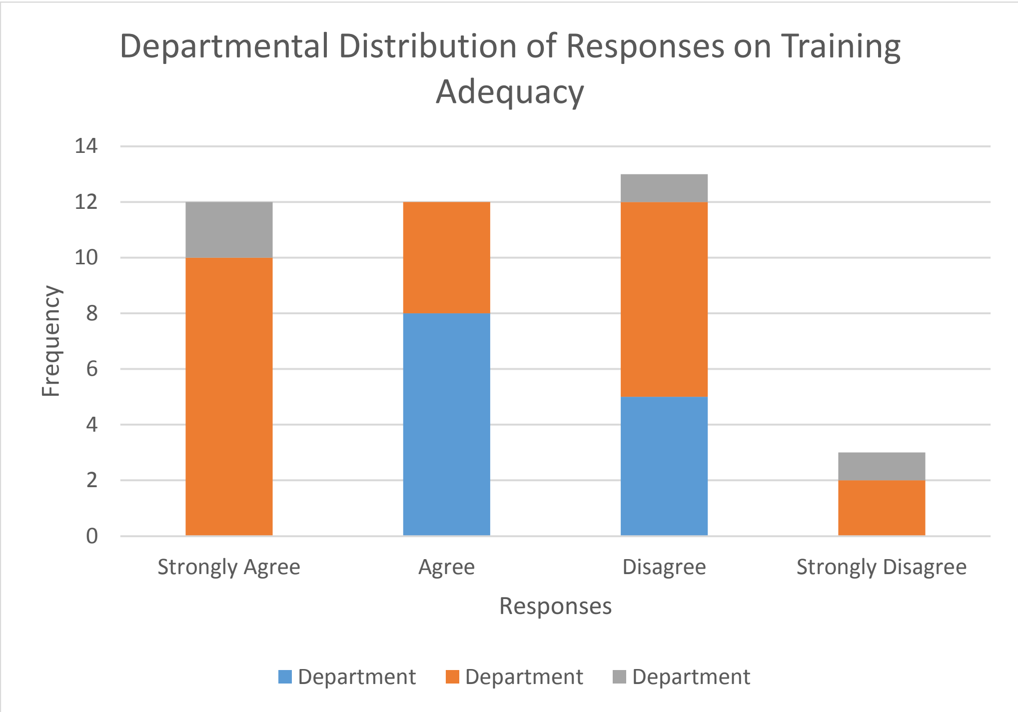

Figure 4.10: Departmental Distribution of Adequacy of training

A further analysis cross-tabulating education and responses to the adequacy of training presented in figure 4.11, below indicate that respondents without tertiary qualification least agree that they are well trained to work in an environment with radiation technologies contributing 63% of those strongly disagreeing. Holders of Bachelors' degrees dominate the distribution across three categories except for strongly disagree constituting 58% of those in strong agreement, 83% in agreement as well as 62% of those disagreeing. Holders of Masters' degrees expressed two opposing opinions making up 28% of those strongly agreeing and 32% of strongly disagreeing that their training is adequate to work safely with radiation.

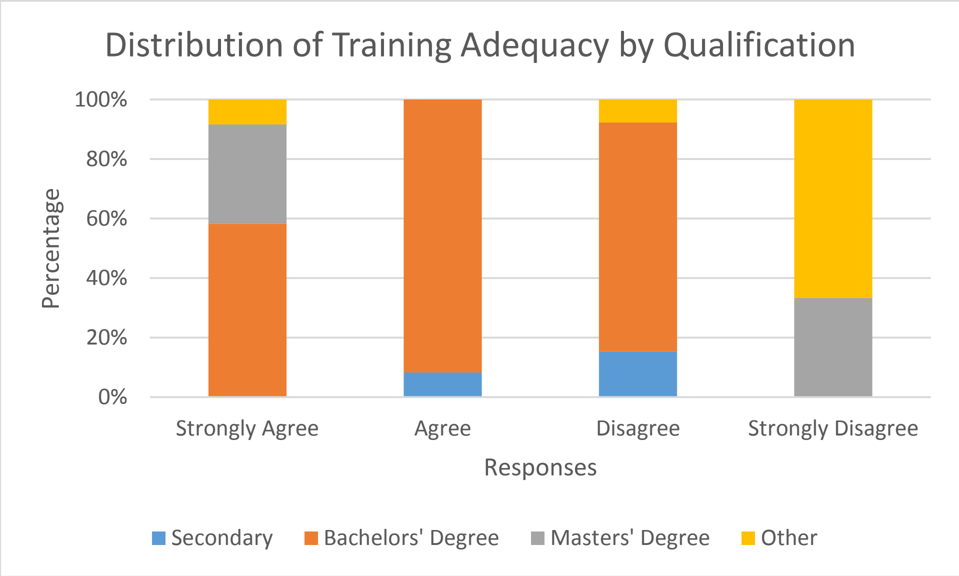

Figure 4.11: Distribution of Training Adequacy by Qualification

A test for correlation was done to examine the relationship between formal radiation safety training and perception on the adequacy of training to work safely with radiation technologies.

