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Perceptions of Radiotherapy employees on Radiotherapy Costing in KZNHealth Provincial Hospitals

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ABSTRACT

Radiotherapy as a critical and cost-effective discipline that treats cancer has its own challenges of radiotherapy patient access, caused by the lack of investments due to the substantial financial constraints, high costs of equipment, human resources and building infrastructure. This makes it difficult for the KZNHealth to control the cancer epidemic. The role of costing in radiotherapy would provide the quality services when there is a challenge of limited resources and budget cuts and provide a gateway towards the investments in radiotherapy to improve radiotherapy access. The aim of this study was to obtain empirical data on the perceptions of the radiotherapy employees regarding the radiotherapy costing, which can be used to improve patient's radiotherapy access at the three KZNHealth provincial hospitals that are providing radiotherapy services.

This was a qualitative study conducted through primary data collection; semi-structured approach was set for the face-to-face interview to 32 of 61 radiotherapy employees. The sampling that suited the study was the convenient, non–probability sampling, as the participants were selected because of their convenient accessibility and proximity to the researcher, as well as their knowledge of the subject matter. Participants were from the radiotherapy departments of these hospitals: Addington, Greys and Inkosi Albert Luthuli Central.

The results of the study revealed a problem with patient radiotherapy access, as the patient numbers demanding the treatment exceeded the capacity of the resources available, thus leading to longer patient waiting periods. The study reveals that more staff is required as current staffing impact negatively on their performance. It reveals the need to treat limited resources like equipment with care for the longer use and the practise of culture of cost saving measures in radiotherapy. It highlighted the need for hospital management to involvement with the radiotherapy department as they are the bridge between radiotherapy department and policy makers. The recommendation from the study shows that costing intervention based on TDABC (modified ABC) need to be adopted by the radiotherapy departments in KZNHealth to resolve these challenges. TDABC will track down the unsaved cost, improve operational efficiency, improve resources allocation and the accurate radiotherapy cost will be used to influence the policy makers for the informed decisions regarding the investments in radiotherapy, thus improving radiotherapy access.

KEYWORDS: radiotherapy access, radiotherapy costing, KZNHealth, ABC

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

3D CRT ----------Three Dimensional Conformal Radiotherapy

ABC----------Activity Based Costing

CT----------Computed Tomography

GDP----------Gross Domestic Profit

GNI----------Gross National Income

GTFRCC----------Global Task Force on Radiotherapy for Cancer Control

HIC----------Higher Income Countries

HPER----------Health Professional Economic Reasoning

IAEA----------International Atomic Energy Association

IMRT----------Intensity Modulated Radiation Therapy

KZNHealth----------Kwazulu-Natal Health Department

LMIC----------Low and Medium Income Countries

MC----------Micro Costing

NHI----------National Health Insurance

PPP----------Public- Private Partnership

PRC----------Primary Radiotherapy Centre

QA----------Quality Assurance

SRC----------Secondary Radiotherapy centre

SRS----------Stereotactic radiosurgery

Stats SA----------Statistics of South Africa

TDABC----------Time driven activity based costing

TRC----------Tertiary radiotherapy centre

VMAT----------Volumetric Modulated Arc Therapy

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Radiotherapy as a critical and cost-effective discipline that treats cancer has its own challenges of radiotherapy patient access, caused by the lack of investments due to the substantial financial constraints, high costs of equipment, high costs of human resources and high costs of building infrastructure (Gospodarowicz, 2014). This is worse in the low and middle income countries (LMICs) where there is the greatest increase in cancer incidents. Cancer is a leading disease in terms of morbidity and mortality and LMICs are accounted to about 70% of cancer cases and cancer deaths (Sullivan *et al.*, 2015).

In South Africa, cancer is the second to TB, as a killer disease, although Stats SA (2014) reported it to be out of top 10 killer diseases in the country. However, Stefan (2015) discovered that the reason for such misplacement in the rankings is because Stats SA (2014) reported cancer individual per anatomical location, rather than as a collective. This misplacement may have some predicaments as cancer may not receive its required attention to the policy makers. Despite such reporting, cancer deaths have shown a noticeable increase from 2011 to 2013, according to Stats SA (2014) and projections showed that it will top the list of killer diseases in the near future (Stefan, 2015). Another point of departure is the economic impact of cancer, although the economic impact in South Africa is not yet determined, but the global impact has shown a total economic loss of USD 1.16 trillion reported in 2010 (Stefan, 2015).

Atun *et al*. (2015) explained that the worrying element is the fact that most of the cancers are treatable, but due to chronic under-investment in radiotherapy resources, they are denied such an opportunity. The South African Government declared its intention to place more emphasis on non-communicable diseases, which include cancer (Stassen, 2013). Minister of Health, Dr. Aaron Motsoaledi reinstated the cancer registry on cancer centres to track, monitor the incidences of cancer and provide the reliable data. A Ministerial Advisory Committee on cancer (made up of medical experts, academics and representatives of advocacy groups) was appointed in 2013 to advice the Minister of Health on cancer prevention and control (Stassen, 2013). Amongst other programmes that

the government has implemented is the HPV vaccination programme in 2013. The programme was meant for the prevention of cervical cancer on young girls as young as 9-13 years, as cervical cancer was regarded as the forth killer cancer disease in South Africa (Tathiah *et al*, 2013). However, public healthcare in South Africa is also challenged by other competing health needs on the already financially constrained environment, as sub-Saharan region is characterised by high burden of HIV, tuberculosis, malaria and high rates of maternal and child mortality (WHO, 2002). This makes all the efforts mentioned by the ministry to be difficult for the allocation of funds and resources to the cancer treatment using radiotherapy, due to the high costs required for the equipment, personnel and infrastructure (Tathiah *et al*., 2013).

This, as a result, has made radiotherapy access by patients to be a huge challenge, caused by the poor investments in radiotherapy in KZNHealth provincial hospitals. Atun *et al*. (2015) and Gospodarowicz (2014) revealed that policy makers have negative perceptions about cancer that it is considered to be a rare and fatal disease that absorbs considerable funds with no visible results. This creates a huge barrier to the investments in radiotherapy. This poor radiotherapy access in KZNhealth provincial hospitals is so severe that it has negatively attracted media attention (The Citizen Newspaper, 2016; Nsele, 2016). A solution to motivate the policy makers to consider radiotherapy in their investment plan is required.

This chapter therefore delineates the background of radiotherapy in the KwaZulu-Natal Department of Health (KZNHealth), explores the motivation for the study, the focus of the study, the problem statement, the research questions, the objectives of the study, as well as the limitations of this study.

1.2 BACKGROUND

KZNHealth

KZNHealth is a provincial Department of Health in public healthcare that covers all district municipalities in KwaZulu-Natal province, with the population of 10 919 100, an increase from 10,267,301 in 2011 (Stats SA, 2011, 2015). Only three public hospitals within the province provide radiotherapy services for the entire population. These hospitals are Addington, Greys and Inkosi Albert Luthuli Central Hospital. The vision and mission

of these hospitals are aligned with the overall strategic plan of the KZNHealth, which is to render optimal healthcare for all citizens in the region. They are all located in the main cities of KZN which are Durban and Pietermaritzburg.

According to the international standards, there must be 6-8 treatment machines per 1 million populations (IAEA, 2008). However, ICON, a South African radiotherapy company, found that a minimum of 3 treatment machines per 1 million is adequate for the country's level of cancer incidents and age profile (Econex, 2010). Currently, there are 6 treatment equipment in KZNHealth and approximately 11 for the private sector, which gives a total of 17 for the province. For the current population, cancer incidents and age profile KZN province would require a total of 32 treatment machines, including the private sector.

Figure 1.1 shows the District municipal demarcations for the Province of KwaZulu-Natal, according to the regions. Radiotherapy services from Greys cater for Region A and some from Region B, while Addington services serve Region B and D and Inkosi Albert Luthuli Hospital serves Region C and some from D.

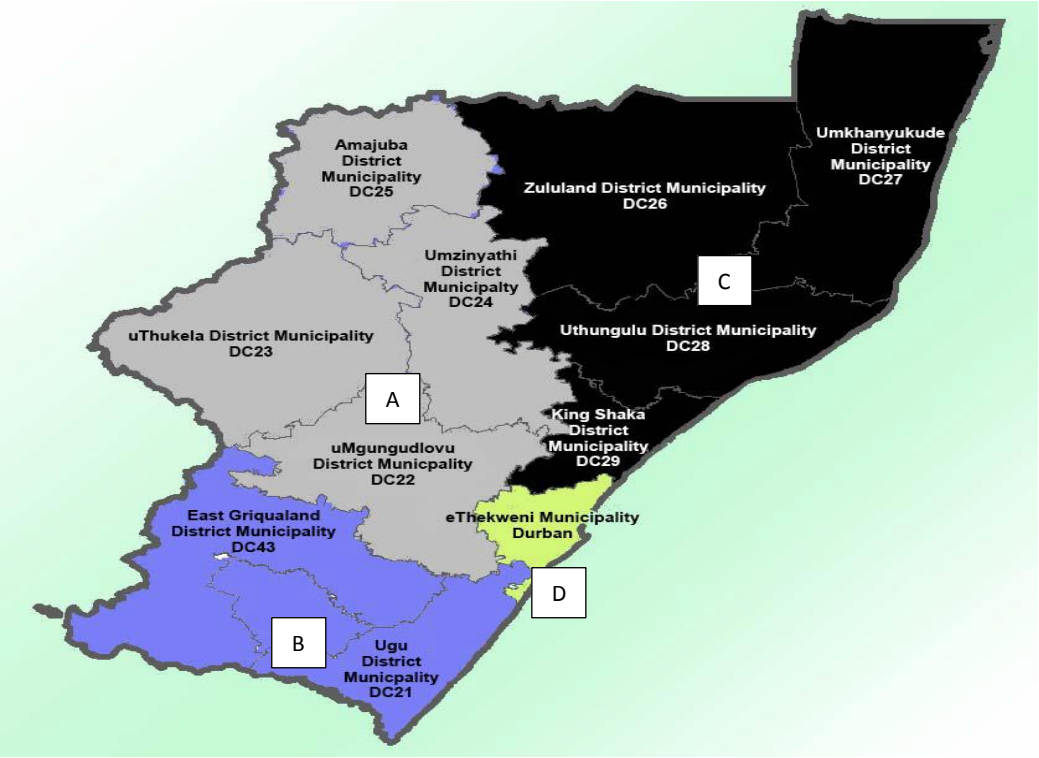

Figure 1.1: Demarcation of the Health District in KwaZulu-Natal per radiotherapy services.

Source: KZNHealth (2009, p.4)

Table 1.1 is an illustration of how districts are grouped in terms of regions and radiotherapy services. Population per health districts were based on the municipal census of 2011 (Stats SA, 2011).

Table 1.1: KwaZulu-Natal municipality district population distributions for the period 2011.

REGION	HEALTH DISTRICT	POPULATION(2011)	%
REGION A	DC 22 UMGUNGUNDLOVU	1,017,763	9.91%
	DC 23 UTHUKELA	668,848	6.51%
	DC 24 UMZINYATHI	510,838	4.98%
	DC 25 AMAJUBA	499,839	4.87%
REGION B	DC 21 UGU	722,484	7.04%
	DC 43 SISONKE	461,419	4.49%
REGION C	DC26 ZULULAND	803,575	7.83%
	DC 27 UMKHANYAKUDE	625,846	6.10%
	DC28 UTHUNGULU	907,519	8.84%
	DC 29 ILEMBE	606,809	5.91%
REGION D	DURBAN: ETHEKWINI	3,442,361	33.53%
	TOTAL	10,267,301	100%

Source: Stats SA (2011, p. 6)

Below are the provincial hospitals that provide public radiotherapy services within the KZN province.

1.2.1 Addington Hospital.

Addington Hospital is a referral and a fully public hospital situated in the South Beach in Durban, KZN. It also offers district and regional services to the greater eThekwini and South Coast regions, with a population of around 4 million. Bed occupancy rate (BOR) is 94%. Current staffing level is 10 radiotherapists, 3 medical doctors and 2 medical physicists, while patient waiting time is about 9 months. The radiotherapy unit at Addington Hospital is equipped with two linear accelerators with advanced technology

called Volumetric Arc Therapy (VMAT) which is supplied with its own Quality Assurance (QA) equipment.

1.2.2 Greys Hospital

Greys hospital is a referral and fully public hospital which provides 80% tertiary services located in the Pietermaritzburg CBD, in KZN Midlands. Its services also cover the region of UMgungundlovu health district, with a population of 1 million. The tertiary services provide sub-speciality support and receive referrals from regional hospitals which benefit 3.5 million populations from 5 health districts in the western half of KwaZulu-Natal. Bed occupancy rate (BOR) is above 90% (KZNHealth, 2012). The current staffing level is 7 radiotherapists, 10 medical doctors and 1 medical physicist, while patient waiting is 12 months. The radiotherapy unit at Greys Hospital is equipped with one linear accelerator with advanced technology called Intensity Modulated Radiotherapy (IMRT) which is supplied with its own Quality Assurance (QA) equipment.

1.2.3 Inkosi Albert Luthuli Central Hospital (IALCH)

Located in Mayville, in Durban, IALCH offers the services of the central and tertiary level. Its intention was to provide a highly specialised service for the entire province and even up to half of Eastern Cape (National Treasury, PPP Unit, 2001). To achieve that, the option of public private partnership (PPP) was viable after a feasibility study was conducted. The private sector was represented by Impilo consortium, while the KZNHealth department represented the public sector. The responsibility for all the medical, information technology (IT) and facility management of the hospital was assigned to Impilo consortium. The initial contract was signed to last from 2002 to 2017 (or 15 years) and KZNHealth department was the majority holder on the stake, focused on the human resource side of the business. The hospital has got less than the expected number of bed occupancy rate (below 80%), because of poor referral system and late commissioning. Other tertiary hospitals within the province have a high occupancy rate, but their budget allocation is far below that of IALHC. The current staffing level is 15 radiotherapists, 9 medical doctors and 4 medical physicists, while patient waiting is 6 months. The radiotherapy unit at IALHC is equipped with three linear accelerators containing the SRS and IMRT.

1.3 MOTIVATION FOR THE STUDY

Costing is a useful tool to determine the appropriate costs and track where the costs were utilised, which also identifies the steps that do not add value within the process. Costing in radiotherapy is regarded as one of the solutions towards investments in radiotherapy which would eventually improve radiotherapy access (Jeffrey *et al.*, 2015). Detailed cost information for radiotherapy treatments determined by costing methods would be an element that would influence policy makers to make informed decisions regarding funding and investments in radiotherapy.

This study is aimed at presenting the current status of radiotherapy access in KZNHealth public hospitals proving radiotherapy services. Perceptions regarding such status are explored on the radiotherapy employees. Costing is examined if it is needed as an intervention to improve such status.

This study is unique because it has not been done in a radiotherapy department in South Africa.

1.4 FOCUS AND SCOPE OF THE STUDY

This study seeks to identify the current crisis in radiotherapy, as well as the perceptions of radiotherapy employees on radiotherapy costing as an intervention towards investments in radiotherapy within KZNHealth. The scope of this research was limited to the three hospitals offering radiotherapy services in Kwa Zulu-Natal province. The study focused on the radiotherapy employees in the three hospitals. These employees included the medical doctors, medical physicists and radiotherapists. The level of position within the category of their jobs was not considered, as radiotherapy problems affect them, irrespective of their positions. Other employees who were not directly involved with radiotherapy treatment, i.e. cleaners; administrative staff and nurses were excluded from the study

1.5 PROBLEM STATEMENT

Poor access to radiotherapy has a negative impact on patients and is usually due to under-investment (Atun *et al.*, 2015). This under-investment is characterised by shrinking budget, limited resources that need to be shared amongst other health related needs and the negative attitudes of policy makers regarding radiotherapy services and costs (Atun *et al.*, 2015). KZNHealth radiotherapy services are negatively affected by this poor investment as it results in the unnecessary treatment delays and waiting times that would make cancer

control become difficult and in some cases, leading to unnecessary and preventable deaths.

Radiotherapy employees are directly affected as poor investments affect the services they provide to patients due to the limited staffing, limited equipment and infrastructure. The global increase in cancer incidents increased patient numbers demanding the treatment within the limited resources in KZNHealth provincial hospitals.

Literature indicates that costing can provide the gateway to improve investments in radiotherapy (Kaplan and Porter, 2011; Jaffray *et al*., 2015). Therefore, it is necessary to research on the perceptions of radiotherapy employees regarding the need of radiotherapy costing in the KZNHealth provincial hospitals. In that view, the objectives of the study are outlined in the section that follows.

1.6 OBJECTIVES OF THE STUDY

This study aims to investigate the need of radiotherapy costing at three KZNHealth hospitals. The objectives of this research are as follows:

- To explore the perceptions of radiotherapy employees on the quality of radiotherapy services in KZN public hospitals.
- To explore the perceptions of radiotherapy employees on the staffing capacity and staffing recognitions by KZN Provincial Department of Health.
- To explore the perceptions of radiotherapy employees on the management of radiotherapy equipment and infrastructure in the target hospitals.
- To explore the perceptions of radiotherapy employees on the cost management and the need for costing within the radiotherapy departments.

1.7 RESEARCH QUESTION

This research attempts to answer the following questions:

- What are the radiotherapy employees' perceptions on the quality of radiotherapy service in their hospitals?
- What are the radiotherapy employees' perceptions on staffing capacity and staffing recognitions by KZNHealth?
- What are the radiotherapy employees' perceptions on how equipment and infrastructure are managed within the radiotherapy departments?

- What are the radiotherapy employees' perceptions on the cost management and the need for costing as an intervention within their departments?

1.8 SIGNIFICANCE OF THE STUDY

The following are the stakeholders that could also benefit:

- Senior hospital managers would benefit from radiotherapy costing as they are faced with the challenge of balancing the limited resources, finance and the equitable budget allocation.
- Managers in radiotherapy departments would benefit from the cost information as it would identify the areas within the treatment process, that produce wastages so that the improvements and optimisations in radiotherapy can implemented.
- Medical insurance would know exactly what they should pay for.
- Patients would benefit on value for money treatment services and better radiotherapy access.
- Proposed National Health Insurance (NHI) would benefit as the correct costing of treatment would be known and transparent.

1.9 OUTLINE OF THE DISSERTATION

This research report is made up of six chapters. This chapter provided an overview of the study by highlight the background information, problem statement, rationale, as well as the objectives of the study.

Chapter two is the literature review; it revolves around the theoretical aspects of the topic gathered from different literature materials regarding the concept of cancer and radiotherapy, investments, costing and the radiotherapy employees' perceptions on radiotherapy.

Chapter three is the research methodology. This chapter outlines the research methods used in conducting the research. The study adopted the inductive approach and primary data were collected through the use of semi-structured interviews. The sampling strategy and population were discussed in light of the underlying research philosophy.

Chapter four presents the findings of the study. It analyses the raw data from the semi-structured interviews.

Chapter five discusses the findings presented in chapter four and provides an analysis and interpretation of the results in light of extant literature.

Chapter six is the conclusion and recommendations. This final chapter attempts to draw inferences from the results, clearly showing that the problem indeed exists. It further provides recommendations for improvement in radiotherapy using better costing, which would motivate investments and thus, improve radiotherapy access in KZNHealth and provides the recommendations for future research.

1.10 CHAPTER SUMMARY

This chapter presents the overview of the research study. It presents the background of KZNHealth and three hospitals within the KZN province that provide radiotherapy services, the motivation and focus of the study. It detailed the problem and the associated questions and objectives.

The next chapter presents the literature review and it explores the existing literature on radiotherapy, investments and costing in radiotherapy, as well as the radiotherapy employees' perceptions on costing of radiotherapy.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Shrinking budgets and the increased number of patients demanding radiotherapy treatment from the limited resources has led to poor access to radiotherapy (Popesko, 2013). This has raised many questions about the quality of radiotherapy services received by the patients. Therefore, the objectives of this study were to explore the radiotherapy employees' perceptions on radiotherapy costing in the three selected hospitals in KZN Department of Health. Various authors believe that costing is one of the approaches that can be used to face the global challenge of radiotherapy patient access (Kaplan and Porter, 2011; Gospodarowicz, 2014, Van de Werf *et al.*, 2012; and Jaffray *et al.*, 2015).

This chapter therefore explores the existing literature on radiotherapy and its relationship with cancer, access and barriers to radiotherapy services, quality control and assurance of radiotherapy services, perceptions of employees on costing of radiotherapy services, radiotherapy infrastructure in public hospitals and staffing of radiotherapy departments in public hospitals.

2.2 CANCER AND RADIOTHERAPY

Globally, millions of people are facing death from cancer. According to Atun *et al.* (2015), the worrying part about this is the fact that some of the cancers are treatable but due to chronic under-investment in radiotherapy resources, the affected patients are denied such opportunities. The future looks scary as the number of new cancer cases reported globally were 14.1 million in 2012 and projected to be 24.6 million by 2030, according to studies by Ferlay *et al.* (2013). Deaths reported for similar period were 8.2 million in 2012 and expected to project to 13 million in 2030, as reported by Bray *et al.* (2012). The American Cancer Society (2014) projected that the number of deaths would be 17.5 million by 2030, latest prediction is always a better predictor as it has considered the latest conditions and the latest trends. Other observation by Gospodarowicz (2014), based on Global Burden of Diseases, has shown that the number of cancer deaths between 1990 to 2010, increased by 38% and if no action is taken, the numbers may increase by 50%. These reports are pointing to the need for investment as a matter of urgency.

Further into the demographics, studies by Sullivan *et al*, (2015) revealed that 70% of cancer deaths occurs in low and medium income countries (LMICs), even though the report shows more cancer incidences in the high income countries (HICs). This is a sign that HICs have some means of reporting, screening programme, diagnosis and treatments, which are better than LMICs. Studies by Murray *et al.* (2012) also revealed that since 2012, globally, cancer has become a leading cause of disability and death. Above all these, cancer cost US$2 trillion worldwide, which shows that it is an enormous economic burden, equivalent to 1.5% of global GDP and this has a negative effect on productivity and on the livelihood of individuals, families and communities (Bloom, 2011).

Studies by Sylla and Wild (2012), as well as Kaplan and Porter (2011) revealed the reasons behind the increased cancer incidences: population growth and ageing, while the increased cancer deaths are mainly due to lack of access to care. Sylla and Wild (2012) also pointed out that cancer deaths are due to the lack of resources and proper cancer control strategies such as modern cancer care equipment.

For the past decade, progress towards the treatment of cancer has been observed, together with advances in early detection and different types of treatment forms or modality, as a result, many cancers are now curable (Pollack *et al.*, 2009, cited by Baskar *et al.*, 2012). Radiotherapy is one of the three forms of cancer treatments. Radiotherapy is often called Radiation Oncology in different literature sources, but it basically means the same thing. Other forms of treatments include surgery and systematic therapy (Rosenblatt, 2014). When studies compared radiotherapy to other two forms of treatment, they discovered that it has fewer side effects, less invasive and less painful to patients, as well as cost-effective modality for both radical and palliative treatment of cancer (Ringborg *et al.*, 2003, cited by Baskar *et al.,* 2014). Radiotherapy accounts for 5% of the total cost of cancer care, even though radiotherapy is given less attention than the other forms of cancer treatments, as a result, it receives limited domestic and international funding (Ringborg *et al*, 2003, cited by Baskar *et al*., 2014; Atun *et al.*, 2015). However, Lievens *et al.* (2015) argued that radiotherapy costs 5% of the cancer total treatment, as there is still more data needed to be certain with the exact figures. The cost-effective aspect of radiotherapy, according to Fisher *et al*. (2014) and Atun *et al.* (2015), include the fact that patients are treated as outpatients, equipment and building have a long life span and the return on investments for the equipment is high.

