A STUDY OF PATIENT FLOW, CAUSES OF LONG WAITING TIME AND SOLUTIONS AT RADISCAN DIAGNOSTICS (IMAGING CENTRE)

Dissertation submitted to

The IIHMR University, Jaipur

for the partial fulfillment for the award of the degree of

Master of Business Administration (MBA)

In

Hospital and Health Management

By

Dr.Himanshu Ashwinkumar Shah

Under the supervision and guidance of

Dr. Monika Chaudhary

2019-21

Date

DECLARATION

I hereby declare that this dissertation titled “A study of patient flow,causes of long waiting time and solutions “is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Dr.Himanshu Ashwinkumar Shah

RADISCAN
IMAGING PVT. LTD

Date: 5th March 2021

TO WHOMSOEVER CONCERNED

This is to certify that Dr. Himanshu Ashwinkumar Shah has joined as **Deputy Medical Administrator** in Radiscan Diagnostics Center on 1st **March, 2021**.

This letter is issued for the purpose of submission of "Internship report and dissertation" for MBA Hospital Management

Yours sincerely,

Dr. Rajendra Solanki
Managing Director
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Internship Completion Certificate

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Date: 18/06/2021

INTERNSHIP COMPLETION CERTIFICATE

This is to certify that Dr. Himanshu Ashwinkumar Shah in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) has successfully completed his internship at Radiscan Diagnostics from 1st March 2021 to 18th June 2021.

He has successfully carried out the study assigned to him during the course of internship.

Yours sincerely,

Dr. Rajendra Solanki
Managing Director- Radiscan Diagnostics

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that Dr. Himanshu Ashwinkumar Shah has successfully completed study/thesis titled "A study of patient flow, causes of long waiting time and solutionsat radioscan diagnostics (imaging centre)"under my supervision during his internship at Radiscan Diagnostics. I have also reviewed and approved internship report.

Yours sincerely,

Dr. Rajendra Solanki
Managing Director-Radiscan Diagnostics

RADISCAN DIAGNOSTICS

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Acknowledgement

I am indebted to Dr Rajendra Solanki, Managing Director Radiscan Imaging Centre who as a preceptor and a guiding star helped me immensely in understanding management lessons at Radiscan Imaging. Dr Rajendra Solanki is a constant source of invaluable inputs and motivation throughout my journey in management. His in depth knowledge both in radiology as a science and as a business point of view is praise worthy. I find myself fortunate that I got chance to learn management pearls from him through one to one interaction. I am thankful to the staff and patients of Radiscan Imaging for allowing me to complete my research project.

I wish to express my profound gratitude to my guide respected Dr Monika Chaudhary , Associate Professor, IIHMR University for the support and encouragement, provided to me during the preparation and execution of this work. I consider myself privileged to have Dr Monika Chaudhary as faculty at IIHMR University. Rule of compulsory class participation in her lectures had created habit of thorough reading amongst students. Dr Monika Chaudhary had unique way of teaching in the classroom so that even weak students could understand the subject very easily. She had taught her subject with equal attention to all the students and I will always remember Dr Monika Chaudhary for her knowledge, patience, insistence for discipline and punctuality in the class.

I am also deeply grateful to the honourable Chairman Dr S D Gupta and President Mr. Sodani of IIHMR University for making my academic journey at IIHMR University truly an academic feast.

I am thankful to the IIHMR Library staff for helping all the students in their quest for knowledge. I am obliged to IIHMR University office staff for their support.

I would like to mention that my journey through MBA Hospital Management would not have materialised without unwavering support from my family.

Abbreviations

AI Artificial Intelligence

CAP Chest Abdomen Pelvis

CI Confidence Interval

SARS CoV Severe Acute Respiratory Syndrome Corona Virus

CT Computerized Tomography

CRM Customer Relationship Manager

DEXA Dual Energy X-ray Absorptiometry

DICOM Digital Imaging and Communications in Medicine

EHR Electronic Health Record

HIS Hospital Information System

ME Margin of Error

MRI Magnetic Resonance Imaging

MSK Musculoskeletal

PACS Picture Archiving and Communication System

PET Positron Emission Tomography

RIS Radiology Information System

RTLS Real Time Location System

RT-PCR Reverse Transcriptase Polymerase Chain Reaction

SD Standard Deviation

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1. Introduction

Imaging services are essential for improving reliability of the care, we provide to our patients. Radiologists have increasingly taken a key role in healthcare delivery and they provide the information, which physicians need to move their patients through their hospital journey most efficiently[1].

Imaging Centre caters to the patients for diagnosis for to aid physicians. For to escape medico legal liability, doctors routinely prescribe radiology investigation to corroborate their clinical findings. This leads to a constant stream of patients.

With technological advancement, Computer Tomography (CT) and Magnetic Resonance Imaging (MRI) have expanded scope of diagnosis and have remained costly. With ever-increasing patients' demand, clinics have not matched pace of infrastructure enhancement due to great fixed and activity costs. It has affected staffing, process time and patient satisfaction. To match and manage demand -capacity in radiology unit, managers have put forth extraordinary attempts to improve process flow –oversee patient flow ,improve better asset usage and accomplish better patient results.

Variability in demand arises from the community via different entry points, with showing constant change each day, week, and season. To meet this demand, variable service capacity is recruited, which itself changes with time. Because of dynamic nature of these elements, it is difficult to manage healthcare environment, since "dynamically matching dynamic demand with dynamic capacity is difficult". Variability in patient flow leads to variability in capacity utilization and mismatch between patient inflow and outflow.
The radiology walk in patient flow is stochastic and unplanned, beyond the control of managers of imaging centre.

Patient registration process, payment, history- brief clinical examination-going through referring physician's note, Imaging test, image processing, report generation take varied time in serving patients. Smoothening patient flow, optimizing and improving process flow are the key elements in enhancing productivity of the imaging centre with patient satisfaction.

1.1 Problem statement

Radiscan diagnostics is a state of the art radio-imaging centre situated at strategic location, easy accessibility, affordability and high diagnostic accuracy. It is a most sought after radio imaging centre of Ahmedabad.

Radiscan imaging has to manage patients with prior appointment and large portion of patients who visit imaging centre as walk in patients. Walk in patients are of two categories. First, is non-acute patients and second is emergency patients with acuity of condition with need of immediate attention. A large group of unscheduled walk in patients are essential for business but causes crowding in imaging centre. The huge volumes of patients frequently lead to extensive serious stress among professionals who feel demotivated, which can straightforwardly lessen the operational effectiveness and healthcare quality.

Capacity of any imaging centre remains fixed. Crowding due to demand capacity mismatch is a routine problem faced by busy hospitals and imaging centres. Unscheduled arrival of patients and subsequent crowding lead to need of overtime and missed breaks with physical and emotional burden on staff. Crowding causes delay and a long waiting time for patients. Sometimes, long waiting for patients with undiagnosed life threatening situation can exacerbate patient's woes. Long waiting time is associated with lack of satisfaction amongst patients, staffing issue for hospital and may lead to loss of business in long run.

Corona pandemic has also affected work process in hospitals and imaging centres. Radiscan diagnostics had to take care of infection control protocols while dealing with patient flow. Corona pandemic had reduced footfall in healthcare organizations that cater non-covid patients. At the same time, radio imaging centres and pathology laboratories were overburdened for X-ray, CT scan and RT-PCR testing. Few of the hospitals were converted in to covid-designated hospitals under essential services act. It caused diversion of patient flow to imaging centres- standalone facilities. That was causing additional burden on standalone imaging centres like Radiscan diagnostics.

1.2 What were the problems faced by Radiscan diagnostics?

Patients who visit physicians and surgeons have tendency to undergo diagnostic tests on the same day and then approach-treating doctor for further line of management back to back. Scheduling walk-in patients and patients with prior appointment is a managerial Achilles heel. Unscheduled arrival of walk in patients cause demand capacity mismatch. Emergency acute patients create delay and long queue for diagnostic services.

Referring physicians sometimes fail to send patient's history, probable diagnosis with requisition slip, which results in to delay in conducting diagnostic test and preparing report. Few of patients, who get prior appointment, fail to show up at centre, leading to underutilisation of services.

Due to these mentality of patients, Radiscan witnessed flow in morning hours, patient spent considerable time at registration desk. Service time of imaging machine was the bottleneck .Image processing and preparing report usually takes time. It was perceived as long waiting time by patients.

Due to corona pandemic, there was slight decrease in utilization of Ultrasonography and Mammography services .MRI usage had remained little bit low. X ray and CT scan usage had increased considerably.

Due to tele radiology tie-ups with other hospitals, Radiscan diagnostics had additional responsibility of preparing report for patients from other hospitals.

1.3 Why study was important for organization

From patient entry to exit from imaging centre, it was felt that patient movement was prolonged, leading to crowding. It led to patient flow inefficiencies and wastage cum inefficient utilisation of resources.

Time taken for radiological examination is fixed. It is a bottleneck of the system. By understanding flow at upstream and downstream of the bottleneck, it is possible to manipulate time spent by a patient in the imaging centre, which can influence patient's satisfaction level. Though CRM takes care of patient satisfaction, waiting time directly influences patient satisfaction.

1.4 Research Questions and Research Objectives

Study was planned with below mentioned research questions and research objectives.

Research Questions

1. How patient flow took place in diagnostic centre?
2. What were the causes of delay (if any) or waiting time in imaging centre, any correlation with patient flow?
3. What could be the possible solutions and any impact on patient satisfaction?

Research Objectives

Broad Objective

To study patient flow in radio imaging centre. Our goal was to find out reasons behind long waiting time in radiology centre and solutions for the same. Whether waiting time had any impact on patient satisfaction or not?

Specific Objectives

.

1. To understand patient flow for utilisation of the radio imaging services.
2. Distinguish every one of the means-steps engaged with finishing demonstrative imaging examinations.
3. Identify points of waiting through imaging process and know average waiting time at each point of care.
4. To find out and enumerate causes of long waiting time.
5. How to streamline patient flow, improve scheduling so to reduce patient waiting time, suggestions to decrease or to eliminate waiting times and at what extent recommendations implemented reduced waiting time.
6. Impact of implementation of interventions on patient satisfaction.

1.5 Radiscan Diagnostics Organizational Profile and imaging modalities

Radiscan diagnostics provides radiology and pathology laboratory services.

Services: It has CT scan, MRI, X-ray, 3D- 4D Ultrasonography, Mammography in radio imaging services at main branch, Shahibaug branch has addition of DEXA scan and interventional radiology. In pathology laboratory, it has clinical biochemistry, clinical pathology, haematology, immunology, serology, microbiology and histopathology and cytopathology department.

-Radiscan Diagnostics has two branches: Main Akhabarnagar branch which also takes care of Shahibaug branch for diagnosis and reporting.