Hypothesis 8: Relationship between Formal radiation safety training and Adequacy of training

H_0: There is no relationship between Formal radiation safety training and Adequacy of training to work safely with radiation;

H_1: There is a relationship between Formal radiation safety training and Adequacy of training to work safely with radiation

Table 4.23 Correlation: Formal radiation safety training and perception on adequacy of training to work safely with radiation technologies

		Formal Radiation Safety Training	Employee Perception on adequacy of Training to deal safely with radiation technologies
Formal Radiation	Pearson Correlation	1	.313

Safety Training	Sig. (2-tailed)		.049
	N	40	40

Source: Primary Data

The results showed that there is a positive, weak and statistically insignificant relationship between Formal radiation safety training and Employee perception on adequacy of training to work safely with radiation technologies **[r=-0.313, p>0.01 (p=0.49)].** This implies that there is no relationship between the two variables and the perception could be arising from the educational training received by the respondents.

Consequently, a Chi-Square test was conducted to check for the association between educational qualifications and perceptions on the adequacy of training to work safely with radiation technologies.

Hypothesis 9: Association between educational qualifications and adequacy of training to work safely with radiation technologies

H_0: There is no association between educational qualifications and perception on the adequacy of training to work safely with radiation technologies;

H_1: The is an association between educational qualifications and perception on the adequacy of training to work safely with radiation technologies;

Table 4.24 Chi-Square Test: Association between Educational qualifications and Adequacy of training

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.710	9	.003
Likelihood Ratio	24.858	9	.003
Linear-by-Linear Association	.257	1	.612
N of Valid Cases	40		

Table 4.24 Chi-Square Test: Association between Educational qualifications and Adequacy of training

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.710	9	.003
Likelihood Ratio	24.858	9	.003
Linear-by-Linear Association	.257	1	.612

Source: Primary Data

Decision

The p –value from the SPSS output of 0.003 is less than 0.05 thus we reject H_0, accept H_1 and conclude that there is an association between educational qualifications and employee perceptions of adequacy of training to work safely with radiation technologies.

Further tests were done on the association between the department of work and perception on the adequacy of training to work safely with radiation technologies.

Hypothesis 9: Association between Department and perception on adequacy of training to work safely with radiation technologies.

H_0: There is no association between department of work and perception on the adequacy of training to work safely with radiation technologies;

H_1: The is an association between department of work and perception on the adequacy of training to work safely with radiation technologies;

Table 4.25 Chi-square: Association between department and adequacy of training to work with radiation technologies safely

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.449[a]	6	.017

Likelihood Ratio	19.838	6	.003
Linear-by-Linear Association	.428	1	.513
N of Valid Cases	40		

Source: Primary Data

Decision

The p –value from the SPSS output of 0.017 is less 0.05 which is significant and thus we reject H_0, accept H_1 and conclude there is indeed association/relation between Department of work and employee's perception on adequacy of training to work with radiation technologies safely.

4.5.3. Attitude to Accidents and Incidents

When asked whether minor incidents can be considered as part of everyday work, 49% agree compared to 51% who disagree. As figure 4.12 indicates 12% strongly agreed compared to 18% that strongly disagreed.