Radiotherapy remains the most important mode of treatment because between 48-62% of all cancer patients benefit from radiotherapy in the course of their treatments. The percentage depends on the extent of the disease at presentation and the profile of the cancer observed in the population (Delaney *et al*., 2005; Barton *et al*., 2014; Mackillop *et al.*, 1999, cited by Rosenblatt, 2014). The impact of radiotherapy in cancer treatment is estimated at 40%, as compared to 49% and 11% of surgery and systematic therapy respectively (Baskar *et al.*, 2012; Rosenblatt, 2014; Barnett *et al.*, 2009).

Radiotherapy may be delivered alone to cure or it can be used in combination with other modes of cancer treatments, depending on the type and stage of the tumour. In LMICs, radiotherapy is the most important mode of treatment of cancer because of the advanced stage of cancer at presentation. Since in these countries most cancers are presented late, radiotherapy alone or with systematic treatment take priority as surgery, is only useful on the localised cancers, but not when the cancer has spread (Goitein, 2007:23). Therefore, the fact that the surgery has most impact amongst other modes is not important for the LMIC.

Based on radiotherapy principles, radiotherapy uses high energy radiation to damage a DNA of cancer cells and blocking their ability to divide and proliferate further (Jackson and Bartek, 2009, cited by Baskar *et al*., 2012). The goal of radiotherapy is to deliver high radiation to the cancer cells and minimum radiation to the normal cells around. This goal is getting more realised as the technology is getting more advanced, which encompasses the improved imaging, fast and high powered computers and software and the modernised treatment equipment (Baskar *et al*., 2012). Baskar *et al.* (2012) also observed that technological advancements in radiotherapy have shown to improve the survival and quality of life for the cancer patients. This implies that having a basic radiotherapy may not be enough to improve survival, but having modern equipment may be providing the added advantage to satisfy the goal of radiotherapy. As the technology in radiotherapy is always evolving, this shows that radiotherapy is a work in progress. Surgery and systematic approach to cancer treatment are not for further discussions, but this study focuses on the radiotherapy approach.

2.3 RADIOTHERAPY ACCESS

The common problem regarding radiotherapy is the patient access (Zubizarreta *et al*., 2015; Gospodarowicz, 2014). The concept "*access"* is referring to how a clinical service

(e.g. radiotherapy service) is utilised by the patients when they need them (Rosenblatt, 2014). Rosenblatt (2014) clearly defined the term "*access to radiotherapy*" as the availability of radiotherapy services, affordability of the radiotherapy services by patients or providers, accessibility to the radiotherapy services by the patients, the awareness of health professionals and general public about radiotherapy and accommodation for patients. All of the above are interconnected to each other; therefore, the existence of treatment equipment may not be enough for access if there is no staff or if service is not affordable. Another example is the geographic location of people needing radiotherapy, this may make the radiotherapy service inaccessible (Rosenblatt, 2014).

2.3.1 Factors affecting radiotherapy access

Gospodarowicz (2014) acknowledged that radiotherapy access is a global challenge, but it is also influenced by the notion that radiotherapy is perceived to be complex, costly and with unpredictable treatment outcomes. Such a notion has led to the assumption that its deployment to the low to medium income nations is not feasible. Gospodarowicz (2014) further explained that the main barriers in the low and medium income countries (LMIC) include the unavailability or limited equipment resources, lack of trained health professionals and substantial financial constraints. Some of these low and medium income countries (LMIC) have their government prioritising other diseases e.g. TB, HIV and others that attract attention. The cancer is considered to be rare and fatal disease that does not deserve investment, as they believe the patient will die anyway despite the treatment. Such a stigma associated with cancer presents a huge barrier between patient treatments and policy makers in making informed decisions (Atun *et al.,* 2015; Gospodarowicz, 2014). The barrier in the high income countries (HIC) is not the unavailability, but the inadequacy to meet the minimum demand of patients. The reason why success rate of cancer treatment is low in the LMIC is due to late presentation of cancer by the patients as some tend to seek other alternative solution before approaching medical solutions. Gospodarowicz (2014) explained that this is caused by poor prevention and screening programmes and poor radiotherapy infrastructures and resources. This leaves the impression that a huge amount was spent for treatment and the patient died anyway. This presents the notion that a good investment in equipment, human resource and infrastructure would be a fruitless exercise if the means of prevention and screening programme are not in place. These programmes can be deployed in the local hospitals which may not necessarily have a radiotherapy department, but based on Primary Healthcare

(Gospodarowicz, 2014). Figure 2.1 shows the picture of common barriers to radiotherapy access. Poor access to radiotherapy, including delays, is well documented and it affects countries differently.

Figure 2.1: Common barriers to radiotherapy access.
Source: Gospodarowicz (2014, p. 74)

Gillan *et al.,* 2012, realising the list of various barriers to radiotherapy access, grouped and categorised the barriers based on reviewing various literature in Canada as follows:

- Health System Context (Distance to Treatment Centre, Wait Times, Treatment Centre Characteristics)
- Sociodemographic Context (Race/Ethnicity, Socioeconomic Status, Other)
- Patient Factors (Age, Cultural Beliefs, Beliefs re: Efficacy/ Burden of Treatment, Life Expectancy, other)
- Provider Factors (Lack of Referral, Lack of Understanding/Awareness)

For this study, the focus will be on the *Health System Context*, where the lack of infrastructure, staffing and equipment, and other support to treatments are categorized under Treatment Centre characteristics.

2.3.2 Global perspectives

The global picture of radiotherapy access is gloomy and studies have shown that the most affected countries are the LMICs. In those countries, only 25% of the population has access to radiotherapy (Dirac IAEA, 2011). Other reports (Zubizarreta *et al*., 2015) outlined the disturbing figures that LMICs resources account for only 5% of the world's resources for the cancer treatment using radiotherapy, but only covers 82% of the total world population. Various authors have considered infrastructure, staffing and equipment as the main challenges for setting up radiotherapy (Fisher *et al*., 2014; Samiei, 2013; Gospodarowicz, 2014; Atun *et al.*, 2015).

Estimation of the additional radiotherapy equipment needed in the world to cover the patients demand is 7000, as reported by IAEA (2014). However, the latest review that included the staffing by Datta (2014) revealed that 9169 radiotherapy equipment, 12149 radiation oncologists, 9915 medical physicists and 29140 radiotherapists would be required by 2020. Though Datta's (2014) research only considered 84 countries due to the availability of information, it was enough to provide a better global estimate, considering the epidemic increase of cancer.

Maruthappu *et al*'s. (2016) studies showed that there is a relationship between the GDP (Gross Domestic Product) of the country, unemployment and cancer deaths. Based on trend analysis from 1990 to 2010, the study showed that an increase of 1% in the level of unemployment is associated with additional deaths of 0.37 from all cancers per 100 000 people, and 1% reduced public healthcare spending as a % of GDP (Gross Domestic Product) affected additional deaths, which was 0.0053 increase in additional deaths from all cancers per 100 000 people. Borras *et al*. (2010), have observed that the situation was worsen by 2008 global financial crisis in which many governments have cut down their spending. This also impacted on radiotherapy infrastructure improvements or development in those countries as it depends heavily on capital investments for its equipment and buildings. The worst affected countries were the LMIC.

Figure 2.2 shows the global picture of coverage of the radiotherapy service. It illustrates that the coverage is poor globally, but Africa has the worst radiotherapy coverage. Globally, acceptable coverage is 1 treatment machine to 120 000 population (Fisher, 2014).

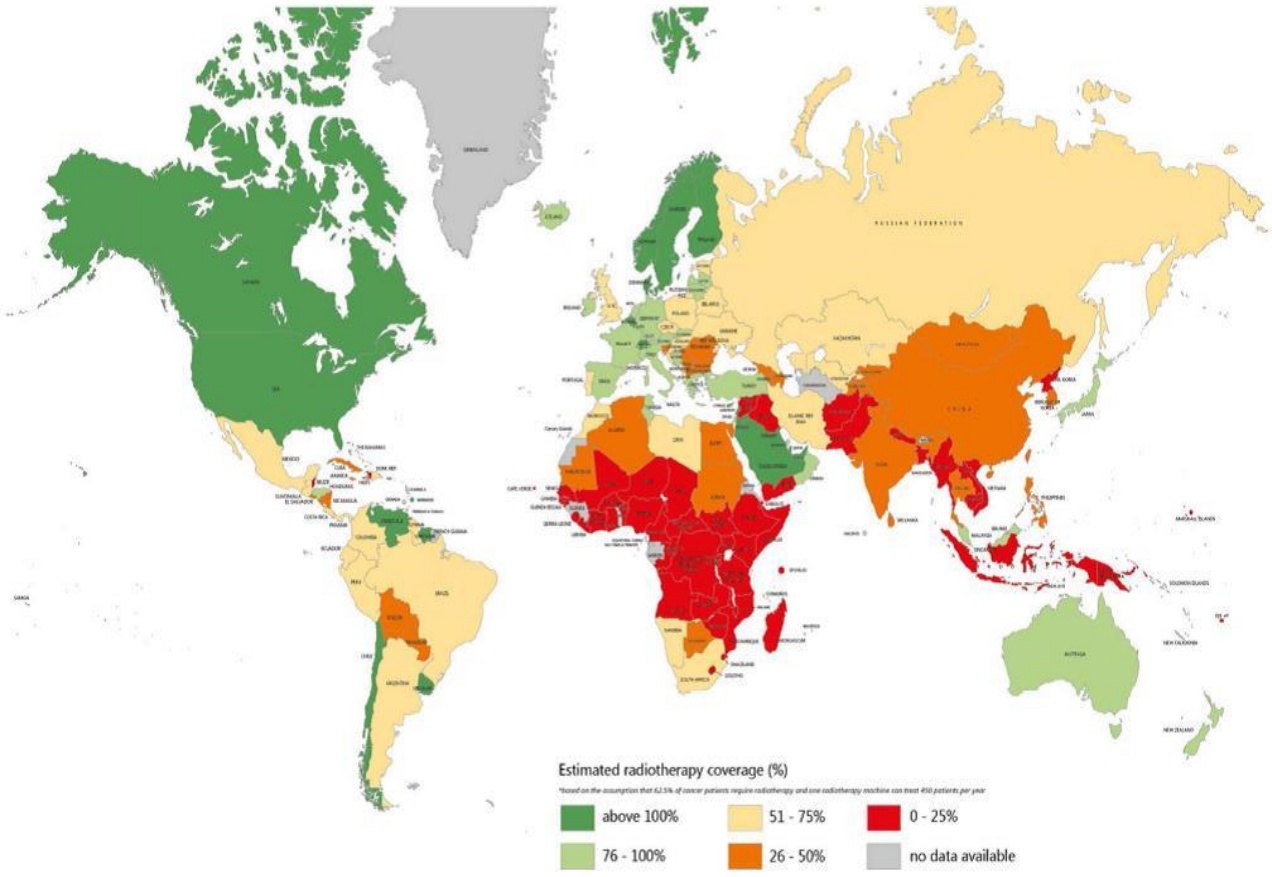

Figure 2.2: Estimation of global radiotherapy equipment coverage.
Source: Rosenblatt (2014, p. 2).

2.3.3 Continental perspectives

Africa is a continent with a population of more than 1 billion people, which covers around 15% of the world's population, but with access to less than 1% of the financial resources. The cancer incidences in Africa are expected to rise by more than 80% in the next 20 years, this is due to the continent's population growth rate. Africa is divided into Sub-Sahara (80% population) and North Africa (20% population) and the differences in health care system are due to the type of disease burden they have and therefore, health policies and priorities. Africa has inadequate health-care systems overall. The priorities to cancer are different between those regions (Harford, 2015). North Africa has cancer on the second position after the heart disease, as a cause of death, while Sub-Sahara has cancer on 7th position with HIV/Aids occupying the first spot. This comes as no surprise that in the Sub-Saharan region, the fundamental priority is not placed on cancer and cancer control programmes by policy makers, as compared to the North African region. Conflicts and

corruption in Africa may play roles in terms of prioritising the limited resource (Harford, 2015).

Africa has the highest number of underdeveloped nations in the world. The status of radiotherapy equipment coverage shows that on average, 1 radiotherapy equipment covers 3.8 million people and in some countries, 1 radiotherapy equipment covers 17 million people (Fisher *et al*., 2014). Africa is the hardest hit continent, with 29 out 55 countries having no treatment equipment at all. The world total number of countries without the treatment equipment is 40, meaning that 73% of countries without treatment equipment in the world are located in Africa, thus, showing how dire is the situation in Africa (Abdel-Wahab *et al.*, 2013). The problem of coverage in Africa is illustrated in Figure 2.3. It has also been noticeable that better equipped countries are those with better income, which concurs with Maruthappu *et al*'s. (2016) studies that relate the spending with the country's income. In Africa, some patients have to travel a long distance to receive treatment. Treatments in the continent are so limited that Senegal, with only one machine donated to it, treats 25% of its patients from surrounding countries. The country has been surviving through collaboration with donor organisations and outreach programs. It is emphasised that cancers in Africa are underestimated because of lack of cancer registry (Fisher *et al*, 2014).

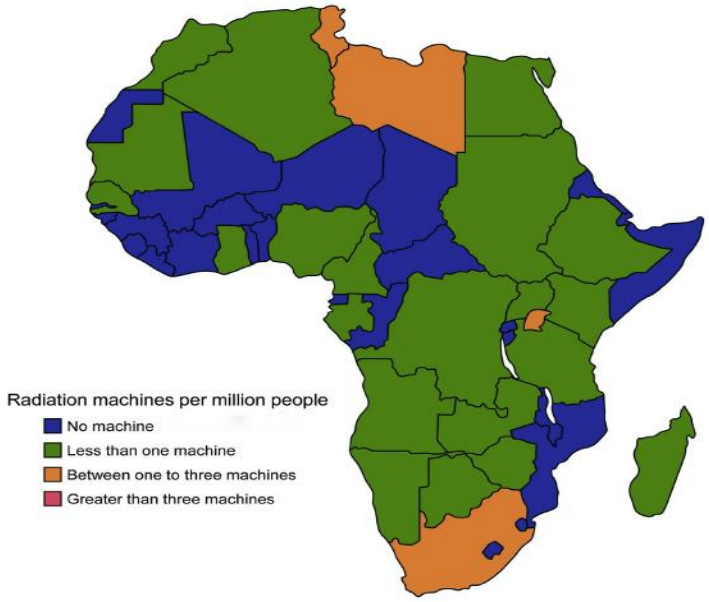

Figure 2.3. Availability of the radiation treatment machines in Africa.

Source: Fisher *et al.* (2014, p 460)

2.3.4 The South African perspective

Economically, the current status of South Africa shows that it is an upper middle income country in Sub-Saharan part of Africa, with a GDP of $350.1 billion estimated in 2014. The GNI (gross national income) per capita was $6,800, as estimated in 2014. The World Bank (2015) defined LMICs as those with GNI equal or below of $12,615. The population is about 54.77 million, with a life expectancy of 57 years estimated in 2015. National poverty head count ratio in South Africa is 53.8% in 2010 (WorldBank, 2015). Unemployment rate is at 26.7% as per Q1 of 2016 and it is the highest since September 2005 (11 years) (Stats SA, 2016). South Africa has the largest healthcare market in Africa, about $29.8 billion by 2013 (Industry report, 2014). The government spends about 11% or R113bn of its budget on public health care. Healthcare as a proportion to GDP is 8.5% and it is expected to grow annually by 8.8% from 2013 to 2017 (Industry report, 2014; Delloite, 2014). However, there is a problem with the disparity, as half of that money only fund 16% of the population in the private sector, while the other half is for the 84% of the people in the public sector (Delloite, 2014; Gouws *et al*., 2012). Such an inequality, which is estimated to be 0,643 in 2011, as per Gini index (on a scale of 0 for minimum inequality to 1 for maximum inequality) (WorldBank, 2011), and limited access to healthcare, have led to the South African government to propose the NHI (National Health Insurance). NHI was designed to ensure that all citizens of South Africa have access to affordable quality health services, irrespective of living standard measures; as a result, equity and efficiency would be promoted (NHI, 2011). NHI is at the pilot stage in South Africa and its feasibility is beyond this study.

Another approach to improve access to healthcare which also includes radiotherapy is the partnership between the public and the private sector. Amongst the benefit is the transfer of knowledge between parties, sharing of the risk between parties, driving the acceleration of the infrastructure, thus serving the interest of public citizens and improve access to healthcare. Challenges may range from the commitment of parties, especially the public sector and the amount of funding to be required towards the Public-Private Partnership (PPP) development (Malao, 2011). The other main challenge is an agency problem between private and public parties, as the private sector is for profit maximisation at all costs, while the public sector is interested in serving the needs of the public, thus, making the partnership not being sustainable in a long term (Malao, 2011).

In radiotherapy, South Africa would need 3 treatment machines per 1 million population, based on the country's cancer incidents and age profile (Econex, 2010). South African cancer burden, based on cancer incidents estimation, is about 255 cases per 100 000 people each year (Ferlay *et al*, 2013). For South Africa to face such a need for equipment, infrastructure and human resource, the Health department still has to share the budget with other competing diseases like the high burden of HIV, tuberculosis and malaria, as well as the high rate of maternal and child mortality (Stefan, 2015). That is why there is poor infrastructure growth in radiotherapy. These, as a result, have given the private sector a chance to establish themselves, which would eventually lead to inaccessible radiotherapy services for the ordinary citizens.

2.3.5 KwaZulu-Natal Provincial perspective

Table 2.1 shows that the KZN province had 6 treatment equipment in public sector and 5 treatment equipment in the private sector in 2009. It should be noted that currently in 2016, the public sector remained at 6 treatment equipment that has also become fragile, while the private sector has increased to 11, which is more than double to what it was in 2009. This situation in radiotherapy has been explained by Rosenblatt (2014) that countries which have developed their radiotherapy services without central planning would find themselves with more private radiotherapy centres than public radiotherapy centres and inaccessible to the majority of the patients.

Table 2.1: Population demographics, equipment and workforce availability in South Africa.

Table 1: SA Population Demographics and Current Radiation Oncology Workforce, 2009

Province	Population estimate	% Share of the total population	Total oncology workforce	% Of total oncology workforce	Ideal number of accelera-tors [10]	Accelera-tors in pri-vate sector	Accelera-tors in pub-lic sector	Shortfall in total sector
Eastern Cape	6,648,600	13.5%	12	9%	20	3	3	14
Free State	2,902,400	5.9%	12	12%	9	2	3	4
Gauteng	10,531,300	21.4%	35	25%	32	13	11	8
Kwazulu Natal	10,449,300	21.2%	21	16%	32	5	6	21
Limpopo	5,227,200	10.6%	2	2%	16	1	2	13
Mpumalanga	3,606,800	7.3%	2	1%	11	1	0	10
Northern Cape	1,147,600	2.3%	2	1%	4	0	0	4
North West	3,450,400	7.0%	4	2%	11	2	1	8
Western Cape	5,356,900	10.9%	39	33%	16	9	5	2
TOTAL	49,320,500	100.0%	129	100%	151	36	31	84

Source: StatsSA, 2009 and Econex research

Source: Econex (2010, p 4)

Poor access to radiotherapy results in poor outcomes in cancer control and longer waiting times, which affect the quality of radiotherapy services to patients (Mackillop *et al*, 1996; cited by Gopodarowicz *et al*, 2014).

2.4 THE QUALITY OF RADIOTHERAPY SERVICES TO PATIENTS

Rosenblatt (2014) describes the quality of radiotherapy as "providing a service that satisfied the expectation of the patient, following the professional practise that is optimised by yielding optimised results, with the regulatory framework at a minimal cost and ensuring that the resources are not wasted". Quality in radiotherapy may therefore have a different meaning to different people like the patient, the administrator or the professional. Expectations that are to be met are the cancer control with the minimal and negative impact on patients' quality of life. Donabedian (2005), cited by Rosenblatt (2014), proposed that quality can be assessed through infrastructure, processes or the outcomes.

The rationale for infrastructure in radiotherapy is that the quality of radiotherapy can be achieved if there is appropriate infrastructure, i.e. building, staffing, competence (enough training) and equipment. For the process, the rationale is that if the process is controlled and conformed to a standard, the quality of the results can be predictable, e.g., operational protocols. Lastly is the outcomes, the rationale is that if the cancer control should be achieved as an ultimate goal, e.g., 5 year-survival. Rosenblatt (2014) further explained that in order to maintain the radiotherapy quality, budgetary provisions are required, machine requirements, maintenance services and repairs, parts and radiation source replacements, consumables and overheads. Also, equally important is the training and education of the employees, as radiotherapy is technologically evolving and the staff should always be dynamic and need gradual training, and continuous education and development programme (CPD) (Samiei, 2013).

Rosenblatt (2014) believes that centres that practise a proper radiotherapy quality must be patient-centred, advances the patients' needs and priorities. Services aspects that are important to patients are high levels of medical care, reduction of waiting times and appropriate communication. Waiting times have been described by Lee *et al* (2010) as an important indicator for the radiotherapy services.

Waiting times are regarded as the time waited by the patient from diagnosis to radiotherapy treatment. Waiting times are normally a sign of patient access problem to radiotherapy

(Tze, 2006). Gospodarowicz (2014) explained that patient access is caused by unavailability or limited equipment resources, lack of trained health professionals and substantial financial constraints. Waiting times increase the risk local tumour recurrence and eventually, the treatment failure to achieve the required outcomes. Rosenblatt (2014) and Lee *et al*. (2010) argue that waiting times indicate the inability of healthcare systems to provide the intended outcomes and thus, causing public health and political crises. Such issues are sensitive to patients and the families in such a way that they approach the media for their relief. Rosenblatt (2014) recommended that the waiting time should not be more than two weeks for the acceptable outcomes.

Quality in radiotherapy can also be viewed from patient perspective. Patients usually interpret their satisfaction as quality in radiotherapy. Their clinical experience and the time it takes for them sitting and waiting for attention. Sandova *et al*'s. (2006) survey found that that patients demanded clear communication and direction of what they should do next and the different options that they can choose from, amongst the treatment options, and how long they would wait to be served. Sandova *et al*. (2006) described information provided and *waiting times* as the main predictors of overall satisfaction, while patient satisfaction is considered one of the multiple aspects in measuring the quality of care. Putting more effort in waiting time reductions would have an impact on patient's satisfaction and patients are more likely to cooperate with their treatment which is, in turn, associated with better clinical outcomes. However, Halkert *et al.* (2015) found that patients want the improvements in communication and delivery of the education throughout their journey. They usually have less information about cancer and as a result, they are nervous and anxious. They feel satisfied whenever they get communication from health workers and they desperately need guidance and education.

2.5 STAFFING CAPACITY AND STAFFING RECOGNITION

To provide an optimal service to radiotherapy, three professional groups are primarily needed, i.e. radiation oncologists, medical physicists and radiotherapists. For this study, they will be collectively referred to as the radiotherapy employees. In their duties, they are supported by the radiation oncology nurses, mechanical, electrical engineers, information technology experts, cleaning staff and administration staff (IAEA, 2014). Radiotherapy employees must have received adequate specialised academic education and training.

Teamwork from these professionals is very important to provide a seamless and optimal radiotherapy (IAEA, 2014).

Gospodarowicz (2014) considered that the investments in human resources and education are very important and required for safety and stability in radiotherapy. Gospodarowicz (2014) pointed out that the lack of investments in human resource is the cause of them being in short supply and when they are not well trained, it limits the decisions to invest in radiotherapy construction and equipment installation. Since their training is highly specialised, it is a major challenge to retain them. Radiotherapy is technologically evolving and the staff should always be in line and need gradual training and continuous education and development programme (CPD) (Samiei, 2013). So, the advanced radiotherapy technologies would require additional staffing levels (roles and responsibilities) and further training of new specialists (Guedea *et al.*, 2012; IAEA, 2008).

