IDENTIFICATION OF ELECTRONIC KEY PERFORMANCE INDICATORS FOR EVALUATION OF THE IMAGING CENTER STAFF

(CASE STUDY: KING FAISAL HOSPITAL)

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By

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30th November 2014

DECLARATION

I KALUME Zamzam hereby declare that this project proposal submitted in partial fulfillment of the requirements for the masters degree in Health informatics at the University of Rwanda, College of medicine and health science, it is my original work and has not previously been submitted elsewhere. Also, I do declare that a complete list of references is provided indicating all the sources of information quoted or cited.

Date and signature of the student

…….

a. *Authority to submit the project proposal*

Dr Frank Verbeke,

In my capacity as a supervisor, I do hereby authorize the student to submit her dissertation.

Date and signature of the supervisor

…….

DEDICATION

This work is dedicated to my beloved husband Ibrahim Gasasira NDAGIJIMANA, my daughters Maj'dah Uwase MUKARUZIMA, Kenza Ikirezi NDAGIJIMANA, and Rania Isaro NDAGIJIMANA.

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I am thankful to God (ALLAH) almighty for his enlightenment throughout my study.

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ABSTRACT

Background: Key performance indicators are a type of performance measurement used to evaluate the success of a particular activity. Staff evaluations in hospitals are mostly based on performance assessment elements which are considered to have a number of limitations. Objective performance measurement based on activity related data recorded into the Hospital Information System can generate more objective Key Performance Indicators.

Aim: To derive electronic key performance indicators from the hospital management information system for evaluation of the performance of imaging center staff at the King Faisal Hospital in Kigali City.

Methodology: This study was conducted at the King Faisal Hospital in the imaging center department, and worked virtually with staff as there was no physical contact. A cross-sectional, descriptive, quantitative study design was used in this study. 15 medical personnel of the imaging center: 4 radiologists and 11 radiographers were involved. 6436 objective care delivery data elements of staff were analyzed from the hospital information system over a period of a year. Eventually data was analyzed descriptively, using the Excel program.

Results: Radiology staff productivity was evaluated based on examination volume, on a daily, monthly and yearly basis. The total average imaging turnaround time is 137 minutes (2 hour 17 minutes) while the total average reporting turnaround time is 142 minutes (2 hours 22 minutes).

Conclusion: Three electronic key performance indicators were identified which are: staff productivity, imaging turnaround time and reporting turnaround time. This study showed that it is possible to carry out an evaluation of staff productivity from the hospital information system for any period of time and further provided an objective comparison of individual performance to peers and assisted also in studying the evolution of individual performance over time. Turnaround time is an important aspect of quality in diagnostic radiology hence shortening turnaround time result in increasing productivity.

ACRONYMS AND ABBREVIATIONS

CEO:	Chief Executive Officer
CT:	Computed Tomography
DEA:	Data Enveloping Analysis
DRC:	Democratic Republic of Congo
ET:	Execution Time
EHR:	Electronic Health record
EMR:	Electronic Medical Record
ICT:	Information Communication Technology
IT:	Information Technology
HIS:	Hospital Information System
HIQA:	Health Information and Quality Authority
HL7:	Health Level Seven
HMIS:	Hospital Management Information System
HR:	Human Resource
HRH:	Human Resource for Health
KFH:	King Faisal Hospital
KPI:	Key Performance Indicators
MBO:	Management By Objectives
MoH:	Ministry of Health

MRI:	Magnetic Resonance Imaging
PI:	Performance Indicators
PM:	Performance Management
PMO:	Prime Minister Order
RIS:	Radiology Information System
RT:	Reporting Time
RTT:	Reporting Turnaround Time
RVU:	Relative Value Unit
SR:	Speech recognition
TAT:	Turn Around Time
UK:	United Kingdom
US:	United States
USA:	United States of America
WHO:	World Health Organization
WTE:	Whole Time Equivalent

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CHAPTER1. INTRODUCTION

1.1. DEFINITIONS OF KEY TERMS

Health system: All activities with the primary goal of improving health – inclusive of family caregivers, patient–provider partners, part-time workers (especially women), health volunteers and community workers'(WHO, 2006).

Human resource for Health (HRH): Persons engaged in the activities contributing to the improvement of the health of the population.

Hospital information system (HIS) is an integrated system designed to comprehensively facilitate the functioning of the hospital with regard to medical, administrative, financial, legal matters through gathering, processing and dissemination of information (WHO, 2008).

Performance indicator or **key performance indicator** (**KPI**) is a factor upon which the success of a particular activity is determined: if what is attained is close to the best possible achievement with the given resources (WHO, 2000).

Performance management (PM) is the organization of the work to achieve the best possible results based on the day-to-day managerial involvement (Fowler, 1990)

Turnaround time is the time that elapses between the moment an imaging exam is ordered, its execution time and the reporting time (Nitrosi et al. 2007)

Reporting turnaround time (RTT) was defined as the time from imaging at the modality to the time when the report was available for the clinician (Koivikko et al. 2008)

1.2. BACKGROUND OF THE STUDY

Increasing competition, rising production and service delivery costs, growing technical and logistical complexity, demand for accountability, and clients' right to standardized information, have led to the introduction of performance indicators for organizations to ensure that there is more objective assessment of achievement of their goals. In the public sector, a number of country health systems have embarked on the process of performance management (WHO, 2000) to ensure, among other aims, that the human resources for health which account for around 29.5% of the government health budget in Africa (WHO 2006a), are focused and fully productive (WHO, 2006b). Performance appraisals are frequently carried out by the Human Resource (HR) management on HRH (Bouskila-Yam & Kluger, 2011) during which HRH and HR management get the opportunity to interact through face-to-face communication, set targets and make a number of decisions on the staff progress, motivation and the development of the health facilities. Because of their importance, performance appraisal systems continually undergo revision with a view to motivating the employees while at the same time focusing on the mission and vision of the organizations they serve (Buchner, 2007; Selden, Sherrier & Wooters 2012).

The goals of the hospitals, which are part of the health care delivery system, are to achieve good health for the population and being responsive (WHO, 2000). These broad goals would normally guide the way the performance indicators of the hospitals and the staff are set. Even though it is conceded that staff appraisal is a formal accountability mechanism in organizations for the staff's work-related behavior (Sherrier & Wooters 2012) and that there are useful outcomes of the appraisals, literature shows that the evaluations have mainly been based on behavioral issues (Smither, London, & Reilly, 2005) with poor measurement of KPI (Gavino,et al. 2012) thereby making more subjective judgments. As a result, there has been the possibility of causing tremendous damage to the morale and self esteem of the staff targeted (Coens & Jenkins, 2000). Many times the staff are not satisfied with the outcome whereby in one study satisfaction levels as low as 40% have been recorded following appraisals (Majumdar & Naratan, 2005). An appraisal system to be successful needs to be well perceived by the employees since that eventually results in high performance with a feeling of organizational ownership by the staff (Jawahar, 2006).

In an attempt to make appraisals more objective and reliable it was proposed that each performance be evaluated independently of the other and be weighted accordingly for each and every employee (Smith, 1986). However, such an intensive approach has not been very successful to undertake because the raters of the staff do not have enough time to do it and/or they are not skilled in the procedure (Smith, 1986). It is therefore evident that some alternative way of using KPI for objectively appraising staff still needs to be sought.

In Rwanda, two referral hospitals have gradually moved towards having many operations being automated, connected and integrated into the electronic HIS, including among others clinical, diagnostic, administrative, and financial and logistics management tasks (MoH 2009; MoH, 2012). The progress of ensuring that electronic HIS is operational in hospitals is in accord with the recommendation of WHO (2005) to reduce duplication of efforts, increase responsiveness and reduce cost, and provide good and equitable health care (WHO 2006). The electronic HIS, therefore, can enable the hospitals to have processed information readily available at the right time, and at the right place, to those who need it (Hübner & Ammenwerth, 2009). With the availability of electronic HIS, it can be contended that, more easily than before, the context specific hospital KPI can be measured more objectively; some of these KPI may include clinical outcomes, number of patients, waiting time, lab turnaround time, hospital bed occupancy rate, average length of stay, number of hospital acquired infections, surgical site infection rate, inpatient mortality rate and patient satisfaction (Hübner-Bloder & Ammenwerth, 2009). The same argument can be used to assert that it should be possible to develop more objective ways of appraising staff using the electronic HIS.

According to WHO (2005) and the Dublin (Ireland) Health Information and Quality Authority (HIQA) (2010) KPI can be general for the whole hospital or specific for a named unit or service. A comprehensive perspective needs to be used while developing KPI as proposed by Kaplan and Norton (1992) in what they termed as “balanced scorecards”. That means that the service user, the internal management aspects, the possibility for continuous improvement and the financial dimension should be taken into account (Kaplan and Norton, 1992). The KPI effectiveness needs to be based on a wide range of criteria to ensure that they appropriately guide the organization decision making process. The criteria may vary but the following have been mentioned by WHO

(2005) and HIQA (2010): validity, reliability, explicit evidence base, acceptability, feasibility, sensitivity specificity, relevance, balanced, tested, safe, avoiding duplication, and timeliness.

The Rwanda public health institutions evaluate the HRH by using an evaluation tool that addresses the capacity and the degree to which the HRH staff have achieved their goals as stipulated in the Prime minister's Order N°121/03 of 08/09/2010 establishing the Procedure of Performance Appraisal and Promotion of Public Servants (PMO, 2010). The targets for the used indicators are agreed upon by the staff concerned and the management. It would be of great interest to find out if such indicators could be derived from the electronic HIS. The approach used in staff appraisal is what is called Management by Objectives (MBO) and it is commended for being linked to mutually developed and agreed objectives (Jing-yi, 2013). Nevertheless, it is argued that the MBO system is time consuming (Jing-yi, 2013). With a view to introducing an even more objective way of staff appraisal, Jing-yi (2013) describes a system which is based on individual staff performance (i.e. the concept of production efficiency) using the Data Enveloping Analysis (DEA) method to come out with the weighted net performance depending on how engaging and important the task might be. The combination of both DEA and MBO constitute the balanced Score Card Method which used KPI. On the bases of this debate the interest of this study is to see how the KPI can make use of the electronic HIS to become more objective.

1.3. PROBLEM STATEMENT

The hospital where the study was planned to be conducted is the only referral hospital in the country that offers some of the highly specialized diagnostic imaging procedures like Magnetic Resonance Imaging (MRI) and receives patients not only from Rwanda but also from the whole region thereby significantly increasing the demand for services. The available unpublished information suggests that the appraisal of staff in clinical units in the hospital is based on performance related to clinical management, staff development, clinical governance, audit and research, service development and finally ward management. Considering that the hospital has achieved remarkable progress in the use of electronic HIS, which is quite in line with WHO (2006) recommendations, it would be a valuable achievement to derive some of the KPI indicators from the electronic HIS and use them for staff evaluation to reduce the weaknesses of

MBO staff appraisals as pointed out by Jing-yi (2013). However, the development of KPI in relation to the HIS inevitably requires first to make consultations with various stakeholders.