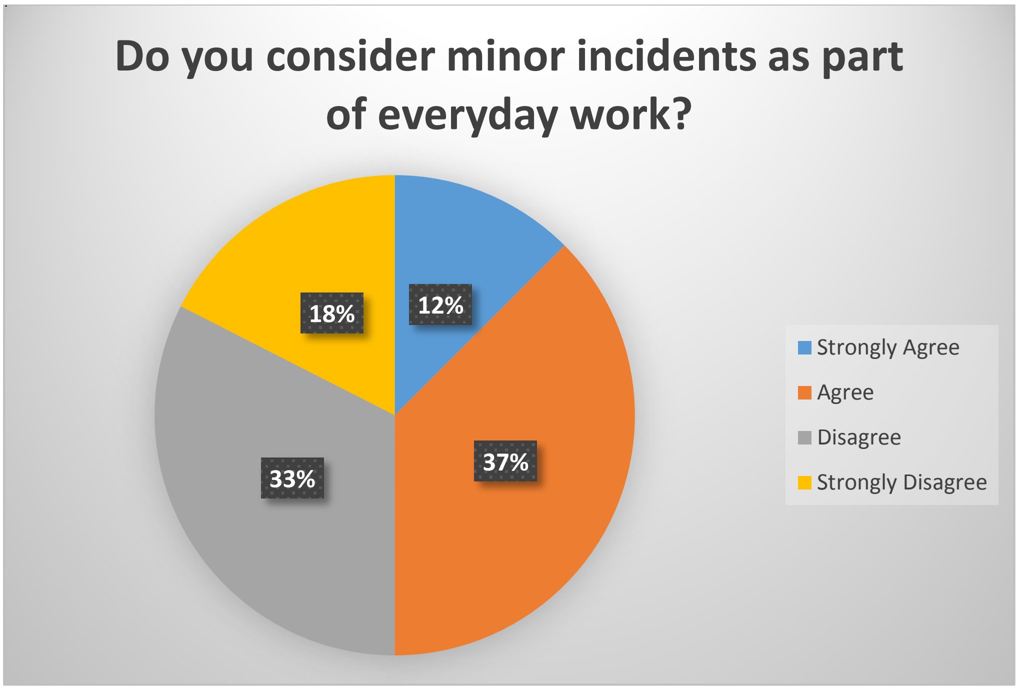

Figure 4.12: Responses on Consideration of minor accidents as part of everyday work.

4.5.4. Voluntary Reporting of Accidents and Near-Misses

Further inquiry yielded that 77.5% of the employees would report to their management if they had an incident or a near-miss. The greater proportion of the remaining 22.5% of those respondents that would not consider reporting such incidents or near misses is made up of employees from the Radiotherapy department where 26.1% disagree.

4.5.5. Importance of Individual Input to Radiation Safety

When quizzed about their perception of the importance of their individual input into radiation safety in the work place, 65% had a strongly positive perception with an additional 25% agreeing affirming the importance of their input. The remaining 10% believed that their input into safety matters does not matter, with 3% maintaining a strong contrary view.

The departmental distribution of perception on individual safety in figure 4.13 shows a strong feeling among employees in all Radiotherapy with 69.5% strongly agreeing and a further 17.3% in agreement while X-Ray is made up of 69.3% strongly agreeing and 30.7% agreeing. HEM had 25% strongly agreeing, 50% agreeing and a further 25% disagreeing.

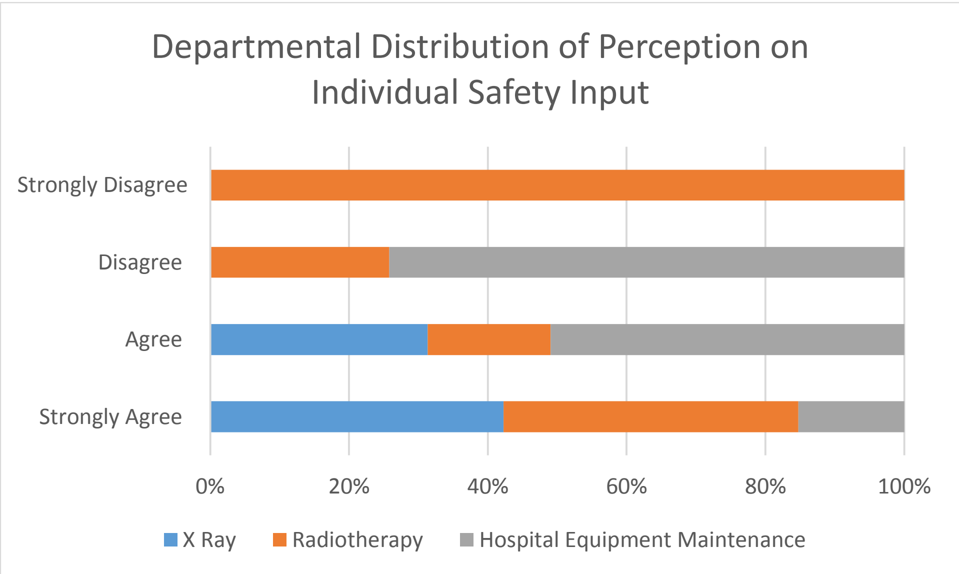

Figure 4.13: Departmental Distribution of Perception on Individual safety Input

As indicated in figure 4.13, above, only respondents from Radiotherapy strongly felt that their input is not important, compared to all respondents from the X-Ray department.