Staffing levels common to many centres are best described by IAEA (2008) and they are very important when budgetary and planning exercises are required, in as much as they are fundamental for patient safety and care. Reasonable staffing levels for the support in radiotherapy have been estimated based on patient population size, equipment availability, infrastructure, and the rates of cancer incidences. IAEA (2008) recommended a benchmark of 400 to 500 patients per radiotherapy treatment unit annually, while 200-300 patients per annum are recommended per radiation oncologists, 300-500 patients per medical physicists annually and 100-150 patients per radiotherapists annually. For the radiotherapists, these apply for each of the station (or technology) that the patients have to pass through as part of radiotherapy journey as shown in Figure 2.4 below.

Latest research suggests that the staffing level should rather be based on activity of the professionals to improve staffing adequacy. This should be based on the detailed measurements of how long the procedure has taken and the activity taken to the procedure as they seem to be logically more useful. This suggested procedure of staffing is the most objective basic evidence to determine the full time equivalent staffing (FTE) levels. (IAEA, Activity based staffing, 2015).

Since the safety working conditions are very important, irrespective of advanced or non-advanced radiotherapy treatments, Dunscombe (2012) recommended that twelve (12) initiatives are required to ensure that the safety regulations are maintained. Staff training, adequate staffing level, standard operation procedure or protocols, voluntary incidents

learning system, usage of check list, effective communication, preventative maintenance and quality control, dosimetry audits, minimisation of interruptions, radiotherapy specific accreditation, risk assess exercises and safety culture.

The staffing is very important to satisfy the radiotherapy treatment quality. Delivering radiotherapy involves many steps, equipment and technology and different professionals already mentioned earlier. Preparation for a patient treatment is specific and depends on the patients' situation; preparation process is usually done once, unless a repeat is requested for a specific reason. Treatment delivery is done several times, or the so called in fractions on the treatment equipment performed by the radiotherapists, and number of fractions depends on the oncologist's prescription and the course of treatment. After the treatment has been completed, the follow up to ensure that the cancer does not progress will be started. Professionals that participate in the follow up are the nurses and the radiation oncologists. Medical physicists' involvement, in addition to the patient treatment, are in all steps associated with infrastructure and building design, technology and acceptance testing, commissioning, quality assurance and quality control, designing of radiotherapy protocols, and all aspects of radiation protection and radiation safety. Figure 2.4 shows the steps required to deliver radiation, technology and professionals involved.

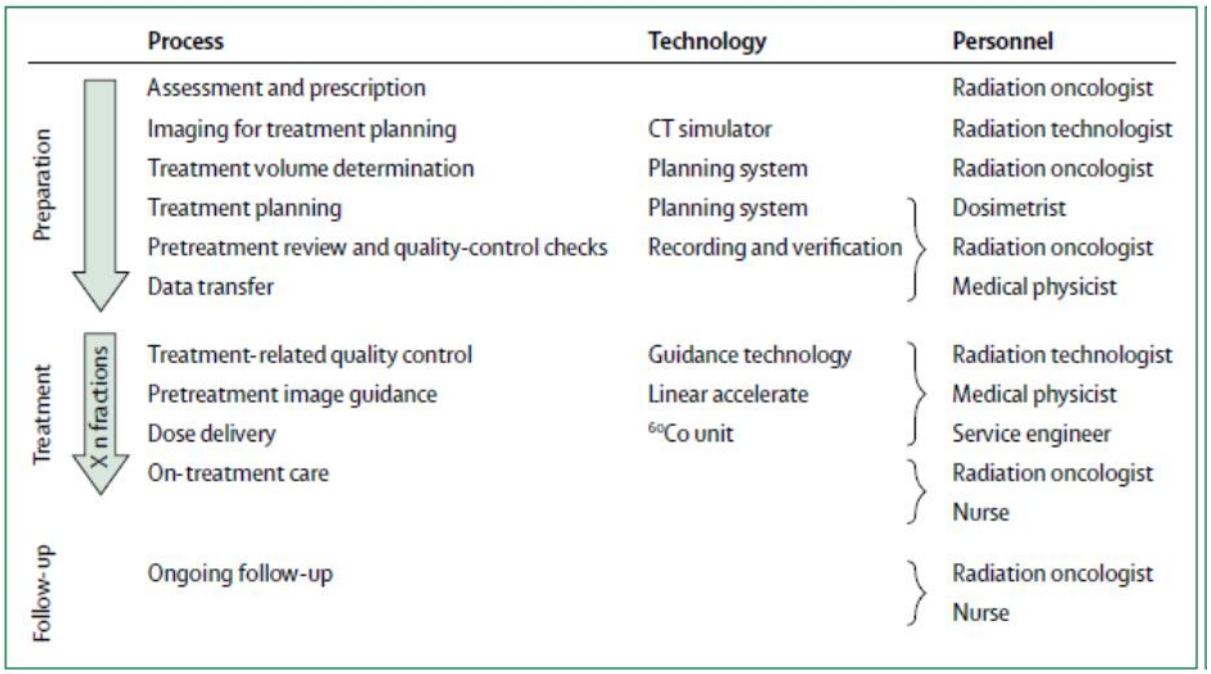

Figure 2.4: Steps for radiotherapy treatments with the technology and professionals involved.

Source: Atun *et al.* (2015, p 1163)

Differences in schemes of the treatment delivery are called fractionation. Fractionation regime may be standard fractionation, hyper-fractional (double dose of fractionation per day with a minimum of 6 hours apart), hypo-fractionation (total dose divided into larger doses and treatments, and delivered in a fewer days than standard fractionation) or single treatment. Newer technologies have made it possible to treat hypo-fractional and single treatment with similar outcome as standard fractionation, but save on patient accommodation and allow more space for more treatments (Fairchild *et al*., 2009; Lievens *et al.*, 2015).

Shorter scheme of fractionation presents the opportunity for time, cost and resource savings. Hypo-fractionated schedules would decrease costs of a particular treatment and helped offset other costs incurred by its increased treatment complexity, the emergence of hypo-fractionated techniques in routine practice, for example, the treatment of patients with breast cancer in 15 rather than 25 fractions or more extreme hypo-fractionation within clinical trials, would mean fewer trips to hospital and related costs would be minimised (Guedea *et al*., 2012). This also agrees with studies by Mathews *et al*. (2009) who noted that hypofractionation comes with benefits as it plays a role of minimising the travelling and lodging cost associated with the rural patients.

Radiotherapy employees are affected by the lack of investments in radiotherapy, as they are at the helm of poor radiotherapy access. Bissonnette and Medlam (2010) pointed out that radiotherapy employees are working in an environment where they are balancing the complex technology with emotional strain of working with patients of cancer, where there is no room for errors, while expected to provide high levels of care. This is worsened by the fact that the resources are limited. As a result, the employees are experiencing high stress levels, high vacancy rates, high demotivation levels and lack of commitment, and questionable level of patient care (Akroyed *et al.*, 2002). Lawrence *at al*. (2011) also pointed out that despite national government (South African) declaring radiotherapy as a scarce skill, there is little effort to improve retention and recruitment strategies. Despite the current working environment, Sehlen *et al*. (2009) emphasised that the defined responsibilities, teamwork and optimisation of working process which includes operational protocols and procedures, are very important to be in place.

When staffing levels are not in a good condition, action like employee recognition usually motivates and encourages the employees to do their work. Employees' recognition makes them feel valued, improves their engagements, reinforces linkage between employee performance and organisational goals, attracts and retains employees, improves employees' motivations and satisfaction (Novascotia, 2012). Employees' recognition is therefore very important for understaffed departments like radiotherapy in KZNHealth, but wishing to provide the quality radiotherapy services. This would ensure that they care for patients and they care for the equipment and infrastructure. It would motivate them to put extra effort beyond their job descriptions to improve radiotherapy from the current crisis. KZNHealth department made efforts for the employee recognitions on long services awards and a 1% annual performance bonus, but as radiotherapy is evolving the frequent training is also equally important. It would be important to recognise the needs that are specific for radiotherapy to show that they are recognised Guedea *et al*.(2012).

Radiotherapy employees have a role in managing and maintaining the limited resources. Malicki *et al*. (2012), in view of cost minimisation, suggested that the focus should be on improving treatment process by streamlining and increasing efficiency to avoid waste, minimise errors and improve outcomes. One of the ways to achieve these is the designing of protocol and procedures of operations, quality assurance programmes and to ensure the use of up to date technology.

2.6 MANAGEMENT OF RADIOTHERAPY EQUIPMENT AND INFRASTRUCTURE

2.6.1 Equipment

A proper practise of radiotherapy will need a linear accelerator (Linac) or Cobalt Unit as a standard cancer treatment units accompanied by the ancillary units like the simulators, CT scanners, treatment planning system, medical physics support in terms of calibration, quality assurance, dosimetry and radiation protection programs on equipment, mould room and brachytherapy (Datta, 2014). Since the equipment is usually sophisticated, it has an impact on healthcare and capital costs (Atun *et al.*, 2015). Healthcare costs become higher when equipment with high technological advancement is used, as more quality assurance (QA) for equipment is required (Lievens and Grau, 2012). The price of the radiotherapy equipment is independent of the national prosperity; therefore, LMICs would feel more

impact on equipment costs and thus, creating a huge barrier to radiotherapy implementation.

According to Guedea *et al.* (2012), advancement in radiotherapy equipment, imaging equipment alongside the information technology and computing power advancements, result in more accurate radiotherapy treatments with better outcomes and better economic impact. The advancement also reduces the treatment times to ensure benefit exceed cost. IMRT (intensity modulated radiotherapy) is one of the advanced treatments with the improved patient outcomes, because of the advantages of less toxicity and improved local cancer control. However, its cost increase ranges from 38% to 88% more than the standard treatment. It is important that one needs not adopt the advanced technology blindly, but should ensure that the safety, fastness, efficacy and most importantly, the cost-effectiveness, are achieved (Guedea *et al*., 2012).

For the developing countries, Datta (2014) recommended that they could still use the standard equipment, although the maximum benefit may not be achievable, but it is better than having no equipment at all. Quality assurance programme on equipment is very important as it ensures the safe use of equipment, but it requires checking tools and checking equipment. Jakovljevic *et al.* (2015) argue that the intensive functioning of equipment or machines leads to frequent technical problems that would need maintenance or repair procedure. This means that the overuse of equipment like for overtime purpose, tend to exhaust the machine. Proper equipment maintenance is a big problem in the LMIC because of the poor planning (Atun *et al*., 2015).

In the studies of equipment status in Nigeria, Nwankwo *et al*. (2013) emphasised the routine maintenance of radiotherapy equipment to ensure equipment continuous operation. They emphasised that it is very vital for a treatment centre to have a service contract in place, so as to plan for the maintenance and repair needs. The contract should ensure the equipment functions properly; repair is done promptly without delays, thus avoiding long and unnecessary interruptions. The service provider for service contract is recommended to be a well-established, close proximity to the centre. Linear accelerator may operate from 10-12 years, or even more with some idling (Samiei, 2013). Therefore, equipment consumes a high capital cost due to the commissioning, operation, training, maintenance requirements and QA programmes. It is therefore recommended that the equipment service provider must also be responsible for purchasing, maintaining and the replacement of the

equipment parts; this is ensuring the pre-defined cost is paid directly to the service provider (Guedea *et al*., 2012).

There is a huge debate about price of the treatment machine. Atun *et al*. (2015) argued that radiation equipment provides safe and effective treatment that benefit patients in terms of survival, high return on investments and usefulness over 10 years. Poor economies of scale and low demand are other factors that push the price up. Gospodarowitz (2014) argued that the focusing on costs while ignoring the benefits may result in loss of opportunities for the policy makers. The cost of equipment and infrastructure is in millions of rands, in era of cost saving and limited resources, as it is difficult for the government to spend more in buying equipment, it is also very important for employees working with the equipment to treat them with care to elongate its usefulness.

2.6.2 Quality Assurance.

Quality assurance (QA) is an assurance about certain procedures that it would lead to the desired outcome (Papakostidi *et al.*, 2015). QA program in radiotherapy contributes to the prevention of systematic errors and the reduction of the frequency and severity of random errors. QA program does not only provide the patients with protection, but the program is also implemented for validation of the proper function of the mechanical and electrical parameters of the equipment. The first step in making sure of quality in radiotherapy is a good planning and good management with proper QA program. Appropriate professionals, equipment and procedure must be selected for the success of the QA program (Papakostidi *et al*., 2015). Radiotherapy managers and medical physicists are responsible for QA program designing and applications, as well as ensuring that all personnel implement it to ensure patient safety and prevent malfunctioning of equipment. Reports from IAEA safety series showed many errors that could have been avoided if QA program was in place, in some cases the consequences were death. In the era of diffusion in technology advanced equipment there is a likelihood of errors and thus making QA program very important. QA program is costly as checking instrument, personnel and time would be required.

2.6.3 Facilities

Geographic access is another problem that radiotherapy has and this affects rural population the most, as most radiotherapy centres are located in the urban areas. Proper planning that would tackle that problem is required. Radiotherapy centre is supposed to be

allocated where the concentration of population is high. A transport system should be properly organised when there is a distance from population to treatment centre (Rosenblatt, 2014). This means that other towns may have the radiotherapy centre as a satellite facility working incorporation with the larger city centres through the Telemedicine Technology (Rosenblatt, 2014).

A strategic approach to the limited resources like radiotherapy facilities is therefore required, a three tier radiotherapy approach was proposed by Datta (2015). This approach proposed the creation of radiotherapy facilities that should revolve around the concept of transport and boarding costs reduction, sharing of expertise and cooperation amongst the various radiotherapy centres using the tele-networking and taking advantage of the Information Age with IT explosion (Datta, 2015). The proposed three tier system should consist of primary, secondary and tertiary radiotherapy centres.

Primary radiotherapy centres (PRC)-based on population density, should be equipped with the treatment equipment only. For the KZN settings, this should be in areas like Richards Bay, Ladysmith and Port Shepstone for the Southern part of the province. Creation of such centres would save transportation costs and time that could be used for better productivity of patients e.g. without losing their jobs because of travel commitment. Therefore, such centres would work as outpatients for the new or follow-up patients, thus plays a huge role in minimising the need and the cost for patient boarding (Datta, 2015). Such centres could serve as focal points for cancer prevention, education programme, organising early detection and other screening programmes, as illiteracy is higher in those regions with primary centres. Primary radiotherapy centres must work in collaboration with the secondary radiotherapy centres for inputs and expertise.

Secondary radiotherapy centre (SRC) - according to Datta (2015), SRC should consist of basic radiotherapy with the brachytherapy unit, but supported by the simulator and treatment planning system. Patients from PRC may be sent to these centres for simulation and treatment planning, which can be a single day, then sent back to the PRC for daily treatment delivery. If the PRC patient requires brachytherapy, then the patient can receive it from SRC. SRC provides better technical and expertise than PRC and therefore, they must coordinate various cancer prevention programmes and other PRC linked activities. This centre is expected to cater for both inpatients and outpatients. Typical KZN regions

for SRC can be Pietermaritzburg, Durban Regional, Newcastle and Empangeni. Patients that need specialised treatment may well be sent to the next level called Tertiary radiotherapy centre.

*Tertiary radiotherapy centre (TRC***) -** is the centre of Excellency, with a state of the art technology, advanced equipment, advanced infrastructure, proper support services and located at a tertiary teaching hospital, according to Datta (2015). Equipment should include all the SRC equipment with better advanced technology, e.g. Stereotactic, IMRT etc., but should be supported by brachytherapy, CT scanner, simulator, treatment planning systems and medical physics support. All other radiotherapy centres should be linked and activities coordinated by the TRC centre, as it is a referral hospital. TRC provides teaching and training of personnel to other radiotherapy centres and assist them in formulating protocols and clinical trials.

Link to all three radiotherapy centres is promoted by the availability of the telemedicine, which would play a role in the transfer of various data like patients' images or treatment plan between the centres. The challenge is that telemedicine has been effective in HIC, where there is low population density and the shorter distance between centres. However, in LMICs, telemedicine is less well used as there is a shortfall in expertise and networking may not be available, or may not have a continuous connection. However its use is very important when there is an expertise shortage and it may well be used in relation to the well-resourced HIC countries. The benefit of such structuring of centres with the assistance of telemedicine in radiotherapy (teleradiotherapy) is minimisation of patient stay in the hospital and thus, reduction in hospitalization costs. The benefit to the personnel is the reduction of the operational costs due to centralisation and optimisation of resources, reduction of training costs and skill development costs.

Facility layout and size affect the cost of radiotherapy (Van de Werf *et al*., 2012) and this can adapted from the IAEA guidance documents (IAEA Radiotherapy facilities: Master planning and concept design considerations, 2014).

Therefore teleradiotherapy network based on Datta (2015) proposal could play a huge role in addressing the problems related to limited radiotherapy facilities and human resource in both LMIC and HIC. This will lead to the improvements in the patients' radiotherapy access.

2.7 COST MANAGEMENT

2.7.1 Cost awareness

Radiotherapy employees have a role in managing and maintaining the limited resources. That is why Vucovic and Jakovljevic (2015) proposed the need for health professional economic reasoning (HPER), which helps in improving the personal responsibility in the cost control, enthusiasm in the formulating of strategy to reduce costs and easy to understand the constraints of providing adequate healthcare within the allocated budget. This HPER plays a role in a better economic healthcare effectiveness. Cost awareness by the healthcare professionals makes them expressive of the unjustified spending in the healthcare institution; developed countries have more efficient control and evaluation of the effects of the current economic healthcare reform.

Nethathe (2015) studied the cost awareness of health professionals in South Africa. The study was influenced by the poor access to healthcare in the country and the study revealed that the financial cost is recognised as a cause of lack of access. Another cause of poor access is the ever increasing cost of healthcare which further decreased the already limited healthcare access. South Africa, when compared to the other countries with the similar development status, has much spending but health-wise, it is one of the worst. This suggests that the country still have the challenge of equitable and resource utilisation. It also means South African costs of providing healthcare are high and are still escalating. Measures have been tried to reduce these expenses. The situation is challenging in radiotherapy due to the high costs of equipment, infrastructure and personnel. Atun *et al*. (2015); Jeffray *et al*. (2015); Lievens and Grau (2012); Gospodarowicz (2014) suggested that one of the approaches to face radiotherapy access challenges is to understand the costs of radiotherapy and then determine the required investments.

2.7.2 Need for investments in radiotherapy

Based on the argument by a 1993 Nobel Prize winner in Economics, Robert Fogel, good health plays a substantial role in economic growth (World Bank, 2013). Therefore, the health of the population with cancer must be positively considered as the value for that is really economic, as it tends to keep the workforce for the longer time, which may decrease costs of care (Efstathiou *et al*., 2015). For the sake of the patient, it also a moral, ethical and humanitarian way of providing health to the citizen of the country, as access to health

is a human right (Efstathiou *et al.*, 2015). Such could be achieved if there is an investment in the Healthcare.

Various authors (Datta, 2014; Atun *et al*., 2015; Gospodarowicz, 2014) argued that the main focus of the policy makers has been on the costs, rather than the benefit and the advancement in equipment has proven that there is a huge benefit over the costs. Gospodarowicz (2014) acknowledged the large initial costs involved when building the radiotherapy capacity, but radiotherapy remains cost-effective, as compared to systematic treatment like chemotherapy and surgery, with a huge impact on cancer treatment. Although health and economic benefits from radiotherapy are realised in a long term and it can be as long as 15 years, Gospodarowicz (2014) argued that even HIV/Aids and malaria programmes took years to manifest.

The global improvement in the radiotherapy investments would improve global health benefits by almost 27 million life years and global economic benefit between $278 billion and $368 billion during the next 20 years through health care savings and higher productivity (Atun *et al.*, 2015). Investment could benefit about 12 million people globally by 2035 and it is achievable with an investment of $97 billion (Atun *et al*., 2015). Global Task Force on Radiotherapy for Cancer Control (GTFRCC) worked on the feasibility of radiotherapy and they also discovered that radiotherapy is an essential service that is feasible and a highly cost-effective investment which can be deployed safely with high quality, globally (Atun *et al.*, 2015). The Commission also discovered that even a relatively small investment can scale up radiotherapy worldwide and they believe the focus should be on financial figures or (cost) to convince the policy makers.

Atun *et al*. (2015) described radiotherapy as a very small market of radiotherapy producing companies, thus, the bargaining power for the reasonable prices is smaller. The industry is fuelled by demand, the lack of investments by governments and other funders in radiotherapy keep the supplier small, thus, unable to pull prices down as economies of scales are lacking.

2.7.3 Investment framework in Radiotherapy

Atun (2014), in agreement with Stenberg *et al*. (2014), emphasised the requirements of the investment framework in radiotherapy. Investment framework will provide economics, social and health benefits for health investments, and evidence of the interventions in cost-effectiveness and the background factors that determine the realisation of the full impact of

benefits. Investment framework's emphasis was based on the success of HIV/AIDS and tuberculosis programmes. These programmes have been able to bring down costs, improved patients livelihood, minimisation of death from HIV/AIDS and return on investments (ROI) has been achieved (Schwartlander *et al.*, 2011).

A typical investment framework for radiotherapy, with the effective delivery of radiotherapy services, this will depend on the successful functioning of a comprehensive cancer control programme, or a system and the availability of enabling services with holistic approaches that would include surgery, pathology, adequate radiological imaging, systemic therapy, sociology services and primary health care (Atun, 2014). The state of readiness is also important and this would include proper training, infrastructure, financing mechanisms and awareness building, to create an enabling environment for investment and scale-up (Atun, 2014).

Figure 2.5 shows an Investment Framework for Radiotherapy that is expected to bear fruits in terms of social, financial and health benefits.

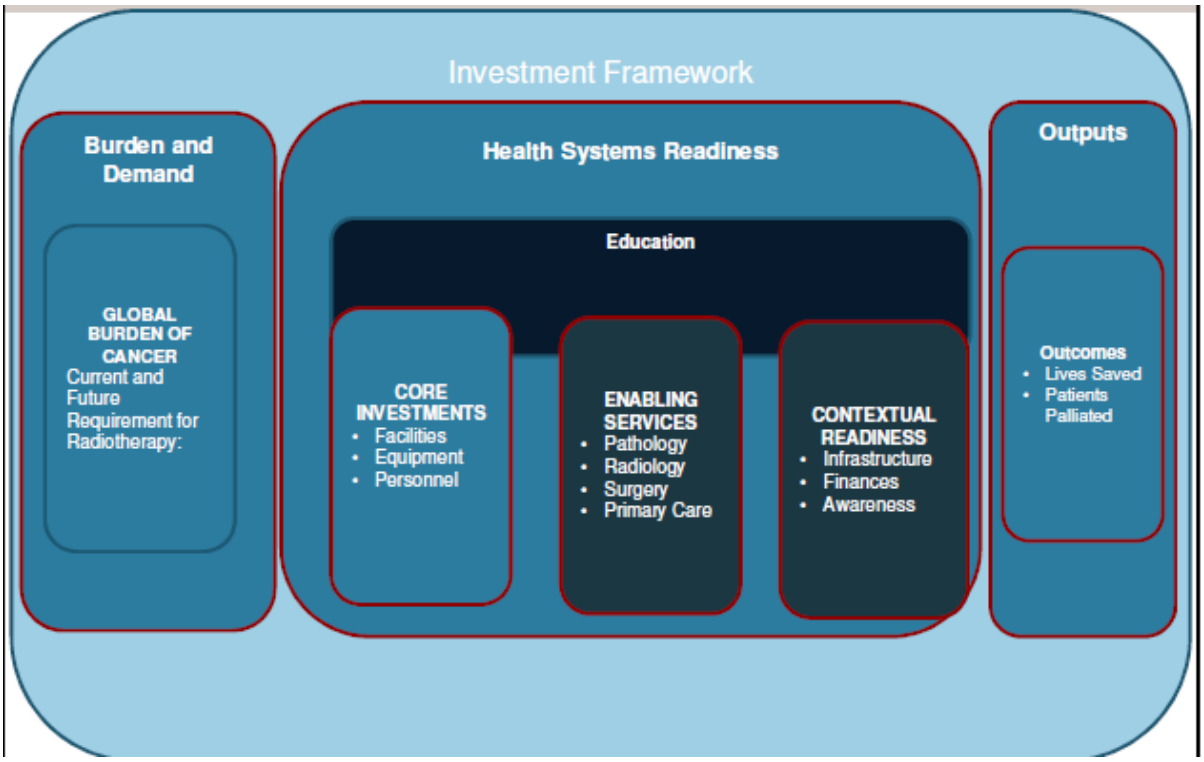

Figure 2.5: Investment Framework for Radiation Oncology.