-Mission

Quality and innovation is our fortress and way of life for us. To us, it is more than a goal. It is our leaders, clinicians, technicians and support staff make Radiscan Diagnostics a place of highly specialized centre of excellence with advanced technology and modern facilities.

Our mission is:

- Providing care with state-of-the art facilities and equipment
- Attract and retain talented workforce with eyes set on pan-India presence.
- Affordable healthcare
- 100 % satisfaction to patients with our services
- Professional and scientific integrity
- Embracing newer technology and management principles for better care of the patients

-Vision

By creating institute of excellence in integrated diagnostic and medical care, it is our vision to deliver excellent health services. Our vision is to promote research and support academics. We intend to deliver ethical practices in safe environment to treat all patients with respect and dignity.

-- Core Values

Quality
Competency
Teamwork
Integrity
Professional secrecy
Respect for patients' rights

Doctor's team –

Dr Rajendra Solanki is the Managing Director and Chief Radiologist. He also serves as Consulting Radiologist at Suyog Imaging Centre, Mehsana.

He was associated with B J Medical College, Ahmedabad as Associate Professor in Radiology. He has been Professor and Postgraduate teacher in Medical College and Diplomat of National Board teacher in Gujarat Imaging Centre & Research Institute, with special interest in Head & Neck Imaging with research focus on MSK and cochlear imaging.

He is a founder member of Indian Society of Head & Neck Radiology (ISHNR). He was member of Governing Council of the Indian College of Radiology & Imaging (ICRI).

He is author of multiple research articles in radio imaging. He has presented research papers at Radiology Society of North America (RSNA) and European Congress of Radiology (ECR). He was a special invitee for to represent research paper at Korean Congress of Radiology (KCR). Two of his books are in process of getting published as co-author-Elsevier publications; USA going to publish one .He has deep interest in international collaboration in academics. He is actively involved in preparing next generation radiologists for to meet future demand of healthcare.

Radiscan diagnostics has 12 full time radiologists with different specialities, 5 pathologist, 2 microbiologist and an immunologist in Akhabarnagar branch. A part of team is engaged in dealing with tele radiology services. Shahibaug branch houses other set of doctors.

Radiscan Diagnostics provides radiology services through tie-ups with all major hospitals and other diverse institutions.

Radiscan provides tele-radiology services also. For the purposes of sharing imaging studies with other radiologists, medical consultants and hospitals, tele-radiology is used. CT scans, PET/CTS and MRIs images transmitted via tele-radiology. Radiologists provide services without actually being present at the location of the patient and enables patient care at distant site. This is particularly important when services of a specialist such as neuro-radiologist, paediatric radiologist, or musculoskeletal radiologist is needed in remote areas, since specialists and super specialists doctors are generally located in large metropolitan areas working during day time. Tele-radiology enables services of trained specialists available 24x7. Radiscan Diagnostics provides tele-radiology services to number of multispecialty and super speciality hospitals of the country.

Imaging modalities

X ray is widely used diagnostic imaging test (CAP and bone imaging) and now available in remote areas too. It is associated with radiation hazards. When X-ray passes through the body, bone and other dense objects block the X-rays and look white on the film of the x-ray. The softer tissues allow it to pass and appear grey on the film of the x-ray. Between the digital X-ray sensor or photographic film and X-ray machine, body part, which needs to be scanned, is positioned by the technician. While the machine emits X-rays and it passes briefly through the body, patient needs to stay still and image is captured on the film.

Ultrasound is a non-invasive and safer imaging modality. Sound waves rather than ionising radiation is used in ultrasonography. Probe sends high frequency sound waves to the body through conducting gel. Sound waves are sent back to the probe when they hit the different structures within the body, forming a real time image. Doppler ultrasound visualises blood flow in body vessels.

CT scan is a high quality, detailed cross sectional images of the body. It is a more potent and technologically advanced x-ray source and a detector that take 360-degree image by rotating around the body. Contrast dye is also injected in the body for differentiating structures. CT scan produces greater clarity image than x ray and gives minute details of the internal organs, bones, soft tissues and blood vessels. Only drawback is it uses very high radiation than x rays.

High strength magnetic fields is used to obtain diagnostic images in MRI without producing harmful radiation. A major portion of human body is made up of water that contains hydrogen and oxygen. A strong magnetic field of MRI scanner forces the protons to align to the magnetic field. Now a fixed radio frequency is applied which has stimulating effect on the protons and it spins them out of equilibrium. Now if radiofrequency source is shut-off, the protons return to their original alignment with emitting energy that is detected by the MRI sensors. Protons in different body tissues return to their normal alignment at different rate allowing MRI to distinguish between various types of tissues and identify any abnormalities. For the patients with ferromagnetic components like cardiac pacemakers such magnetic forces can be dangerous.

Low-dose x-ray system is utilised in Mammography to examine breasts and help in the early detection and diagnosis of breast diseases in women.3 D-mammography creates view of 1-millimeter, 3-D "slices". Specificity and sensitivity of 3-D mammograms is higher and it increases cancer detection.

1.6 Patient flow in healthcare – patient journey in imaging centre

Patient flow in healthcare

Flow is nothing but progressive movement of the people, information and products, in a sequence of processes. When a car moves on a highway without interruptions or traffic jam, you can label it in simpler term as flow.

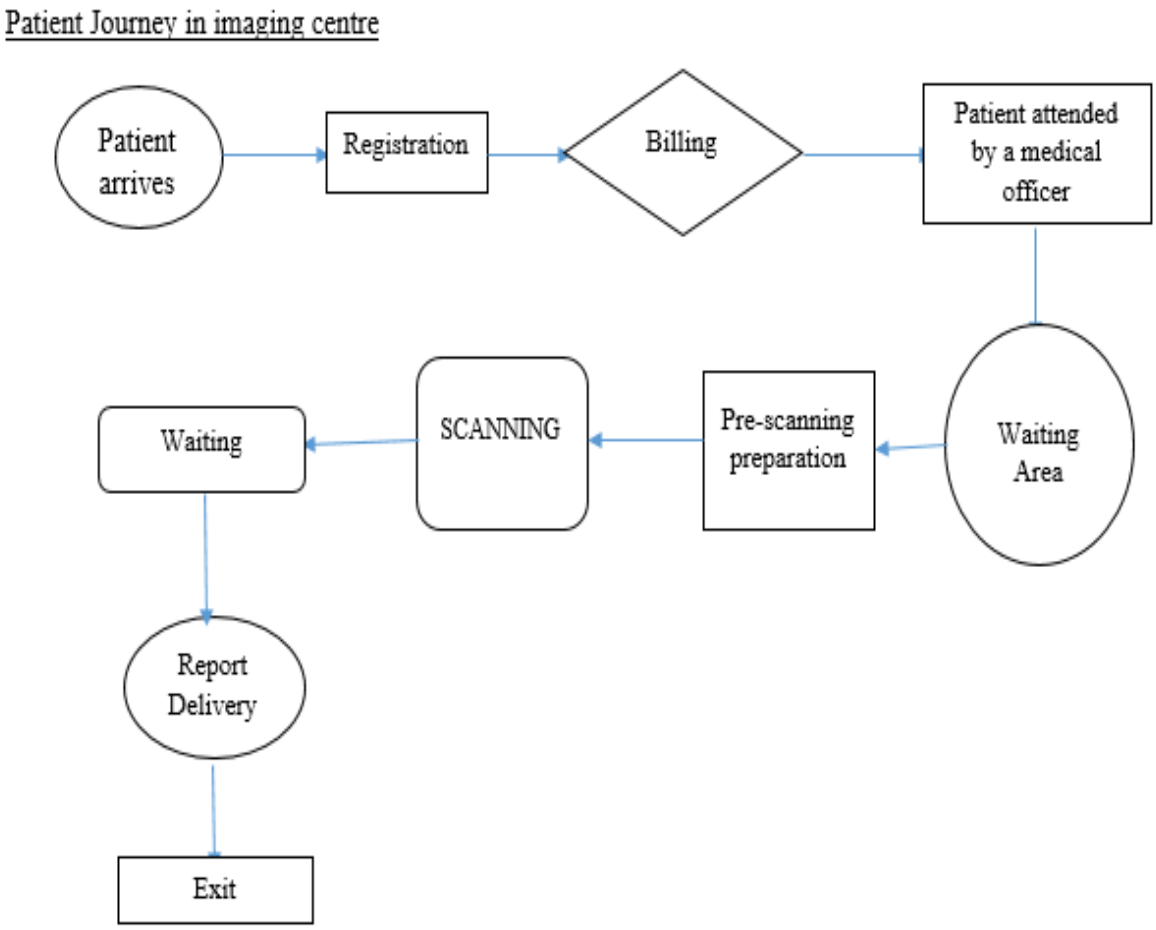
In hospital set up, flow is the movement of data, patients, drugs or equipment in-between the, departments, staff groups or organisations .It is a part of a patient's care pathway. Passage of patients through multiple stages of care gives rise to patient flow. Variability is the inconsistency or dispersion of inputs and outputs. Variability threatens the process as it results in to uncertainty. Suppose an imaging centre is getting two patients per hour for CT scan and starts getting ten patients per hour then it will affect operations and outcome. Variation in patient flow can be natural or artificial. Reasons for seeking imaging services and time chosen to visit imaging centre causes natural variations in patient flow. Most of the variations are artificial, for example; scheduling staff duty roster, maintenance work of the equipment or planning elective procedures .People, processes, resources, information, treatment all have an impact on flow.

Throughput is the rate at which the services are performed. Now if patient flow is haphazard then it reduces benefits, increases burden so value of enterprise decreases[2]. Value = benefits received / burden endured.

Value of any services increases with increasing benefits and decreasing burden. Unmanaged patient flow can reduce value of the enterprise[3].