1.4. MAIN OBJECTIVE

To derive electronic key performance indicators from the hospital management information system for evaluation of the imaging center staff performance at the KFH referral hospital in Kigali City.

1.5. SPECIFIC OBJECTIVES

1. To determine staff productivity or examination volume performed by the imaging center staff from the Management Information System at King Faisal Hospital.
2. To estimate the imaging turnaround time of imaging center staff members at King Faisal Hospital.
3. To estimate the reporting turnaround time of imaging results in the hospital management information system.

1.6. SIGNIFICANCE OF THE STUDY

This study provided a method for objective comparison of individual performance to peers. It assisted also in studying the evolution of individual performance over time; calculate the imaging turnaround time and reporting turnaround time. Furthermore, this study assisted in providing baseline information that might be used by the human resource department as turnaround time is not measured today.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the literature review pertaining to the study, discusses on the performance management, radiology productivity, radiology turnaround time and the description, characteristics and implementation of KPIs. It also explores the use of information technology in health care, more specifically in the radiology department. This chapter finally explains the quality improvement related to key performance indicators in radiology and radiology report generation and review.

2.2 PERFORMANCE MANAGEMENT

Performance management is a vital component of human resource management that ensures the effective use of scarce resources and is also a continuous process of identifying, measuring and developing the performance of individuals or teams and aligning that performance to the strategic goals of the organization (Lutwama et al, 2013). Hence Lindsay et al, (2011) argued that providers of radiology services have a responsibility to audit their performance on a regular basis and to address any deficiencies that are identified as a result.

Measuring performance is essential to assessing the effects of continuous efforts to improve quality of care and ensuring the pursuit of excellence in hospitals (Koné Péfoyo and Wodchis, 2011). Anema et al. (2013) further argued that monitoring the quality of health care by means of performance indicator scores is part and parcel of national health care systems. Performance indicators (PIs) are used to monitor and improve quality and patient safety and to stimulate accountability and market processes in countries worldwide. To play this role effectively, performance indicators need to be reliable and valid measures of health care quality particularly when hospitals' performances are ranked and sometimes published.

Mendelson and Rubin (2013) acknowledged that performance can be measured and should meet certain thresholds as a requirement for practice. They further referred to scenarios where IT tools (HMIS, PACS, etc) are providing solutions that enhance the delivery and measurement of quality in radiology practice.

In many quality indicator programs, (e.g. in the USA: Kaiser Permanente, Veteran Affairs Quality program) the coordinating organizations are responsible for performance indicator data collection and computation, as opposed to programs that rely on self-reporting by the participating hospitals. They abstract the indicator data from digital administrative (hospital information system) or financial databases using computerized data abstraction algorithms. This approach however, is effective only when the data-systems are identical for all participating hospitals.

When hospitals do not have an integral electronic patient record, patient information is stored in several information systems and when a country has a liberal software market (US, The Netherlands) and the PIs are based on self-reporting, coupling of these independent information systems in an attempt to automatically collect the data might be difficult and prone to error due to the various software environments. Manually selecting the data from all the systems and paper records seems less error-prone, but very time consuming. It could be assumed, therefore, that hospitals obtain their own, unique, strategy to compute the PI score, which makes comparison of the PI scores difficult.

2.2.1 PERFORMANCE MEASUREMENT

Chew F. and Chew A. (2008) said that a performance measurement is a means to measure the job performance of an individual or group (unit) against some criterion for fulfillment of a task or achievement of a goal. Mendelson and Rubin, (2013) further argued that efforts are laying down the fundamental methodology to enable the collection of all kinds of performance indicators from data in the HMIS, permitting measurement, comparison, feedback and remedy when problems are identified. In parallel, QA officers are exploring ways to make this educational rather than punitive. To conclude effective performance measurements should be simple and understandable. Once a performance measurement system is in place, measurements will be obtained over time (Chew F. and Chew A. 2008).

According to Geis (2007), radiologist efficiency varies perceptibly and causes for this are hard to quantify. Chew F. and Chew A. (2008) further emphasized that there are other issues with certain clinical performance measures. First of all, they generally focus on only one aspect of a radiologist's clinical activities quantity and do not address quality. Second, they can be measured

individually, and therefore may hurt cooperation and coordination between radiologists, encouraging competition rather than cooperation. However Morgan et al., (2008), explained that there are variations between individual radiologists' turnaround times.

A clinical radiology dashboard represents a novel way to get important work flow information to the radiologist where he or she can quickly see it and act on it. In particular, an unsigned report monitor in a PACS-integrated radiology dashboard, when coupled with an actionable link to report signing software, resulted in an overall 24% decrease in time from report transcription to finalization (Morgan et al., 2008) whereas Chew F. and Chew A. (2008) revealed that performance measurements for radiology departments could be divided into five categories: productivity, reporting, access to examinations, customer satisfaction, and finance. Productivity indicators studied included examination volume and examination volume per modality.

2.3 RADIOLOGY PRODUCTIVITY

Chew F. and Chew A. (2008) defined examination volume as the number of examinations interpreted during a specified period of time. This can be used as a performance measure. While Mackinnon AD et al, (2008) defined productivity as the number of reports issued per whole time equivalent (WTE) radiologist per month.

Although this would appear to be simple and understandable, the manner in which the measure is derived can lead to variations in the count. Caterina et al., (2006), said that a considerable impact is found both on productivity and management of the workflow process, especially in radiology departments.

The introduction of PACS has resulted in increased productivity (Mendelson and Rubin, 2013). Lepanto et al, (2006) further said that PACS can lead to increased productivity by improving efficiency at many levels. Previous studies showed that technologists' productivity can be improved through the elimination of tasks associated with film production and handling. Finally Knechtges and Carlos, (2008) argued that a properly functioning PACS system can significantly enhance radiologist productivity and clinician access to images. There are opportunities for significant time and cost savings associated with no longer having to print or hang film. In addition, images can be distributed almost instantaneously to multiple locations, dramatically

enhancing clinician access. A properly functioning PACS can also increase productivity and report turnaround time by rapidly retrieving comparison studies.

According to Mendelson and Rubin, (2013), radiology staff order, schedule, interpret, report, archive, bill, and share (exchange) the data they generate. They close the circle by performing quality analytics and research on this data to improve performance and advance their knowledge. Details regarding the study performed need to be stored in the HMIS for a variety of reasons. The type and volume of contrast (or dose and activity of radiopharmaceuticals) and the method of administration need to be documented for billing purposes. Some insurers require including contrast doses in the body of the radiology report, so the information must be readily available for the radiologist at the time of dictation. Ideally, information is entered directly into the HMIS and is available electronically at the time of interpretation. However, most HMIS systems are not robust enough to eliminate paper requisitions (Janick, 2008).

Emery DJ et al., (2009) said that the common strategy to reduce waiting times is to increase the supply throughout, on the one hand the enhancement of the production capacity (ie, boosting the opening hours of scans to perform more examinations per scanner and increase the number of examinations per radiologist), and on the other hand the increase in personnel/equipment or the contracting out.

Agreement on the explicit description of the measurement for examination volume and how it is derived is important (Chew F. and Chew A., 2008) whereas Mehta et al., (2000) said that all data could be obtained by running queries through the HMIS defining specific criteria. These criteria included the time of completion of a study, the time to enter "preliminary" status, and the time to enter "final" status.

Ondategui-Parra et al, (2005) articulated nine productivity indicators: examination volume, examination volume per modality, technical relative value units (RVUs), professional RVUs, technical RVUs per FTE employee, professional RVUs per FTE employee, gross charges by modality, collections by FTE employee, and examination volume by resource or device (i.e. magnetic resonance imaging or computed tomography unit). While Lindsay et al, (2011) said that when assessing the performance of a radiology department six indicators are most

commonly used: productivity, reporting time, ease of access, finance and satisfaction (of both clinicians and patients.

2.4 RADIOLOGY TURNAROUND TIME

Mendelson and Rubin, (2013), argued on how we can measure the report "turnaround time" for radiologists in a practice. This is difficult without a standardized terminology. Does "turnaround time" refer to the time from order entry to final signature or from exam completion time to the time of a preliminary dictation or some other combination? According to Koivikko et al. (2008), a report turnaround time (RTT) was defined as the time from imaging at the modality to the time when the report was available for the clinician. While Chew F. and Chew A. (2008) defined report turnaround time (RTT) as a metric for quality, usually measuring the time from exam completion to finalized report (report turnaround time) or from preliminary report to finalized report (signature/ verification time). Likewise Mehta et al., (2000) defined turnaround time as the time from completion of a study on the hospital management information system to the time a report was available on the hospital information system. Mackinnon AD et al, (2008) defined reporting time as the time taken from patient registration to report availability. Nitrosi et al. (2007) also defined TAT as the sum of the time that elapses between the moment an imaging exam is ordered, its execution time (ET), and the reporting time (RT), which is the time lapse between the image execution time and the availability of the imaging exam's report.

Breil et al. (2011) described the 11 different time intervals found in radiology literature review. The most common definition was report TAT, which was measured from the X-ray completion until the availability of the radiology report in the HIS (10 articles). Four of these definitions concerned dictation-, typing- and signing-process, which ranged from X-ray completion until delivery of results (6 papers). The next frequent TAT definition was from radiology request to X-ray completion (5 papers). Three papers defined a TAT from radiology request to the availability of the report.

When clinicians evaluate radiologists' reports, some of their most common complaints relate to the availability of reports. Furthermore when they are asked to rank their demands for a high-quality radiology report, the most common problems with radiology reports is that 55% are not timely delivered (Yousem, 2008). Timely report finalization is an important aspect of quality in

diagnostic radiology (Morgan et al., (2008)). Hawkins R., (2007) further argued that turnaround time is one of the noticeable signs of diagnostic service and is often used as a key performance indicator of diagnostic performance. Quality can be defined as the ability of a product or service to satisfy the needs and expectations of the customer. Despite technical, transport and information technology improvement in recent decades, turnaround time continues to be a cause of customer dissatisfaction.

Lepanto et al, (2006) said that PACS shortens dictation turnaround time and increases productivity. These impacts were observed for different modalities with the greatest impact seen in plain radiography. Most radiologists recognize that the large improvement in report turnaround time is worth some additional effort on their part. However, increasing volumes of imaging workload per physician exerts countervailing pressure to increase individual productivity (Sistrom C., 2005) while Ralston et al., 2004 affirmed that there is largely achievement through tight integration of the PACS with the Radiology Information System (RIS) and with the dictation/ transcription system; that it has created a benefit for the radiologists in increasing productivity, balancing the workload, and decreasing stress levels. He further stressed that there are many possible ways to document and measure radiology report turnaround times, which will focus on the time between when the radiologist dictates an exam and when the typed report is available for the referring physician to read.