Source: Atun (2014, p 10)

Atun (2014), Gospodorowicz (2014), Datta (2014), Lievens *et al.* (2003) and Van de Werf *et al*. (2012) agree that the major cost components of radiotherapy are the buildings, facilities and human resources, and these are placed at the core investment on the investment framework of radiation oncology. They are the reasons why much focus will be on them because policy makers show resistance and perceive them as costly and unnecessary to invest in.

Atun (2014) determined that the core radiotherapy costs have two major components, i.e. *upfront and operational costs*. The upfront costs cater for the developing of the facility which includes equipment, building and pre-training of the staff which are classified for the *core investments* on investment framework shown in Figure 2.3. Operational costs cover the costs of delivering radiation dose once the facility has already been established, which forms the component of *contextual readiness***,** education and training of personnel falls under this component. Component of *enabling services* is more likely to be the *overheads costs***,** which may include the support not directly linked to the production of the product or service. Atun (2014) further explained that the variability of costs is affected by facility size, level of treatment complexity, equipment, construction and the staff costs, as well as clinical operational conditions (time it takes to perform certain tasks to deliver a service).

This brings us to the point that the knowledge of costs is very important in determining the radiotherapy investments. It necessitates the need for us to discuss the concept of cost and costing.

2.8 COSTING

2.8.1 Costing concept and definitions of terms

Terms, '*cost'* and '*costing'* are related but have different meanings, the former is a term, while the latter is a process to determine costs, it is also called a technique used for the determination of cost of production of either the service or product (Institute of Cost and Management Accountant, 2002). It was Blocher *et al*. (2013:54) who described the term "*costing"* as a cost incurred when a resource is used for some purposes.

Wheldon *et al*. (1975) broadly defined 'costing' as the way of classifying, recording and appropriate allocation of expenditure for the cost determination of the products or services.

It is also useful for the presentation for the suitably arranged data for the purposes of control and guidance of the management.

However, Mogyorosy and Smith (2005) employed a modern way of defining *costing* as "the process of estimating the monetary value of inputs that are necessary in the delivering of a particular service or product". In their definition, they added that the total cost of services or product is dependent on –

- *Which resource were consumed and*
- *The unit costs of resources.*

Costing therefore involves –

- *Measuring the quantity of inputs (resources) which are needed to deliver particular services in natural units, and*
- *The valuation of inputs in monetary terms.*

Such definition of *Costing* is in line with most modern literatures.

According to Malepe (2013), costing concept is important to-

- *Assist management to analyse, interpret, make proper costing decisions*, e.g. buy or lease,
- *Help management on planning and allocation of resources*.
- *To make more fully informed budget decisions*
- *For management to appreciate scarce resources*
- *Assist management on the cost awareness, control and management of cost and*
- *When the budget is tight, costing assists management to eliminate wastages, inefficiencies and identification of profitable and unprofitable products and*
- *Help in providing guidance for the management to formulate policies*

Costing is a very important process for the companies willing to keep track of their expenditure in the production and distribution process. By understanding such cost information, it is the first step towards controlling the costs. Therefore, it is important for an organisation to select an appropriate cost calculation system/ costing system suitable for their product type and industry (Senthilkumar *et al*, 2015:288). Le Roux and Lotter (2003:3) maintain that the purpose of a costing system is to provide management with information and reliable data for decision-making purposes.

Kaplan and Anderson (2004), has argue that despite all the positives about costing, but they tend to be time consuming, resource consuming and need expertise to be executed correctly to avoid misinterpretations.

The following are terms that are important in understanding *Costing*:

- **Resources**- an economic factor required to accomplish an activity, it may be in a form of money, staff, equipment, material and other assets that may be drawn on by an organisation or by the person in order to function effectively (Gopal, 2009:341)
- **Cost centre**- it assists in the ascertaining of cost by location, item, equipment, people or a combination of them, for the purpose of the cost control. It is required that the size and number of cost centres be defined (Gopal, 2009:350).
- **Cost units** represent the unit of the product or service, or the combination of them in relation to which costs may be ascertained, e.g. radiotherapy treatment service, its cost unit can be per number of patients or per number of fractions (Gopal, 2009:350).
- **Cost object** is any object or activity for which the management may wish to accumulate cost; examples may be product, service, customer, department or project. In general, the cost object is the focus of profitability analysis (Blocher *et al*, 2013:54). The total amount of cost for cost object is influenced by cost drivers.
- **Cost drivers** represent any factor that shows an effect of changing the certain level of total cost for a cost object. Examples may be the cost of electricity for the radiotherapy department (cost object), is influenced by the number of treatment machine hours, therefore, machine hours are a cost driver for the cost of electricity (Blocher *et al*, 2013:54).
- **Cost pools** are the collection of costs into meaningful groups.
- **Activity cost drivers**-they are identified with the use of activity analysis. For each step in production or manufacturing, each activity has its own cost drivers. And for each activity, cost driver is developed to explain how the cost incurred for that activity change. For radiotherapy patients, this can be charted from the start to the finish of the whole radiotherapy treatment administration and delivery. Then the total cost to the radiotherapy department is affected by cost drivers for each of the activity. (Blocher *et al.*, 2013:54; Van de Werf *et al.*, 2012).

2.8.2 Costing in Radiotherapy

According to Kaplan and Porter (2011), whenever cost calculation in healthcare is used it's important to understand its right meaning as it is interpreted differently from different point of view. Cost calculation in healthcare is poor understood as it has been based on the assumption that most of the healthcare costs are fixed, as the delivery of service is done using the shared staff, space and equipment thus leading to wrong calculations. Kaplan and Porter (2011) recommended that the healthcare cost be correctly determined for appropriate management decisions as policy makers may find it easier to make bolder and political decision on proper funding when accurate cost information is in their hands and thus leading to the improved service delivery.

According to Al Rashdi (2011), the costing is very important as it promotes cost-effectiveness in the healthcare, maximising resource availability to the healthcare workers by managing the services offered to patients and identifying opportunities that would need further improvements. The best way to determine such benefits of costing is to perform it at the departmental level as a bottom up approach (Oseifuah, 2013).

The need for managers to have an accurate method of costing in hospital organisation is frequently emphasised in many spheres, as resources and budget are shrinking and the healthcare demands the advanced equipment for quality outcomes (Gujral *et al.*, 2010; Popesko, 2013). Popesko (2013) further explained that the key factors for effective hospital management is the ability of accurate estimation of the cost of products, as the product cost is an essential economic tool used to accurately quantify the cost of intervention carried out, such as the investment. Radiotherapy employees play a huge role in providing hospital managers with the cost information as they can measure, determine, as well as influence such information due to their operations.

Lievens *et al*. (2015) pointed out that the knowledge of radiotherapy costs data is very crucial to ascertain access to radiotherapy. Lievens *et al.* (2015) also articulated that difficulty with radiotherapy costs is that they tend to evolve with time due to technology advancements. More complex treatment requires more time spending, sophisticated equipment and well trained personnel and thus, increases costs. Thus, cost system and techniques needed should consider those dynamics to ensure accurate determination of

costs. Jakovlijevic *et al.* (2015) pointed out that investigation of the cost for radiotherapy would not only justify the investment needed, but also allow evidence-based budget planning. This has been evident in Serbia, where proper cost calculation helped them to secure World Bank loan to buy 6 more radiotherapy equipment. This also shows that costing may not be limited to government funding, but also other funders as long as the cost intervention is accurately determined.

2.9 COSTING TECHNIQUES OR ACCOUNTING SYSTEMS IN RADIOTHERAPY

Costing technique is required for an accurate cost determination. In healthcare and radiotherapy, there are two common costing techniques i.e. traditional costing (also known as absorption costing) and modern costing called Activity Based Costing (ABC) (Carvalho *et al*., 2010). Traditional costing systems are based on the assumption that product drive cost directly to product without considering the activities. This result in a product cost being distorted (Oseifuah, 2013). Failure of traditional methods to consider activities and accounting for overheads led to the creation of costing technique called activity based costing (ABC). ABC was introduced by Kaplan and Cooper (1998) as an alternative, since the traditional cost accounting prevented the managers from understanding, identifying and reacting correctly to the costs that they should be managing (Oseifuah, 2013).

Although modern costing systems are dominated by ABC, there are others, but they work differently. Microcosting (MC) is one of them, but has not been widely used and their success has not been well established (Lievens *et al*., 2015). MC computes the cost in a bottom up approach only; it uses very detailed unit estimates of consumed resources, usually obtained from the time and motion studies. Even though it provides a thorough insight into a well-defined radiotherapy treatment, but due to its precision and focus, it tends to lose the overall picture. ABC on the other side, is well established and it can provide cost in both bottom up approach (approach from unit department based on time data using personnel and equipment) and top down approach (approach done for the overheads by applying the hospital wide overhead proxy by management) (Lievens *et al*., 2015). For this study, ABC using the bottom up approach is essential as radiotherapy cost data is obtained from the radiotherapy department unit, then cascaded into hospital management and then to the policy makers for their decisions.

2.9.1 Activity Based Costing system

What is ABC?

Activity based costing (ABC) is defined as '*An approach to the costing and monitoring of activities which involves tracing resource consumption and costing final outputs. Resources are assigned to activities, and activities to cost objects based on consumption estimates. The latter utilises cost drivers to attach activity costs to outputs.'* CIMA Official Terminology, 2005.

ABC history is traced back just after the World War II, as overhead costs were increasing in different sectors. Since the traditional method could not incorporate overheads costs and they were inaccurate to give the true costs and thus, leading to mispricing or leading to the poor decision (Chapman, 2010). Transaction based method was later remodelled by Kaplan and Porter (1988) to be Activity Based Costing. The main argument from Cooper and Kaplan (1988) in the development of ABC was that almost all firm activities exist to support and enable the production and delivery of products and therefore, should all be considered in the determination of the product costs. ABC identifies all the work activities and the costs that enter into the manufacturing of the product or production of the service. It allocates overhead costs to the product on the basis of the resources consumed by each activity involved in the design, production and distribution of a particular product. This is accomplished through assigning the cost pools that represent specific activities and allocating these costs using appropriate cost drivers to the product (Manalo, 2004). Since this is done step by step per activity, ABC is able to identify areas of high overhead consumption per unit, which may identify value adding or non-value adding activities. Non value adding activities are those that create waste and may result in delays, but adding cost to the product instead of creating value for money. ABC identifies and tries to eliminate those activities and therefore, enhancing the product quality and process simplification and efficiency. Therefore, ABC enables managers to see if the resources were used effectively or wastefully. Since ABC considers all activities an05d overheads that contribute to the cost determination of the product, it is the reason why it is considered more accurate than traditional costing (Manalo, 2004).

2.9.2 ABC Framework

According to Lievens *et al*. (2015), ABC methodology have three classes of entities, which are the resources, activities and cost objects (product or service or treatment) as shown on

Figure 2.6. Whenever an accurate cost per product needs to be calculated, resources are assigned to activities through the "resource drivers". Then consequently, the activities are assigned to objects through "activity drivers", i.e. the number of times an activity is performed. The eventual cost calculation is then done by simply adding up the cost of all assigned activities for each cost object (Hulstaert *et al.*, 2013).

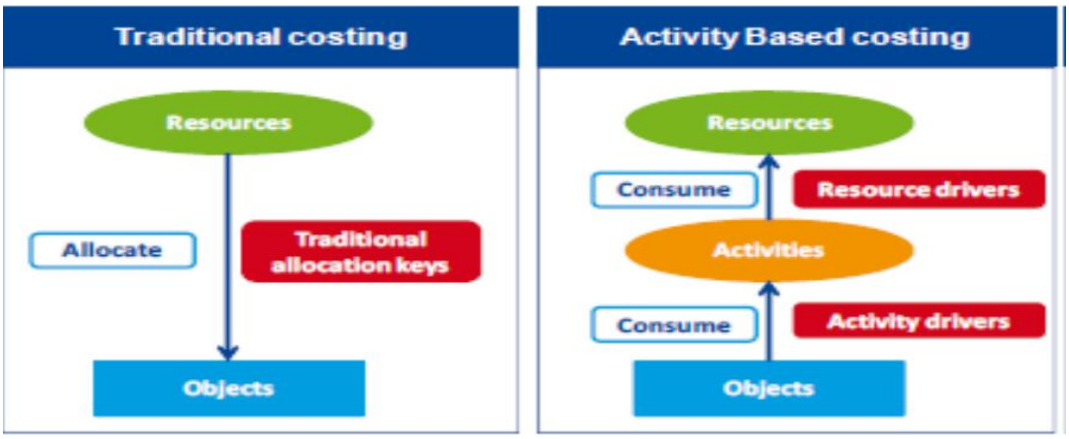

Figure 2.6: Traditional versus Activity Based Costing.

Source: Hulstaert *et al.*(2013, p 9)

The main feature of ABC is that it is a two stage cost accounting technique that assigns overhead cost to services, product or any other cost objects or combination of them. For the first stage, an organisation has to identify significant activities and to assign overhead costs to those activities in accordance with the way the resources are consumed by these activities. For the second stage, those overhead costs assigned to the activities or activity cost pools are assigned to the product, service or any other cost object in proportional to the amount of the cost driver consumed by each of them. Therefore, the cost allocated to the product or service will be in proportion to their consumption of this activity (Gosselin 2007). ABC focuses on the causes behind indirect costs. Indirect costs like utilities, depreciation, rent, indirect labour, are assigned to the costs pools using resource drivers (e.g. rent is assigned using the floor space) (Cardos, 2012).

2.9.3 Advantages of ABC

ABC provides the following advantages:

- ABC provides the accuracy and reliability in product cost determination and it does that by focussing on the cause and effect relationship in the cost occurrences.
- ABC identifies all the work activities and their costs that enter into the manufacturing of the product or production of the service
- ABC is able to recognise the activities which cause costs, not products and it is product which consumes activities.
- ABC system traces costs to areas of managerial responsibility, processes, customers and department, besides the product costs.
- ABC system provides the manager with reliable data from the product cost, for better decision making.
- It considers the overheads to ensure cost accuracy of the product.

2.9.4 Disadvantages of ABC

Like any other cost method, ABC has its own challenges.

- It requires a higher cost and time to implement.
- It requires staffing for the collection of information accurately.
- If data were collected incorrectly, they provide wrong cost information.
- It requires the change in the way of thinking of the employees and managers and therefore, a long assimilation period before the general use within the company (Cardos, 2012)
- ABC requires detailed records of the cost associated with producing, products and services, as compared to traditional methods.

Van de Werf *et al.* (2012) concur with such argument regarding the complexity of ABC calculation program, workload from personnel needed, details needed from costs, activities, products and cost drivers, as well as the time to perform activities. However, Van de Werf *et al*. (2012) emphasised that the accuracy of ABC model improves as more details are available and further elaborated that the model is more complex and costly at the development phase due to time and resource needed, but once it is fully installed, much effort would not be required as experience would be better. To ensure that the model calculates what is expected of it, the model should be checked (updated) annually to consider any changed input parameters (Van de Werf *et al*., 2012).

Cardos (2012) emphasised that the accuracy of ABC in cost determinations, improves when the activities, resource consumption or cost objectives are clearly defined. Rising costs, time consumptions, difficulty in implementation and complexity of the method, were demotivating many organisations until the Time Driven Activity based activity was introduced by Kaplan and Anderson (2004, 2007). It was derived from the original ABC (traditional ABC), but differed mainly in their time estimation technique. While traditional ABC focuses on total work as reference point estimating time (typically in relative units, i.e., percentages); TD-ABC directly refers to the single activities estimating time (typically in absolute units, i.e., minutes and seconds). TDABC can calculate cost per activity, while ABC would need to know the total time to determine the fraction of total time before determining the cost per activity.

Thus, time estimates in traditional ABC (different from TDABC) have to account for the number of times a specific activity has been performed. While the reference point for estimation in traditional ABC is total work time, TDABC directly focuses on the single activities without worrying about the proportionality of time for other activities (Schuhmacher *et al.*, 2013). Schuhmacher *et al*. (2013) and Kaplan and Anderson (2004, 2007) observed that the accuracy of estimates in traditional ABC deteriorates significantly with the amount of times activities are performed. While TDABC provides more details and is more accurate, it accounts for the unused capacity and it is cheaper to adapt and implement than the traditional ABC, Kaplan and Anderson (2004, 2007).

There is still a challenge of applying the ABC in the whole organisation like the hospital as there are many challenges they have to encounter which are beyond this study (Bopesko, 2013). Currently the ABC has been narrowed to the specific department in the healthcare organisations.

For this study, since TDABC is a modified ABC and originated from a similar concept, their use will be interchangeably.

2.9.5 ABC in public sector

Adoption of ABC is relatively little in the public sector in South Africa, only a few municipalities used it, while the private healthcare is starting to use it due to the pressure from Health ministry to justify their pricing (Botha and Vermaak, 2015). A study by Oseifuah (2013) suggested that the financial challenges faced by South Africa in the public

sector can be addressed by ABC, as the traditional method which is in use is inaccurate when there are large numbers of overheads. ABC adoption in the public sector can provide vital information on the costs of providing government services for strategic decisions (Oseifuah, 2013). According to Oseifuah (2013), public sector organisations have the uniqueness that they are overhead intensive service entities and therefore, they are good candidates for the use of ABC costing system. Studies by Oseifuah (2013) indicated that some of the benefits regarding the ABC utilisation were improvement of the insight into the causes of cost, provision of better cost control and cost management, better understanding of the cost reduction opportunities, improvement of managerial decision making, provision of more accurate cost information and pricing for the product or service. With this information ABC can be useful in any public sector to provide policy/ decision makers with valuable information and cost data. Cost information is very significant for decision makers to make well informed choices on how to allocate the limited resources.

2.9.6 Radiotherapy centres using ABC

MD Anderson Cancer in the USA, recognising that TDABC (Modified ABC) is a powerful tool to improve cost, also recognised that it is an accurate costing that allows the impact of process improvement to be readily calculated, validated and compared (Kaplan and Porter, 2011). They took the TDABC for a pilot project to access its feasibility of applying modern cost accounting in healthcare, but specifically in radiotherapy. They used TDABC to check if it would provide any level of accuracy and that project involved clinicians and some financial staff officers. The project started with the creation of case delivery value chain that mapped out the steps involved to complete a radiotherapy treatment, which included the resources required (personnel, equipment and infrastructure). The time taken for each task was estimated and the capacity cost of the healthcare provider was estimated. Their project showed that personnel cost consumes about 75% of the total cost, as the cost was measured per patient, cost per each activity step.

TDABC resulted in 16 % in process time reduction, 12% decrease in cost for technical staff, 67% reduction in costs for professional staff. Thus, a 36 % overall reduction of cost was witnessed without change in clinical outcomes. Although the model was found to be straightforward to implement, it required a significant time investment to develop process maps for all care areas required to complete treatment (Kaplan and Porter, 2011).

Similar results were observed in a radiotherapy project in Hospital Leuven using TDABC, but they also compared the benefits of using shorter number fractions on the new treatment techniques. They were able to calculate the cost of verifying if the new treatment would add any value, and results were in agreements (Hulstaert *et al.*, 2013).

These two projects showed that TDABC can be used successfully in cost determination, but more data are required to affirm this (Copper and Kaplan, 2011). Various authors have faith in the use of ABC to the radiotherapy discipline, as this discipline is complex but predictable process of successive activities delivering multiple treatments (Lievens *et al.*, 2003; Van de Werf *et al*., 2012; Kaplan and Porter, 2011).

McBain *et al*, (2016) has highlighted that the application of TDABC in high income countries has shown some formidable results by yielding significant cost savings. Based on its principle it is able to measure the cost of all the resources used to treat patient medical condition over the treatment cycle of care, and therefore cost and outcome are measured at the patient level. There is still a problem of adoption in low income countries in which it pointed to the lack of standard set of tool to apply this approach, lack of technical expertise and resources, lack or difficulty or time consuming in obtaining required data. McBain *et al*, (2016) further explained that the analysis at the low income setting on TDABC may have a different meaning. Therefore TDABC should be viewed as descriptive rather than prescriptive as short time spent on a patient by the physician in low income countries may be mistaken for efficiency in high income countries while it really means inadequate staff and inadequate resources.

2.9.7 Implementation of ABC in Radiotherapy.

For this research, the bottom up approach is used where cost calculation based on ABC is performed within the radiotherapy department. Object that consumes most resources and wastages can be identified from each and every step of calculation. The term "product" in radiotherapy means a course of treatment, e.g course of IMRT breast treatment. ABC calculated the cost of the product as summated cost of care process activities (simulation, treatment planning, dose verification and dose delivery) and the related resource (equipment, infrastructure and personnel) involved in generating that product.

The first step before the implementation of ABC is the application of the process based on industrial engineering called process mapping, which gives us a clear picture by defining all activities required for patient to complete treatment. It should also identify resources

involved like personnel, equipment, consumable (e.g. mask) and space. This may be presented in the form of flow chart or any other presentable chart. It must identify the personnel that perform each step and then estimate the time spent by each of the resource in each of the activity (Halperin *et al.*, 2012; Kaplan and Porter, 2011). Mapping differs for different care path of the patient due to their different circumstances. Thus, mapping provides in detail, all the steps that the patient has to follow.

The second step based on Cost Accounting is called ABC applications and it uses financial skills to determine the cost of a complete patient's care cycle of radiotherapy. The actual cost calculation model is using ABC, which is based on the concept that activities consume resources to produce a product (Kaplan and Porter, 2011). Treatment delivery is the activity that consumes most resources and this is due to its repeatability nature of activity. Common activities required for complete radiotherapy care were presented on the Figure 2.7. The time spent on each activity will be a cost driver that will be used to assign the resource costs to the product (Van de werf *et al*, 2012).

The 7 major activity-groups and their sub-activities.

First patient contact	Simulation	Delineation	Dose calculation	Treatment delivery	Quality assurance	End of treatment
Status	Simulation	Target delineation	Calculation dosimetrist	Baseline radiotherapy delivery	General at start	Discharge
	CT-simulation	Delineation organs at risk	Calculation physicist	Extra time IMRT	Patient specific IMRT	Tarification
	Contrast	Target delineation stereotaxy	Calculation stereotaxy	Extra time stereotaxy	Patient specific stereotaxy	
	4D-CT scan	Target delineation brachytherapy	Calculation brachytherapy	Extra time gating	Medical supervision plan	
	Mask	Delineation boost volume	Calculation boost dosimetrist	Clinical follow up	Physicist supervision plan	
	Application stereotactic frame	Image fusion	Calculation boost physicist		Off-line portal imaging	
					Online portal imaging	
					Cone beam CT	
					In vivo dosimetry	
					Chart round	

Abbreviations: QA: quality assurance; IMRT: intensity modulated radiation therapy.