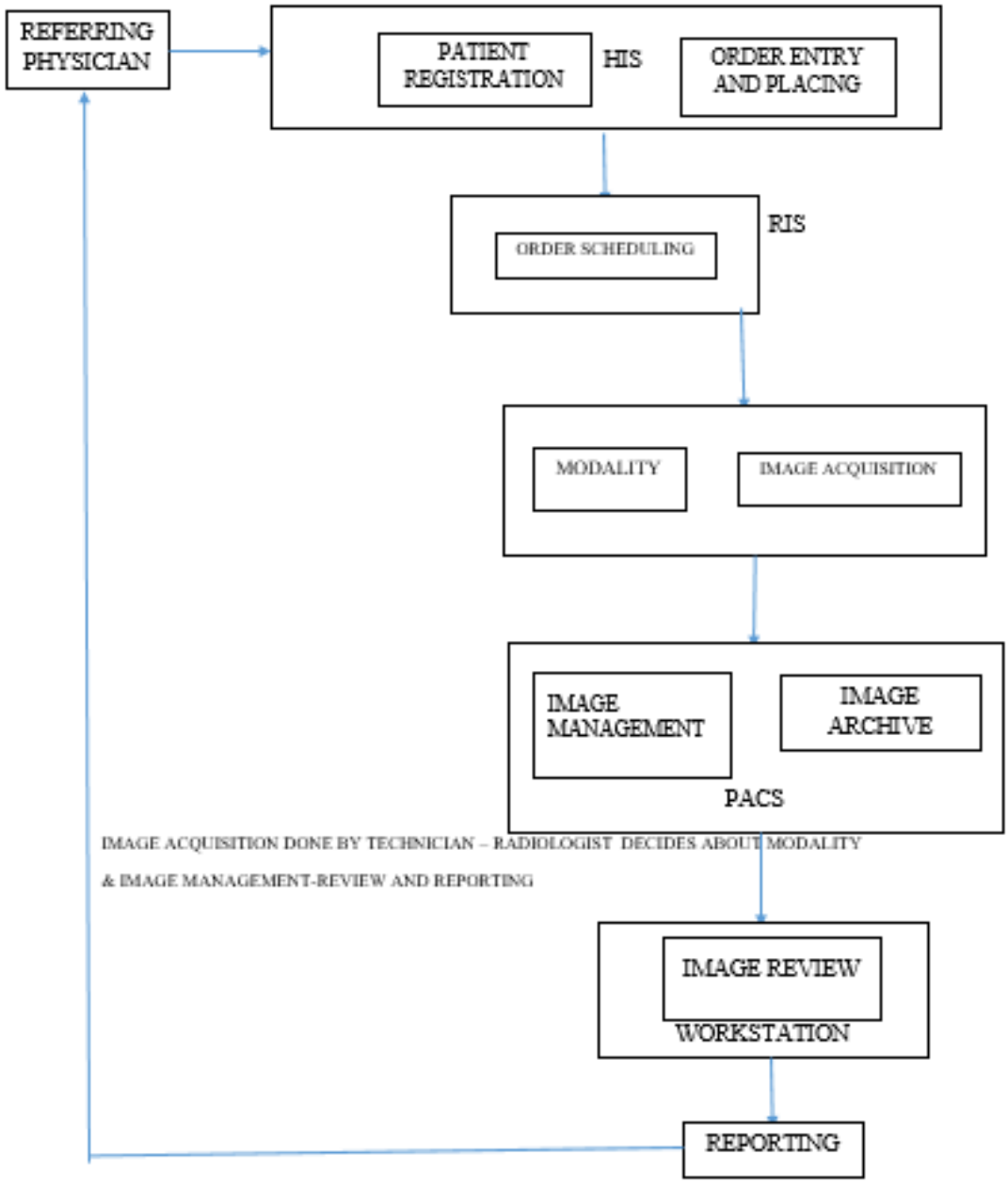
To tackle with variability, one needs to map the patient's journey through clinical and administrative processes and identify the bottlenecks and barriers. Manager has to take demand and capacity of the service in to consideration for to deal with variation. At each step, try to find out scope of quality improvement with keeping time and cost in mind, which will have greatest impact on the flow. Steps in the process that do not add value for patients can be eliminated and by eliminating barriers, processes can be simplified.

Figure 1.6.1



1.7 Process flow in radiology and PACS

Figure 1.7.1



Referring clinicians send examination request. Administrative staff of the imaging centre takes care of patient registration and billing with placing order entry in the system. Medical Officer/Operational assistant receives patient for preparing for the examination. Radiologist decides examination protocols .Radiographer conducts examination with guidance of radiologist. DICOM used for images and processed. Image is stored with help of PACS system for interpretation by radiologist. Image is reviewed by radiologist at last to prepare report.

Radiologist workflow

- Enter in to PACS system
- Choose cases and set worklist filters
- Start the case
- Clinical data collection
- Examine the image and interpretation
- Report
- Conveying personally unexpected findings
- Review and authentication of report by signing
- Check ongoing cases

Technologist workflow

- Enter patient data
- Following set protocol
- Do scanning and get images
- Quality check of images
- Post processing
- Uploading images to PACS
- Submit study in RIS

PACS

PACS utilises software and hardware for storing images on both a short and long-term basis. From the site of image acquisition, captured images are transmitted to different locations with the help of the PACS. PACS is a convenient and economical way to access radiographs, CT-MRI-Ultrasound images simultaneously at multiple locations inside the same hospital or outside the hospital across the globe.

PACS has following components:

1. Digital analog devices creates inputs for the PACS (X-ray, CT, MRI or Ultrasound)
2. Image acquisition device
3. Data storage device or server which stores data for short term or long term storage

4. Local Area Network or Internet based network
5. User interface, Imaging workstation and display
6. Facility to create hard copy images
7. Co-ordination and integration of PACS , RIS and HIS

Importance

If a patient undergoes radiological examination in one hospital and for purpose of giving care, suppose radiologists and physicians outside the hospital (may be doctors across the globe) want to study the same then PACS is helpful. It rapidly transfers images without change in quality of images.

Storing and archiving hard copy images is difficult. Quality of images deteriorates with long storage of hard copies.

Limitations

Resolutions of display monitors at different locations usually differ and can lead to poor quality suboptimal images. If data is not stored properly or there is some technical failure then it can hamper data retrieval with rare possibility of data loss.

-PACS is used for processing images, display of images, distribution and transmission of images. Communication and image storage are functions of PACS.

It also supports other functionalities in radiological work. It can manipulate grey scale, size and orientation of images. For to support the organizational and management work PACS provides digital lists. PACS is helpful for communication within the network centres. Image formatting, image analysis (for historical images also) and diagnosis is done with the PACS system. Distance, areas of the image, angles within the image can be measured with PACS.

PACS along with RIS provide solutions for patient scheduling, tracking of patients, reporting of images, documenting, image tracking and billing. Workflow in digital radiology practices is made smooth by crucial system called PACS.

1.8 Waiting in radio imaging centre

Time a patient spends at each service point before receiving actual service is called “Waiting time” and from patient’s entry in to the hospital to the registration desk to scanning up to leaving the facility , this time period is called total turnaround time. In Radio imaging centre, waiting time has two components. First waiting time experienced

from registration to imaging test done. Second from end of the imaging test until patient receives report. Therefore, it covers the time from when the patient reports to the reception area to the time the report is dispatched to patient. Measure of waiting time can thus cover the time the patient is registered for the investigations, until the time patient finally collects his/her diagnostic report.

Indirect waiting time and direct waiting time are two types of waiting time. Time between requesting appointment and real appointment date is indirect waiting time. Direct waiting time is in-office delay and it is delay in between patient's appointment time and the time when physician attends the patient.

-Access ratio = Arrivals / Served patients. If it is more than 1 then length of the queue and the access time both will increase because arrivals outweighs service rate. Moreover, if it is less than 1, the access time will shorten.

-A mathematical model is used to calculate wait time as per the utilisation of the service. Kingman's formula is:

$W = T_s(U / 1 – U) \times [(CV_a^2 + CV_s^2) / 2]$

Where W = mean wait time

Ts = service time

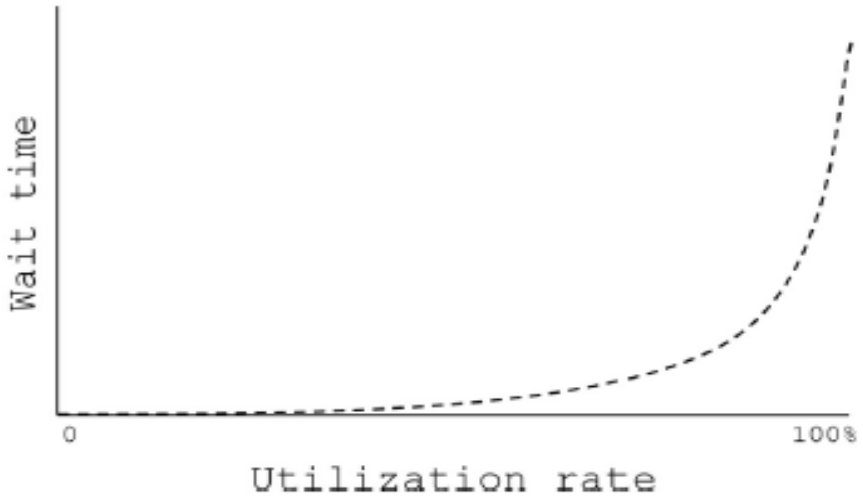
U = Utilization rate

CV_a = coefficient of variation regarding customer arrival

CV_s = coefficient of variation regarding service time of the servers

Few points can be deduced from Kingman's equation for to understand theories of queues. (1) Waiting time is directly proportional to service time.(2) Waiting time increases exponentially with increase in utilization rate.(3) Waiting time for patient is proportional to customer arrival variability and $service\ time^4$.

Figure 1.8.1

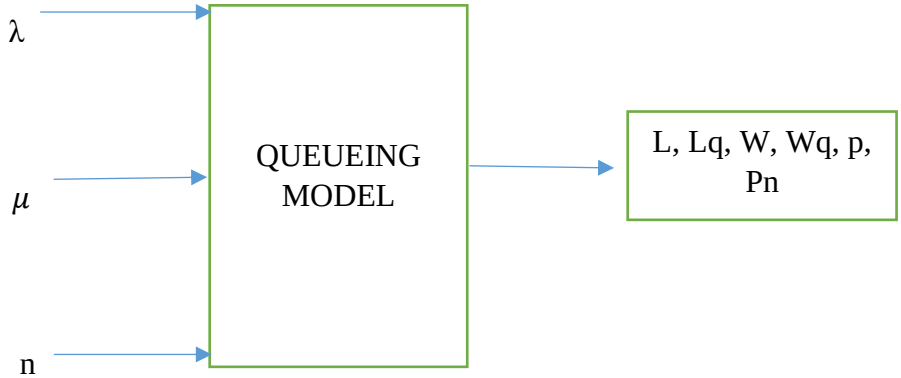


A queue is defined as a line of waiting customers at one or more servers for to get service. Whenever demand for the service exceeds the current capacity of the service facility, a queue is formed; so whenever servers are busy and arriving customers do not get immediate service, waiting line is formed.

Scientific study of the waiting line systems is known as Queueing theory.

Figure 1.8.2

Analytical Queueing Models give information flow



If arrivals is less than service rate then there are five equations, common for all infinite source models and fundamental for queuing formulations. This has been mentioned in course module of Operations Management of IIHMR University.