Mehta et al., (2000) said that the average time for a preliminary report for abdominal and pelvic CT, to be available in alphanumeric form on the hospital information system using hard-copy film was 3.73 days. The installation of a PACS system decreased this turnaround time to 0.56 days, representing an 85.0% improvement. Report turnaround times ranged from 0.002 to 25.8 days, with a median of 0.29 days

Ralston et al., (2004) study indicated that in the pre-PACS environment, report turnaround time averaged 50–100 hours. No reports were available to clinicians within 2 hours. The process of changing over to PACS, by itself, resulted in fundamental changes whereby approximately 50% of reports were viewed within 4 hours of the time they were dictated and that a typical turnaround time during routine day- time work hours is less than 2 hours. Overall, including nights and weekends, average report turnaround time has decreased to 15–20 hours, with 50% of all exams available within 1 hour. The proportion of reports that lag to beyond 24 hours is

typically less than 5%. The resulting improvements in the clinical timeliness and relevance of the radiology reports have been a gratifying enhancement to the way their radiology department is perceived within the medical community. Hurlen et al. (2010) indicated that the impact of the ICT introduction was that the radiology turnaround time (RTAT), i.e. the time from the examinations until the reports were completed, was reduced after one year. For preliminary reports, the median RTAT was reduced from 13.4 to 2.7 hours. For final reports, median RTAT was reduced from 22.6 to 15.1 hours. Mackinnon AD et al, (2008) study findings indicated that between 2002-2006 mean reporting times have improved substantially post-PACS, plain radiograph reporting time decreased by 26% (from 6.8 to 5 days; $p=0.002$) and specialty modalities reporting time by 24% (4.1 to 3.1 days; $p<0.001$).

Turnaround time is an important measure in radiology department as M Hardy et al, (2013) study findings indicate that the mean report turnaround time in the delayed reporting arm was 1.09 days (range 0.02–9.53 days) and was calculated as the average time from completion of radiographic examination to time of availability of a verified report. To determine the mean report turnaround time in the immediate reporting arm, the average time spent in radiology (from patient arrival at X-ray reception to patient referral back to the emergency department) was calculated for each arm and compared. In the delayed reporting arm, patients spent an average of 0.33 h (19.8 min) in the X-ray department compared to 0.41 h (24.6 min) in the immediate reporting arm. Consequently, the mean immediate report turnaround time was estimated to be 5 min (the difference in time between the two arms).

Nitrosi et al. (2007) study findings shows the data before and after the PACS implementation, a set of queries was created to automatically extract the information from the HIS/RIS data for the turnaround time (TAT). For MRI scans, the mean TAT decreased from 38.4 to 24.9 hours; for CT scans, the mean TAT decreased from 29.6 to 13.5 hours. To understand the improvement of traditional radiography exams, the chest x-ray examination was analyzed as one of the most common and standardized procedure. The mean TAT decreased from 36.0 to 8.9 hours.

2.5 KEY PERFORMANCE INDICATORS

According to Ibrahim (2001), Key performance indicators (KPIs) are measures that may be used to assess the health of an organization, define and quantitatively measure progress toward organizational goals. Furthermore Rubin et al., (2001) emphasized that KPIs also may be linked to an organization's strategy for success. Once KPIs are developed, they are rarely redefined or changed unless the organizational goals change. Thus, it is important that KPIs be meaningful, scientifically sound, and interpretable. According to the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO), a KPI is "a measurement tool used to monitor and evaluate the quality of important governance, management, clinical, and support functions". KPIs are especially helpful for assessing and measuring difficult-to-quantify processes such as healthcare quality. They can be integrated with strategic institutional objectives that include directional change, benchmarks, targets, and time frames. Progress can be tracked by using a performance dashboard or balanced scorecard (Abujudeh et al., 2010).

Balanced scorecards are used to track or measure key performance indicators; in the past few years a growing number of health care provider organizations have adopted the balanced scorecard (BSC) framework to develop a more comprehensive set of performance indicators. The BSC is a management tool, originally applied to business in the private sector (Kaplan and Norton, 1996). Its creators describe it as "a multidimensional framework for describing, implementing and managing strategy at all levels of the enterprise by linking objectives, initiatives and measures to an organization's strategy" (Weir et al, 2009). Among the conceptual frameworks employed for measuring organizational performance, the balanced scorecard (BSC) has steadily gained momentum as a popular strategic management tool in the health sector. In comparison to the traditional performance metrics that measure health outcomes, the scorecard offers an integrated measurement and management system, that links the mission and policy of the organization through strategic mapping of multiple performance domains facilitating benchmarking and fostering a culture of accountability (Weir et al., 2011).

Abujudeh et al., (2010) explained that the formulation of KPIs is intended to aid strategic decision making by facilitating the tracking of areas of departmental performance that have been targeted for improvement. KPIs are most effective in encouraging improvement if they are integrated into staff performance appraisals and linked to financial compensation. The moni-

toring and revision of KPIs should be dynamic; if a KPI is no longer relevant, it should be replaced. For example, when a published report showed that improvement in hand hygiene was a hospital-wide safety initiative that was incorporated into the initial list of KPIs. After the targeted level of hand hygiene was achieved or exceeded for a period of time specified by the departmental leadership, this KPI can be replaced by others with greater strategic importance.

2.5.1 CHARACTERISTICS OF KEY PERFORMANCE INDICATORS

Parmenter, (2010) stated that the most important characteristic of KPIs is that they cannot be expressed in terms of currency for example in dollars, yen or pounds. He concluded that KPIs are nonfinancial measures. Among other characteristics, the author further pointed out that they should be measured frequently (daily, weekly, monthly or yearly) to allow in depth analysis. Once analyzed, they should be acted on by CEO and senior management team and discussions should be held with relevant staff to enquire what is going on in the institution. After the discussion with the interested parties, the KPIs clearly indicate what action is required to be taken by staff. This shows that the KPIs are measures that tie the responsibility down to the team and this has a significant impact as they encourage taking appropriate action.

2.5.2 IMPLEMENTATION OF KEY PERFORMANCE INDICATORS

Abujudeh and Bruno (2012) said that the most important step for success in performance measurement is in how the PIs and KPIs are introduced and implemented in the organization. Furthermore they explained four foundation stones for the successful development and utilization of KPIs in any organizations, which are (1) a strong partnership with all organization's members and customers, (2) a transfer of power to the front line, (3) the integration of measurements, the reporting and improvement of performance, and (4) the linkage of performance measures to the organization's strategy. Finally they emphasized that since the changes brought about via PIs and KPIs can be great, a significant mutual understanding and acceptance of the need for change among management, employees, unions and customers is very important. Hence performance is measured and reported in a way that results in action.

The health care system is complex, difficult to understand, and hard to manage. Given the current concern for health care accountability and quality, a robust policy approach to

performance monitoring must be devised to support the growing demands of the public for high-quality care.

2.5.3 KEY PERFOMANCE INDICATORS IN RADIOLOGY

WHO strategic orientations into key performance indicators are encompassed into six interrelated dimensions: clinical effectiveness, safety, patient centeredness, responsive governance, staff orientation, and efficiency. It advocates a multidimensional approach of hospital performance: all dimensions are considered interdependent and are to be assessed simultaneously. This multidimensional approach forms the basis of the definition of hospital performance including the radiology department. Table 2.1 provides the detailed explanation of the key performance indicators that can be evaluated in a radiology department (Abujudeh et al., 2010).

Table 2.1 Radiology key performance indicators

Key Factor and Related KPIs	**Metrics**
Clinical performance	
Intradepartmental division success rates	Peer review of image interpretation by staff, correlation of radiologic findings with pathologic findings, complications rate
Department-wide success rates	False-positive and false-negative rates, peer review agreement rate, percentage of examinations with unnecessary recommendations
Communication with referring physicians	Audits of e-mail alerts sent to physicians, rate of compliance with standardized protocols, and rate of compliance with report quality standards
Research	
Funding	Amount of funding received, source of funding, contribution of radiology depart-ment resources to research

Publications	Numbers of publications in peer-reviewed and non–peer-reviewed journals, rank of authors, number of patents
Patient experience (service level)	
Outpatient service	Survey of patients receiving pre-appointment examination information and education, measurement of waiting time from patient arrival to beginning of examination, measurement of appointment delay from scheduled examination time to beginning of examination, outpatient report turnaround time
Outpatient access	Appointment availability (overall score, percentage of open slots for the next 30 days)
Safety	Number of incidents resulting in patient injury
Inpatient service	Inpatient report turnaround time, inpatient imaging turnaround time
Resource utilization and productivity	
Equipment idle time	Percentage of time when equipment is unavailable because of unscheduled downtime
Equipment utilization	Ratio of number of hours available to number of hours in use
Equipment staffing level	Ratio of number of imaging staff (technologists, technologist assistants) to number of machines
Professional staff productivity	Number of reports generated (relative value units) per professional full-time employee (radiologist)

Technical staff productivity	Number of examinations performed (relative value units) per staff full-time employee (technologist, technologist assistant)
Referring physicians and their staff	
Satisfaction	Survey of referring physicians, survey of their staff (numeric rating on a scale of 0–10)
Report turnaround time	Outpatient report turnaround time, inpatient report turnaround time
Comments	Numbers of complaints, requests, and compliments received by telephone or e-mail
Patients	
Satisfaction	Numeric rating on a scale of 0–10
Outpatient access	Appointment availability as a score and as a percentage of openings in the schedule for the next 30 days
Comments	Numbers of complaints, requests, and compliments received by telephone or e-mail
Compensation and recognition	
Recognition of performance excellence	Number of awards distributed, total dollar amount of pay incentives disbursed for excellent performance
Actual and relative pay scales	Comparison of pay at each level with that at the same level in other radiology departments, overall rank among radiology departments (percentile)
Resources	

Equipment quality	Average age (in months) of major imaging and information technology systems, number of late-generation imaging devices, variance in number of hours of scheduled maintenance from manufacturer recommendations
Equipment availability	Machine downtime not due to scheduled maintenance (in hours per week or month)
Equipment diversity	Number of machine manufacturers represented
Equipment staffing levels	Ratio of imaging staff (technologists and technologist assistants) to imaging machines
Continuing education	
Access	Annual numbers of courses and training programs offered
Utilization	Percentages of staff participating (department-wide and per role within the department)
Work-life balance	
Vacation utilization	Number of vacation days available, ratio of vacation days used to days available
Workload	Average overtime hours worked (per employee)
Commute	Average hours spent commuting to work (per employee)
Variety of work	Average number of different examination types performed by technologist

2.6 USE OF INFORMATION TECHNOLOGY IN HEALTH CARE

According to Novak et al (2012), there is widespread agreement that electronic health records (EHRs) and other clinical informatics applications have significant potential for improving healthcare. Yet, the adoption and use of informatics tools vary with the local context, producing results that are unpredictable and dynamic. Also, they documented unintended consequences of informatics implementations that create inefficiencies for users and threaten patient safety and concluded that improving the safety and success of informatics implementations and related user adaptations in work practice is very important. Hence Lorenzi et al (2008) said that the implementation research in healthcare informatics has produced valuable case studies that present lessons learned, analyses producing classifications of unintended consequences, explications of best practices, and conceptual models of work, tools, and behavior. Finally Ammenwerth and de Keizer (2007) stated that healthcare IT systems have been shown to increase quality and efficiency of health care. However, there are also examples where IT systems failed to provide the expected benefits or even seem to have negative effects on patient care. The effectiveness of the HMIS in part depends on data reporting and feedback relationships as well as on trained and motivated staff at each level that properly carry out their data collection, reporting and use responsibilities (David et al. 2005).