4.5.6. Safety Behaviour of Workers under Pressure

The researcher also solicited for views on how the respondents would react when under pressure. The survey results in figure 4.14, below indicated that 10% of the respondents strongly agree to taking safety risks when the work-schedule is tight. A further 30% also agree leaving 60% of respondents who indicated that they would not compromise on safety even when under work pressure, with 23% strongly disagreeing.

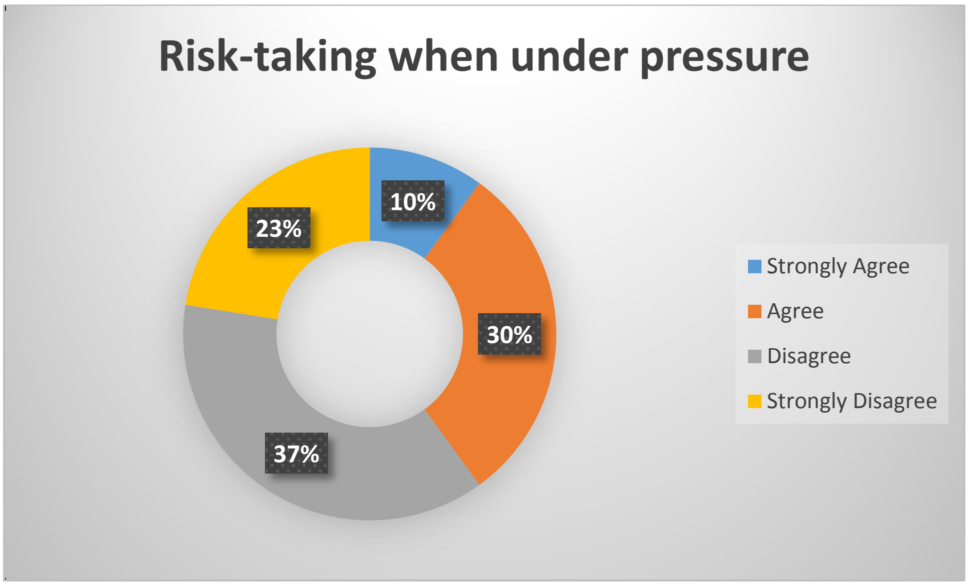

Figure 4.14: Risk –Taking Perception when under pressure

The distribution of risk-taking perceptions across departments is illustrated in figure 4.15, below and indicates that the greatest opposition to risk-taking was from the Radiotherapy department where 15 out of 23 of the respondents do not accept taking a risk when under work pressure.

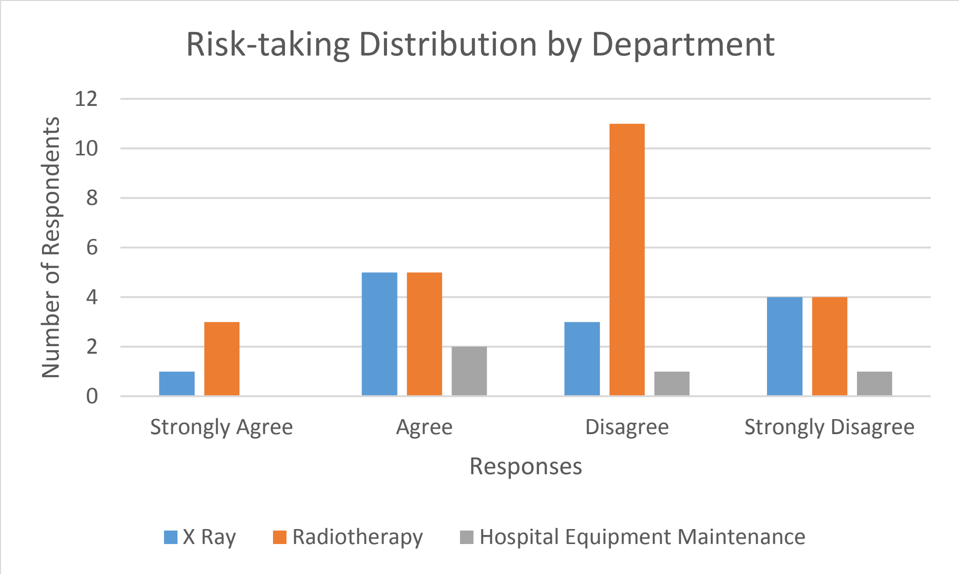

Figure 4.15: Departmental Distribution of Risk taking Perceptions

A correlation analysis was conducted on the relationship between the perception that minor accidents are an everyday occurrence at work and employee willingness to take risks when under pressure.