1. Ratio of arrival to service rate gives average number of patients being served in the system.

$$r = \frac{\lambda}{\mu}$$

2. Average number in line plus the average number being served is equal to the average number of patients in the system.

$$L = L_q + r$$

3. When average number in line is divided by the arrival rate, it gives average time spent in the line.

$$W_q = \frac{L_q}{\lambda}$$

4. Sum of the time in line plus the service time gives the average time in the system.

$$W = W_q + \frac{1}{\mu}$$

5. The ratio of arrival rate to service capacity is equal to system utilization rate.

$$\rho = \frac{\lambda}{s\mu}$$

Exponential service time and Poisson arrival is used for single channel server (M/M/1)

A system with one server is the simplest model and first come, first served is followed. Poisson distribution can approximate customer arrival and service time by a negative exponential distribution as per assumption.

- Formulas for the single channel model are as follows.

P_o is probability of no arrival, P_n is probability of n arrival and L_q is length of the queue.

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$P_0 = 1 - \frac{\lambda}{\mu}$$

$$P_n = P_0\left(\frac{\lambda}{\mu}\right)^n$$

Queuing theory helps in[5]

Calculation of mean of waiting patients

Mean waiting time

Resources/capacity utilised

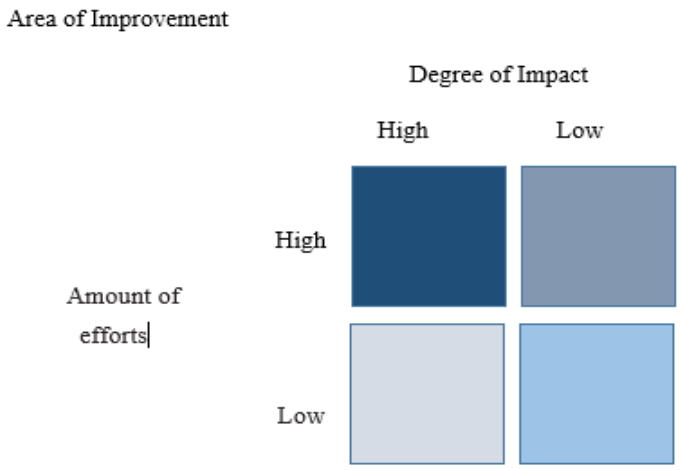
Costs incurred for capacity planning

Probability of waiting for new arrivals

1.9 (a) How waiting time can be reduced with six sigma, lean and theory of Constraints

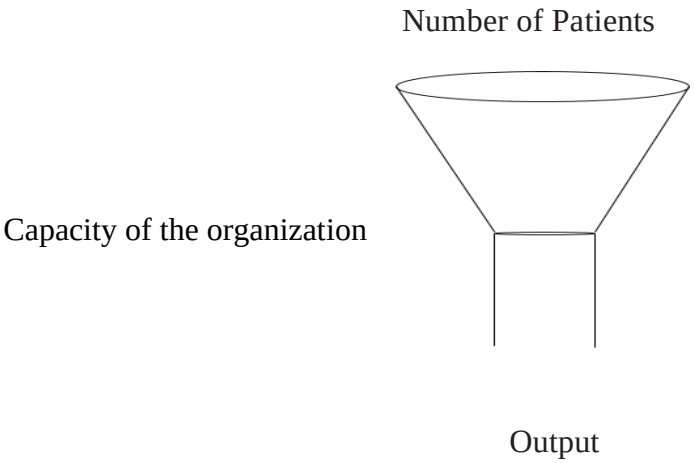
--For to bring change, you need to adopt a strategy which requires low amount of effort with high degree of impact.

Figure 1.9 (a) 1



--Concept of bottleneck – For same level of output, one needs to manage patient arrival or to manage crowding, system needs to enhance capacity, which will increase output also.

Figure 1.9(a) 2



--Six Sigma Theory is utilised to reduce variation. It is a problem-focused approach. Lean means eliminating unnecessary processing and waste[6]**.** Define Measure, Analyse, Improve and Control –DMAIC is the lean six-sigma methodology for to tackle problem. Different tools for each step in DMAIC.

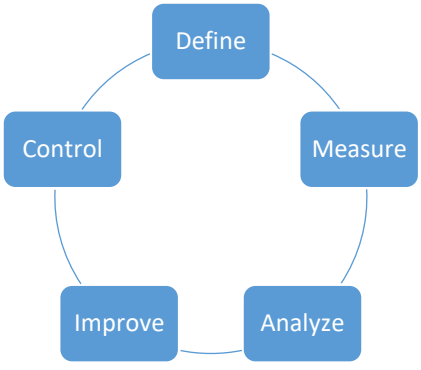
Primary effect is to bring uniform process output with secondary effect on waste reduction and fast throughput.

5 steps:

1. Defining process improvement goals, in alignment with organization's strategy and customer's demand.
2. Measure vital aspects of current process with data collection.
3. Analysing the information to verify cause-and-effect relation. Ensuring that all factors have been considered in determining what the relationships are. Identification of bottlenecks and problems on the basis of analysed data.
4. Improve-Evaluation of the proposed ideas. Implementation phase to remove defects. Design of Experiments very useful technique of data analysis in improving the process.
5. Control-Correction of deviations from target, before defect production.

   Control step also includes testing process capability,establishing control mechanisms and vigilant monitoring of the process.

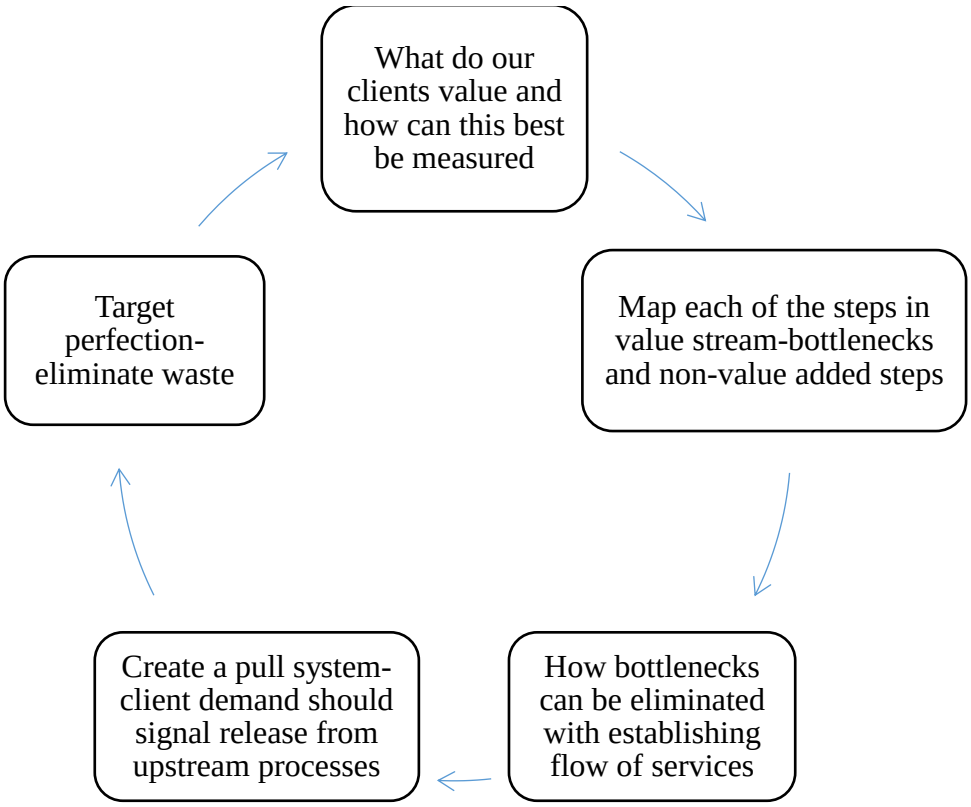
Figure 1.9 (a) 3



--Lean thinking theory is utilised for eliminating unnecessary processing and waste[6]. It is a flow-focused theory.

- Identify value
- Identify value stream
- Flow
- Pull
- Perfection

Figure 1.9 (a) 4



Primary impact is on reducing flow time with secondary impact on reducing variation.

Value Stream Mapping (VSM)

It is a technique to explain information-material-work-process flow with wait time, process time, lead-time and first-time quality as metrics. It is a visual presentation of the value stream and helps in identifying defects/ problems. Areas, which need focused attention, can be identified by VSM.

Three categories:

(1) Processes creating value as perceived by the customer, (2) No value but needed at present and so cannot be sacrificed (3) Actions that have no value as perceived by the customer and immediate elimination is possible. Actions falling into category 3 are known as Muda. It is the Japanese word for waste, specifically used for any human activity that utilizes resources and creates no value[7].

--Theory of constraints manages constraints with focus on system's constraints

1. Find out the constraint.
   In chain of systems of all the businesses, constraint is the worst performing link in the chain.
2. Make use of constraint with goal to optimize performance. Break "dummy" and "policy" constraints.
3. Match each of the processes to the pace of the constraint. Decrease the overproduction etc.
4. Invest in reducing the constraint if production is still low (e.g., capacity in terms of human resource or equipment should be increased for performing the constraint process).
5. Keep repeating until target performance achieved. After that, there can be new constraint.

Primary impact is bringing fast throughput with secondary effect on reducing waste.

1.9 (b) Form format for waiting time, feedback and survey questions

<u>Form for time taken for each step – start time, end time</u>

1. Arrival time
2. Registration
3. Billing
4. Case Review and consent
5. Waiting Area
6. Scanning Preparation Procedure
   Changing clothes (if needed),
   Venous line insertion until patient is asked to take position
7. Scanning

8. Report hand over time
9. Exit

Feedback questions

(a)

Was there any delay?

Where you experienced long waiting time - Reception area
Billing area
Brief history taking and review
Before scanning
Inside scanning room
Reporting time

Cause of delay

(b)

Efficiency of service and any problem faced during procedure

Receiving sufficient information on: How to prepare for the exam

Explanation of payment and billing procedures

How was doctor's response?

Precautions against corona taken or not?

The confidentiality and privacy of the service

Was staff helping, courteous and received a friendly greeting from each staff member

General appearance of the diagnostic centre

Value for service

Will you recommend or visit Radiscan imaging again?

2. Review of Literature

-Research paper on patient flow, arrival rate and waiting time

In 2021, a study was published in International Journal of Healthcare Management by Kenneth K Agwu et al. titled, Improving patient flows: A case study of a tertiary hospital radiology department. In this cross sectional study, patient flow system was analysed and ways to optimize scheduling of patients in the radiology department was studied. There was uncertainty and unpredictability of pattern of patient arrival time. Average 7 ± 5.4 patients/hour arrived per day. From 7.00 am to 10.00 am, patient's arrival peaked with arrival of 12 patients/hour. Mean service time was 15 minutes. 116 minutes was the overall mean waiting time. The waiting time had direct correlation with the arrival rate (at $P < 0.05$).