2.6.1 INFORMATION TECHNOLOGY IN RADIOLOGY

Information technology has been widely used to enhance quality of care in the department of radiology in many settings. The PACS integration with the radiology department's diagnostic modalities, RIS/ HIS and the electronic medical record (EMR) leverages the overall PACS benefits (Buccoliero et al. 2009). Nitrosi et al. (2007) further argued that a well-planned, fully integrated digital radiology department can simplify workflow throughout the hospital. PACS technology, empowered with speech recognition systems and web distribution tools, can deliver significant benefits to a health care institution. Staff and interdepartmental cooperation is important to this process. Driving workflow optimization and detailed continuous performance monitoring are a must, as well. Lepanto, (2003) further said that the introduction of information technology is seen as an opportunity to improve efficiency and quality in all facets of operation in a radiology department. An important justification for the introduction of information technology in imaging departments is the expected impact on productivity. These technologies,

by either eliminating or shortening steps in the traditional workflow, have been shown to increase productivity. The Radiology Information System (RIS) makes it possible to follow the status of individual examinations from the moment a study is requested until the moment a final report is available. This allows a time-line study of the workflow in a radiology department and also makes it possible to assess the impact of various modifications to the various processes.

Janick (2008) said that a PACS system needs to accept images sent by the various imaging modalities; he further explained that organization of studies by location, modality, dictation status, or dates all have their place. The images need to be organized in an efficient and effective manner to speed viewing and facilitate reporting. Lepanto (2003) further stressed that the timely delivery of radiology reports is an important objective in any department. Many steps are involved, from the moment an imaging study is requested to the moment a final report is produced and available, either on paper or on a computer network. The introduction of electronic signature can accelerate this process by shortening the time between transcription and signature. The moment the reports are signed, they immediately become available on the hospital information network and are identified as final. Electronic signature significantly shortens the time between transcription and finalization of radiology reports. The RIS allows assessment of workflow by recording the timeline of status changes of imaging studies and can be used to evaluate the impact of interventions on the processes in a radiology department.

The implementation of a Radiology Information System (RIS) and a Picture Archiving and Communication System (PACS), and the integration of these systems with the Electronic Medical Record (EMR), may improve the use of diagnostic imaging in clinical practice. This Information and Communication Technology (ICT) can reduce the radiologists' reporting time, and make the reports and images instantly available to clinicians (Hurlen et al. 2010). Janick, (2008) stressed that there are needs to have an interface between the PACS system and HMIS. Unless the two systems are directly integrated by a single vendor, information is sent from the HMIS to the PACS system using an HL-7 interface. De Azevedo–Marques et al., 2004 also said that the HMIS/PACS integration is the basis for a successful electronic radiology practice, preventing data inconsistency and assuring the integrity of information among the involved databases.

The RIS manages and stores the textual information for the patients, the studies, and the study reports. The RIS can stand alone or be integrated with the HIS. With a stand-alone RIS, the imaging- related HIS functions are taken up by the RIS itself. Specifically, in most hospital environments, the HIS either contains or is closely integrated with a master patient index (MPI), which stores the name and medical record number of the patients in the information system. Order entry may occur directly through the RIS or through the HIS (Janick, 2008). He further said that the scheduling program may be embedded directly in the RIS or HIS, or it may be a standalone radiology specific or enterprise-wide product. If order entry information is populated within the system, it is important that this information flows back to the RIS and appears on the study requisition. RIS and HIS systems evolve very slowly; part of the reason is that extreme care must be taken to assure data integrity, rock solid stability, and backward compatibility with prior versions. PACS has greatly increased radiology productivity and efficiency. Improved information transfer increases clinical accuracy and effectiveness.

The future will be hyperlinked and integrated: a PACS-integrated digital dashboard designed to alert radiologists to their unsigned report queue status, coupled with an actionable link to the report signing application, is an effective method of decreasing report turnaround times according to Morgan et al., (2008)

The HIS (or the responsible departmental information systems) must record particular examination times, results, and billable information. Clearly the most dramatic point is the accelerated turnaround time of information and its availability. Furthermore, when used in conjunction with other computer assisted methods (eg, voice recognition), the acceleration of diagnostic reports to the primary physicians may greatly increase the referrer's confidence that diagnostic examinations will provide timely input in treatment decisions (Langer S., 2000). Mehta et al., (2000) said that as an addition to PACS, voice recognition software empowers the radiologist to provide timely and accurate interpretation services. Besides Buccoliero et al. (2009) alleged that PACS may be implemented with different levels of integration with the Radiology Information System (RIS) and with the rest of the Hospital Information System (HIS). As far as personnel is concerned, studies assessing the impact associated with organizational processes redesign show, on one hand, improved stability in the number of clinical and technical personnel and, on the other hand, a drop in the number of administrative personnel (secretarial tasks and filing). However, this effect does not depend exclusively on the technology. Rather, it

is the result of the analysis and redesign of the organization processes coherent with the PACS scale, the new technology potential, and the skills of the people involved in the change. Finally Caterina et al., (2006) said that a remarkable advantage of radiology information systems (RIS) and picture archiving and communication systems (PACS), is that they enable filmless and paperless operations.

2.7 RADIOLOGY QUALITY IMPROVEMENT

The achievement of an optimal quality of care not only requires solid information, accurate problem identification, and rigorous analysis; it also depends on the ability to measure and re-measure performance. Recurring measurement of healthcare quality is important for determining whether an action has led to improvement of care. Because imaging services are widely used and affect patient care in every area of a hospital, much attention has been focused on quality assurance in radiology departments over the past several years (Abujudeh et al., 2010). While Knechtges and Carlos, (2008) believed that advances in imaging and information technology have increased the importance of the radiologist not only by increasing utilization of diagnostic imaging, but also by moving the radiologist into a more central role in integrated patient care. They further emphasize that while image generation and interpretation remain central to the practice of radiology, the radiologist's role in the integrated healthcare system has expanded to provide significantly more value to the healthcare system. The results of the radiological examination may determine the need for additional diagnostic tests, specialist referral and/or hospital admission.

Radiologists are under pressure to add more value to medical imaging to provide more educated, accurate, useful, and efficient interpretations in the face of increasingly large and complex imaging studies and to communicate this information quickly and in the most useful manner (Geis, 2007). Whereas Abujudeh et al., (2010) acknowledged that given the growing demands for quality improvement in radiology practice, it is increasingly important to develop a standard set of metrics for the routine evaluation of radiology department operations and patient care. Such metrics could also be used in conjunction with the Practice Quality Improvement program (part of the American Board of Radiology maintenance of certification process) to measure individual radiologists' performance. Thus Cook et al., (2013) said that there is a movement to

assess physicians' clinical performance in everyday practice to allow identification of poorly performing physicians and to guide quality improvement and professional development.

Morgan et al., (2008) alleged that with the increasing complexity of digital information management, radiology departments must focus not only on being more efficient, but also on being more effective. Work flows are optimized when radiologists have real-time information to make informed decisions, and the capacity to efficiently act on that information. Whereas Chew F. and Chew A. (2008) said that one of the most important duties of the leader of a radiology practice or department is to create the opportunities for his or her people to do their very best. Sometimes it becomes necessary to try to measure precisely how well they are doing and learn whether their performance is improving and if their performance is not as good as it should be, it may become necessary to change their behavior or to motivate them.

Reiner (2013) thought that radiologists and clinicians providing diagnostic interpretation of medical imaging exams would therefore be provided with a powerful incentive to continuously refine their skills, adopt decision support technologies, and perform targeted continuing medical education, in an effort to enhance their diagnostic performance measures. It is important to note that both the information and the methods for obtaining it already exist in most systems. Most departments already accumulate data and run reports for administrative and quality assurance purposes from their PACS, RIS, and/or other systems using standard methods and protocols such as Health Level Seven (HL7). However, increased complexity of digital systems and their supporting infrastructures have created an environment wherein radiologists are faced with the task of operating within complex systems but lack the tools to efficiently and effectively monitor these systems in real time. A PACS-integrated digital dashboard can help address this system deficiency and facilitate informed, optimized workflow decisions. Possible applications include workflow consolidation, workload distribution, and urgency evaluation. A dashboard should be optimized, context-specific, customizable, and workflow-integrated (Morgan et al., 2006)

2.7.1 RADIOLOGIST REPORT GENERATION AND REVIEW

Before RIS implementation, reports were entered manually, checked by specialists, forwarded for typing, then printed, corrected, reprinted, signed, and forwarded to the medical archive service. This process had an average turnaround time of 2–3 days. With RIS implementation

turnaround time was reduced considerably because once the report was reviewed it was made available for online search (De Azevedo–Marques et al., 2004). Janick, (2008) explained that with conventional transcription, the transcribed report needs to be imported into the RIS and made available to the radiologist for approval. There needs to be a mechanism for the radiologist to know that reports are awaiting approval. Next, the radiologist must open the reports within a viewing application and cycle through the reports. Editing may be possible directly within the application or may require opening the report in an external word processing application. Once approved, the report needs to be locked for legal purposes and any further modification must be made in the form of an addendum. Last of all, there should be an administrative tool that alerts the ‘‘boss’’ to unsigned reports; this produces the sometimes needed ‘‘loving’’ reminder that all reports must be signed. It is also useful if the system can generate standard reports to show report turnaround and sign-off times. This should be a motivator and a generator of important measures of quality.

According to Bosmans et al., (2012) structured reporting systems may lead to rapid report turnaround time, reduced reporting costs, improved communication, more satisfied referring providers, and simplified quality and compliance reporting. Furthermore Abujudeh et al (2010) confirmed that for several years, their department encouraged structured reporting in the belief that this practice would help decrease variation among radiologists' reports of similar studies. It was thought that greater consistency in reporting style would facilitate reading and comprehension by referring physicians. Initially, the department provided templates that radiologists could access electronically and use as a skeletal structure for completing their reports. Penetration and acceptance of this reporting method in their department varied significantly according to modality. For example, the chest radiography report template was used in about 24% of cases in 2007, whereas the neck CT report template was used in about 84% of cases. Adoption of a new dictation system that inserts the appropriate electronic template automatically into each study (so that the radiologist no longer has to actively retrieve it) resulted in increased compliance of more than 90% across modalities. After multiple measurements showing that compliance consistently exceeded 90%, they stopped measuring this parameter.