Figure 2.7: Illustration of the typical 7 major groups of radiotherapy activities and their sub-activities.

Source: Van de Werf *et al*. (2012, p 150).

"Product" by definition in radiotherapy represents a list of radiation treatments, based on the departmental registration system (Van de Werf *et al*, 2012).

For the determination of the product cost, we need to allocate the resources to the activities and then allocate the activities to the product cost. First we have to understand the resources and its cost in radiotherapy. Resource cost include, equipment, wages, buildings, materials costs and overhead costs expressed in the country's currency (ZAR for South Africa) and their source of data cost is explained by Van de Werf *et al.* (2012).
Activities involved are presented on Figure 2.7, for a specific radiotherapy treatment a specific sub activities will be chosen. When considering activities involved, all supporting activities (not directly linked to treatment) like departmental-supporting activities (care and non-care related), but performed by personnel from other departments e.g. laboratory staff but of which costs are assigned to the department. They are allocated to overheads costs (Van de Werf *et al*., 2012).

Details for the implementation of ABC in a radiotherapy department are well explained step by step by Van de Werf *et al.* (2012). With this, the results will show accurate, detailed and transparent costs, produced for each care process, as well as the costs of all the unused capacity in the system and the solution to minimise costs should be determined (Kaplan and Porter, 2011). These calculated results can be compared to the results obtained from MD Anderson Cancer and Leuven Hospitals who already implemented ABC.
For the existing radiotherapy centres, the cost information obtained from the calculations can also be used to improve capacity in terms of staffing, equipment, facilities and evaluation of the new equipment that need to be acquired and cost control plans.

For new radiotherapy centre requirements, data from GLOBOCAN 2012 will be required to estimate radiotherapy coverage based on number of radiotherapy incidents. GLOBOCAN 2012 takes into consideration the country's population, cancer types and its proportion for the specific country, the mean number of fraction needed for the cancer type. This will determine type of treatments required with associated activities (Ferlay *et al*. 2013; Atul *et al*. 2015). Then ABC is applied to estimate the capacity needed e.g. equipment, personnel, building and infrastructure and subsequently the radiotherapy costs required to provide such services. These determined radiotherapy costs of product will be projected back to the investment framework to determine the amount of investments needed. The investment information will be used by the policy makers or the funders to make informed decisions.

2.10 CHAPTER SUMMARY

This chapter explored the literature review regarding the perceptions of radiotherapy employees on radiotherapy treatment costing. It has provided the theoretical framework comprising crucial elements and when combined with research data, it would assist in addressing the research problem and research question already presented. It probes the different global problems of radiotherapy access, deficiencies of the access and the effect. Then, a radiotherapy treatment costing approach is identified to aid the problem of radiotherapy access. Costing approach using ABC was defined and justified; its advantages and disadvantages were addressed. The implementation of ABC in the radiotherapy department was also presented, as it is important to have an updated, unified, reliable and transparent method of measuring the costs of the hospital and service received from the treatment (McLaughlin *et al*., 2014). Teamwork is also important for such costing to work properly for cost determination, cost control, it improves care quality and the elimination of waste and excess capacity (Kaplan *et al.*, 2013). This would also help policy makers on their views regarding cost, as they can see exactly where the cost is determined and controlled. The perceptions of radiotherapy employees on radiotherapy treatment costing were also highlighted.

The next chapter discusses the research methodology utilised for this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methodology used to complete the study on the *'perceptions of radiotherapy employees on radiotherapy costing in KZNHealth Provincial Hospitals'*. Hence, covered in this chapter are issues related to the research methodology, sampling strategy, the research instruments used and the reasons why they were used, as well as data analysis.

3.2 RESEARCH METHODS AND DESIGNS

There are two main types of research methods used for data collections. They are quantitative and qualitative research method. Quantitative Research is empirical research where the data are in the form of numbers, while the Qualitative Research on the other hand is empirical research where the data is either words, images or objects (Cooper and Schindler, 2006:163). Qualitative studies in comparisons to quantitative studies are suitable in the areas where little research has been done. They are characterised by the subjectivity, richness and comprehensive text based information from the focused group or interview (Hilal and Alabri, 2013). They tend to pursue relationship between categories and themes of data seeking to expose the understanding of the phenomena. The properly use of qualitative data is based on face to face interview, field observation and document analysis which lead to the researcher to gain deeper understanding of the problem (Hilal and Alabri, 2013). Another advantage of the qualitative research methods is that it helps the researcher to expand his/her insights and conceptualisation of issues and dilemmas. It also helps the researcher to explore different ways that have been used to address similar problems (Cooper and Schindler, 2006:164).

Qualitative studies are classified into descriptive, casual and exploratory research (Cooper and Schindler, 2006:163). Descriptive research is usually concerned with describing a population with respect to important variables, while the causal research is a qualitive study in which the major emphasis is on the determination of cause and effect relationship of one variable on another (UNAD, 2014).

This study followed the exploratory approach which is an unstructured research which is more adequate when the research problem is more or less understood as it should be conducted in the best possible way. Its major emphasis is on gaining ideas and insights,

getting information and then construct explanations. It may not be expected to come with final answers, but it is expected to produce hypothesis about what is going on in a situation (Gravetter and Forzano, 2014:20).

The guidelines that direct the process of collecting, organising and analysing data are called research design (Srikanth and Doddamani, 2013). There are 5 common qualitative research designs, namely; Phenomenology, ethnography, case study, grounded theory and historical research (Cooper and Schindler, 2006). Phenomenology research design was utilised for this study because it is an in depth interview that is usually conversational than structured. Its purpose is to identify phenomena through how they are perceived by the participants in a situation. Phenomenology is concerned with the study of knowledge and experience from individuals' perspectives. It is powerful for understanding subjective experience, gaining insights into people's motivations and actions and emphasises the importance of personal perspective and interpretation. Since our study is concerned with individual interpretation and experience from the radiotherapy employees, phenomenology was a suitable technique for this study (Cooper and Schindler, 2006).

The objective of the study was to seek an understanding of the perceptions of radiotherapy employees on costing of radiotherapy services. This study fits well with the qualitative research as the topic is not well researched and deeper understanding is very important, the participants attitude, opinion, beliefs and their individual relationship is of great importance. This was done by interviewing radiotherapy employees from three KZNhealth provincial hospitals providing radiotherapy services.

3.3 LOCATION OF THE STUDY

KZNHealth has three hospitals that are providing the radiotherapy services. These hospitals are located in the two main cities of KwaZulu-Natal province, namely Durban and Pietermaritzburg. There are two hospitals in Durban and one hospital in Pietermaritzburg.

3.4 TARGET POPULATION

Target population refers to the entire group of individuals or objects to which researchers are interested in generalizing the conclusions. Participants in the study were experts in the area of radiotherapy. Selection of the participants was based on their characteristics in

relation to the research topic (Jepsen and Rodwell, 2008). The study population comprised 61 radiotherapy employees from the three hospitals. Greys Hospital in Pietermaritzburg has a total of 18 radiotherapy employees comprising 10 medical doctors, 7 radiotherapists and 1 medical physicist. Addington Hospital has a total of 15 radiotherapy employees comprising 3 medical doctors, 10 radiotherapists and 2 medical physicist, while Inkosi Albert Luthuli Hospital has 28 radiotherapy employees comprising 9 medical doctors, 15 radiotherapists and 4 medical physicists.

3.5 SAMPLING TECHNIQUE

Onwuegbuzie and Collins (2007) defined sampling as the process of selecting a portion, piece or segment that represents the whole. It is an important step in the research processes as it aids to inform the quality of inferences made by the researcher, that stem from the underlying findings. Probability sampling and non-probability sampling are two main sampling methods used in research (Onwuegbuzie and Collins, 2007). Probability sampling was found to be inappropriate for the qualitative studies because the probability sampling of a population is likely to produce a representative sample only if the research characteristics are normally distributed within the population (Marshall, 1996). Non probability sampling may be divided into four approaches. These approaches are judgement (purposive), theoretical, snowballing and convenient. For the purposive sampling, the researcher selects the sample that appears to him/her to be most productive representative of the population to answer the research question. For the theoretical sampling, it involves the process of data collection for generating theory. For Snowballing or word of-mouth techniques make use of participants as referral sources. Convenient –is the least rigorous technique, involving the selection of the most accessible subjects, its least costly to the researcher, in terms of time, effort and money (Marshall, 1996).

Radiotherapy employees involved a total population of 61 from the three KZNHealth provincial hospital. The sampling that suited the study was the convenient, non–probalility sampling, as participants were selected because of their convenient accessibility and proximity to the researcher, as well as their knowledge of the subject under investigation, which in this case is radiotherapy (Onwuegbuzie and Collins, 2007). Since the researcher was based at Greys Hospital at the time of study, this shows why Greys Hospital's participants have a largest proportion (47%) on the sample than other hospitals. A sample

of 32 participants with the mean work experience of 6 years that ranged from 1 to 15 years, were selected to participate in the study.

3.6 SAMPLE SIZE

The researcher must decide on the number of participants and selection of sample members. Onwuegbuzie and Collins (2007) further argued that the size of the sample should be informed primarily by the research objectives, the research questions and the subsequent the research design. Onwuegbuzie & Leech (2007) disputed the common misconception that numbers are not important in the sampling strategy for the qualitative research, yet sample size may prove to be too small, enough or too much to support the claim. So, selecting the appropriate sample size in the qualitative research is a matter of experience and judgement to evaluate the quality of information collected. Morse (2000) also argue that if the studied topic is difficult to grab, this would require more participants than when the topic is clear and obvious. Extensive experience and knowledge of the participants in relation to the topic may require fewer participants to the study. Morse (2000) also highlighted that the number of participants also depends on the research method used. For example, semi-structured interviews with few participants would results in relatively low data, but the richness of data can be obtained if participants were at least 30 to 60.

Since our study is based on semi structured interview with the 32 participants, it satisfies the appropriate sample field size for the qualitative studies.

3.7 RESEARCH INSTRUMENT AND DATA COLLECTION TECHNIQUES

In qualitative studies, research data are collected through the use of open ended questions. The research instrument used is either the interview guide, participant observation, focus group,or other data gathering methods like reflections (Johnson & Christensen, 2008). According to Cooper and Schindler (2006), the interview is the most common source of data in the qualitative studies as:

- it gives the researcher a chance to observe the respondents' reactions and expression in open and free conversation.
- it gives the researcher the chance to interact directly with respondents and build upon discussion as it goes.
- it allows the results from data collected to be easy to understand.

- in-depth interviews based on this method enable the researcher to have a more accurate and clear picture of the respondents' position and attitude because of the open ended questions and freedom of expression from the respondent.
- it allows the collection of information at first hand through observation.

Participants would also get their opportunity to express in their own words, as well as how they feel about the subject being investigated. While the researcher is afforded the opportunity to view the partipants' feelings and to probe deeper into participants, if neccesary. Listening skills from the researcher are required (Cooper and Schindler, 2006).

For this study, data were directly gathered from the participants in all abovementioned locations. Participants were selected based on the radiotherapy employee profession and those but also willing to partcipate. A face to face interview, semi-structured approach with open ended questions were conducted. Using the semi structured approach, the researcher was able to ask the prepared questions, while at the same time being flexible to ask probing questions to get more insights into the subject. The researcher in this study executed his interviewing duties to ensure first hand information. Each interview took almost 15-20 minutes. Questions were the same in each and every participants from each of the selected hospitals to ensure fairness. Interviews were recorded in the note book, fully typed and coded.

3.8 PRE-TESTING

The pretesting detects possible errors within the research instrument and helps to identify obstacles and thus, to increase the reliability and validity of the study. Pre-testing is very important to ensure that the research project does not fail, this may range from checking if questions are ethical, research protocols were followed, relevant concepts, culturally relevant, understandable, attention getting or doable. Pretesting is also important to help check if instruments used are appropriate or too complicated (Hurst *et al.*, 2015).

For this study, there were two individuals with more than 5 years working experience within the departments involved in this study who were pretested to check if the interview questions were not sensitive, complex or understandable. They suggested that the questions are all relevant but just need rewording and made simply to understand. Those participants were excluded in the main study.

3.9 CREDIBILITY, CONSISTENCY, APPLICABILITY AND NEUTRALITY

This exercise is done to evaluate the quality of research if the finding has to be applied practically. Concepts like validity and reliability are meant to ensure soundness of the research, these terms are ussually associated with the quantitative research (Noble and Smith, 2015). However, tests and measures used to establish validity and reliability for the quantiative research cannot be applied to the qualitative research as those two research methods are inherently different in terms of philosophical position and qualitative methods lack statistical information. Such differences have called upon the alternative to be applied for the qualitative. Noble and Smith (2015), offered an alternative test that considers true value (credibility), consistency, neutrality and applicability as a replacement for validity and reliability.

Credibility- has been defined by Noble and Smith (2015) as the validity that recognised that multiple realities exist, the researcher's outline of personal experiences and the point of view can result in methodological bias. For this study, the researcher has experience relative to the research study, but he ensured that the perceptions of participants were captured as they were without filtering to reflect their views and reality. Collected information was recorded in themes and were kept as they were presented to support the researcher's findings and conclusions.

Consistency- Noble and Smith (2015) defined it as the term related to the trustworthiness by which the methods were undertaken and that the researcher's decisions were clear and transparent. It should be in such a way that the independent observer would come to the similar or equivalent findings, thus, showing consistency. The researcher in this study ensured the consistency by following the same style of methodology to all the participants and keeping of the same questions to the participants to maintain consistency and maintain equal interviewing time (attention).

Applicability - Noble and Smith (2015) defined applicability as the consideration that presents the feasibility of transferring the research from one group to another or different settings. Noble and Smith (2015) pointed out that the higher the transferability, the higher the validity of the research study. Similarities of the group increase the transferability. For this study, it was found to be holding as the research was conducted in three different hospitals with the similar practice of radiotherapy. Since the participants provided similar responses, it was found to be applicable.

Neutrality- is very important for both validity and reliability. It is achieved when the credibility, consistency and applicability have been addressed. Lack of researcher's neutrality can lessen the value of the research. This is usually caused by the researcher's personal interest in the study, as the conclusion may have unintended consequences. For this study, transparency was maintained from the study design, data collection, data analysis and findings, thus, making the research study to maintain the credibility and validity. Despite the concerns that the researcher is also a radiotherapy employee and was also interested in the radiotherapy costing research outcomes, he played the independent position and remained transparent to avoid influencing the results. Participants' information was treated fairly and the researcher maintained ethics without distorting the information from the participants.

3.10 DATA ANALYSIS

The main goal of data analysis is to produce convincing discussion and conclusions. Data analysis involves reviewing; categorising, tabulating and recombining evidence to ascertain meaning which is related to the dissertation's initial aim and objective, as well as the research questions and issues (Bhatacherjee, 2012:139). Researchers also have ethical obligations to the scientific community on how data are analysed and reported in their study. Unexpected or negative findings should be fully disclosed, even if they cast some doubt on the research design or the findings (Bhatacherjee, 2012:139). Raw data collected were edited to ensure neatness, accuracy, completeness and consistency with intended questions.

Data collected were related to concepts, opinions, values and behaviours. They may be in a format of structure and unstructured text or audio recording. For this study the deductive approach was used by using the research question to group the data and then look for similarities and differences, such approach was convenient as the resource and time were limited and the qualitative data forms a smaller component of the quantitative data (Nigatu, 2009). Qualitative data is usually rich with comprehensive text based information and its analysis is often vague and time consuming thus needing a special tool for analysis. A computer software data analysis called QSR Nvivo 11 was used to provide deep level of analysis and simply such rich information. The software identified the similarities, extract themes, identify relationship, highlight differences and create generalisation (Hilal and Alabri, 2013).

3.11 ETHICAL CONSIDERATIONS

Prior to institutionalizing this research, authorisation was received from the University of KwaZulu-Natal Research Ethics Committee.The University of KwaZulu Natal respects ethical ways of conducting the research, in order to protect the vulnerables. All correct procedures were followed. Therefore, the researcher obtained ethical clearance from the research office (see appendix D). All the participants were informed of the nature of the study and were asked for their consent to participate in the study, they were also advised that they could withdraw from the study at any given time during the interviews should they wish to do so. They were assured that their names and adresses would not be disclosed for their protection. The identities of the participants were protected. Data were kept in an electronic format on the disk and the computer that required the regularly altered passwords to access. Therefore, data protection and integrity was maintained. Data were kept for five years in order to protect the participants.

3.12 CHAPTER SUMMARY

This chapter presented the research strategies used to collect data. It outlines the research design and methodology, the research instruments used, as well as sampling and sampling techniques. The next chapter describes how such strategies and methods were applied.

CHAPTER 4

PRESENTATION OF RESULTS

4.1 INTRODUCTION

The main goal of data analysis is to produce convincing discussion and conclusions. This chapter presents the results obtained from three hospitals that provide the radiotherapy services in KZNHealth. The data presented here were from the 32 respondents who were employed in the radiotherapy unit, and their results were coded and captured in the NVivo 11 data analysis software. These results were used for descriptive analysis. The chapter thus starts with the demographics of the participants, and then it examines the employees' perceptions on radiotherapy costing, based on individual interviews.

4.2 QUALITATIVE DATA

This section will bring out the overview of the response from the qualitative interviews which was administered to the employees from three of the KZNHealth public hospitals that provide radiotherapy services. The profiles of the participants are presented, followed by the response to the interviews

4.2.1 SAMPLE PROFILE

This section presents the biographical details of the sample. It attempts to present the respondents' demographics in terms of gender, age, nationality, qualifications, employment category and length of service. The employment category consists of radiotherapists, medical doctors and medical physicists as radiotherapy employees from those three public hospitals.

Hospital's Distribution of the respondents

Table 4.1 and Figure 4.1 show how the respondents were distributed across the three hospitals, (46.9%) of the respondents were from Greys hospital (GH), while Addington hospital (ADH) was (25%) and IALCH was (28.1%) of the respondents.

Table 4.1: Distribution of the respondents in three hospitals

Name of organisation	Frequency	Percent	Valid Percent	Cumulative Percent
ADH	8	25.0	25.0	25.0
GH	15	46.9	46.9	71.9
IALCH	9	28.1	28.1	100.0
Total	32	100.0	100.0	

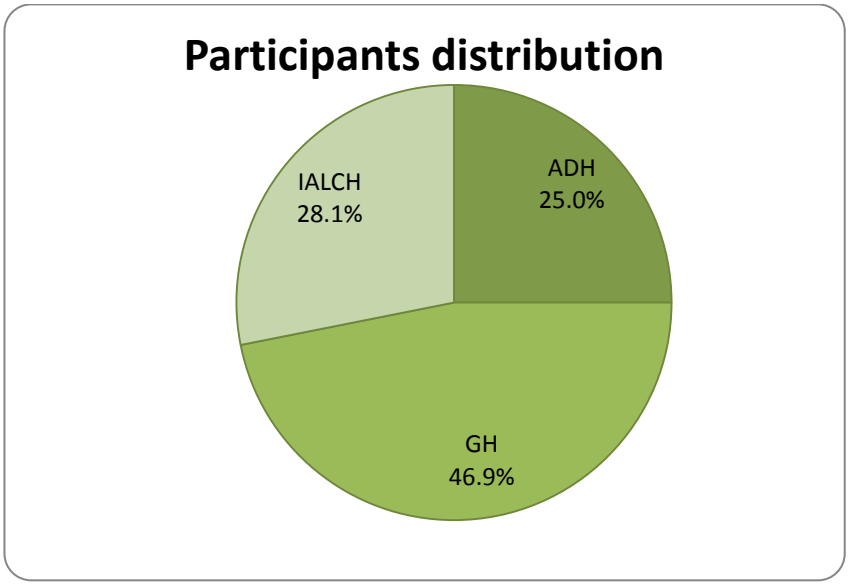

Figure 4.1: Graphical presentation of distribution of the respondents in three hospitals.

Gender distribution of respondents

Table 4.2 shows the equal distribution of gender amongst the respondents, (50%) males and (50%) females.

Table 4.2: Distribution of the respondents according to gender.

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	16	50.0	50.0	50.0
Male	16	50.0	50.0	100.0
Total	32	100.0	100.0	

Distribution of age amongst the respondents

Table 4.3 shows the summary of the age of respondents. Age ranges from 22 to 68 years, with a mean age of 37.4 years.

Table 4.3: The information on the respondents' age in three hospitals

Summary statistics for age	
N	32
Mean	37.3750
Median	35
Mode	30
Std. Deviation	11.4124
Variance	130.2419
Range	46
Minimum	22
Maximum	68
Skewness	1.2093
Std. Error of Skewness	0.4145
Kurtosis	1.4560
Std. Error of Kurtosis	0.8094

Position held by the respondents

Table 4.4 shows the position held by each respondent; it shows the details whether respondents were junior or senior or manager and whether a medical doctor is an ordinary medical officer or the specialist.

Table 4.4: The information of number of positions held by respondents

Position held	Frequency	Percent	Valid Percent	Cumulative Percent
Assistant Manager Physicists	2	6.3	6.3	6.3
Assistant Manager Radiotherapists	2	6.3	6.3	12.5
Chief Radiotherapists	9	28.1	28.1	40.6
Deputy Manager Physicists	3	9.4	9.4	50.0
Medical Officers	5	15.6	15.6	65.6
Medical Physicists	1	3.1	3.1	68.8
Oncologists	2	6.3	6.3	75.0
Radiotherapists	4	12.5	12.5	87.5
Registrars	2	6.3	6.3	93.8
Senior Radiotherapists	2	6.3	6.3	100.0
Total	32	100.0	100.0	

Job category of the respondents

Table 4.5 has grouped position held already presented in Table 4.4 into the job category as level of position is not important. Radiotherapists are presented as majority job category with (53.13 %) of the respondents, while the medical physicists were the smallest job category at (18.75%) and the medical doctors in the middle at (28.13%)

Table 4.5: Job category of respondents' age

Job Category	n	%
Radiotherapists	17	53.1
Medical Doctors	9	28.1
Medical Physicists	6	18.8
Total	32	100.00

Figure 4.2 shows how the job category is distributed using the graphical presentation. Radiotherapists are majority at (53.1%), medical doctors at (28.1%) while the medical physicists are at (18.8%)

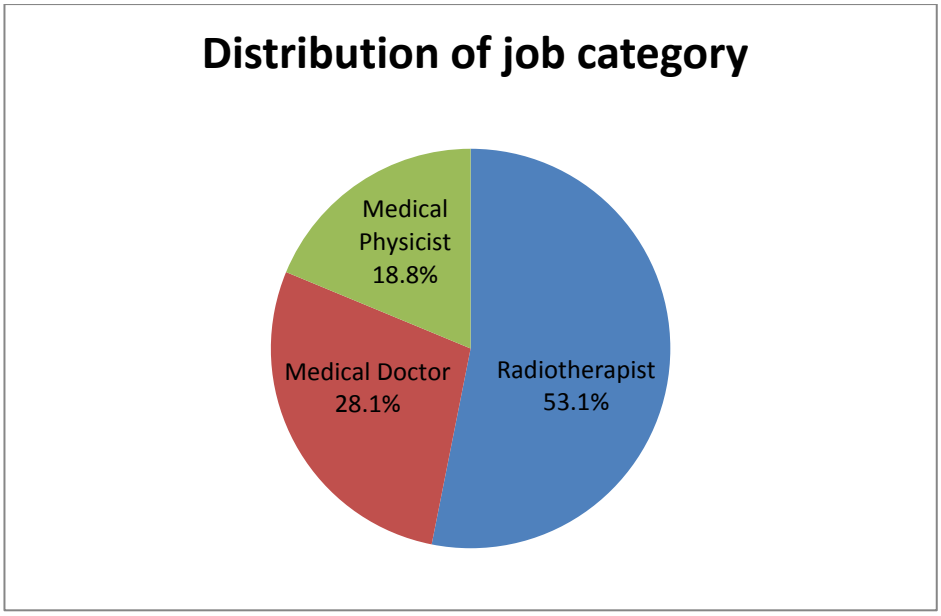

Figure 4.2: Graphical illustration of job category for the respondents, (n=32)

Respondents' years of service in their positions

Table 4.6 shows the years that the respondents have been in their positions. 3-years is the most frequent, with the percentage of (21.9%)

Table 4.6: Frequency distribution of the positions held by the respondents

Years	Frequency	Percent	Valid Percent	Cumulative Percent
1	3	9.4	9.4	9.4
2	4	12.5	12.5	21.9
3	7	21.9	21.9	43.8
4	3	9.4	9.4	53.1
5	1	3.1	3.1	56.3
6	3	9.4	9.4	65.6
7	1	3.1	3.1	68.8
8	2	6.3	6.3	75.0
10	6	18.8	18.8	93.8
12	1	3.1	3.1	96.9
15	1	3.1	3.1	100.0
Total	32	100.0	100.0	

Table 4.7 shows the analysis of the years the respondents have been in their position. 3-years is the most frequent period, with the (21.9%) mean years of holding the position is 5.53 years.