- Research paper on Flow chart in radiology department

Maria Joao Maia in 2011 published her research paper on Decision-making process in Radiology: the magnetic resonance example in the TA context. Her study was published in journal of "Enterprise and Work Innovation Studies". A flowchart for performing an examination in a Radiology Department of multispecialty hospital was enumerated in her study. Our study is done at a radio-imaging centre, which is not part of any hospital. So, steps involved in radio imaging process are little bit different than study performed in a hospital with radiology department.

-Research paper on capacity management in radiology department

L. Hofman in 2014 had published a study on" Capacity management at the radiology department of Isala- Managing the variability of scheduled and unscheduled patient arrivals ". He showed reasons that affect the variability in demand .He also mentioned bottlenecks with negative impact on performance. He showed that in radiology department, variability could be reduced by change in scheduling process .As per employees, high fluctuations in the demand made forecasting of the demand nearly impossible. Performance in terms of access time, waiting time, utilisation level, workload, and costs can be improved by removing the bottlenecks.

-Research paper on root causes of delay and factors leading to waiting time in radiology department

Andrew Worster, Kevin Eva and Christopher M B Fernandez published a study in Journal of Imaging Nursing -2006 on "Identification of root causes for emergency diagnostic imaging delays at three Canadian hospitals". One of the motives of the study was to find out points of delay. It was a prospective, cross-sectional, modified time-in-motion study. Multicentre study was conducted at three urban emergency departments of a Canadian academic centre for the period of three weeks. There were three main reasons of delay (1) Delay in processing of X-ray request order by nursing staff (2) Time taken for transporting patients (3) Location of imaging centre.

Rebecca Bisanju Wafula submitted a Research Thesis on "Factors associated with patient waiting time in outpatient clinic of Nairobi Health Services" in 2014. In her cross sectional study, in outpatient clinic, average waiting time was around 60 minutes. Most of the patients were of opinion that 60 minutes of waiting time was reasonable. Availability of the doctors had major impact on the patient waiting time in the hospital. Study participants suggested that improving availability of health workers would help in shortening waiting time.

-Research paper on how to reduce turnaround time and waiting time

A thesis was submitted by Johann Daniels. It was a cross sectional study .Title of the study was "Assessing the impact of a waiting time survey on reducing waiting times in primary care clinics in Cape Town, South Africa". He submitted thesis before University of Cape Town for master of public health degree in 2015. He showed that active participation of the relevant clinic staff was necessary in implementing recommendations on reducing waiting time. As per the study, delay at primary care services in the public sector can be decreased or eliminated and it was good to measure waiting times as a service quality improvement strategy.

Giles W. L. Boland et al. published a paper in American Journal of Roentgenology in 2010 titled Radiologist Report Turnaround Time: Impact of Pay for Performance Measures. It was an analytical study and he stated that pay for performance program for radiologist has impact on report turnaround time. He carried a baseline study for three months without implementing pay for performance program and then he carried out study on impact of pay for performance program on report turnaround time in radiology for next two years. Motivation works in improving performance.

Dr (Brig). A. P. Pandit, Ms.Tanima Debmallik in 2016 published an article "A lean six sigma approach to reduce waiting and reporting time in the radiology department of a tertiary care hospital in Kolkata" in International Education And Research Journal.
In their study. Issue of the imaging services cycle turnaround time (TAT) of the Radiology Department was addressed by six sigma-DMAIC approach. Gemba Walk interview and Time motion study can map the entire process. After mapping the process, reasons of delay were identified in first two stages of DMAIC .Root causes of delay was shown with help of pareto chart.. As solutions, approaches to enhance patient orientation and preparedness for the scan undertaken resulting in reduction of pre-test waiting time and smoothening operations. The reporting process decreased both, pre-test and post-test waiting times.

Hyojung Kang and Ethan Haswell published a study in 2020 titled" Patient Flow Analysis Using Real-Time Locating System Data: A Case Study in an Outpatient Oncology Centre' in JCO Oncology Practice Journal. They showed that EHR and RTLS decreased waiting time. EHR and RTLS data combination helped in capturing dynamic aspects of patient flow realistically. In any complex system, accurate input data can help in making decisions about operational changes to rectify patient flow.

-Research paper on waiting time and patient satisfaction

In 2016, Anna Holbrook et al. published an observational study titled shorter perceived outpatient MRI wait times associated with higher patient satisfaction in journal of the

American college of radiology. They measured actual and perceived waiting time incurred in outpatient MRI set up. It was shown in the study that shorter the perceived and actual wait times were, higher were the satisfaction scores.

3. Research Methodology

3.1 Research Design, data collection, study population, sample size and sampling

Study Design

Staffing schedule was noted.

The preceding research questions and objectives were used to articulate an explorative study that had both quantitative and qualitative approaches

Variation of patient flow was noted.

Patients were assessed for inclusion /exclusion criteria on arrival. Selected patients were informed about the study and study design. Their consent for participating in the study obtained. They were given a form for observation of timing for each event and a survey form.

At the time of exit of patients, suggestions received from each participant that what needed to be done for improving services.

Employees were also interviewed for root cause analysis of delay if any, at particular step.

Data presented before the authority, possible solutions were discussed and solutions, which were feasible, implemented.

Multivoting was used for to arrive at decision to implement which one of all the suggestions should be implemented for reducing delay. Recommendations implemented for short period, to prevent any impact on service and revenue. If data was suggestive of benefit due to change, it was decided to implement permanently, after discussion.

After implementing recommendations, change due to its impact was observed,data was analysed. Impact of change on patient satisfaction noted.

Management intern/ trained assistants to the research team followed the patient care activities (starting from patients entering in the imaging centre until the disposal of the patients) during collection of data.

Data collection

Data form by patients
Personal observation
Interviews with patients and staff
Imaging Centre's computer data entry system

Study population

The study population comprised patients under inclusion criteria who visited Radiscan Diagnostics for radiology imaging and had given consent for the study for the period from 1st March 2021 to 15th June 2021.

Study population also included employees involved at each level of process flow.

Sample size

The sample was composed of only those patients who were available during the period of study/ data collection and who expressed willingness to participate in the study.

10 % of Radiscan patients was chosen for the study and as per recommendations by management, solutions implemented, Patients data was analysed to assess impact of change implemented.

Sampling

It was purposive, non-probability convenience sampling from the pool of patients who attended imaging centre for radiological examination during study period.

Research participants were most readily available and convenient group of patients visiting diagnostic centre.

3.2 Inclusion and Exclusion criteria

Inclusion criteria

Patients above 18 years of age and patients below 65 years of age were included in the study. Only stable, conscious and ambulant patients were included in the study.

Concerned department staff also included in study for gathering data.

Exclusion criteria

Patients under 18 and above 65 years of age were excluded from the study.

Patients with history of psychiatric illness who were unable to comprehend the study were excluded from the study.

Trauma patients for accident were excluded from the study.

Patients with diseases, which affect their mental capacity for judgement, were excluded from the study.

3.3 Limitation of the study

Study could not be said free from the following limitations:

1. Study took place at one imaging centre; outcome could not be generalized on to the whole population.
2. Study was conducted for fixed time duration.
3. During SARS CoV pandemic, so many of the hospitals were converted in to covid-designated hospitals. There was change in patient flow pattern in almost all the healthcare organizations.
4. Patients are the source of data. Errors taking place due to dishonest answering practices by patients could not be eliminated. Sometimes patients avoid doing complaint or avoid pinpointing problems in the system due to fear of repercussions; participants might not have provided actual information.

3.4 Ethical considerations

After getting approval for the study from diagnostic centre's concerned authority, patients were approached for consent after explaining them about study. They were included in study voluntarily and no monetary benefit given to patients for to be part of the study. Confidentiality of patient and data security was taken care of during the study.

3.5 Analytical tools-

Data analysed with Microsoft excel and whenever needed with SPSS software.

4. Observations

4.1 Staff Scheduling Pattern

→3 Radiologists provided service from 8 am to 5 pm

5 Radiologists provided service from 11am to 8 pm

2 Radiologists provided service from 8 pm to 8 am.

2 Radiologists worked as Medical director and Medical Superintendent with duty to oversee operations.

→ Nursing staff was given duty shift of 8 am to 4 pm, 10 am to 6 pm,12 noon to 8 pm and 8 pm to 8 am night duty. (3, 2, 2, 2)

→Duty of sonographers and radiology technicians also scheduled as 8am to 4 pm, 2 pm to 10 pm, 8 pm to 8 am (4, 3, 3)

→Duty of reception staff (inquiry, registration, billing, coordination) was scheduled 8 am to 4 pm, 4 pm to 10 pm, 10 pm to 8 am. (4, 4, 3)

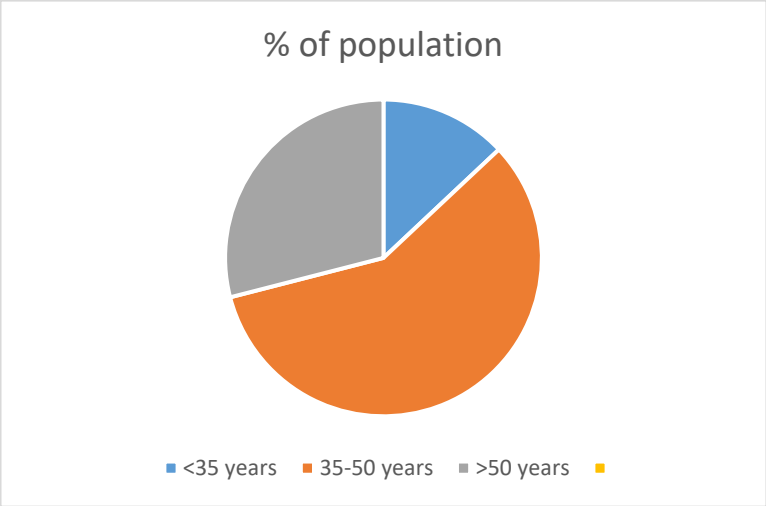
Duty of technicians and nursing staff was scheduled in the way that it provided maximum workforce strength from 10 am to 4 pm.