Hypothesis 10: Relationship between perception on minor accidents as part of everyday work and employee willingness to take risks when under pressure

H_0: There is no relationship between employee perception of minor accidents as part of everyday work and their willingness to take risks when under pressure;

H_1: There is a relationship between employee perception of minor accidents as part of everyday work and their willingness to take risks when under pressure

Table 4.26 Correlation: Relationship between perception on minor accidents and Willingness to take risk when under pressure

		Minor accidents part of everyday work	Employee willingness to take risk when under pressure
Minor accidents part of everyday work	Pearson Correlation	1	.031
	Sig. (2-tailed)		.850
	N	40	40

Source: Primary Data

The results show that there is a positive, very week and and statistically insignificant relationship between employee perception of minor accidents being part of everyday work and their willingness to take risks when working under pressure **[r=0.031, p>0.01 (p=0.85)].** This implies that there is no relationship between the two variables.

4.5.7. Responsibility for Personal Safety

When probed on their perception of responsibility for personal safety, the responses revealed that only I employee representing 2.5% of the sample did agree while 77.5% strongly agreed as indicated in table 4.27, below.

Table 4.27: Responsibility for personal safety

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	31	77.5	77.5	77.5
	Agree	8	20.0	20.0	97.5
	Disagree	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Further, all respondents agreed to having responsibility over the responsibility of co-workers as shown in table 4.28, below, with 62.5% of them strongly agreeing.

Table 4.28: Responsibility for the safety of co-workers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	25	62.5	62.5	62.5
	Agree	15	37.5	37.5	100.0
	Total	40	100.0	100.0	

4.6. Regression Analysis

Regression analysis was used to measure the relationship between the department as an independent variable and selected dependent variables that included safety induction, training, confidence in management dealing with radiation safety, responsiveness and employee perception. The regression analysis was of the form:

DPT= $\beta0$ + $\beta1$ (safety induction) + $\beta2$ (management confidence) + $\beta3$ (training) + $\beta4$ (employee responsiveness and perception) + ε

Stepwise regression was done to evaluate the strength of departments with training and safety induction without the control variables and another regression was also done with control variables. This was to determine if the result would have been different without the control variables.

Table 4.29 , below , illustrates the regression result for model 1 showing an R square of 0.143, which implies that 14.3% of total variation in the departmental performance is affected by the constant attributes analyzed.

Table 4.29 Model Summary for R Square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.378[a]	.143	-.045	.633	.624

a. Predictors: (Constant), Employee understanding of safety goals of the department and organisation, Management blames workers when an accident occurs, Induction Before Work, Radiation Safety Briefing in past 1 Year, Formal Radiation Safety Training, Employee confidence in the management's ability to deal with safety, Adequacy of training to work with radiation technologies safely

Table 4.30 model summary for autocorrelation Coefficients

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.867[a]	.751	.006	2.43577	.751	1.007	3	1	.607	2.891

Source: Primary Data

a. Predictors: (Constant), training, confidence in management dealing with radiation safety, responsiveness and employee perception
b. Dependent Variable: Department

The study used Durbin Watson (DW) test to check that the residuals of the models were not auto correlated since independence of the residuals is one of the basic hypotheses of regression analysis. Being that the DW statistic were close to the prescribed value of 3.0 (2.891) for residual independence, it can be concluded that there was no autocorrelation

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1. Radiation Risk Management Framework

The study results indicate that the risk management framework at PGH is not commensurate with the risks presented by the radiation technologies used. This is reflected in the absence of an organisational radiation safety policy nor the attention to radiation safety issues given in any other policies of the institution. International Safety Standards require that management at every facility using radiation should establish, review and maintain an appropriate system, policies and procedures to manage radiation risks (IAEA, 2008).

The institution currently uses radiation protection programmes that were prepared as a regulatory requirement. However, the survey revealed that only 40% of the employees are aware of the existence of the radiation protection programmes and 12.5% were involved one way or the other in the development and review of the document. Although there were variations among the departments, these were not significant and the performance mirrors the overall situation.

The results also show that the institution does not have a functional induction programme for new employees. Only 40% of the respondents underwent induction, leaving the majority who went straight to undertake their duties without induction. As HSE (2005) indicates, induction presents an opportunity to communicate the organisational safety policies, procedures and commitment to safety.

Further, due to the changing nature of radiation and related risks as well as the international protection standards, there is need for continuous training. The results indicate that PGH is not performing well in this regard as only 40% of the respondents have taken part in a formal radiation safety training since joining the institution. This perhaps indicates that there is no formal plan for continuous training and human capital development to match the changes in the industry.