Table 4.7: The analysis of the year a position held by the respondents

How long position held for?	
N	32
Mean	5.5313
Median	4
Mode	3
Std. Deviation	3.7242
Variance	13.8700
Std. Error of Skewness	0.4145
Kurtosis	-0.3724
Std. Error of Kurtosis	0.8094
Range	14
Minimum	1
Maximum	15

Educational levels of the respondents

Table 4.8 shows that the BTech is the most frequent qualification, at (37.5%) and the less frequent qualifications are Honours and MSc at (3.1%).

Table 4.8: Most frequent qualifications.

Educational level	Frequency	Percent	Valid Percent	CumulativePercent
BTech	12	37.5	37.5	37.5
Diploma	3	9.4	9.4	46.9
Honours	1	3.1	3.1	50.0
Masters	4	12.5	12.5	62.5
MBChB	7	21.9	21.9	84.4
MMed	2	6.3	6.3	90.6
MSc	1	3.1	3.1	93.8
Nat Diploma	2	6.3	6.3	100.0
Total	32	100.0	100.0	

4.2.1.1 Summary of sample profiles

A total of 32 respondents were interviewed in this study. (46.9%) of the respondents were from Greys Hospital (GH) and (25.0%) from Addington hospital (ADH) and (28.1%) from Inkosi Albert Luthuli Central Hospital (IALCH). Both genders enjoyed equal representation in the study. The average age of the interviewees was 37 years, with the eldest being 68 years old and the youngest being 22 years old. Most of the interviewees were Radiotherapists (53.1%), followed by Medical Doctors (28.1%) and Medical Physicists (18.8%). The average number of years that positions were held for was approximately 6 years, with the most experienced in their position having held them for 15 years. In terms of qualifications, most interviewees had BTech degrees (37.5%) followed by Medical degrees (21.9%) and diplomas (15.7%).

4.2.2 RADIOTHERAPY EMPLOYEES' INTERVIEW

This section brings out the overview of the responses from the qualitative interview which was administered to the employees at the three KZNHealth hospitals.

Objective 1: To explore the radiotherapy employees' perceptions on the quality of radiotherapy services they provide to patients.

This section introduces the element of patient management, which explores the perceptions of the radiotherapy employees on patient access to radiotherapy, as well as service delivery to patients.

Quality of radiotherapy service to patients and challenges

All 32 respondents felt that the quality of radiotherapy service at their institutions were at acceptable levels. However, interviewees felt that there were areas that needed improvement to enhance the quality and standard of the service offered to patients.
This is what some of the interviewees had to say:

"The waiting list is long and the process from diagnosis to treatment is also long. Waiting time needs reduction."

"More training is required, minimize communication barrier with patients and improve on

service delivery and minimization of waiting time."

"Machines are required, considering the number of patients, more staff posts and more lodger facilities, improve budget allocation to reduce waiting time."

"Long waiting really affects the cancer management."

"Waiting list is long; regime of treatment is forced to change from radical to palliative."

"Waiting is too long, 4-6 weeks breaks between surgery and radiotherapy."

"More machines and staff are needed to meet the number of patients to reduce waiting."

"Required improvement in employees, equipment, training of staff, staff accommodation to minimize waiting"

A breakdown of their suggestions is depicted in the Figure 4.3.

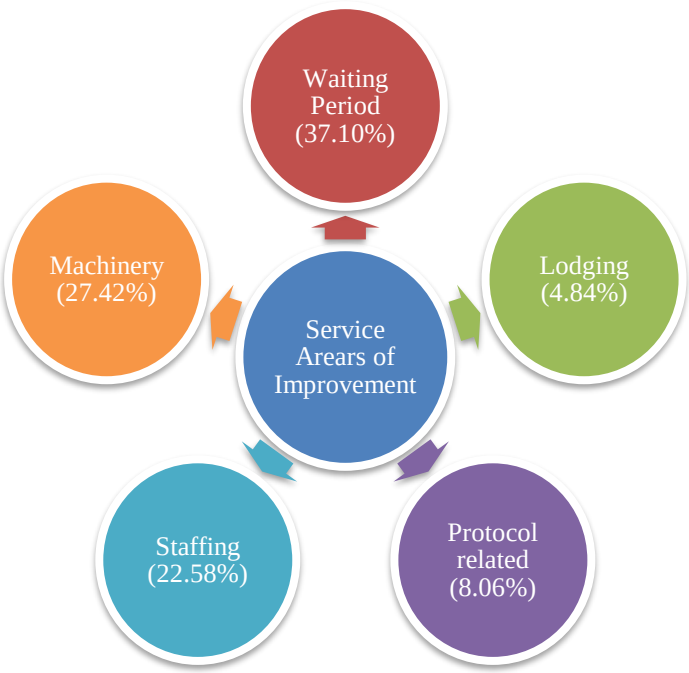

Figure 4.3: Suggestions to improve radiotherapy service

As illustrated in Figure 4.3, the interviewees highlighted patient waiting period as one of the most important areas that needed improvement. They indicated that patient waiting time was too long. Waiting included time lags from diagnosis to therapy and from surgery to therapy. This affected cancer management, often forcing treatment changes from radical to palliative. Suggested improvements included employing and training more staff, purchasing more equipment.

Machinery and staffing were highlighted as the second and third most important areas of improvement respectively. It was suggested that more and newer equipment be purchased to improve the quality of results, reduce patient waiting times and to cope with the number of patients requiring radiotherapy. The interviewees also felt that they were understaffed and therefore, could not handle the patient load. In order to remedy the situation, they proposed that more departmental posts be created and advertised to attract the right people to help improve the radiotherapy services to patients.

Waiting list and radiotherapy access.

All 32 interviewees were aware of the challenges faced with access to radiotherapy. As seen in Figure 4.4, the most challenges revolved around resource limitations. Logistical challenges were also highlighted as hurdles to access to radiotherapy services.

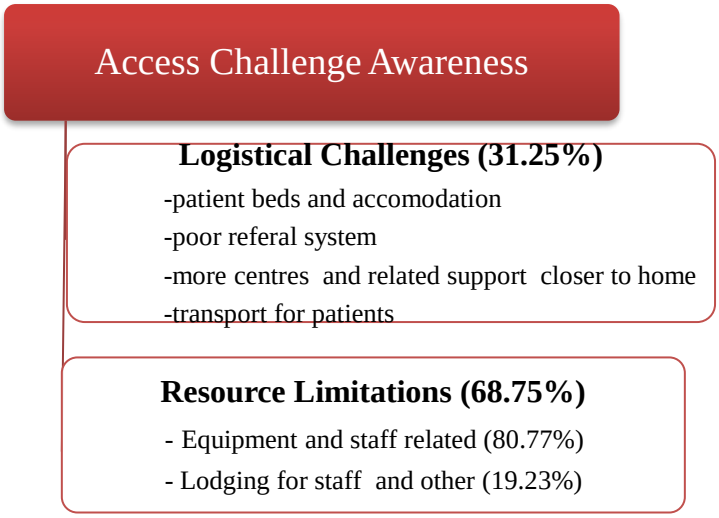

Figure 4.4: Awareness of challenges with access to radiotherapy services

Equipment and staff dynamics featured as the top limiting factors to radiotherapy access and the resulting backlog. Here, slightly over (80%) of the responses within this category indicated that this was a major area of concern and needed to be improved upon. Logistical challenges were presented (31.25%) of the time as a cause preventing the smooth access to radiotherapy. Logistical challenges ranged from poor referral systems, the development of more centres and related support close to home, accommodation and transportation for patients from rural areas and the poor resources (e.g. staff and equipment) to patient ratio (poor capacity). Of major concern to many of the interviewees in this theme was bed space to accommodate patients travelling from afar.

Resource limitations featured as a major focus area that needed improvement. Resource limitations included being understaffed, lack of equipment, lack of infrastructure and poor capacity of the existing infrastructure, as well as the lack of management involvement.
A solution proposed by one of the interviewees was *"This may be improved by workshops and seminars around radiotherapy to other departments to improve knowledge. Improve referral system, from other hospitals as well as its impact on disease progression."*

It was also felt that there were presently not enough centres in KwaZulu-Natal to facilitate access to radiotherapy. As one interviewee puts it *"More centres [are] needed in KZN for all regions, not only the three urban centres"* and *"More staff, equipment and infrastructure [are] needed, patient wards, CT Scanners and step down facilities."* This sentiment was shared by other interviewees. To quote a few:

"Suggest two more centres, south coast and north coast, with staffing even if planning can be centralised."

"...for improvement staffing, equipment, infrastructure and improvement in evenly distributing the radiotherapy centres."

Other solutions to improve access ranged from implementing shift work and overtime to staff in order to reduce the backlog and to reduce the access to the therapy waiting period. In the words of one of the interviewees *"...creative solutions like shift [work] and overtime with reasonable incentives. This would be required from management".* Yet another interviewee also felt the same, saying that *"Overtime can be used as an interim to reduce*

backlog". Apart from the staffing concerns, one interviewee felt that staff attitudes needed some adjustments in order to make the system run efficiently. In their words *"Staff must improve passion for work".*

In order to improve the referral system, it was suggested that open communication, co-operation and teamwork among relevant stakeholders be instituted. This could be achieved through, for example, awareness campaigns. As put by one interviewee *"PHC practitioners, nurses and district need more awareness and basic communication on oncology. This can improve the referral system and can avoid patient unacceptable disease progression that forces radical to be palliative"*.

Recognitions of radiotherapy's benefits by patients.

All the respondents felt that patients receiving radiotherapy recognised its benefit(s). However, some interviewees raised concerns about patient attitudes and perceptions of / or towards the therapy that they were receiving. Slightly over 21% of concerns raised centred on patients "going through the motions" as it was evident that some patients had already given up the fight and / or were despondent. The vast majority of interviewees (78.57%) felt that the patients did not really understand the purpose and logic of radiotherapy, despite some form of explanation being given to them. To highlight a few interviewees' comments:

"..But they seem to not understanding the treatment as they believe whatever the doctor says, presuming the doctor is never wrong."

"They don't tend to question the doctor but take as they are told. This may be due to socio economic challenges."

"...but a lot are illiterate and don't believe in radiotherapy, but on traditional methods. Education programs are needed also to tell them that its curable if treated in early, life can be prolonged for late cancers."

"...but they need more education"

"...but they also lack understanding"

"...they are sometimes limited by literacy"

"...but the literate understands better"

"...sometimes some patients overestimate the expectation, this might mean they are not well informed."

"...but also, most don't comprehend, despite explanation about radiotherapy. Seems they need education to improve awareness."

Objective 2: To explore the radiotherapy employees' perceptions on the staffing capacity and staffing recognitions by KZNHealth.

This section explores the perceptions of the core radiotherapy staff, with respect to staffing recognitions by the KZNHealth department. This section is meant to approach the staffing problems and challenges.

Profession recognitions by the Health Department.

The interviewees that felt that the Department of Health did not recognise their professions, stated that they were not recognised as medical physicists, radiotherapists and oncology medical doctors. They also felt that the Health Department did not view their profession as an essential service. Part of the belief among some interviewees was the Department's attitude towards the service that they offered, namely a service to patients that are going to die anyway. This is what one interviewee had to say:

"They don't recognise the profession and radiotherapy, otherwise the budget would be improved. They [are] not familiar with [the] oncologist profession and they think they don't work. They believe patients will die anyway."

Of the interviewees that were not really convinced of the KZNHealth Department's recognition of their profession, the consensus view from radiotherapists, medical physicists and oncology medical doctors was that their work was not viewed as an essential service

and that other doctors and nursing staff from other departments were prioritised. The argument that rose was that if the KZNHealth Department did recognise their profession, then radiotherapy department would not experience the resource shortages that they were currently experiencing, otherwise the budget would be allocated to the profession accordingly. Restated, interviewees felt that there was a directly proportionate relationship between the KZNHealth Department's recognition of their profession and the resources allocated to them. To quote some interviewee responses:

"Not exactly, they don't treat the radiotherapist as essentials. They don't know therapist's role, including the radiotherapy equipment"

"...not well recognised, they can't define what the physicist is doing. They think we are not important"

"...recognised but not treated as essential service, otherwise we won't be struggling on staffing, equipment and accommodation.

"...not well recognised as radiotherapist are overshadowed by diagnostic radiographers. They easily freeze a radiotherapist's post, unlike doctors, therefore not taken as essential service."

"They don't really recognise the oncology doctors; they need more knowledge about the profession. They seem not to prioritize them; if they do they will see the need to increase the staff equipment and infrastructure."

"Staffing level shows that the recognition for us (radiotherapy employees) is poor."

As can be seen in Figure 4.5, less than half of the interviewees felt that the Department of Health recognised their profession. This is evidenced by only 14 (44%) of the respondents clearly indicated that they felt that the department recognised their profession, while (22%) felt that their profession was not acknowledged by the Health Department, while the remaining (34%) of the respondents felt that the Department's recognition of their profession was not up to the standard that they envisioned.

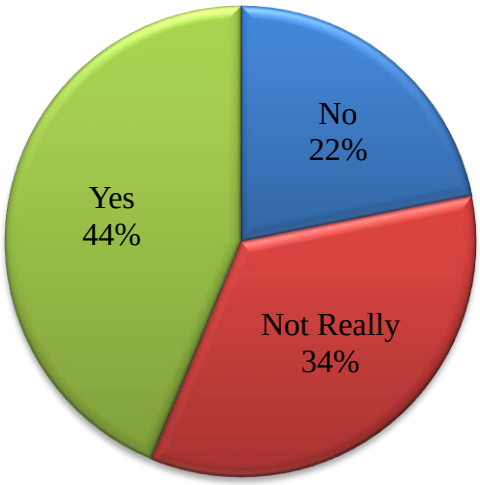

Figure 4.5: Recognition of profession by Health Department

Radiotherapy expectations for recognition of their professions.

In response to the expectations that the interviewees had from the Health Department as forms of recognition, three main themes emerged, namely "staff development and compensation", "recognition of the profession" and "involvement and being heard" (see Figure 4.6). Of the 17 interviewees that offered solutions, 47.06% of their responses related to developing staff and to remunerating them satisfactorily. Suggested staff development took the form of study bursaries and training. Compensation translated almost exclusively to remuneration and included better salaries, annual bonuses and performance bonuses. Interviewees also felt that the risks involved in performing their duties should also be factored in and appropriate danger compensation made. Typical risks mentioned included radiation and emotional risk. Interviewee responses in this regard include:

"...better salary and 1% performance bonus"

"...pay progression and EPMDS can be considered as recognition"

"Bursaries needed [and] equipment needed, salary improvements and staffing"

"...danger allowance is needed [for e.g. radiation risk]"

"...salary needs improvement, emotionality of the job need to be considered."

"...salary and work environment need improvement."

"...being registered with HPCSA, better salary and 1% performance bonus"

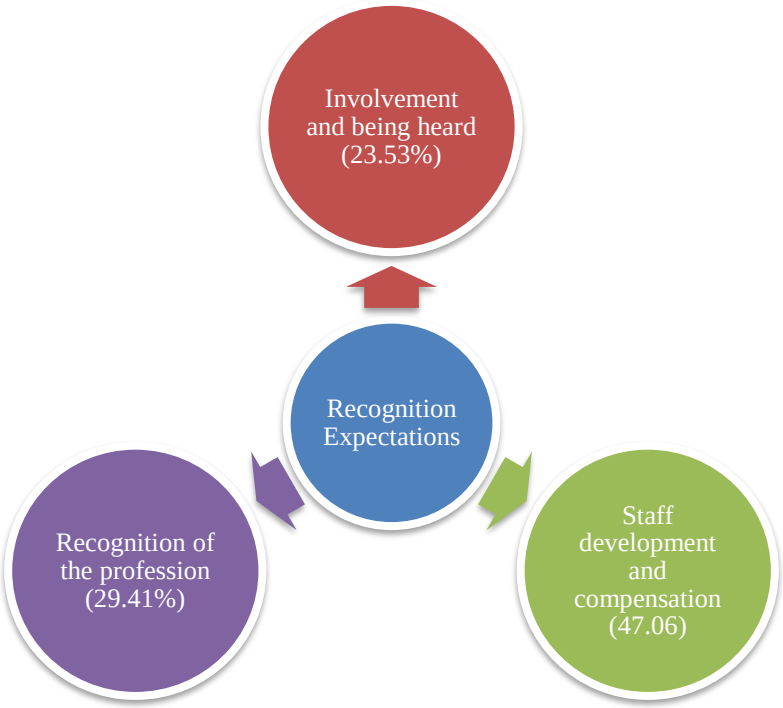

Figure 4.6: Expectations of recognition from the Health Department

Current overstaffing and understaffing, as well as their effects on staff and service delivery.

The vast majority of the interviewees were very dissatisfied with the current level of staffing. Specifically, (84%) of them felt that they were understaffed and the remaining (16%) felt satisfied with staffing. Satisfied staff members, however, felt that staffing was "tight" in that they were given just enough staff to execute their day-to-day operations. This posed a challenge for them in that there was not much flexibility to accommodate the staff going on leave. A few of their comments included:

"..staff is adequate for physicist, but too tight, problem starts when one takes leave."

"..Staffing is adequate, but when one of the staff takes leave problem starts."

"...adequately staffed, satisfied, no effect to staff except when one is a leave."

"...as doctors, staff is adequate but too tight, and leave is a problem..."

Dissatisfied staff mostly felt that they were very understaffed and overworked. This demotivated the employees and negatively impacted on their health. As a consequence, staff would take sick leave due to stress, adding additional pressure to the already

overworked radiotherapy team. This also filtered down to the quality of service that they gave to their patients. Most of the respondents felt that there was not enough time to spend with patients to enhance their therapy experience. Some of their views are as follows:

"We are understaffed, [therefore] unable to provide best service; we are overloaded with work, not enough time to [provide] necessary attention to patients. No time to learn."

"...understaffed, patient care is affected, No time to give patients attention (well being of patient). Production driven than quality. Strain lead to exhaustion, leading to sick leaves."

"...understaffed, substandard treatment, demotivating to staff and leads to overworking."

"...understaffed, not enough staff to cover clinics. Unable to take leave, always on call. Clinics always busy with increased patient numbers. Overworking and over thinking is part of work, come to work even when you sick."

"...understaffed, this affects you personally at a physical level, put high strain and there is no time to break. Limited time for patient attention"

"...understaffed, not satisfying. Too many sick leaves, causes strain and unable to take the leave when you want."

"...understaffed, overworked, unable to take breaks and strained to a perform work ethically."

"... You end up being overworked. It is stressful and tiring. This leads to poor service to patients, errors and mistakes."

"We are overworked, [therefore] unable to take leave easily. Unable to give attention to patients and time is limited."

"...not satisfied, understaffed, we can only do so much, patients cannot always get what is expected due to understaffing, we are frustrated due to limited staff and thus affecting the quality of treatment, it's worse when the machine is down."

Objective 3: To explore the radiotherapy employees' perceptions on the management of radiotherapy equipment and infrastructure.

This section explores the employees' perspectives on the managing, maintenance and cost related matters for radiotherapy equipment and infrastructure

Maintenance standards for radiotherapy equipment and infrastructure

All 32 interviewees agreed that the radiotherapy equipment and infrastructure needed to be treated with care. This was mainly because this equipment was very expensive and needed to be kept at optimal functioning levels to produce the quality results needed for patient care. In the long term, treating radiotherapy equipment with care also amounted to cost savings as the life of the equipment would be extended. Interviewees also felt that treating equipment with care also affected patient waiting times, particularly with time loss due to the repair and replacement of faulty or broken machinery.

Apart from the fact that maintenance affects the quality of radiotherapy treatment to be obtained from optimally functioning machinery, patient and staff safety is also confidentially assured. This brought to the fore the importance of QA reports (e.g. for the detection of inconsistencies), regular maintenance and speedy repair (in the case of breakages). In order to use the machinery properly, interviewees felt that employees needed to be trained to use it properly. This highlighted the importance of having protocols and procedure in place on how to use the radiotherapy equipment. Below is the list of what the interviewees had to say:

> *"Yes, it's required for equipment and infrastructure to last longer, keep functioning properly, international standard of QA must be followed."*

> *"Yes, for proper functionality of equipment. Acceptable standard of care, avoiding unnecessary treatment gaps, QA important to address problems and implement solutions."*

> *"Yes, care important since there is a problem in government financial constraints. To avoid long waiting for fixing of the machine that could jeopardise patient treatment."*

> *"Yes, machines should be cared for to ensure its working properly and safe from radiation exposure."*

"Expensive equipment, radiation safety should be ensured, maintenance must be done all the times."

"Yes, maintenance for equipment is important to last longer. Our equipment is valuable assets."

"If we don't care, the cost of maintenance and repair will be higher. Prolong the life of equipment."

"Yes, they avoid major breakdown and unnecessary radiation exposure. It ensures the consistency and reliability of the equipment."

"Yes, cost saving leads to service delivery that is not compromised, machine will not be down too much. Protocols of use and treatment techniques should be followed all the time."

Do you think radiotherapy equipment costs are justified / evidence of value adding is required?

There was a tight split between interviewees who felt that costs spent on radiotherapy equipment were justified and those who did not. The two stances differed by only 1 interviewee with 16 (50%) feeling that costs were justified and 15 (46.88%) feeling that they were not justifiable (see Figure 4.7). The remaining respondents were not really convinced that the costs were justifiable, but did not take a proper stance in this regard.

Most often, interviewees who thought that the costs were justified based their motivation on the positive correlation between higher costs and improved value adding. More specifically, they felt that the equipment added value to their work and hence, the justification for paying more for them. In addition, the equipment was high-end on the technology scale and returned its investment in performance. One interviewee summed this up by saying:

"Justified when considering the 15 years of use and good results on patients and [the] mentality applied in designing it, and [the] lack of economies of scale. Higher cost of equipment equals improved value adding."

In similar sentiments, another interviewee said

"Yes, justified. They do good work and are hi-tech. Many patients treated over ten with one machine. The higher the cost of equipment the better the value added".

Interviewees who felt that the costs were not justified based part of their decision on the price of these highly technical and specialised machines being dictated by a monopoly. This meant that buyers were price takers and had no bargaining power to bid the price of the equipment down. Interviewees generally felt that the equipment was unreasonably expensive. Some felt that the costs spent on the equipment did not equate the value that they expected of them. Expected value, as mentioned by an interviewee, should be *"...increased speed, images and more advanced technology".* In addition, the frequent breakdowns experienced with the equipment brought into dispute whether the equipment was value for money. This is what two interviewees had to say on this issue:

"Sometimes machine keeps on breaking. At such cost paid, efficiency is expected"

"Breakdown is not acceptable for an expensive machine."