4.2 Demographic data, image modalities usage and covid 19 status

<u>Demographic data</u>

1. Mean age of our sample was 43.42 ± 7.33 at 95% confidence interval
2. Age distribution

Figure 4.2.1



Sample had

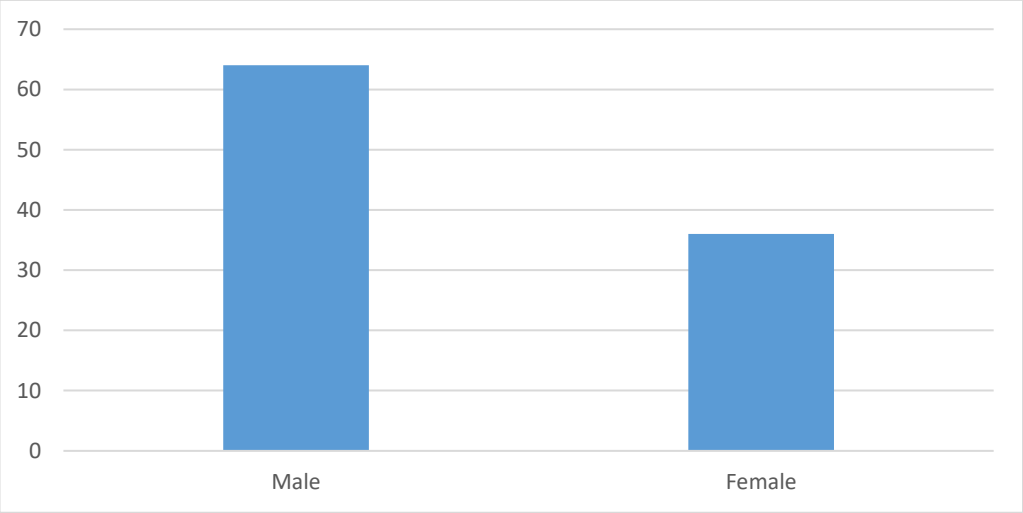
13 % of study sample below 35 years of age

58 % of study sample between 35 to 50 years of age

29 % of study sample above 50 years of age

Figure 4.2.2

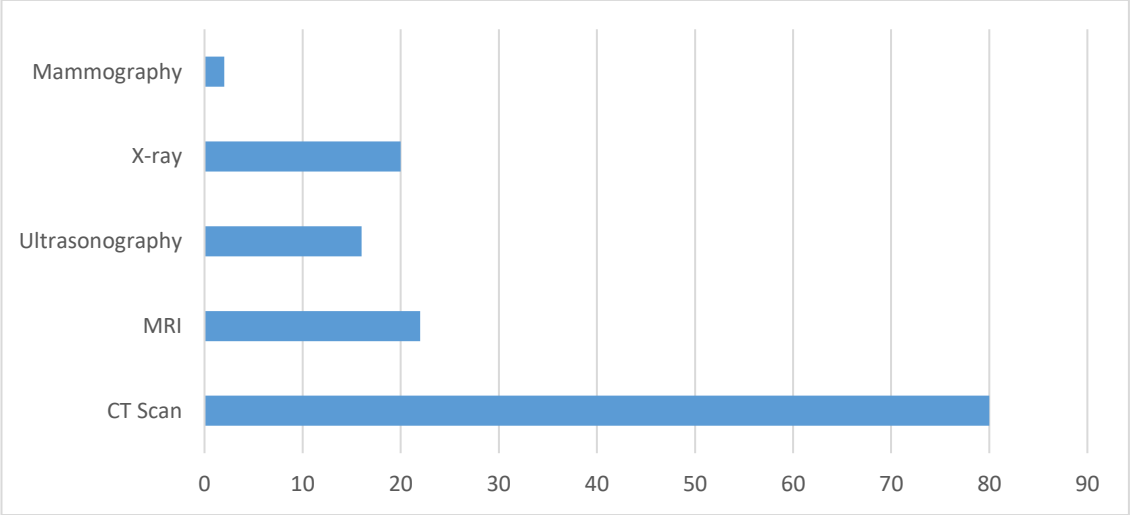
Sex data



Study had 64 % male participant and 36% female participant

Figure 4.2.3

Radio imaging modality usage



--Bar graph showing average number of patients per day for each modality

During study period, average number of procedures conducted are shown in above chart. Every day around 80 CT scan, 22 MRI procedures, 20 X-rays, 16 ultrasonography procedures and around 2 mammography procedures were carried out in imaging centre.

Table 4.2.1

Data of Covid 19 status

Image modality	Positive	Negative
CT Scan	79%	21%
USG , MRI ,X-ray ,Mammography	5%	95%

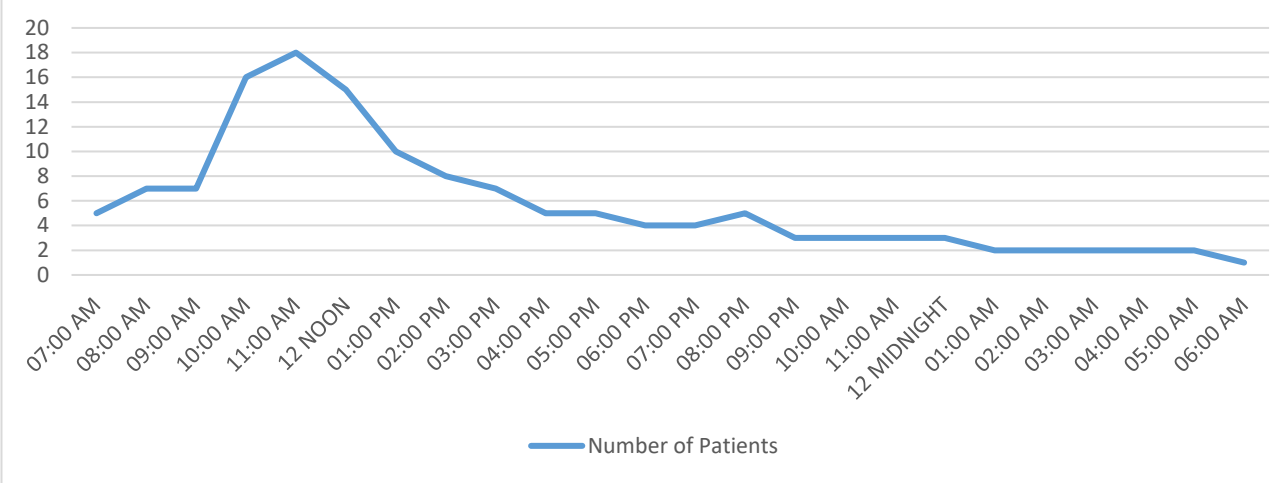
From morning 7 am to 10 am – CT scan was utilised for Covid negative patients. After 10 pm to 6 am in morning, CT scan was utilised for Covid positive patients. In the morning, at 6 am CT Scan room was disinfected for next batch of Covid negative patients

For other imaging modalities, if patient was having symptoms, history of exposure to corona patients or corona positive test report then after imaging procedure, room and machine was sanitised. Waiting area of covid positive patients was kept separate.

4.3 Daily patient flow, weekly patient flow, monthly patient flow and scheduling data

Figure 4.3.1

Daily Patient Flow

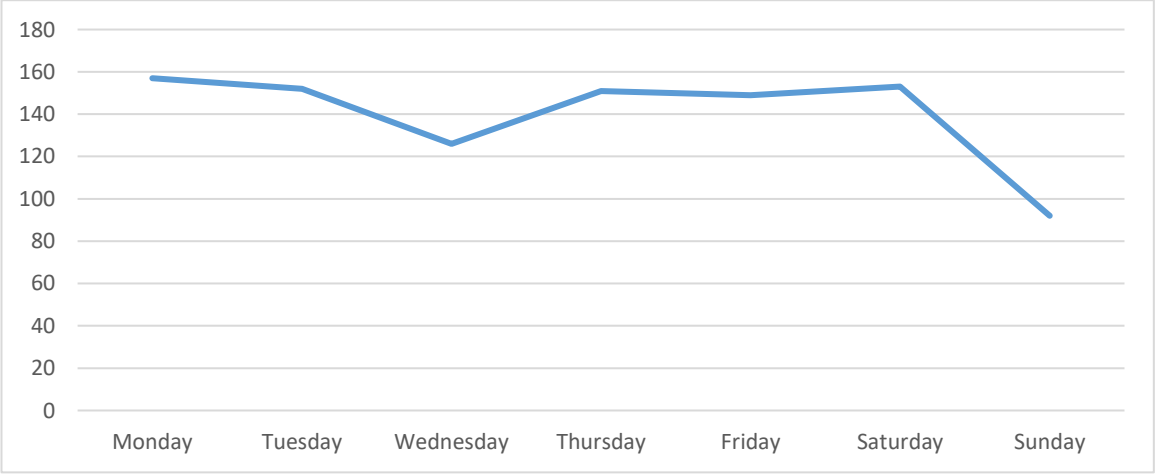


Maximum patient flow registered in between 9 am to 2 pm and it coincided with OPD timings of the referring physicians. In the graph, you can correlate number of patients with “m” of am or pm.

Average patient per hour was 5.83, SD is 4.66, at 95% CI, ME is 32.21%.

Figure 4.3.2

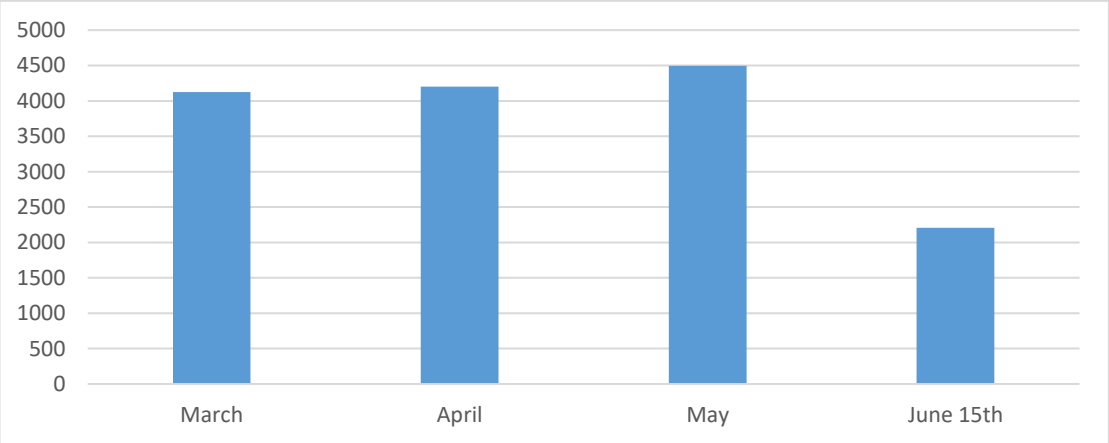
Weekly Patient Flow



Line diagram showing average number of patients who visited imaging centre each day during the week. It is seen that due to some superstition for Wednesday and holiday of referring physician on Sunday, number of patients visiting imaging centre was low. Average patient footfall was 140 with SD of 23.44 and ME of 12.42% at 95% confidence interval.

Figure 4.3.3

Monthly Patient Flow



Number of patients per month from 1st March 2021 to 15th June 2021.