5.2. Leadership and Management for Safety

The study revealed that responsibilities for radiation safety lie with the respective heads of departments (HODs) with some delegated to the Radiation Safety Officer (RSO) in each of the departments in line with the requirements of the Radiation Protection Act [Chapter 15:15]. However, HODs in interviews indicated that lack of support from senior management indicated in the low priority in allocation of resources required for safety affects effectiveness. All requests are forwarded to the Director of Operations where prioritization is done at executive level. None of the HODs are in the executive management. Further, it was revealed that the hospital is in the process of establishing a Radiation Safety Committee to be chaired by one of the directors and tasked with overseeing the development and implementation of the radiation safety policy in line with international best practices. This committee when functioning effectively is expected to improve the prominence and prioritization of radiation safety matters within the executive.

Generally, the survey perceptions indicate that employees believe that management for radiation safety at the institution is not as effective as required. The results highlight weaknesses in prioritization of safety over work, involvement of employees in safety decisions, encouragement for workers to adhere to safety rules at all times and management's responsiveness in addressing identified safety concerns. Positively, the results show that management performs better in providing safety information although 45% of the respondents did not agree. However, provision of safety information should have 100% coverage in order to reduce risks and protect all workers. The majority of respondents, 52% do not have confidence in management's ability to effectively address the radiation safety risks that the hospital faces. This may be attributed to the experiences that employees have had in trying to have specific safety issues addressed in their departments. Furthermore, 45% of respondents do not believe that there is a just culture in the organization as management blames workers in the event of an accident. This perception is likely to dissuade employees from reporting minor incidents and near misses as pointed out by Canso (2008).

Statistical tests for association conducted revealed that the identified management strengths and shortcomings are not confined to specific departments, thus they are a reflection of the overall organisational outlook.

5.3. Employee Participation and Attitudes to Safety

The survey results indicate that 97.5% of employees are aware and accept their responsibility for personal safety as well as the safety of their colleagues. This is a positive indicator on which to build future safety programmes. The employees also indicated that they believe that their views on radiation safety matter, hence the need for involvement in safety decisions. Similarly, 72.5% understand the safety goals of the department. However, no documentation of such goals was found indicating a gap in formalising such and a reliance on informal systems and expected norms in the departments. Additionally, 60% of the employees believe that they are adequately trained and well equipped to deal with radiation risks. Further tests that were conducted indicated that this perception emanates from the basic educational qualifications which reflects on the proportions of radiation technology trained staff and those providing support services in the departments such as administrators, nurses, cleaners and security. However, a reliance on educational qualifications , some of which were earned more than 10 years ago gives a false sense of security as technology has been changing as well as the basic safety standards. A gap of 40% is still significant to warrant intervention by developing an appropriate training programme. Further, statistical tests conducted revealed that the perception of adequacy of training is significantly associated with departments hence the need to identify in the department in which gaps exist.

The results show that the majority of employees surveyed do not view minor accidents and near- misses as part of everyday work. This is a negative attitude to safety which may inhibit the ability of employees to own up and learn from their mistakes. Additionally, 40% of the employees would consider taking risks when the work schedule is tight while 60% are not prepared to compromise on safety. However, 77.5% indicated that they would voluntarily report to management if they are involved in an accident or near-miss. This is a good indication of a reporting culture postulated by Canso (2008) which is a precursor of a learning culture as well as an informed culture.

5.4. Departmental Variations

The results of data collected on various safety culture attributes indicate variations across the three departments surveyed. Further statistical tests on association in the form of Chi-Square and regression analysis indicate that in most cases the differences among departments are not statistically significant to conclude that there are differences in approaches among them. The exception was identified in relation to perceptions on the adequacy of training to work safely with radiation technologies. The regression analysis model presented in Section 4.6 further shows a 13% variation of attributes across the departments. Thus it can be concluded that the performance of safety culture attributes is fairly uniform across all departments in the organization hence any planned interventions should be cross-cutting.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The analysis of results presented in chapter 4 indicate that the level of safety culture at Parirenyatwa Group of Hospitals has not developed to a level commensurate with the radiation risk at the institution. The risk management framework is weak due to the absence of specific policies or policy provisions to address the associated risk. This is reflected by the poor performance of related metrics such as safety induction, radiation safety training, awareness of radiation protection programmes and employee involvement.

Leadership and management for radiation safety also performs below expectations due to the low prioritization of safety related aspects , inadequate involvement of employees in safety decisions as well as poor response to identified safety concerns. Management is also perceived to blame employees in case of accidents which negates the principle of a just culture thereby inhibiting the development of reporting and learning cultures that are essential for continual improvement in the organisation. Further, management is not firm on emphasising the overriding priority of safety over production and the strict adherence to safety rules at all times so as to reduce the risk of overexposure and injuries.