Langer S., (2000) supposed that the implementation of medical center-wide voice recognition capability or structured reporting templates will shrink transcription turnaround from hours to

minutes. The time from radiology dictation to reach EMR (human transcription) would be 4 to 6 hr. Consequently Hawkins et al (2012) said that there are many benefits to using speech recognition software to dictate radiology reports. Its use has dramatically decreased the amount of time between performing a radiology study and having a signed, dictated report available to the healthcare providers caring for the patient. Many radiology departments have demonstrated a marked improvement in turnaround time after implementing speech recognition software. Therefore Janick (2008) explained that at the time of study interpretation, all the acquired information regarding the patient, the study, and the patient's past radiology history needs to be available at the radiologists' fingertips to facilitate interpretation. Ideally, the information is filtered and arranged in an optimum order and style for maximum efficiency. Finally Mendelson and Rubin, (2013) said that there are applications available, primarily voice recognition transcription systems with recognition engines that can approach 99% accuracy or better for some users.

The technologist performs the study and prepares the images for the radiologist, who may need to be consulted before or during the procedure to direct the imaging protocol. The images are viewed by the radiologist and interpreted within the clinical context of the patient history, if the findings are critical or the clinical situation requires it, the radiologist may need to transmit a preliminary interpretation in advance of either the final interpretation or transcription of the dictated report. The final report needs to be reviewed and signed by the interpreting radiologist (Janick, 2008). Chew F. and Chew A. (2008) stated that because radiology reporting in the radiology information systems record when patients are scheduled, when they arrive, when their examinations become ready for interpretation, when their reports are finalized, and all of the intermediate steps, this work flow analysis may be used to identify bottlenecks in the system. In conclusion Caterina et al., (2006) explained that radiological workflow starts with examination booking, but the data collection started with patient registration, which marks the time when the patient approaches the admittance front office. The whole process ends when the report is in the hands of the patient and Yousem (2008) said that the end product of a radiologist's work is an official finalized report, which is their contribution to patient care and that a radiologist's report should be concise, complete, timely, accurate, and helpful to patient management.

M Hardy et al, (2013) said that the reporting of some radiographs has been delegated to appropriately qualified radiographers, and previous studies have demonstrated that the quality and accuracy of radiographer reports are similar to those of consultant radiologists, despite the increasing reporting capacity as a consequence of radiographer involvement in reporting.

According to Schwartz et al, (2011) the radiology report is generally the key point of contact between radiology and other medical specialties. Clinicians are demanding faster report turn-around times. He further argued that the complexity of medical imaging has increased dramatically over the past few decades, providing radiologists with an ever-larger number of images to interpret and more imaging modalities to compare. The style and format of radiology reports have generally remained unaltered. Most reports still contain free-form text dictated or typed by the radiologist, with an introductory section (summarizing the examination technique and clinical history), a main body (consisting of a paragraph or more describing the findings), and a brief overall impression section.

CHAPTER 3: RESEARCH METHODOLOGY

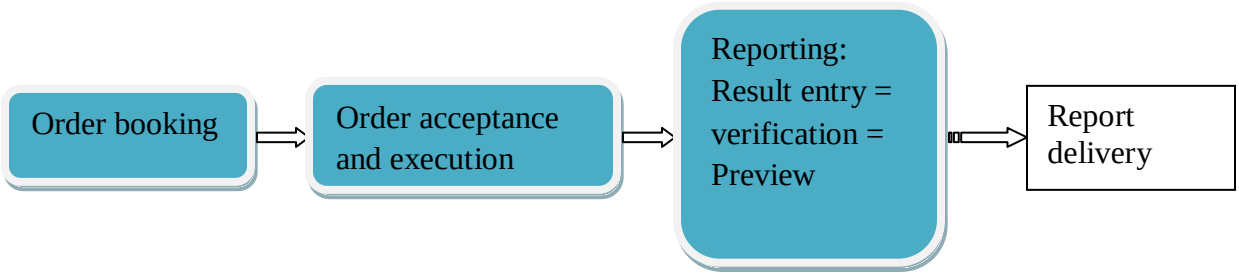
3.1. STUDY AREA

The present study was conducted at the KFH referral hospital in Kigali City. Specifically, the study was conducted in the imaging center of the hospital, which is a state-of-the-art diagnostic unit that allows the hospital to offer a full range of radio-diagnostic services to the national and regional patients. The imaging center is equipped with a wide range of radiology equipment which includes: the General Conventional Radiography, CT-Scan, Ultrasound and Mammography, and Fluoroscopy machines. The King Faisal imaging center is the only hospital in Rwanda that possesses an MRI scan.

The Hospital Management Information System (HMIS) at KFH, named NAPIER, provides seamless integration with devices used in the hospital diagnostic practices. One of the widely used integrated devices is the Picture Archiving and Communication System (PACS) dedicated to store electronic images generated by imaging machines (called modalities) against a particular patient's record for future use and reference.

3.2. STUDY DESIGN

A cross sectional, descriptive, quantitative study design was used in this study. The study is quantitative in nature because the data was obtained in numerical form from the Hospital Management Information System. The NAPIER hospital management information system specifically in radiology recorded all the processes from order booking, order acceptance, result entry, result verification, print or preview to report delivery.



3.3. STUDY POPULATION

This study worked virtually with staff working in the imaging center department at the KFH for the reason that there was no direct or face to face contact; only the data they entered into the NAPIER hospital management information system was the basis of this study. There are 15 medical personnel working in the imaging center of the hospital comprised of 11 radiographers and 4 radiologists. The center receives on average 35 patients per day and this study analyzed data for a period of 1 year.

3.4. STUDY SAMPLE AND SAMPLING STRATEGY

The performance was assessed for all 15 staff working in the imaging center at King Faisal Hospital.

The data analyzed have been extracted from the HMIS NAPIER database and have been exported into Microsoft Excel. These data cover the period from October 2013 to September 2014.

3.5. DATA COLLECTION METHODS AND PROCEDURES

3.5.1. DATA COLLECTION INSTRUMENT

Data was accessed from the HMIS (NAPIER) to collect information pertaining to the staff KPIs. Daily, monthly and annual activity data was extracted from the HMIS using Structured Query Language (SQL) in order to generate activity tables as shown in APPENDIX B, C and D respectively. These tables presented the information coming from the system related to the volume of cases or tasks handled per staff or number of examinations performed (units) per staff.

3.5.2. DATA COLLECTION PROCEDURE

After obtaining the ethical clearance, permission to conduct the study was sought from King Faisal Hospital. The human resource directorate was approached to identify currently used staff performance procedures and further discuss on the purpose of the study.

Some of the radiologists and radiographers of the imaging center department were approached at their convenient time seeking explanation about the data extracted from the hospital management information system after introducing the researcher and explaining the purpose of the study.

Furthermore the IT department was asked to provide access to the HMIS for collecting the data pertaining to the staff performance for a period of 1 year.

3.6. DATA ANALYSIS

After the data collection, we improved the capture sheet according to the data extracted. Clarifications were sought in order to understand some codes. i.e staff codes in order to differentiate radiographers from radiologists.

Data was analyzed descriptively, using the Microsoft Excel program. Staff data entered into the hospital management information system was evaluated in order to check their productivity. Examination volume performed by each staff member was summed up and therefore easy comparison could be made for individual productivity over time and with peers.

Imaging turnaround time and reporting turnaround time was calculated manually.

The analyzed data was presented by means of charts and tables. Percentages were provided as well.

3.7 PROBLEMS AND LIMITATIONS OF THE STUDY

3.7.1 PROBLEMS

The researcher encountered problems to secure the permission to conduct the study. The institutional review board, the KFH, K ethics and research committee took longer as the proposal had to be read by the reviewers who are already busy with their work. Even after the approval, the KFH, K ethics and research committee secretariat took longer to produce the report and the approval letter to the researcher. Challenges were faced to obtain the data because it was the first time that the IT staff retrieved such information. Furthermore, it was difficult to obtain the explanation of some of the data obtained as some of the staff was not familiar with the data retrieved from the system. This problem had an impact on the interpretation and discussion of some of the results obtained.

3.7.2 LIMITATIONS

“The Hospital Management Information System (HMIS) at KFH, named NAPIER, provides seamless integration with devices used in the hospital diagnostic practices” this information was quoted from KFH website, but the reality on the ground is that NAPIER HMIS and PACS are not fully integrated.

The researcher could not have access to PACS database because it is managed by (external contractors) who could not avail the data needed by the researcher.

3.8 ETHICAL STANDARDS

Ethical clearance was obtained from the College of Medicine and Health Sciences Research Ethics and Consultancy Committee. Permission to conduct the study was sought from the authorities of King Faisal Hospital. The KFH, K ethics and research committee reviewed the dissertation proposal and granted the researcher with a temporary permission to gather more information about the NAPIER hospital management information system. The researcher addressed the comments of the KFH, K ethics and research committee and finally got granted a full permission to conduct the study on condition that the researcher should deposit a final copy of the research in the office of continuing quality improvement in KFH for their records. The data obtained was used for the academic and research purposes only.

CHAPTER 4: RESULTS PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter presents the results of this study. This includes the identification of electronic KPI to be included in the staff evaluation or appraisal which are daily, monthly and annual production of clinical procedures by the imaging center staff recorded in the management information system, the time spent on clinical procedures (imaging turnaround time) and the time spent from exam execution till obtaining the imaging report (reporting turnaround time).

The imaging center has 15 staff members: 4 radiologists whereby 2 are permanent and 2 work on part time basis and 11 full time radiographers who rotate everyday in different imaging procedures according to the roster. The day shift starts from 7 am to 7 pm and is comprised of all personnel available excluding 2 who perform the night shift that runs from 7 pm to 7 am.

The data analyzed below have been extracted from the HMIS NAPIER database and have been exported into Excel.

4.2 ELETRONIC KEY PERFORMANCE INDICATORS

In KFH HMIS, Three electronic key performance indicators have been identified based on activity related data which could assist in making informed decision, effectively monitor operation hence improve efficiency of staff output. These are staff productivity, imaging turnaround time and reporting turnaround time. They can be integrated into the actual staff appraisal currently used at KFH. Other indicators like equipment idle and utilization time could not be analyzed because of missing information while others like image quality and reporting errors are beyond the researcher’s capacity.