Table 4.3.1

Data of scheduled and unscheduled patients

Pattern	Percentage %
Scheduled (Appointment by phone)	10
Unscheduled Appointment	90

4.4 Data on time taken for registration and billing with waiting time

Table 4.4.1

Data of Time taken for registration and billing process and waiting experienced during the same

	Registration		Billing	
	Process Time	Waiting time	Process Time	Waiting time
Mean	5.04	1.50	3.97	1.15
SD	1.13	2.33	1.53	1.62
ME at 95 % CI	± 0.41	± 0.38	± 0.52	± 0.35
Maximum	8	11	7	10
Minimum	3	0	2	0

4.5 Data for waiting time before procedure for CT and MRI in scheduled and unscheduled patients

If rate of patient arrival was less than service rate of imaging modality than there was no queue in the system. If arrival rate exceeded the rate of service. It started building queues.--For X-ray, USG and Mammography; there was no significant time lapse between registration/billing and radiological examination

Table 4.5.1

➔ For CT scan and MRI examination, waiting time data in minutes as below for unscheduled walk-in patients

	CT scan	MRI
Mean Waiting Time	37.07	19.40
Standard Deviation	42.72	21.37
ME at 95% CI	± 9.36	± 9.60
Median	19.5	9
Maximum	127	78
Minimum	0	0

Table 4.5.2

➔ For CT scan and MRI examination, waiting time data in minutes as below for scheduled patients

	CT scan	MRI
Mean Waiting Time	3.63	5.15
Standard Deviation	2.61	4.67
ME at 95% CI	± 0.63	± 2.10
Median	4	4
Maximum	10	19
Minimum	0	0

4.6 Time taken for scanning in each modality and value stream mapping of different scanning procedures

Table 4.6.1

Average Procedure Time for each modality

	Mean	SD	ME at 95%CI	Maximum	Minimum
CT Scan	4.93	2.18	± 0.48	12	3
MRI	19.96	5.51	± 2.35	33	14
USG	8.9	4.38	±3.36	20	5
Mammography	5.8	1.37	±0.69	9	4
X-ray	1.4	1.08	±0.30	4	1

Radiologist while doing sonography usually gave brief review of findings. So, sonography patients usually know the result immediately.

<u>Value Stream mapping for each imaging modality for actual procedure</u>

A-Patient changed clothes-B-Arrived in scanning room –C-Informed by attendant how to take position and patient take position-D-for contrast preparation if any-E-scanning done-F-Patient moved out-G-Patient changed clothes-K-Those who received contrast media given additional information

Figure 4.6.1

Value Stream Mapping of CT scan

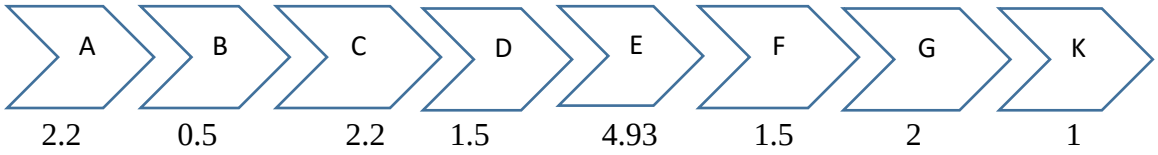
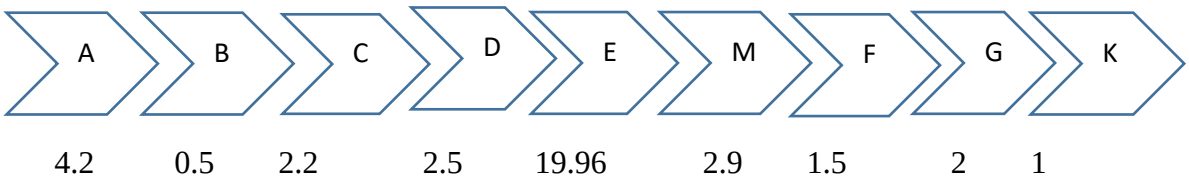


Figure 4.6.2

Value Stream Mapping of MRI process



--For MRI examination, M represents time delay or wastage due to patient movement.--

--For USG, X-ray, and Mammography-A- patients arrived in the room-B- removed clothes if needed-C- took position for examination-D- examination done E-Patient put on clothes-F-patient moved out of the room

Figure 4.6.3

Value Stream Mapping of Mammography

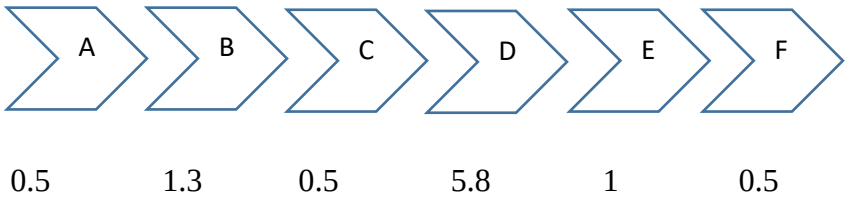


Figure 4.6.4

Value Stream Mapping of Ultrasonography

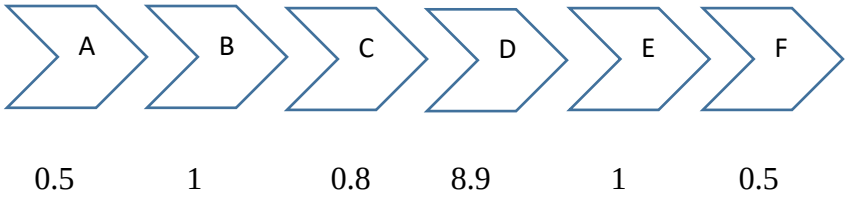


Figure 4.6.5

Value Stream Mapping of X-ray

0.5 1 0.5 1.4 1 0.5

For X-ray, USG and Mammography -time consumed for each step up to scanning was very less,there was not much scope in reducing time duration of the steps followed.

4.7 Data on time taken from scanning completion to report delivery

--Once Scan is completed → Radiology technician reformatted and processed images, sent images to PACS→Radiologist reviewed image and prepared report with digital signing→ Report was printed→Report was put under envelop and handed over to the desk for to be delivered to patients

4.7 (a) Waiting time before processing images (Images are processed by different technicians with different skill sets, knowledge and speed)

Usually, images of X-ray-Mammography and USG processed and uploaded on PACS soon. CT scan and MRI images were processed with some delay.

Table 4.7(a)1

	Mean	SD	ME with 95% CI	Maximum	Minimum
Time in between Scanning and Processing Image	14.18	8.60	±1.41	40	1

4.7(b) Time taken for processing image in different modalities

Table 4.7(b)1

Modality	Mean	SD	ME with 95% CI	Maximum	Minimum
X-ray	1.31	0.24	±0.46	3	0.5
Sonography	4.25	0.89	±0.43	5	1.5
Mammography	2.2	0.58	±0.36	3	1.5
CT scan	7.45	4.6	±1.94	10	4
MRI	8.45	2.30	±0.96	12	4

4.7(c) Time taken for reporting after images processed and uploaded on PACS

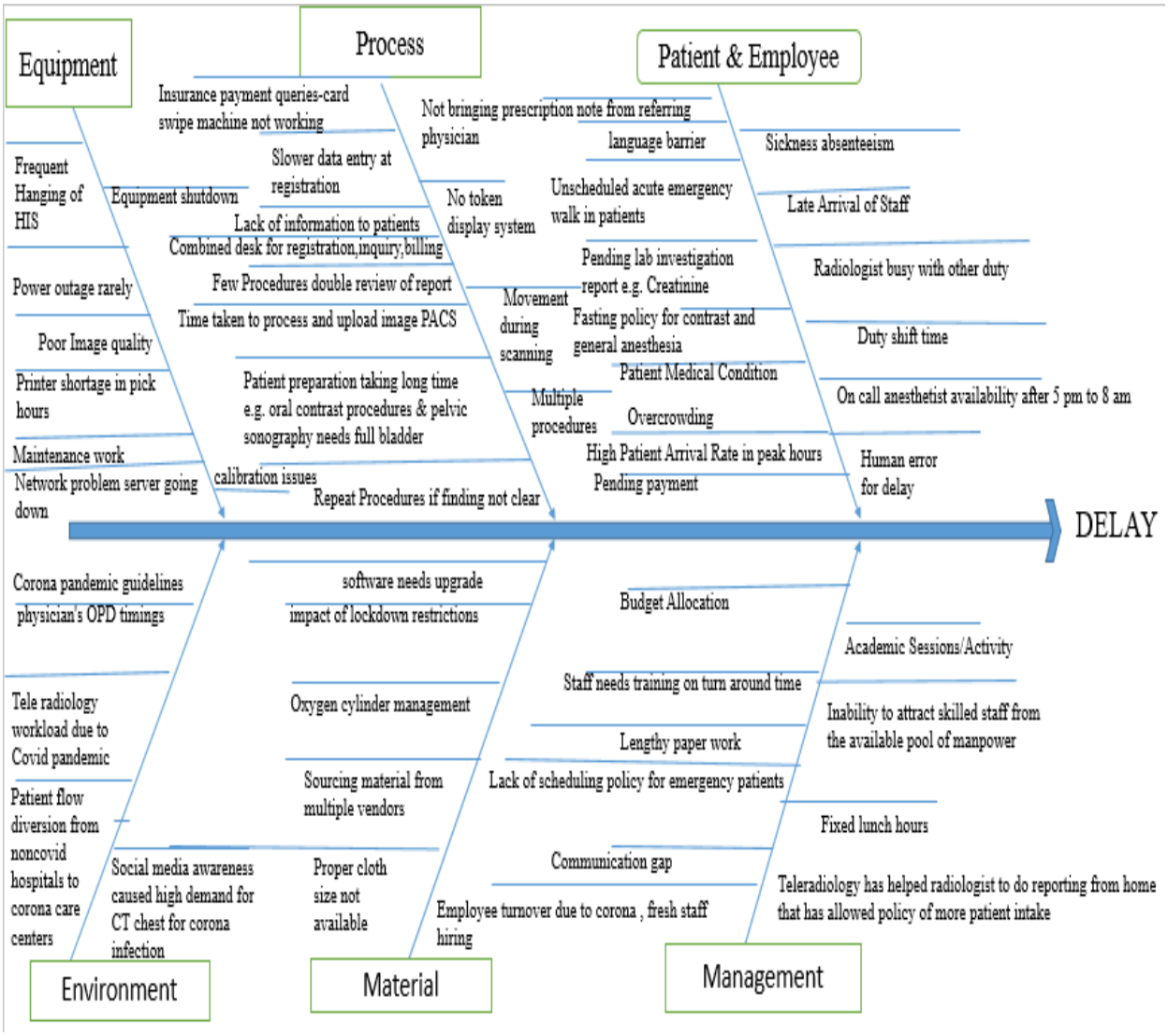
Table 4.7(c)1

	Mean	SD	ME with 95% CI	Maximum	Minimum
Time delay before examining images by radiologist for diagnosis	9.82	4.46	0.756	20	1
Time taken to review ,final diagnosis and typing	5.44	1.64	0.51	9	1
Time taken to send typed report to desk	3.77	1.66	±0.61	6	1