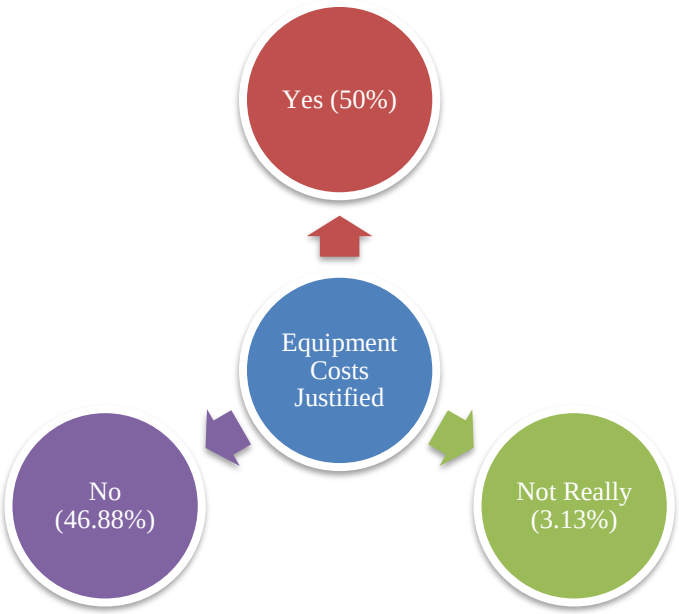

Figure 4.7: Radiotherapy equipment costs justified

Objective 4: To explore the radiotherapy employees' perceptions on the cost management and the need for costing within the radiotherapy department.

This section examines the attitude of radiotherapy employees with respect to cost saving, cost awareness and responsibility.

Do you think cost saving exercise when treating patients is everybody's responsibility, or it should be limited to radiotherapy managers within the radiotherapy department?

All 32 interviewees felt that it was everybody's responsibility to cut down on costs when treating patients. A strong emphasis was placed on teamwork and individual responsibility to help reduce costs, saving money, which could then be diverted towards reducing identified service problems such as lodgings for patients and staffing challenges. Apart from this, there was no real observable trend between the responses of the interviewees. In other words, all the interviewees were of a similar mind when it came to cost savings. Below are a few quotations from the interviewees:

"Everyone [responsibility], as radiotherapy is a high cost department. Saving exercises will convince management to acquire more equipment for optimal service. It shows responsibility.

"Equipment must be used efficiently and effectively."

"Everybody [responsibility], as it really affects our budget and finances."

"Everyone [responsibility], we should work together (responsibility should start from referral doctor up to radiotherapy treatment and follow up)."

"Everybody [responsibility], as saving can make money available for accommodation, staff, equipment and infrastructure."

Do you think measures are required to identify and minimize radiotherapy cost and wastage (e.g. time, duplications, treatment steps that don't add value)

In reviewing the responses of the 32 interviewees, most of their responses seemed somewhat generic without any real theme emerging. Nonetheless, all 32 interviewees thought that measures were required to identify and minimize cost and wastage. This was viewed as important in that saved costs could be used for expansion and to ensure that more patients received radiotherapy. In addition, time saved in having a smoother or more

efficient radiotherapy offering could be used to attend to more patients. This would ensure that the waiting lists and backlogs were reduced. It was suggested that proper information management systems, protocols and monitoring systems be implemented and utilised to minimise wastage.

However, there sometimes seemed to be a conflict between the need for minimising wastage and the means of attaining this. For instance, in order to improve efficiency (i.e. reduce or eradicate wastage) interviewees often offered suggestions that involved increasing costs in one form or another. Typical suggestions included hiring more staff, investing in research to identify areas of improvement, introducing dose fractionation techniques like hypo-fractionation, staff training and auditing. In the long term, however, such measures could save time and reduce costs, thereby benefitting the radiotherapy department and most importantly, the patients. A few interview responses are listed below:

"Yes, very important to help saving cost."

"Yes definitely, measures required as saving can be used for expansion."

"Yes, once proper monitoring of saving and minimizing wastage, more patients can access radiation. In addition, lunches must be decreased; radiobiological calculations like hypo-fractionation are needed."

"Large volumes of patients are treated, ensuring the cost saving more patients can be treated, and saving time means more access to other patients."
"Yes, policies need to be drawn and protocol for step by step treatment. Information management system should [be] improved via proper training of admin staff. Radiation safety workshop required amongst the staff.

"Yes, checking each other as part of teamwork and QA. Having monitoring systems, like recording, may help in managing costs."

Do you think managing cost and minimizing wastage can increase the patient access to radiotherapy?

All the interviewees agreed that the management of costs and the minimising of wastage would definitely increase patient access to radiotherapy. Cost savings, it was thought, would release more money to employ more staff and to buy more equipment (or more high-tech equipment). Consequently, these would help to reduce patient waiting, freeing more access for other patients to receive therapy. Some of the interviewee responses follow:

"Yes, definitely, access will increase as more money can be realised and human resource and equipment can be improved."

"Yes, definitely. More access will improve as saved cost can be employed in buying more equipment, and more staff. Acquiring of advanced technology that saves lives.
Intelligent buying is required, e.g. buying of reusable mask is very important."

"Yes, time saving and cost saving will allow more patient access."

"Yes, this plays a big role to reduce the waiting list and access to radiotherapy."

"Yes, it will definitely improve. Government will not complain and more patients will be treated."

"Yes, money can be saved from wastages and be channelled to extra staff and public awareness and equipment."

"Yes, definitely more patients can be treated and workflow will improve."

Do you think hospital management are well aware about radiotherapy problems and radiotherapy treatment cost?

Almost (72%) of the interviewees felt that management was aware of the challenges of radiotherapy and its associated costs. Almost (15%) of interviewees thought that management was only partially aware, while the remaining (12.5%) were unsure whether management was aware. This is illustrated on Figure 4.8 below. Most interviewees (across the three levels of responses) pointed out that management's level of awareness was mostly confined to the cost aspects of treatment and fell short of being aware of the

challenges associated with radiotherapy. Interviewees felt strongly that management needed more information on operations to have a holistic view of therapy challenges. A proposed solution was that management get more involved through departmental visits. It was also felt that management did its best, given its multi-tasking roles (e.g. managing many departments) and the red tape that they had to overcome in order to meet present and arising challenges.

In their words of the interviewees:
"Yes, they are aware, but they lack sense of urgency, due to multiple departments they are managing within institution. They require more information on radiotherapy."

"Yes, but they don't understand the full details, information is required."

"Yes they are aware, but not on problems. They need a proper departmental visit. They must be aware that due [to} fractional treatments patient come several times for treatment, not once off. Information is required by management to be better informed"

"Yes, they aware, red tapes need to be minimized for hospital management to provide the solution. Management looks at things superficially and don't get involved with operational. They lack information."

"They need to get more involved. They need more information"

"They are aware of the expensive and sophisticated department, but they are unable to meet their demands. They need more information."

"Yes they are aware, but they are not sole provider as their hands are tight. They need to wait for head office approvals. More information is needed for them to understand radiotherapy costs."

"Yes, they respond well, as equipment has been bought. However, they need more information to understand department well."

"Yes, they are aware, as they are always on the negative side of the news. They need to get more involved. They need more information".

"They are aware as they try their best but their hands are tied. More information may be helpful to manage the complexity of radiotherapy."

Figure 4.8: Management's level of awareness of radiotherapy challenges and treatment costs

4.3 CHAPTER SUMMARY

This chapter presented the results obtained from the semi-structured interviews of the radiotherapy employees. Demographics of the participants were covered e.g. age, gender, qualification, employment category, years of service category, and length of service. It also provided the analysis of the qualitative research on the employees' responses to the interviews. Results were presented in a text, graphical and theme form. The next chapter (Chapter Five) presents the discussion of the findings presented in Chapter Four.

CHAPTER 5

DISCUSSIONS OF FINDINGS

5.1 INTRODUCTION

This chapter provides a formal discussion of the research findings obtained from this study. The researcher draws inferences from the collected data. The results will then be explained and interpreted according to the objectives of the study.

5.2 RESEARCH OBJECTIVES AND FINDINGS

The primary objectives of this study were to explore the perceptions of radiotherapy employees on radiotherapy costing. The approach was to follow these objectives logically by first identifying the problems within the radiotherapy departments in KZNHealth, then explored if the costing can be used to solve these problems and thus improving the patients' access to radiotherapy.

Literature review was performed to gather much needed information regarding the radiotherapy access challenges to the patients. Literature review was used to provide an understanding of the elements that should be explored to improve patient access to radiotherapy within the Department of Health in KZN, as suggested by various authors. Since various authors suggested that costing can be used to improve patients radiotherapy access, they believe that costing can be useful in staffing challenges, equipment challenges, operational challenges as well as a gateway towards the investments in radiotherapy as it enables us to determine the accurate cost that can be presented to policy makers. This has been boosted by the fact that with latest developments in radiotherapy, most cancers are treatable thus motivating for more investments into radiotherapy to improve the patient access.

Therefore, the main objective of the study is the exploration of radiotherapy employees' perceptions on the need for radiotherapy costing. The discussion of the results of the study addresses the overall objectives and analyses the responses from the respondents.

5.2.1 Objective 1: To explore the radiotherapy employees' perceptions on the quality of radiotherapy services they provide to patients.

Findings showed that all the respondents from all three centres believed the quality of radiotherapy is acceptable, but they pointed out that there are areas that still need improvements. Most pointed areas shown in Figure 4.3 include high rates of waiting time (37.10%), machinery and equipment needed (27.42%), need for staffing (22.58%), protocol and procedures (8.06%) and patient lodging (4.84%). Most of these pointed areas are interlinked. Lee *et al.* (2010) described that waiting time as an important indicator of radiotherapy quality services. Gospodarowicz (2014), in agreement with Lee *et al.* (2010), described waiting time as a sign of patient access problem, but explained that patient access is caused by the unavailability or limited number of equipment resources, lack of trained health professionals and substantial financial constraints. Rosenblatt (2014) and Lee *et al*. (2010) also agreed that waiting times have shown the inability of healthcare system to provide the intended outcomes and thus, causing a public health and political crisis. From the respondents' results, the high rate of waiting time results from the lack of staffing, machinery and equipment, procedural protocols and patient lodging respectively, and therefore according to them, when these are sorted, the waiting time and patient access would be improved. A study done by Rosenblatt (2014) recommended that the waiting time should not be more than two weeks for the acceptable outcomes. Currently, Addington Hospital waiting time is up to 9 months, Greys Hospital is up to 12 months and Inkosi Albert Luthuli Central Hospital is up to 6 months.

All respondents were aware of the waiting list and its relationship to patient access, due to limited resources as shown in Figure 4.4. *Resource limitation challenge* involved the equipment, staff related matters and lodging for staff (68.75%) and *logistical challenges* involved poor referral system, accommodation for patients/ bed allocation and poor transport system for rural patients (31.25%). This agrees with argument presented by (Atun *et al*, 2015; Gospodorowicz, 2014; Datta, 2014; Lievens *et al*., 2003; Werf, 2012) that staff, equipment, building and facilities are major components of radiotherapy and they have a challenge of the major cost and must be placed at the core investment on the investment framework of radiation oncology. Therefore, limited resource components needed urgent attention than logistics to ensure high quality of cancer management.

Expansion of new and current centres for the limited resources were suggested by the respondents to expand the services as only three centres with a total of 6 treatment machines concentrated in the two main cities were covering the whole rural and urban areas of KZN province. Research by ICON noted that the required number of equipment in KZN for both public sector and private sector should be a minimum of 3 treatment machines per 1 million. This is adequate for the country's level of cancer incidents and age profile (Econex, 2010). Currently, the province has 17 treatment machines (6 public sector and 11 private sector), while the recommended total should be 33, based on the current population of 10 919 100 in the province. The private sector treatment machines have doubled over 6 years, while the public has remained the same number with problem of frequent breaking downs. This situation of radiotherapy KZN province has been explained by Rosenblatt (2014), that countries which have developed their radiotherapy services without central planning would find themselves with more private radiotherapy centres than public radiotherapy centres and inaccessible to the majority of patients. Therefore, the growth of the private sector treatment equipment has not much impact on the 84% of the population of the country, as these people are not funded by health insurances. When Canada was faced with a sudden growth of the private sector, they motivated for an increase in government spending to avoid the privatisation of the health sector, which could lead to socially unjust medical system (Podgorsak, 2009). This therefore raises the need for proper planning from public healthcare in KZN to avoid being overruled by the private healthcare.

Some respondents, who acknowledged the presence of the backlogs due to waiting times, preferred working overtime. However, Jakovljevic *et al*. (2015) argue that the intensive functioning of equipment or machines leads to frequent technical problems that would need maintenance or repair procedures. This means that the overuse of equipment, like for overtime purposes, tend to exhaust the machines. This can be a problem if there is no maintenance contract, as authorizing approval may delay the process of fixing the equipment.

All interviewee believed that the patients recognise the benefit of radiotherapy. However the majority of respondents (78.57%) believed that patients do not seem to understand radiotherapy, thus, they are unable to ask about their progress of treatment and tend to depend on whatever the doctor says. Halkert *et al*. (2015) stated that patients prefer

communication from the health professionals and explanation to their journey of their treatments, but also, they have less information about cancer and as a result, they are nervous and anxious as they mostly depend on what the professionals would have said. This shows that patients need education and guidance for them to be well informed about cancer and the treatments options available for them. This agrees with the article by Anand *et al*. (2008), which recognised that there is still a problem of high illiteracy in Africa and low levels of Primary Health Care, as well as in some countries in Europe, like Serbia which is a barrier to proper communication of information.

KZNHealth lacks proper central planning for the radiotherapy, which may be causes by policy makers' attitude that radiotherapy is expensive, complex, unattainable, not considered to provide a positive outcomes and not for the LMICs. This result in minimal investments in radiotherapy and it's worsened by the limited resources and lack of cost information resulting in poor service delivery reflected by patient waiting (Gospodarowicz, 2014). TDABC may be used as one of the components of central planning for the KZNHealth as it provides vital information which will play a role in budget planning.
TDABC is able to trace the path of a patient care for a specific radiotherapy treatment, and it's able to identify the actual cost of each resource used, such as personnel, space, consumables, and equipment. It is able to documents the amount of time the patient spends with each resource (Kaplan and Porter, 2011). Since the cost calculation based on TDABC is able to determine the cost of treatment, determine the saved process time which may improve time slot for more patients by eliminating wastages and unnecessary steps. It is able to determine adequate staffing, equipment and infrastructure needed based on number of activities, time taken to complete activity and estimated number of KZN population requiring radiotherapy. This vital information can be used to reorganise the staffing, equipment capacity and infrastructure or be presented to the policy makers for more funding based on accurate information which will ultimately improve radiotherapy quality service provided.

5.2.2 Objective 2: To explore the radiotherapy employees' perceptions on the staffing capacity and staffing recognitions by KZNHealth.

Some of the respondents (44%) felt recognised, others (34%) were not sure, while (22%) felt they were not being recognised by the Department of Health. They believed that their profession and radiotherapy were not taken as essential by the Department of Health and

they also believed that it could be one of the reasons why radiotherapy was not allocated a better budget. This may be a lack of information by the department as the KZN department seems to be clueless on what the physicists and the radiotherapists do (their job descriptions). This is in agreement with Lawrence's (2011) observation that radiotherapy in South Africa was declared a scarce skill and essential services on paper, but that has not translated into reality. When exploring what radiotherapy employees would take as a sign that they get the attention they deserve, the respondents considered staff development and compensation as the most important. This is in agreement with the studies by Guedea *et al.* (2012) that radiotherapy is evolving and it requires frequent training, to keep up with the changes. On ranking of recognition expectation from the radiotherapy staff, they showed a lack of staff development and compensation (47.06%) as a leading factor, while recognition of professional came second (29.41%), as well as being listened to (23.53%).

On staffing capacity, the majority of the respondents (84%) felt understaffed and those who felt that they were not understaffed (16%) argued that their staffing was tight, especially when one employee takes a leave of absence. Understaffing limits the professionals, especially the doctors, to have enough time with patients in order to enhance their therapy experience and this has led to overworking and stress, thereby indirectly affecting the patients' quality of services (Sehlen *et al*., 2009).

Accurate data make sure that the staffing matches the amount of work, thus, avoiding the burnout, frustration and pressure, as reported by Sehlen *et al*. (2009). Organisations like IAEA (2015) believed that the cause of understaffing in radiotherapy is because of public sector's staffing which is based on operational system rather than activity system. They proposed the use of ABC costing method to be used for activity based staffing for accuracy in staffing determination. Since ABC also exposes who perform activities for each of the cost object, this will inform the Department of Health about the role of each of the professional in radiotherapy, and their skills and area of needed training will be known. Thus ABC plays a role of human resource management tool. Tibor *et al*, (2017), have acknowledged that the use of TDABC in their centre (Mayo Clinic Radiology Centre) has played a huge role in the improved sense of job satisfaction to the employees because of saved process time calculated.

5.2.3 Objective 3: To explore the radiotherapy employees' perceptions on the management of radiotherapy equipment and infrastructure

Radiotherapy equipment and building infrastructures are characterised by high costs and this tends to be a barrier in improving radiotherapy access and therefore, requires proper management (Samiei, 2013). All of the 32 respondents agreed that equipment and infrastructure must be treated with care, as they are very expensive and must be kept at the optimal function level to maintain a standard of care to patients. This highlights Nwankwo *et al*'s. (2013) assertion that the manner in which the equipment is managed plays a role in cost saving and the life of the equipment would be extended, as this indirectly and positively affects the waiting times, as time and money would be saved for the replacement of faulty or broken machinery. Fully operational machines do not only affect the quality of radiotherapy treatment, but also the safety of patients and staff are assured, thus, making QA (quality assurance) to be important. Respondents showed that they required regular training on the equipment to ensure procedures are properly followed. The respondents were asked if they believed the costs of equipment were high and if the cost is justified as focus may not only be limited to costs, but also on the benefits. Respondents who believed that the cost was justified (50%) were almost equal to those who said the cost were not justified (46.88%). Those who accepted justification, most of them believed that, equipment is hi-tech, equipment can be useful for over ten years and save many lives and they have high return on investment. Those who rejected the justification raised the issues like 'monopoly', lack of economies of scales, frequent breakdown of the high cost equipment.

Many suggestions have been made to face this cost challenge, like buying equipment as groups (bulks) to create economies of scale, as the radiotherapy market is very small and buyers have no bargaining power, buying the standard equipment with the proven track record of success, especially for the LMICs and avoid rushing to advanced equipment when there is a lack of trained staff and expertise, as well as when there is no conclusive evidence of their effectiveness (Gospodarowicz, 2014; Datta, 2014). This also meant that radiotherapy equipment buyers are price takers and had no bargaining power to bid the price of the equipment down.

Costing methods like TDABC would be useful to justify the equipment needs of different centres and in addition to that, they might require the manufacturing companies to justify their prices to avoid overpricing (Botha and Vermaak, 2015). Cost calculation based on the

activity of the equipment will determine if it's expensive and will determine if it is underutilize or overutilized and this will play a role in the improved resource planning for department. TDABC will also play a role when evaluating between the different treatment equipment (Lievens *et al.*, 2015).

5.2.4 Objective 4: To explore the radiotherapy employees' perceptions on the cost management and the need for costing within the radiotherapy department.

All 32 respondents agreed that the cost saving is every employee's responsibility and not limited to management, as this can cut down unnecessary costs in each step that the radiotherapy employees participate in patient treatment. Respondents emphasised that teamwork is the key to such an exercise. Respondents believed that the saving of cost would be helpful in sparring money and that money could be used for other purposes like patients lodging. They believed that the cost saving exercise could make top management to take them seriously and eventually listen to their needs and views for funding. Respondents' perceptions concur with Vucovic and Jakovljevic's (2015) proposal that since the healthcare is expensive globally and resources are limited, there is therefore a need for health professional economic reasoning (HPER). This HPER would help in improving the personal responsibility in the cost control, enthusiasm in the formulating of strategy to reduce costs and make it easy to understand the constraints of providing adequate healthcare within the allocated budget.

A study by Nethathe (2015) showed that South Africa desperately needs cost awareness programmes for its health professionals, as the services that they provide are overpriced, as compared to their counterparts with similar development status. All 32 interviewees thought that measures were required to identify and minimise costs and wastage. This was viewed as important in that saved costs could be used for expansion and to ensure that more patients received radiotherapy. Different measures were proposed, including the procedural protocols, but the most dominant was the application of costing methods based on ABC cost calculations (Kaplan and Porter, 2011; Gospodarowicz, 2014; Van de Werf *et al.*, 2012). Employing costing methods and better fractionations are some of the measures required, and can be very helpful in cost saving, while at the same time improving accuracy and patient access.

The study also revealed that 72% of the participants felt that the hospital management was aware of the challenges of radiotherapy and associated cost, but needed more insight. While 15% believed that hospital management was partially aware, 12.5% of the participants were unsure. Those who believed that the hospital management was aware specified that they were aware of the high costs of radiotherapy treatment but limited to other radiotherapy challenges. Many participants proposed that hospital management must get involved through departmental visits, they also felt that hospital management seems to be overwhelmed by multitasking of managing many departments and also limited by the red tapes of the government. All 32 participants strongly believed that hospital management needed more information about the radiotherapy in order to manage it better. This concurs with Popesko (2013) that key factors for effective hospital management is the ability of accurate estimation of the cost of products, as the product cost is an essential economic tool used to accurately quantify the cost of intervention carried out, such as the investment. TDABC will play a very important role in cost determination of radiotherapy treatments as it considers all activities, resources, direct and indirect costs involved thus being considered as accurate (Manalo, 2004).

The relation between the hospital management and the radiotherapy department is very important, as hospital management plays a huge role of bridging the gap between the radiotherapy department and the policy makers. Hospital management has to cascade the radiotherapy cost information which includes accurate cost calculations using TDABC and cost saving measures and other radiotherapy challenges from the department to the policy makers, for them to make informed decisions on investments (Sullivan *et al*., 2015). Therefore, costing is very important for the aspects of investments in radiotherapy and management, radiotherapy employees have a role to play in changing the costing information into a fundamental weapon in order to influence the investments in radiotherapy.

5.3 CHAPTER SUMMARY

This chapter has discussed the findings obtained from the empirical data analysis. The qualitative data outlined the problem that the KZN radiotherapy departments are facing. These problems affect radiotherapy access for patients in the province. Such problems require the intervention and it has been shown that there is a lack of investment in radiotherapy. Literature proposed the use of "Costing" as the gateway to achieve the

required investments so that the patients could be able to access radiotherapy. Costing has showed that it played a huge role, not only on cost determination, but it also helps in budgeting, estimate the required staffing, estimate the required equipment, identification of wastages, as well as the evaluation of new equipment in terms of cost-effectiveness. The next chapter presents the recommendations and conclusion on improving access to radiotherapy.

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

Cancer is a global challenge in the healthcare system, while radiotherapy is a very critical and important component of comprehensive cancer treatment and care. However, the radiotherapy access is still a challenge in the LMICs. This chapter attempts to draw conclusions based on the results obtained from the study, as they were presented and discussed in the previous chapters. This chapter is offering the research recommendations and conclusions for solving the research problem and recommendation for future studies to ensure that access to radiotherapy improves.

6.2 QUESTIONS TO BE ANSWERED IN THIS RESEARCH.

Research has attempted to answer the following key questions.

- What are the radiotherapy employees' perceptions on the quality of radiotherapy service in their hospitals?
- What are the radiotherapy employees' perceptions on staffing capacity and staffing recognitions by KZNHealth?
- What are the radiotherapy employees' perceptions on how equipment and infrastructure are managed within the radiotherapy departments?
- What are the radiotherapy employees' perceptions on the cost management and the need for costing as an intervention within their departments?