4.2.1 RADIOLOGY STAFF PRODUCTIVITY MEASUREMENT

4.2.1.1 DAILY STAFF PRODUCTIVITY

Table 4.1: Daily staff productivity results

Staff code	Staff category	Exam type	Exam number	Total
RD13	Radiographer	X-RAY ABDOMEN	1	
		X-RAY OF THE, HIP/KNEE/ANKLE/WRIST/ELBOW/SHOULDER /TMJ/PER VIEW	1	2
RD6	Radiographer	MRI SPINE LUMBAR	4	
		BILATERAL MAMMOGRAPHY	4	
		EXAMINATION OF THE WHOLE ABDOMEN	1	
		ULTRASOUND EXAMINATION OF THE ABDOMEN	9	
		ULTRASOUND GUIDED BIPOSIES OF DEEP ORGANS,E.G, LIVER/RENAL/PANCREATIC/PERITONEAL/RETROPERITONEAL LESIONS.	6	
		ULTRASOUND OF THE PELVIS	1	25
RD4	Radiographer	X-RAY CHEST	3	3
RD1	Radiographer	NON CONTRAST CT ABDOMEN (INCLUDING BASE OF CHEST)	1	
		CONTRAST CT SCAN EXTRA	1	
		X-RAY CHEST	1	
		X-RAY ABDOMEN	1	
		MRI PELVIS OBSTETRIC	1	
		X-RAY SPINE	1	
		MRI1	1	6

The results of this study show the possibility of determining the performance of the staff on a daily basis looking at the examination volume recorded into the system.

Table 4.1 shows the results of the exams performed by each staff member on a day chosen randomly in the record from one year.

On this day there were 4 radiographers on duty. They performed 36 radiology examinations in total. The number and type of exams performed are different for each radiographer (e.g. radiographer RD13 did 2 procedures while RD6 performed 25).

4.2.1.2 MONTHLY STAFF PRODUCTIVITY

Table 4.2: Monthly staff productivity

Staff code	Staff category	Week 1	Week 2	Week 3	Week 4	TOTAL
RADIOGRAPHER						
RD1		9	15	1	1	26
RD2		18	13	5	13	49
RD3		21	19	24	5	69
RD4		9	19	6	21	55
RD5		8	7	8	4	27
RD6		58	35	0	0	93
RD13		7	12	7	4	30
RD8		6	8	0	4	18
RD9		7	8	7	9	31
RD14		0	3	10	18	31
RD12		2	13	11	8	34
RADIOLOGIST PART TIME						
RD10		0	0	36	34	70
RADIOLOGIST FULL TIME						
RD11		14	4	11	0	29
RD7		2	3	11	39	55

The results of this study show that examination volume can be measured on a monthly basis. Table 4.2 shows the results obtained in a randomly selected month.

The total monthly examination volume was 617 exams whereby 75% (463) were performed by radiographers, 11.3% (70) were performed by a part time radiologist and 13.6% (84) were performed by full time radiologist.

Four of the radiographers RD9, RD12, RD13 and RD14 performed almost the same number of examinations during this month (5% (31), 5.5% (34), 4.8% (30) and 5% (31) exams respectively).

The highest examination volume was performed by RD6 with 15% (93) exams while the lowest was performed by RD8 with 2.9% (18).

For example RD12 performed 2, 13, 11, 8 exams during week 1, 2, 3, 4 respectively. This clearly shows the individual performance overtime.

4.2.1.3 ANNUAL STAFF PRODUCTIVITY

The findings of this study show that examination volume can be measured for the whole year.

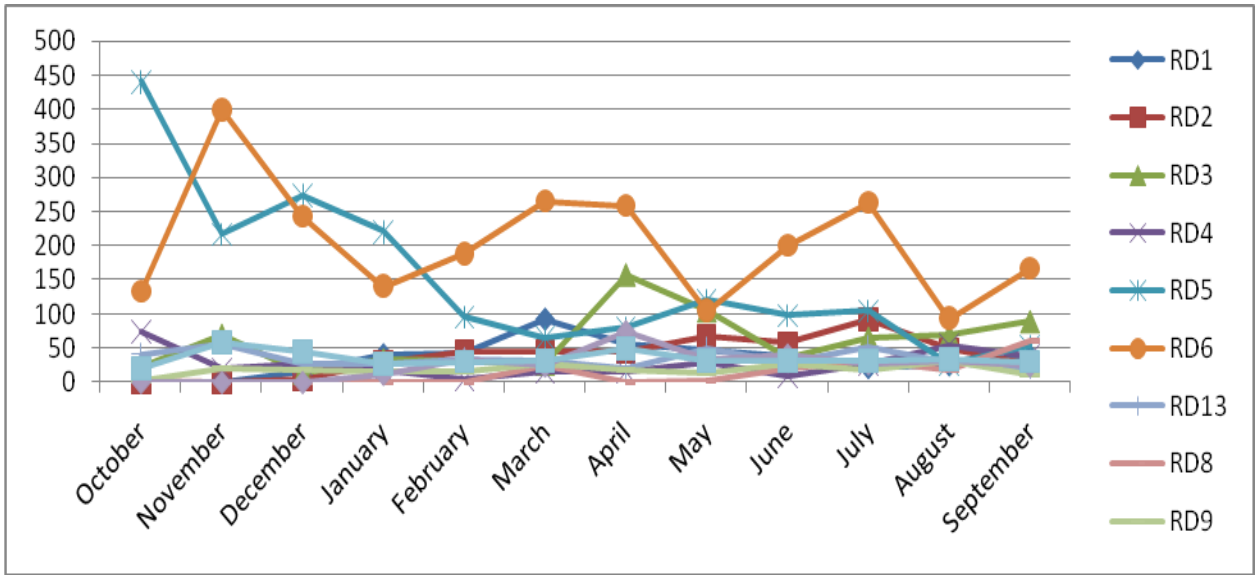


Figure 4.1: Annual staff productivity for radiographers

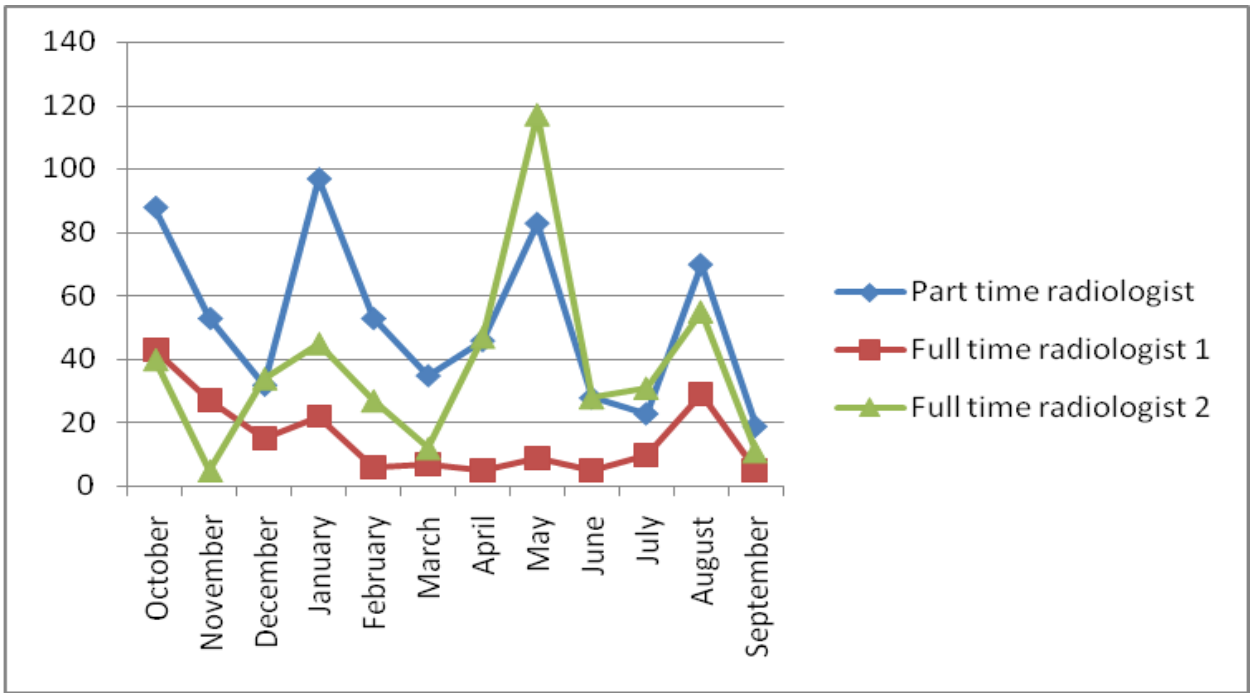


Figure 4.2: Annual staff productivity for the radiologists

Figure 4.1 and Figure 4.2 show the results obtained for radiographer annual productivity and radiologists respectively for a period of a year that starts from October 2013 to September 2014. The total annual examination volume was 6436 exams whereby 85% (5511) were performed by radiographers, 7% (454) by a part time radiologist and 7.3% (471) by full time radiologists.

The above figures show that despite the fact that staff falling within the same category (radiographer or radiologist) and working on the same hours, some of them have a remarkable higher productivity compared to others.

4.2.2 IMAGING TURNAROUND TIME

Table 4.3: Imaging turnaround time (minutes)

Exam	Total no	avg time (min)	RD1	RD2	RD3	RD4	RD5	RD6	RD7	RD8	RD9	RD10	RD11	RD12	RD13	RD14
FINE NEEDLE ASPIRATION (SUPERFICIAL LESIONS)	1	**1**				1										
MRI SPINE LUMBAR	26	**134**			63			146	235			159	97			0
MRI CHEST SEQUENCES	1	**1**														1
MRI TEMPORAL BONE HR	1	**0**	0													
DCE-MRI(DCE-DYNAMIC CONTRAST ENHANCED)	4	**0.9**		0.25		0				0					1	
MRI OTHERS SERVICES	4	**1.25**					3								1	0.5

28	2	**0.5**								1				0		
X-RAY CHEST	127	**9.6**	2.5	0.3	13.8	0.75	0.8		189	0.4	33			2.5	0.13	1.2
X-RAY ABDOMEN	12	**246**	1	0	60	1.5	0							1	0.5	2830
X-RAY SPINE	16	**23.8**	0	0.66	2	122.6	0.3							2		1
X-RAY LIMBS	18	**2.4**		0.75	1	31	1			18	0.5			0.57	0	
X-RAY PELVIS/PER VIEW	2	**0.5**					0							1		
BARIUM MEAL AND DEDICATED GASTRO-INTESTINAL TRACT FOLLOW THROUGH	1	**1**				1										
908202	3	**261**	14			499					9					

908203	2	**423**			15				832							
BILATERAL MAMMOGRAPHY	33	**1499**						169	800		128	2835	1812			
CT SCAN BRAIN	7	**76**			79	374					0			1		1.5
CT SCAN CHEST WITHOUT CONTRAST	9	**28.7**		0	1.3							253		1	0.5	
CT SPINE CERVICAL	2	**0.5**		1						0						
NON CONTRAST CT ABDOMEN (INCLUDING BASE OF CHEST)	10	**1.6**	1		2.25	0	3			0						0
EXAMINATION OF THE WHOLE ABDOMEN	11	**573.4**						565	1386			90.6				0.5