The attitude of employees to safety still requires further strengthening. A significant proportion is not prepared to understand that accidents and near misses are part of everyday work from which lessons can be drawn to improve safety. Similarly, a significant proportion to warrant a concern are not prepared to voluntarily report accidents and near misses as well as understanding the safety goals of the department. On the other hand, the employees understand the important responsibilities they have for personal safety and the safety of their colleagues.

Overall, the safety culture variables are almost identical across departments with insignificant differences thereby requiring the development and implementation of interventions that cover the entire organisation. Such efforts require the attention of senior, executive management to yield the intended results.

6.2. Recommendations

In order to address the identified safety culture concerns, Parirenyatwa Group of Hospitals is recommended to take the following actions:-

1. Urgently establish a risk management framework that encompasses the Radiation Safety Committee headed by a member of the executive management and mandated to develop the radiation safety policy covering the activities of the entire organisation as well as ensuring that departmental specific procedures, protocols and instructions for safe use of radiation are established;

2. Management should consider conducting a situational analysis to establish the gaps that require attention with regards to human resources, equipment, training needs and others so as to develop an informed action plan;
3. HODs should strengthen existing systems based on the radiation protection programmes and implement departmental level interventions such as regular meetings to discuss the views of employees on existing and planned actions related to radiation safety; and
4. Develop leadership and management training to equip responsible managers with skills to effectively carry out their mandate in cultivating and sustaining the required safety culture;

Relevant regulators such as Radiation Protection Authority of Zimbabwe (RPAZ) and National Social Security Authority (NSSA) are recommended to:

5. Review legal and regulatory provisions to strengthen requirements for safety culture as a strategy for occupation protection for radiation workers. This should be supported by guidance documents to help facilities understand and implement requirements;
6. Conduct safety culture assessments for users of radiation technologies and ensure that it is commensurate to the risks thereof; and
7. Strengthen enforcement against safety and safety culture violations as a deterrence measure and encouraging users of radiation to establish and maintain the required level of safety culture thereby safeguarding workers and the public.

Scholars and researchers are recommended to:-

8. Conduct further research to unearth the underlying, deep-sited contributing factors to the current situations so as to recommend effective solutions to redress the challenges.

REFERENCES

- Marsh, D. and Furlong, P. (2010) A Skin Not A Sweater: Ontology and Epistemology in Political Science, in D. Marsh and G. Stoker (Eds) Theory and Methods in Political Science, 3rd Ed., Palgrave MacMillan, pp. 184-211.
- David Marsh and Gerry Stoker (eds.) Theory and Methods in Political Science, 3rd ed. (Houndmills, Basingstoke; New York: Palgrave Macmillan, 2010).

- S. Balwinder, S. Jaspreet, K. Amritpa (2013), Applications of Radioisotopes in Agriculture, Int J BiotechnologY and Bioengineering Research 4 (3) 167–174.
- M.H. Nassef, A.A. Kinsara, Occupational Radiation Dose for Medical Workers at a University Hospital,
- Klervi Leuraud, David B Richardson, Elisabeth Cardis, Robert D Daniels, Michael Gillies, Jacqueline A O'Hagan, Ghassan B Hamra, Richard Haylock, Dominique Laurier, Monika Moissonnier, Mary K Schubauer-Berigan, Isabelle Thierry-Chef, Ausrele Kesminiene,(2015) : Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): an international cohort study in Lancet Haematol Journal; Issue 22: P.276–81
- Liu JJ, Freedman DM, Little MP, et al. Work history and mortality Risks in 90 268 US radiological technologists. Occup Environ Med 2014; 71: 819–35.
- Linet MS, Kim KP, Miller DL, Kleinerman RA, Simon SL, De Gonzalez AB. Historical review of occupational exposures and cancer risks in medical radiation workers. Radiat Res 2010; 174: 793–808.
- Report 60 Recommendations of the International Commission on Radiological Protection. International Commission on Radiological Protection (ICRP), 1990, Publ 60, Ann ICRP 21 (1-3).
- Valentin (2002), ICRP PRINCIPLES FOR THE RADIOLOGICAL PROTECTION OF WORKERS in
- Blewett , V (2011), Clarifying Culture, Safe work Australia, Canberra
- Antonsen, S. (2009). Safety culture and the issue of power. Safety Science, 47(183–191).
- Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytic review. Journal of Occupational Health Psychology, 11(4), 315–327.
- Fernández-Muñiz, B., Montes-Peón, J. M., & Vázquez-Ordás, C. J. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. Journal of Safety Research, 38, 627-641.
- Al-Shammari, M. M. (1992). Organizational climate. Leadership & Organization Development Journal, 13(6), 30-32.
- Andriopoulos, C., & Dawson, P. (2009). Managing change, creativity and innovation. London: Sage Publications Inc.