6.3 CONCLUSIONS

This section drew the conclusions from the research findings of this study.

Implications of the study were are follows-

- Patient radiotherapy access problem was revealed, Patient demanding treatment exceed available resource capacity in KZNHealth, thus leading to longer patient waiting periods before receiving radiotherapy treatments. Main cause of waiting times pointed to mainly on the lack staff, equipment and patients lodging.
- More staff is required to improve quality service to patients; current staff needed better recognitions by KZNHealth as they show dedication under the difficult

condition of limited resources. Poor working conditions negatively affected them emotionally and impacted on service they are providing to patients.

- Need for equipment to be treated with care including quality assurance, use of equipment handling procedures and maintenance contract would aid in saving cost and longer time use of equipment, high return on investments, economical and healthcare benefits. Health Professional Economic Reasoning (HPER) needs to be implemented to encourage the culture of cost saving and minimizing wastages. Motivating for more equipment is vital to improve radiotherapy access.
- Hospital Managers must have a relationship with the department to acquire the vital information, including costs, as they are the bridge to policy makers.
- Radiotherapy access challenges need urgent intervention.

These implications of the study shows that questions has been answered and based on various literatures it has been shown that costing as an intervention can be used effectively for each of the points mentioned above. Costing is helpful in capacity determination of staff, equipment and infrastructure needed, thus avoiding understaffing which could have an impact on the staff burnout. Costing would enable policy makers to make informed decisions on investment when the cost of investment is known. The study has also shown that although the TDABC (modified version and easier version of ABC) require quite an amount of time, cost and teamwork, Van de Werf *et al*. (2012) emphasised that the accuracy of ABC model improves as more details are available and further elaborated that the model is more complex and costly at the development phase due to time and resource needed, but once it is fully installed, much effort would not be required as experience would be better.

Success observed in the radiotherapy centre of the high income countries like Hospital Leuven in Belgium and MD Anderson Cancer in USA, may not be easily realised in South Africa as one of the LMIC (McBain *et al*, 2016). This is due to the lack of standard set of tool to apply this approach, lack of technical expertise and resources, lack or difficulty or time consuming in obtaining required data. These are the challenges need to be faced first and thus need other supports from outside institution for the implementation of TDABC. Therefore further research is needed in the LMIC to ensure that TDABC can be applied successfully.

Proper calculation in radiotherapy follows the work of Van de Werf *et al.* (2012) and Kaplan and Porter (2011).

6.4 LIMITATIONS OF THE STUDY

Research methodology has been limited by the following –

- Higher proportion of participants' sample from one hospital than other two hospitals due to the use of convenient non–probability sampling, as it was convenient for accessibility and proximity to the researcher
- Difficulty to reach other participants due to time constraints on their part.
- Taking into consideration the sensitivity of the subject, few of the target participants chose not to participate in the study.

6.5 RECOMMENDATIONS

The following recommendations are therefore presented in an effort to improve patient access to radiotherapy.

- To improve patient access to radiotherapy, it would need the involvement of the hospital management to understand the dynamics of the radiotherapy department. Hospital managers must request the vital information to determine the cost of radiotherapy. As many people still do not understand radiotherapy, workshops and cancer awareness campaigns must be organized, while ensuring that management is involved, as this is the opportunity for hospital management to engage the department.
- Due to the small markets in radiotherapy, the economies of scales are weak; service providers usually take advantages and dictate the price because of monopoly. It is recommended that the Department of Health must be opened for competition and thus, companies would fight for better prices. Competition would also improve innovation and efficiency without increasing the price of equipment. Buying in bulk with other centres or provinces could help in improving the economies of scales and thus, pulling prices down.
- Based on Atun *et al*. (2015), the LMICs pay most of the expenditure to equipment due to poor equipment planning. Service contract must be in place to ensure that the equipment functions properly and repairs are done promptly without the unnecessary delays, thus avoiding long unnecessary treatment interruptions that might be a factor affecting access to radiotherapy. Centres without service contract run the risk of longer

delays and unplanned expenditures due to the various approvals and red tapes before final approval is attained.

- Whether the equipment should be standardized or advanced, research has shown that advanced (sophisticated) equipment tend to improve the outcome, but there is a lack of enough statistics to be conclusive about them. However, standard equipment has the advantages that it is affordable, proven track record and therefore, it means when there are financial constraints, standard radiotherapy equipment would make a huge difference, especially in the LMICs. As for the advanced equipment, it should be fast, efficient and cost-effective and good return on investments with better outcomes, but they come with a burden of further staff training needs and the cost of equipment maintenance increases.
- Human resources need to be taken as an asset for the KZNHealth department, Hospital managers must create an environment that is conducive and must provide support. Since the employees' perceptions showed a strong need for staff development and compensations, the employees must be allowed and must be funded to attend the training, workshops and conferences to improve their knowledge, as radiotherapy is a discipline that is evolving and is technology-based. Managers must also ensure that the skilled personnel are matched with the activities that require skills.
- Based on the growth of the private sector radiotherapy in the province, it shows that the public sector, with all its equipment breakdowns, would soon be pushed aside if no proper plans of action are done. This would further limit access to radiotherapy, as those patients who cannot afford the private sector would be excluded from benefiting, thereby creating injustices to the citizen due to procrastination, policy makers' myth and misconceptions about the high costs and inefficiency of radiotherapy. When Canada was faced with similar situation, policy makers motivated for an increase in government spending to avoid privatising the health sector, which could lead to socially unjust medical system (Podgorsak, 2009). This may be a bit tricky for South Africa to just spend if there are other competing health issues like HIV and TB, while the unemployment rate is so high and a number of people are living below the poverty line, thus making it difficult to spend as they wish (Maruthappu *et al.*, 2016). So, prioritisation on radiotherapy, changing the attitude on focussing on the benefits rather than cost of radiotherapy, as well as changing the misconceptions about radiotherapy being costly, determination of the investments needed and creating a proper cancer plan, could collectively create the much needed change (Podgorsak, 2009).

- In a resource constraint environment like South Africa, it is recommended that the radiotherapy employees regularly receive the workshop and training on cost awareness, to minimise wastages, to improve how they care about equipment, to improve how they choose equipment and other accessories when faced with more than one alternative. They would optimize ordering and avoid over ordering.
- Costing is a useful tool to determine the appropriate cost, assist management in making proper costing decisions and when such information is accurate, it can inform the policy makers for the purpose of investing in radiotherapy, help them in planning and the allocation of resources, help in appreciating scarce resources, can create cost awareness and control, assisting radiotherapy management to eliminate wastages, inefficiencies and identification of profitable and unprofitable products, as well as to eliminate duplications. It is thus recommended that costing should be used in radiotherapy to determine how well a resource is spent to complete a patient radiotherapy, to calculate the cost of treatment that would be helping in determining the correct number of staff and equipment needed and thus, avoiding the understaffing. If the government has moratorium on the number of the staff posts, costing would be able to determine the workload needed for the staff in hand. Costing is recommended to be used for the fully informed budgeting, and therefore, for better accuracy, ABC costing tool is recommended. ABC provides efficient information that is crucial in cost determination and tracking down of the unsaved costs. It is able to measure the cost around the patient, rather than the department. It also aids in designing and determining the costs of a new radiotherapy facility based on population, cancer prevalence and the demand of radiotherapy services.
- Based on global trends, it is recommended that the hospitals implement the cancer prevention program which promotes preventative measures like screening and early detections, and if they are combined with the quality diagnosis and proper treatments with the best use of the available resources, they become a foundation of cancer control programme they have shown to cure and prolong patient's life (WHO, 2002). This often leads to less complex and less expensive care later, as they tend to consume expensive resources (Kaplan and Porter, 2011).
- Based on CANSA research, South Africa could reduce cancer deaths and some of the programmes are already implemented by Minister Motsoaledi, but need to be kept in practice. Results may be realised in later years, and the demand for access to radiotherapy would be reduced: (a) Keep the program of vaccination of the younger girls (b) keep

cancer registry working to gather prevalence and incidence information which would determine how to spend available resources adequately, (c) modernising equipment requirement, and ensuring that maintenance and payment for service is up to date, (d) keep the cancer council to coordinate cancer fighting efforts. It should address prevention, treatment and research (e) recommended that a yearly R8 billion tax collection be used for used for cancer promotion programme (Malan, 2012).

- Policy makers usually take decisions based on what they know. They must be informed by the hospital managers on the information about radiotherapy. Sullivan *et al*. (2015) believe that educating policymakers, patients and the general public is key to bridging the gaps in global cancer care.
- It is highly recommended that the hospitals adopt the costing technique such as ABC in their respective radiotherapy departments, as it is a bottom up approach. This would ensure that costs are determined correctly and directly from the cost consumers to motivate for better investments in radiotherapy, tracking down of the unsaved cost and helping management with budgeting. This would eventually have a role in improving access to radiotherapy.

6.6 SUGGESTIONS FOR FUTURE RESEARCH

This study explored the perceptions of radiotherapy employees regarding costing in radiotherapy. It would be of interest to obtain the view of patients regarding the quality of treatment they receive. This would ensure that the services provided to them improve, as all main stakeholders have their views.

Costing methods suggested in the study are practical, following studies may be done in KZNHealth using TDABC.

- Determination of the enabling factor to ensure that TDABC will be applied successfully in KZNHealth.
- Determination of key drivers of cost in radiotherapy in KZN provincial hospital to help with better budgeting.
- Determination of optimal operational efficiency to help improve the process time.
- Evaluation of resource allocation in radiotherapy department in KZN province to help with proper staffing, equipment and infrastructure.

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APPENDIX A: LETTER OF INTRODUCTION

UNIVERSITY OF KWAZULU-NATAL

Good Day

My name is Nhlakanipho Mdletshe; I am a qualified Medical Physicist (UFS), currently working as a Deputy Manager at Greys Hospital, Oncology Department. As part of continuous education, I am also enrolled as a 3rd year student at UKZN for a Master in Business Administration Degree (MBA). For any further information, please contact me on 0833057953 or send me an email at nipho.mdletshe@kznhealth.gov.za or nhleks76@gmail.com

You are being invited to consider participating in a study that involves research.

The aim of this research is to investigate perceptions of hospital's radiotherapy employees regarding the cost of radiotherapy and whether the costing information of the radiotherapy will assist them in radiotherapy budget allocation under the conditions of ever shrinking healthcare budget and increased cancer burden. The study is part of continuous improvement to make sure senior managers and policy makers make informed decisions in terms of budget allocation in the provision of radiotherapy services.

Patients will benefit as value for money service and more access to radiotherapy will be improved. Medical insurances will also benefit as they will know exactly what they are paying for. Staff and departmental managers will be able identify steps within the treatments that consume high or low cost and steps that are adding value or wastage

The study will take place in Pietermaritzburg and Durban. The study is expected to voluntarily enrol radiotherapy employees (i.e. doctors, radiotherapists and medical physicists) from KZNHealth hospital within radiotherapy departments, with all of the

interview guide for interviews expected to be valid for the research. The participants will be approached in Addington Hospital (Durban), Greys Hospital (Pietermaritzburg) and Inkosi Albert Luthuli Hospital (Durban). The duration of your participation if you choose to enrol is expected to be between 15 minutes to 20 minutes. The study is funded by Nhlakanipho Mdletshe.

The study will create the following benefits:

1. To be able to understand the senior managers' perceptions on radiotherapy costs.
2. To be able understand which costing system that will gives us the best estimate for radiotherapy costs.
3. To be able to understand how radiotherapy budget allocation will be improved using an accurate costing system.
4. To be able understand how the information of the infrastructure, materials, building, staff labour and other indirect activities participate to produce the radiotherapy cost.
5. To be able to identify activities that consume most/ less cost and eliminate unnecessary steps that does not add value during the radiotherapy treatments.

- To be able to understand the radiotherapy employees on the quality of radiotherapy service they provide to patients.
- To be able to understand the radiotherapy employees on the staffing capacity and staffing recognitions by KZNHealth.
- To be able to understand the radiotherapy employees on the management of radiotherapy equipment and infrastructure.
- To be able to understand the radiotherapy employees on the cost management and the need for costing within the radiotherapy department.

Your participation in this research is voluntary and there will be no criminal or incriminating activity involved with taking part in the study. All the information provided in the question is **confidential and the identity of the participant remains anonymous**. You as the participant have the right to withdraw from the survey at any time without prejudice and negative consequences imposed against you.

The interview will be conducted from the participants and all the data collected from the interview will be analysed. From the analysed data, conclusions will be drawn about the findings and recommendations will be made.

After completion of the interview, the interview guide questions will be protected and stored in a storage area at the discretion of the researcher. Subsequently, the interview results will be destroyed using a paper shredding machine after the completion of the 5th year.

The participants of the survey may get hold of the results directly from the researcher by requesting them via email (nipho.mdletshe@kznhealth.gov.za or nhleks76@gmail.com)

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number: **HSS/0559/015M**). Approval from KZNHealth Health Research and Knowledge Management has a REF**: KZ_2015RP13_8**

In the event of any problems or concerns/questions you may contact the researcher at

- Name of Researcher: Mr Nhlakanipho Mdletshe
- Cellphone: 0833057953 and Telephone: 0338973540

Email: nipho.mdletshe@kznhealth.gov.za or nhleks76@gmail.com

or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

APPENDIX B: LETTER OF INFORMED CONSENT

UNIVERSITY OF KWAZULU-NATAL

Participant Consent document

I_____, have been informed about the study entitled, *Senior managers' perspectives on radiotherapy costing in KZNHealth provincial hospitals* by Mr Nhlakanipho Mdletshe

I understand the purpose and procedures of the study is to provide continuous improvement by making sure that patients receive the radiotherapy service that is value for money. To achieve that, proper radiotherapy funding and budget allocations are necessary and their accuracy improves when radiotherapy cost information is known.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at Email: nipho.mdletshe@kznhealth.gov.za or nhleks76@gmail.com

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

UKZN HUMANITY AND SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

University of KwaZulu-Natal

Research Office.

HSSREC _College of Law & Management Studies

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2608350 - Fax: 27 31 260 3093

Email: hssreclms@ukzn.ac.za

Signature of Participant	**Date**
Signature of Witness (Where applicable)	**Date**
Signature of Translator (Where applicable)	**Date**

APPENDIX C: INTERVIEW QUESTIONS FOR RADIOTHERAPY EMPLOYEES

UNIVERSITY OF KWAZULU-NATAL

QUESTIONAIRRES FOR QUALITATIVE INTERVIEW

INTERVIEW QUESTIONS

Candidates profile:

i) Gender of the candidate _____

ii) Age of the candidate _____

iii) Name of the organisation _____

iv) Position in the organisation _____

v) How long has this position been held _____

vi) Education level _____

A. PATIENT MANAGEMENT

1.1 In your opinion, do you think our quality of radiotherapy service to patients is of acceptable standards? Any area of improvement required?

1.2 Waiting list reflects difficulty in accessing the radiotherapy, are you aware of its cause and do you have any idea how we can improve radiotherapy access.

1.3 Do you think radiotherapy patients recognised the benefit of radiotherapy?

B. STAFFING

2.1 Do you think your profession is recognised by the Health department? What are your expectations as a sign of recognition from Health Department?

2.2 Is the current staffing (over or understaffing) satisfies you? How is affecting you and service you providing?

C. RADIOTHERAPY EQUIPMENT

3.1 Do you think radiotherapy equipment and infrastructure need to be treated with care?
3.2 Do you think QA, maintenance, repair and protocol of use are important in that regard?

3.3 Do you think radiotherapy equipment costs are justified/ evidence of value adding is it required from equipment?

D. COST MANAGEMENT

4.1 Do you think cost saving exercises when treating patients is everybody's responsibility or it should be limited to radiotherapy managers within the radiotherapy department?

4.2 Do you think measures are required to identify and minimize radiotherapy cost and wastage (e.g. time, duplications, treatment steps that don't add value?)

4.3 Do you think managing cost and minimizing wastage can improve the patient access to radiotherapy?

4.4 Do you think hospital management are well aware about radiotherapy problems and radiotherapy treatment costs?

APPENDIX D: ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

20 July 2017

Mr Nhlakanipho Mdletshe (9405154)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Mdletshe,

Protocol reference number: HSS/0559/015M
New Project Title: Perceptions of Radiotherapy employees on Radiotherapy Costing in KZN Health Provincial Hospitals

Approval notification – Amendment Application

This letter serves to notify you that your application for an amendment dated 20 July 2017 has now been granted Full Approval as follows:

- **Change in Title**

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

[redacted]

Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

cc Supervisor: Prof S Migiro
cc Academic Leader Research: Dr Muhammod Hoque
cc School Administrators: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** xmbap@ukzn.ac.za / anymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

APPENDIX E: GATEKEEPERS LETTER

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:
Health Research & Knowledge Management

Physical Address: 330 Langalibalele Street, Pietermaritburg
Postal Address: Private Bag X9051
Tel: 033 395 2805/ 3189/ 3123 Fax: 033 394 3782
Email: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference: 290/15
KZ_2015RP13_8

Date: 27 October 2015

Dear Mr N.Mdlethse
Email: nipho.mdletshe@kznhealth.gov.za

Approval of research

1. The research proposal titled **'Senior managers' perspectives on radiotheraphy cost management in all three KZN Health provincial hospitals'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at Grey's Addington and Inkosi Albert Luthuli Central Hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

[redacted]

Dr E Lutge
Chairperson, Health Research Committee
Date: 29/10/15

Fighting Disease, Fighting Poverty, Giving Hope

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Inkosi Albert Luthuli Central Hospital
Ethekwini Health District
Office of the Medical Manager
Private Bag X 03, Mayville, 4058
800 Bellair Road, Mayville, 4058
Tel.: 031 240 1059,
Fax.: 031 240 1050
Email.:ursulanun@ialch.co.za
www.kznhealth.gov.za

Reference: BE017/15
Enquiries: Medical Management

3 July 2015

Mr N Mdletshe
Graduate School of Business & Leadership
Westville Campus

Dear Mr N Mdletshe

RE: PERMISSION TO CONDUCT RESEARCH AT IALCH

I have pleasure in informing you that permission has been granted to you by the Medical Manager to conduct research on: **Senior managers perspectives on Radiotherapy Cost Management in all three KZN Health Provincial Hospitals.**

Kindly take note of the following information before you continue:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Kindly ensure that this office is informed before you commence your research.
4. The hospital will not provide any resources for this research.
5. You will be expected to provide feedback once your research is complete to the Medical Manager.

Yours faithfully

[redacted]

Dr M Letebele
Medical Manager

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Inkosi Albert Luthuli Central Hospital
Ethekwini Health District
Office of the Medical Manager
Private Bag X 03, Mayville, 4058
800 Bellair Road, Mayville, 4058
Tel.: 031 240 1059,
Fax.: 031 240 1050
Email.:ursulanun@ialch.co.za
www.kznhealth.gov.za

3 July 2015

Mr N Mdletshe
Graduate School of Business & Leadership
Westville Campus

Dear Mr N Mdletshe

Re: Approved Research: Ref No: HSS/0559/015M: Senior managers perspectives on Radiotherapy Cost Management in all three KZN Health Provincial Hospitals.

As per the policy of the Provincial Health Research Committee (PHRC), you are hereby granted permission to conduct the above mentioned research once all relevant documentation has been submitted to PHRC inclusive of Full Ethical Approval.

Kindly note the following.

1. The research should adhere to all policies, procedures, protocols and guidelines of the KwaZulu-Natal Department of Health.
2. Research will only commence once the PHRC has granted approval to the researcher.
3. The researcher must ensure that the Medical Manager is informed before the commencement of the research by means of the approval letter by the chairperson of the PHRC.
4. The Medical Manager expects to be provided feedback on the findings of the research.
5. Kindly submit your research to:

   The Secretariat
   Health Research & Knowledge Management
   330 Langaliballe Street, Pietermaritzburg, 3200
   Private Bag X9501, Pietermaritzburg, 3201
   Tel: 033395-3123, Fax 033394-3782
   Email: hrkm@kznhealth.gov.za

Yours faithfully

[redacted]

Dr M Letebele
Medical Manager

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

ADDINGTON HOSPITAL
OFFICE OF THE HOSPITAL MANAGER
Postal Address: P.O. Box 977, DURBAN, 4000
Physical Address: 16 Erskine Terrace, South Beach
Tel.: (031) 327-2970, Fax.:(031) 368-3300
Email.: reshma.boodhai@kznhealth.gov.za
www.kznhealth.gov.za

AD/9/2/3/R

Enquiries: Dr M Ndlangisa
Extension: 2970/2568

1 July 2015

Principal Investigator:
- **Mr N Mdletshe**

PERMISSION TO CONDUCT RESEARCH AT ADDINGTON HOSPITAL: "SENIOR MANAGERS' PERSPECTIVE ON RADIOTHERAPY COST MANAGEMENT IN ALL THREE KZN HEALTH PROVINCIAL HOSPITALS"

I have pleasure in informing you that permission has been granted to you by Addington Hospital Management to conduct the above research.

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. Addington Hospital will not provide any resources for this research.
5. You will be expected to provide feedback on your findings to Addington Hospital.

[redacted]

DR M NDLANGISA
HOSPITAL MANAGER
ADDINGTON HOSPITAL

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

GREYS HOSPITAL
OFFICE OF THE CEO
Private Bag X 9001, Pietermaritzburg, 3200
Town Bush Road, Chase Valley, Pietermaritzburg, 3201
Tel.:033 – 897 3321 Fax.: 033 - 8973398
www.kznhealth.gov.za

To:	**Mr. N. Mdletshe** **Department of Oncology and Radiotherapy** **Grey's Hospital**
From:	**Mrs. K.T. McKenzie** **Acting CEO - Greys Hospital**
Date:	**30 June 2015**
Re:	**Request for permission to conduct research at Grey's Hospital: *Senior Managers' Perspectives on Radiotherapy Cost Management in All Three KZN Health Provincial Hospitals.***

Dear Mr. Mdletshe

Your request to conduct research at Grey's Hospital refers.
Permission to conduct the above study is hereby granted under the following conditions:

- Your ethics approval and research protocol are assumed to be valid and final ethics approval is a prerequisite for conducting your study at our hospital. Once obtained, please submit a copy of the full ethics approval;
- You are also required to obtain approval from the Provincial Department of Health KZN Health Research Unit prior to commencing your study at Grey's Hospital. You will find more information on their website: *http://www.kznhealth.gov.za/hrkm.htm*
- Confidentiality of hospital information, including staff and patient medical and/or contact information, must be kept at all times;
- You are to ensure that your data collection process will not interfere with the routine services at the hospital;
- You are to ensure that hospital resources are not used to manage your data collection, e.g. hospital staff collating data; photocopying; telephone; facsimile, etc.;
- Informed consent is to be obtained from all participants in your study, if applicable;
- Policies, guidelines and protocols of the Department of Health and Grey's Hospital must be adhered to at all times;
- Professional attitude and behaviour whilst dealing with research participants must be exhibited;
- The Department of Health, hospital and its staff will not be held responsible for any negative incidents and/or consequences, including injuries and illnesses that may be contracted on site, litigation matters, etc. that may arise as a result of your study or your presence on site;
- You are required to submit to this office a summary of study findings upon completion of your research.

[redacted]
Dr L. Naidoo
Senior Manager: Medical Services

Approved by:
[redacted]
Mrs. K.T. McKenzie
Acting CEO

APPENDIX F: TURNITIN REPORT

turnitin Turnitin Originality Report
SENIOR MANAGERS' PERSPECTIVES ON RADIOTHERAPY COSTING IN KZNHEALTH PROVINCIAL HOSPITALS 3 noref.docx by nhlakanipho mdletshe
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