HIGH DEFINITION SCAN (SMALL PARTS): THYROID, BREAST LUMP, SCROTUM, ETC	2	**0.5**														
ULTRASOUND EXAMINATION OF THE ABDOMEN	121	**308.5**	233	459	198	509		145	677	258	220	412	349	174		69
CTG CAESA SECTION	1	**450**			450											
CT NECK SOFT TISSUE	1	**2**			2											
CT Abdominal without CONTRAST	2	**5.5**	0			11										
NON CONTRAST CT BRAIN SCAN	23	**12.5**		0.5	23.6	0	1			0	0,66			0	0	
CONTRAST CT SCAN EXTRA	31	**29.7**	1	0.3	26.4	65.5	2			0	0	227		1	0.3	

X-RAY, FOOT/HAND /FINGER/TO E/CALCANE US/PER VIEW	6	**0.5**		0.3	0			1			1					
X-RAY FEMUR/TIBI A/FIBULA/H UMERUS/UL NAR/RADIU S/CLAVICLE /PER SEGMENT	3	**0.3**					0			1					0	
X-RAY OF THE, HIP/KNEE/A NKLE/WRIS T/ELBOW/S HOULDER/T MJ/PER VIEW	8	**3.25**		0.5		23	0.5			1					0	
MRI PELVIS OBSTETRIC	2	**1**	1													
MRI OF THE HIP/PER HIP JOINT	1	**0**	0													
MRI1	14	**15**	1		2		42.4				0.5	0			0	
MRI NECK TISSUE-VASCULAR	1	**0**												0		

MRI BREAST-PER BREAST	2	**119.5**										238		1		
MRI CARDIAC	2	**12.5**									24			1		
POST CONTRAST CT SCAN /ADDITIONAL	3	**13.6**	11					30								0
ULTRASOUND CHEST	75	**694.9**			41	65		1182.4	439.8	276	22	620.8	497.8			1130
ULTRASOUND GUIDED TRANSRECTAL PROSTATE BIOPSY	2	**0**									0					0
ULTRASOUND OF THE PELVIS	14	**802**						118	858			1401.5				
ULTRASOUND CHEST	6	**0.5**						0.5								
TOTAL	612	**137**														

RD: Radiologist or radiographer

Time is expressed in **minutes**

The results of this study show the imaging turnaround time which is the time from when the exam has been booked up to the time it is performed. Table 4.4 shows the average time each staff spent in imaging turnaround time per exam for a period of one month. The total number of examinations which were used in the calculation of the imaging turnaround time is 612 and the total average imaging turnaround time is 137 minutes (2 hours 17 minutes) whereby the exam with the lowest imaging turnaround time is 0 minutes and the exam with the highest imaging turnaround time is 1499 minutes (24 hours 59 minutes).

The results also show the average imaging turnaround time per exam and the average imaging turnaround time that each staff spent on a particular exam. For example for MRI spine lumbar exam, a total number of 26 exams were performed and the average imaging turnaround time is 134 minutes (2 hours 14 minutes) whereby the staff RD7 had the highest average imaging turnaround time (235 minutes or 3 hours 55 minutes) and staff RD14 had the lowest turnaround time for that particular exam (0 minutes).

4.2.3 REPORTING TURNAROUND TIME

Table 4.4: Reporting turnaround time

Exam	**Total number**	**Average time (minutes)**	**R0**		**R2**		**R3**		**R5**		**R20**	
			N	**Time**	**N**	**time**	**n**	**time**	**n**	**time**	**n**	**time**
MRI spine lumbar	87	**308**	4	**68**	24	**936**	19	**18**	23	**125**	17	**50**
UNILATERAL MAMMOGRAPHY	42	**137**	12	**300**	17	**24**	11	**155**	1	**0**	1	**34**
BILATERAL MAMMOGRAPHY	404	**233**	142	**391**	88	**192**	131	**19**	11	**1163**	32	**196**
EXAMINATION OF THE WHOLE ABDOMEN	82	**258**	15	**489**	25	**14**	17	**244**	20	**409**	5	**227**
HIGH DEFINITION SCAN (SMALL PARTS): THYROID, BREAST LUMP, SCROTUM, ETC	567	**221**	154	**219**	167	**226**	101	**61**	143	**334**	2	**21**
ULTRASOUND EXAMINATION OF THE	1762	**102.6**	208	**133**	507	**112**	452	**87**	458	**113**	137	**37**

ABDOMEN												
ULTRASOUND GUIDED BIPOSIES OF DEEP ORGANS,E.G, LIVER/RENAL/PANCREATIC/PERITONEAL/RETROPERITONEAL LESIONS.	607	**86**	51	**36**	220	**180**	130	**47**	147	**23**	59	**25**
ULTRASOUND OF THE PELVIS	13	**41.5**	2	**3**	2	**247**	3	**1**	5	**7**	1	**0**
ULTRASOUND CHEST	10	**78.5**	4	**196**	0	**0**	2	**0**	3	**0.3**	1	**0**
TOTAL	3574	**142**										

n=number **R**=radiologist **Time** is expressed in **minutes**

Out of the 6436 exams performed in the year of study 55.5% (3574) were reported into NAPIER while 44.5% (2862) exams were reported into PACS. In KFH, the PACS database could not be accessed as it is managed by external contractors. Therefore the data in the table below have only been extracted from NAPIER HMIS from October 2013 to September 2014.

The results of this study show the reporting turnaround time which is the time between when the exam has been performed and the time the report is saved after interpretation. It is then that the report is available into the system.
The total number of examinations is 3574 and the total average reporting turnaround time is 142 minutes (2 hours 22 minutes). The exam with the lowest reporting turnaround time is 41.5 minutes and the exam with the highest reporting turnaround time is 308 minutes (5 hours 8 minutes).

Table 4.5 shows the average reporting turnaround time per exam, the number of exams that the radiologists reported and the average reporting turnaround time that each radiologist spent on a particular exam. For example for MRI spine lumbar exam, a total number of 87 exams were performed and the average reporting turnaround time is 308 minutes (5 hours 8 minutes) whereby the Radiologist R2 had the highest average reporting turnaround time (936 minutes or 15 hours 36 minutes) and Radiologist R3 had the lowest reporting turnaround time for that particular exam (18 minutes).

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

According to Ibrahim (2001), Key performance indicators (KPIs) are measures that may be used to assess the health of an organization and define and quantitatively measure progress toward organizational goals. Furthermore Rubin et al., (2001) emphasized that KPIs also may be linked to an organization's strategy for success. Hence Abujudeh et al (2010) identified some radiology KPIs which are: intradepartmental division success rates, department-wide success rates, communication with referring physicians, outpatient service, outpatient access, safety, inpatient service, equipment idle time, equipment utilization, equipment staffing level, technical staff productivity, professional staff productivity, satisfaction, report turnaround time, equipment availability, workload, etc

This study identified 3 electronic KPIs which are: imaging center staff productivity, imaging turnaround time and reporting turnaround time. Data were obtained by running queries through the HMIS defining specific criteria. They were further discussed hereto.

Radiology processes recorded into KFH hospital management information system start with order booking, order acceptance, result entry, result verification, print preview/print and result delivery.

5.2 RADIOLOGY ELECTRONIC KEY PERFORMANCE INDICATORS

5.2.1 RADIOLOGY STAFF PRODUCTIVITY

The use of the radiology information system is useful because it stores all the detailed information of the exams performed from the request to the availability of the results (Janick, 2008). The information stored can be analyzed to assess the performance of the individual staff including the attendance. This argument is in accordance with the results of this study indicating that on a selected day there were four radiographers on duty. Therefore this study shows that it is possible to verify the attendance of the staff from the hospital management information system. This would also be used to verify the plan of the department according to the staff roster.

The findings of this study indicated that staff productivity could be assessed in the HMIS by checking the examination volume for each staff at any time period. Furthermore, the results of this study indicate that the number and type of exams performed are different for each radiographer. This shows that it is easy to monitor productivity of each staff member from the hospital management information system on a daily basis.

Likewise, the results of this study show that examination volume can be measured on a monthly basis. The examination volume, number and type of exams performed were different from staff to staff. The study shows that a part time radiologist was more productive than the full time radiologist on that particular month while it is shown that the part time radiologist worked for two weeks only. This could serve as the basis for more enquiries into the reasons why there might be discrepancies in the staff productivity.

According to the radiology department organization, the unit manager schedules the roster whereby radiographers rotate everyday from different modality to share the workload. From this point of view, the number of patients received by each radiographer could be almost the same. However the result of this study indicates that there are variations in the number of exams performed by radiographers. Therefore further investigation is needed to assess the reasons why there is great discrepancy in the number of exams performed.

The study shows that examination volume can be measured for the whole year using the same method. It is clear that the staff productivity can be measured for any period of time whether daily, weekly, monthly or annually. These results could be of interest to the unit manager, head of department and the human resource department to monitor and evaluate staff productivity looking at the fact that there are radiographers with very high productivity compared to peers. The same observation was made whereby one part time radiologist was more productive than the two full time radiologists.

The results of this study indicate that staff productivity reports could be discussed in the management meeting for evaluation and identification of area of weakness and could serve as the basis for planning and further improvement.

5.2.2 TURNAROUND TIME

Imaging turnaround time

According to Mendelson and Rubin (2013), turnaround time is referred to as the time from order entry to final signature or exam completion time to the time of a preliminary dictation or some other combination. In this study imaging turnaround time is the time from when the exam has been booked up to the time it is performed.

Booking of the examination is done by nurses, health care assistant or radiographer. The imaging turnaround period at KFH is determined by the time from the order booking to the order acceptance of the exam in the hospital management information system. The latter is done by the radiographer when the exam is ready to be conducted. There are many circumstances that could lead to an increased imaging turnaround time period. For example, many patients seeking the same procedure characterized by long queues, some procedures are requiring patient preparation, equipment defects after booking.

Further clarifications were sought as to the reasons why the imaging turnaround time value would be 0 minutes; it was explained that this could happen when the imaging department receives cases like emergency cases, VIP cases or inpatients during night shifts. The radiographer books the exam and accepts immediately. If the time between booking and accepting the exam is less than 1 minute the system rounds it to zero because it doesn't record seconds.

Reporting turnaround time

The data set exported from the NAPIER hospital management information system showed that 5 people do imaging reports. Explanations were sought to that and find out that people who produce these reports are: 2 full time radiologists, 2 part time radiologists whereby 1 has an official KFH staff ID with full access to the system while the other one does not have an ID hence limited access to the system, he can only produce reports. Finally the fifth person who produces reports is a radiographer who is specializing in ultrasound hence produces only ultrasound reports. This situation may be accepted in certain situations as indicated by Hardy et al, (2013) that the reporting has been delegated to appropriately qualified radiographers, and

previous studies have demonstrated that the quality and accuracy of radiographer reports are similar to those of consultant radiologists. Therefore, the use of radiographers would help in increasing the reporting capacity as it is the case of KFH.