- Antonsen, S. (2009). Safety culture and the issue of power. Safety Science, 47(183–191).
- Clarke, S. P. (2006). Organizational Climate and Culture Factors Annual Review of Nursing Research (Vol. 24, pp. 255-327).
- Dawson, P. (2003). Understanding organizational change: The contemporary experience of people at work. London: Sage.
- DeJoy, D. M., Gershon, R., R.M., & Schaffer, B. S. (2004). Safsety climate: Assessing management and organizational influences on safety. Professional Safety (July), 50-57.
- Fernández-Muñiz, B., Montes-Peón, J. M., & Vázquez-Ordás, C. J. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. Journal of Safety Research, 38, 627-641.
- Hatch, M. J., & Cunliffe, A. L. (2006). Organization theory: modern, symbolic and postmodern perspectives (2nd ed.). New York: Oxford University Press.
- Haukelid, K. (2008). Theories of (safety) culture revisited—An anthropological approach. Safety Science, 46, 413-426.
- Health and Safety Executive. (2002). Evaluating the effectiveness of the Health and Safety Executive's Health and Safety Climate Survey Tool. London: Health and Safety Executive.
- Health and Safety Executive. (2005). A review of safety culture and safety climate literature for the development of the safety culture inspection toolkit - RR367. London: Health and Safety Executive, UK.
- Hudson, P. (1999, 1-2 December 1999). Safety Culture—Theory and Practice. Paper presented at the Human Factors and Medicine Panel (HFM) Workshop: The Human Factor in System Reliability—Is Human Performance Predictable?, Siena, Italy.
- Hudson, P. (2007). Implementing a safety culture in a major multi-national. Safety Science, 45, 697-722.
- International Atomic Energy Agency (IAEA). (1986). Summary report on the post-accident review meeting on the Chernobyl accident. Vienna: International Safety Advisory Group.
- Isaksen, S. G., Lauer, K. J., Ekvall, G., & Britz, A. (2001). Perceptions of the best and worst climates for creativity: Preliminary validation evidence for the situational outlook questionnaire. Creativity Research Journal, 13(2), 171-184.

- Kimbrough, R. L., & Componation, P. J. (2009). The relationship between organizational culture and enterprise risk management. Engineering Management Journal, 21(21), 18-26.
- Meyerson, D., & Martin, J. (1987). Cultural change: An integration of three different views. Journal of Management Studies, 24(6), 623-647.
- Morgan, G. (1997). Images of organization (2nd ed.). Thousand Oaks: Sage Publications.
- Parker, D., Lawrie, M., & Hudson, P. (2006). A framework for understanding the development of organisational safety culture. Safety Science, 44, 551-562.
- Reason, J. (1997). Managing the risk of organizational accidents. Aldershot: Ashgate Publishing Ltd.
- Richter, A., & Koch, C. (2004). Integration, Differentiation and Ambiguity in Safety Cultures. Safety Science, 42, 703–722.
- Rollenhagen, C. (2010). Can focus on safety culture become an excuse for not rethinking design of technology? Safety Science, 48, 268–278.
- Schein, E. H. (1990). Organizational culture. American Psychologist, 45(2), 109-119.
- Schein, E. H. (2010). Organizational Culture and Leadership (4th ed.). San Francissco: Jossey-Bass.
- Shannon, H. S., & Norman, G. R. (2009). Deriving the factor structure of safety climate scales. Safety Science, 47, 327-329.
- Shaw, A., Blewett, V., Stiller, L., Aickin, C., Cox, S., Ferguson, S., et al. (2008). Digging Deeper: Wran Consultancy Project Final Report. Sydney: NSW Mine Safety Advisory Council.
- Walker, G. W. (2010). A safety counterculture challenge to a ‘‘safety climate”. Safety Science, 48, 333-341.
- Westrum, R. (2004). A typology of organisational cultures. Quality and Safety in Health Care, 13(Suppl II), ii22–ii27.
- Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. Journal of Applied Psychology, 65(1), 96-102.
- Zohar, D., & Luria, G. (2005). A Multilevel Model of Safety Climate: Cross-Level Relationships Between Organization and Group-Level Climates. Journal of Applied Psychology, 90(4), 616-628.