HMIS and PACS integration is the basis for a successful electronic radiology practice, preventing data inconsistency and assuring the integrity of information among the involved databases (De Azevedo–Marques et al., 2004). Janick (2008) indicated that there is a need to have an interface between the PACS system and HMIS. Unless the two systems are directly integrated by a single vendor, information is sent from the HMIS to the PACS system using an HL-7 interface. The result of this study showed that 55.5% of the exams were reported into NAPIER while 44.5% exams were reported into PACS. This constituted the limitation of this study as the two systems are not fully integrated and there was no access to the PACS database.

A report turnaround time was defined as the time from imaging at the modality to the time when the report was available for the clinician (Koivikko et al. 2008). Chew F. and Chew A. (2008) qualified report turnaround time as the metric for quality, usually measuring the time from exam completion to finalized report or from preliminary report to finalized report (signature/ verification time). Timely report finalization is an important aspect of quality in diagnostic radiology (Morgan et al., 2008). In this study the reporting turnaround time is the time from when the exam has been performed up to the time the report is saved and available into the system.

This study result showed that the average reporting turnaround time is 142 minutes (2 hours 22 minutes). The reporting turnaround time in this study is shorter than the reporting turnaround time reported in the study conducted in a hospital in the US after the introduction of PACS system where the mean turnaround time was 0.56 days (13h 26 minutes) (Mehta et al., 2000). Different factors may be the cause of this longer reporting turnaround time, (i) because it was calculated right after the introduction of PACS, (ii) because of the study period, (iii) because of the selected modalities that may take longer, etc.

On the other hand Ralston et al., (2004) study findings indicated that reporting turnaround time during routine day-time work hours is less than 2 h. This study finding is approximately similar to Ralston's.

There is a need to integrate the reporting turnaround time into the performance evaluation as stressed by Abujudeh et al (2010), who states that the report turnaround time is an important measure of quality of radiology service. The authors further suggested that effort should be dedicated to educate radiologists about the importance of reducing the reporting turnaround time in order to increase the quality of service. Basis

The study found out that the turnaround time is an essential indicator to monitor the quality of the services in the radiology department. Turnaround time could also be used during the performance assessment and can serve as the basis for evaluation and improvement. Radiology staff could work towards reducing the turnaround time in order to receive and examine more patients and provide the results on time. This improves the early treatment, and improves the well being of the clients in general.

5.3 INTEGRATION OF ELECTRONIC KEY PERFORMANCE INDICATORS INTO RADIOLOGY STAFF EVALUATION

Key Results Areas are performances identified in the KFH staff performance appraisal. In the radiology department these are:

Clinical management which entails establishing and supervising advanced radiographical practices within the department, managing the radiographers, ensuring the patients receive high quality clinical care and a good patient experience, having regard for their customs, religious beliefs and doctrines, reviewing and maintaining standards of documentation in accordance with hospital standards for records and record-keeping, implementing research / evidence –based practice and auditing clinical outcomes, informing and leading clinical practice and setting clinical standards, supervising drug intravenous therapy and blood administration, using and maintaining appropriate equipment correctly whilst ensuring the patient's safety.

Staff development which entails motivating, developing, supporting and identifying training needs for radio graphical department staff, monitoring recruitment and retention and use all available strategies to retain and motivate staff e.g. professional development, appraisal and

considering a flexible working policy where necessary, participating in professional teaching and training.

Clinical governance, audit and research which entails maintaining standards of delivery of care and infection control, contributing to the development of policies, procedures and clinical guidelines and ensuring adherence by the radiology services, undertaking clinical and associated audits as appropriate for the given area, recording and reporting incidents, accidents and complaints involving staff, patients and visitors in accordance with the hospital policies and initiating investigations as required.

Service development which entails developing and maintaining the quality of the services provided by the department, obtaining feedback on patient and public experience in order to address concerns in a timely manner and enhance performance and delivery, developing, implementing and evaluating radiography service protocols, auditing and monitoring the activities of the radiography department and participating in the implementation of changes to improve service delivery.

Radiography department management that entails formulating job profiles for all posts within the department, conducting meetings with internal staff and planning and assigning work within the department, maintaining health, safety and infection control standards, conducting performance appraisals with staff and arranging and monitoring individual development, ensuring constant and accurate supply of materials.

All of the data sources for these performance areas that are currently used for evaluation are paper based and this exercise is done once a year.

The Hospital Management Information System (HMIS) solution at KFH, named NAPIER, states that it provides seamless integration with devices used in the hospital diagnostic practices. One of the widely used integrated devices is the Picture Archiving and Communication System (PACS) used to store electronic images generated by imaging machines (called modalities) against a particular patient's record for future use and reference. However there is no integration of both systems at King Faisal Hospital.

The electronic key performance indicators identified from the hospital management information system are staff productivity, imaging turnaround time, reporting turnaround time, equipment idle, utilization time, image quality and reporting errors. All of these electronic performance indicators could be integrated into radiology performance evaluation for efficient staff evaluation or appraisal.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Three electronic key performance indicators were identified which are staff productivity, imaging turnaround time and reporting turnaround time.

This study showed that it is possible to carry out an evaluation of staff productivity from the NAPIER hospital management information system for any period of time and further provided an objective comparison of individual performance to peers and assisted also in studying the evolution of individual performance over time.

Turnaround time is an important aspect of quality in diagnostic radiology to assess and improve performance, monitor departmental evolution, and track progress toward the fulfillment of the KFH vision and goals hence shortening turnaround time results in increasing productivity. The turnaround time observed at KFH is reasonable compared to other studies hence radiologists should be educated about the importance of reducing the turnaround time which might and improve the well being of the population.

6.2 RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

KFH should integrate electronic key performance indicators as objective indicators into their performance evaluation or appraisal to increase productivity.

PACS should be fully integrated with the NAPIER system to prevent data inconsistency and to assure the integrity of the information.

PACS database should be available to and managed by King Faisal Hospital IT department to have access to data relevant to support the administration in planning, management, monitoring and evaluation.

Customization of the reports so that staff productivity and turnaround time report is available on the NAPIER hospital management information system interface.

Further research could be conducted using all identified electronic key performance indicator for longer period to be able to generalize the findings.

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APPENDICES

APPENDIX A: COMMITMENT LETTER

I, Zamzam KALUME, student at the University of Rwanda, college of medicine and health science, doing research on staff performance evaluation system, commit myself to take into consideration all the ethical requirements pertaining to the present study.

While having access to the hospital management information system and subsequently patient's records, I will not share the patient information for whatever reason other than for research purposes and the identity of the patients will be protected to the maximum extent possible.

Student:
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The supervisor:
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University of Rwanda
College of Medicine and Health Sciences

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Mr Maurice KANYONI
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University of Rwanda
College of Medicine and Health Sciences

APPENDIX B: DAILY CAPTURE SHEET

STAFF CODE	CATEGORY	EXAM TYPE	EXAM NUMBER	TOTAL

APPENDIX C: MONTHLY CAPTURE SHEET

STAFF CODE	CATEGORY	EXAM TYPE	Week 1	Week 2	Week 3	Week 4	Total monthly

APPENDIX D: ANNUAL CAPTURE SHEET

Year		2013			2014									
Staff code	Category	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TOTAL

WORK PLAN

Tasks to be performed	Dates to be completed	Personnel assigned to tasks	Person / days required
Research proposal preparation and submission	01/02/2013 to 30/05/2013		
Proposal oral presentation	18/05/2014		
Ethical clearance and permission to do the work	16/08/2014		
Contact KFH for approval to conduct the study	01/8/2014		
Data collection from KFH HMIS	01/9/2014 to 01/10/2014	2	2persons * 20days
Data analysis	03/10/2014 to 20/102014	2	12persons *15days
Report writing (First draft)	21/10/2014 to 05/11/2014	2	2 persons * 14 days
Report presentation	8/11/2014		
Report correction	10/11/2014 to 15/11/2014		
Submission of final report	20/11/2014		

GANTT CHART

Tasks to be performed	Apr	May	June	July	Aug	Sept	Oct	Nov
Research proposal preparation and submission	****	****						
Proposal oral presentation			*					
Ethical clearance and permission to do the work				*				
Contact KFH for approval to conduct the study					*			
Data collection from KFH HMIS					**	**		
Questionnaire distribution and collection					**	**		
Data analysis						***	*	
Report writing (First draft)							***	
Report presentation								*
Report correction								***
Submission of final report								*

BUDGET OF THIS STUDY

1. **PREPARATION OF THE STUDY**

Activities 1	**Description of Person**	**N° of person**	**Number of days**	**person days**	**Unitary cost Rwf**	**Total price Rwf**
Proposal preparation and Submission	Researcher	1	20	1*20=20	3.000	60.000
Ethical clearance and permission	Researcher	1	15	1*15=15	3.000	45.000
Subtotal						**105.000**

2. DATA COLLECTION

Activities	**Description of person**	**No of persons**	**Number of days**	**Person days**	**Unitary cost**	**Total price**
Data collection	Researcher	1	30	1*30=30	3.000	90.000
	Research assistant	1	30	1*30=30	3.000	90.000
Transport	Researcher	1	30	1*30=30	2.000	60.000
	Research assistant	1	30	1*30=30	2.000	60.000
SUBTOTAL						**300.000**

3. PRODUCTION OF REPORT

Activities	**Number of persons**	**Number of days**	**Number of persons-days**	**Unitary cost (Rwf)**	**Total cost (Rwf)**
Data coding &entry	1 1	20 20	1*20=20 1*20=20	3.000 3.000	60.000 60.000
Data analysis	1	10	1*10=10	3.000	30.000
Report writing& Result presentation	1	30	1*30=30	3.000	90.000
SUBTOTAL					**240.000**

4. FEEDBACK OF RESEARCH PROPOSAL PROJECT

ACTIVITIES	Number of persons	Number of days	Number of persons-days	Unitary cost (Rwf)	Total cost(Rwf)
Submission of final report	1	1	1*5=5	3.000	15.000
Dissemination	1	1	1*1=1	100.000	100.000
SUBTOTAL					115.000

5. OTHER EXPENSES

Items	**Quantity**	**Unit cost(Rwf)**	**Total cost(Rwf)**
Printing	15	10.000	150.000
Communication	6 months	5.000	30.000
Translation	2	100.000	200.000
Subtotal			380.000

6. SUMMARY OF BUDGET

Activities	**Amount(Rwf)**
Preparation of the study	105.000
Data collection	300.000
Production of report	240.000
Feed back of the research proposal project	115.000
Other expenses	380.000
TOTAL	**1.140.000**