4.8 Root cause analysis, Pareto charts and patients views on waiting time

Figure 4.8.1

Root cause analysis for causes of waiting or delay as per interviews with employees and feedback from patients



Among patients who complained long waiting time, 89% of complaints were done by patients who had arrived in diagnostic centre in between 8 am to 4 pm

Figure 4.8.2

Reasons in % for long waiting time as per patients' feedback form

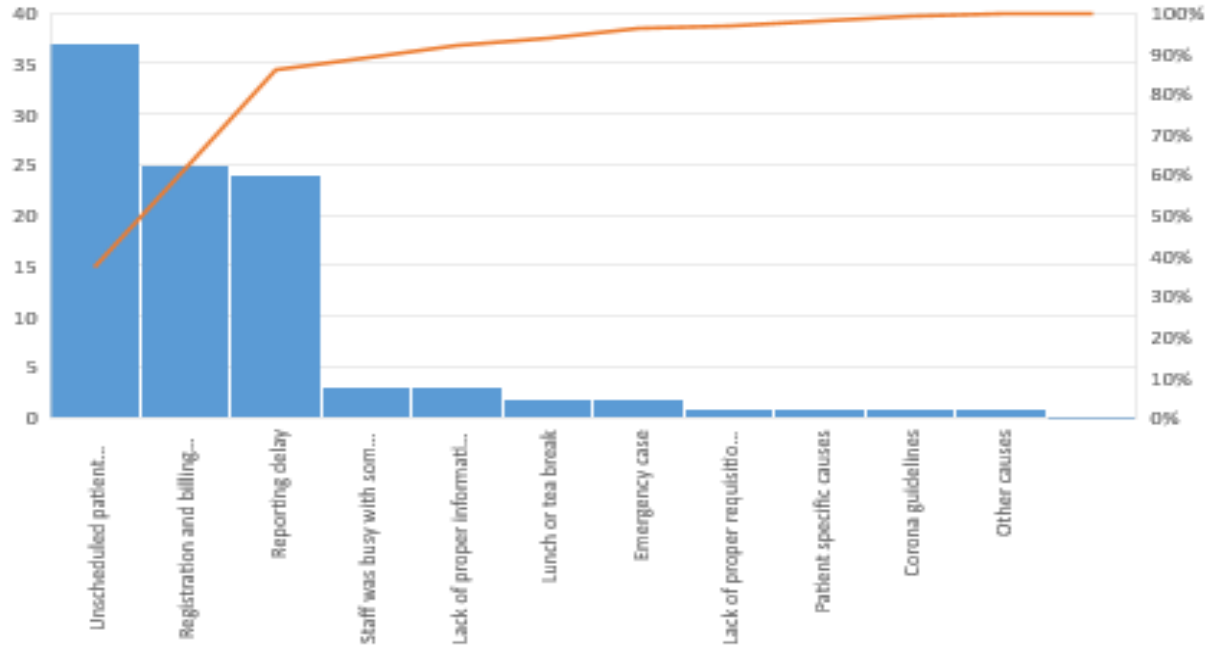


Figure 4.8.3

Reasons in % for long waiting time as per employee's interviews

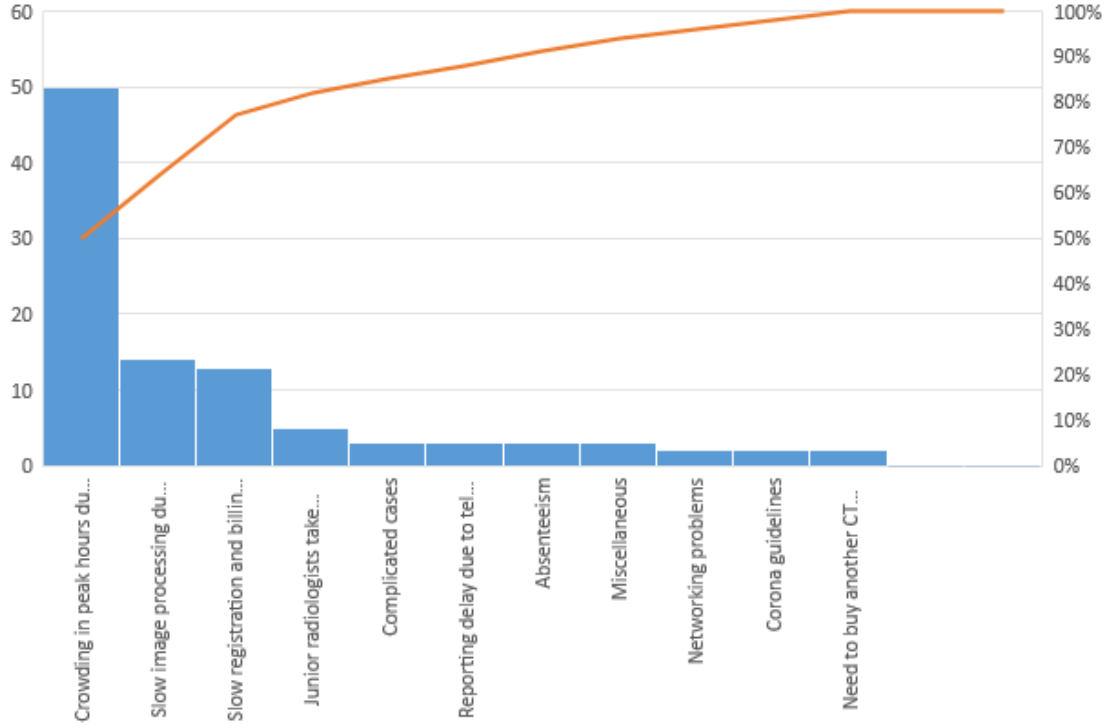


Table 4.8.1

Views of patients on waiting time

Patient Arrival Pattern	Waiting Time Long	Waiting Time Not Long
Scheduled	28%	72%
Unscheduled	62%	38%

Amongst scheduled patients who complained about long waiting time, had considered reporting time lengthy.

Unscheduled patients had complaints about registration process, billing delay, scanning and reporting delay.

4.9 Solutions implemented, survey and patient satisfaction

As per Kingman's formula mentioned earlier, wait time directly proportional to variability in customer arrival rate and it increased with utilization rate. M/M/1 queuing system represented a state where arrival rate was lower than service rate. If customers arrived faster than they were served then queue could become infinitely long, waiting time becomes infinite so, first attempt should be to match arrival rate with service rate during peak hours. For to match service rate with demand rate, capacity should have been increased. But in Radiscan main branch, there was constrain for space, so we decided to manage arrival rate and reduce process time to increase service rate.

Observations

- 63 % of patients visited imaging centre in between 6 am to 2 pm.
- Waiting period was longest for patients arriving before 2 pm.
- Feedback from patients suggested that registration process and reporting need attention.

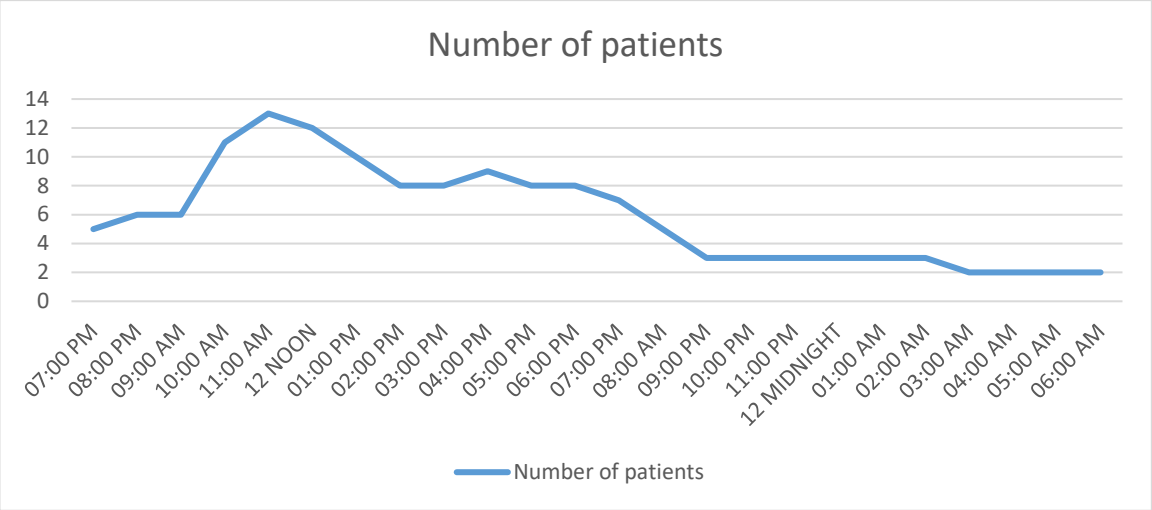
4.9 (a) Solution implemented as pilot study to see the change

As a pilot study for few days, all referring physicians were requested to divert at least 25 % of patients to visit diagnostic centre after 3 pm, citing rush in morning hours. For a week, this system was implemented average patient flow was 143 patients per day.

Every day around 22 MRI scan, 82 CT scan, 19 USG examination, 2 Mammography, 19 X-ray test conducted as average of weekly flow.

Figure 4.9(a) 1

Daily patient flow was as below



-Registration delay mean 0.44 min and billing delay came to 0 .40 min

-There was a remarkable change in waiting for CT scan . mean was 2.93 min with SD of 3.68 min . Maximum delay was 15 min , minimum delay was 0 min. For MRI , mean delay was 4.13 min with SD of 6.3 minutes. Maximum delay was 20 minute and minimum was 0 minutes.

- Delay for processing images by radiology technician reduced to mean of 5.22 minutes with SD of 1.99 minutes.

- Delay by radiologist to review scan and to diagnose reduced to mean of 7.20 minutes with SD of 1.34 minutes

4.9 (b) E-registration process , duty shift –staff relocation , eliminating waste of time

On second week ,as pilot study , we introduced e-registration process on a separate computer counter at the entry and on voluntary basis, asked patients to fill the form online and pay through a link given with e-registration tab. And, then just collected token for examination from the reception counter . Around 24 % patients (33 patients) out of average 138 patients ,opted for e-registration .

E-registration process reduced registration time to mean of 3.67 min and SD of 1.95 , online payment through e registration reduced billing time to mean of 3.23 min and SD of 2.08 min.

-Duty shift of one of three radiology technician was changed from night duty to 10 am to 6 pm . His services was utilised in processing images. Mean time of delay in processing images reduced to 4.21 with SD of 2.99

-Diagnostic centre just changed place of printer from stationary room to the reception desk , it eliminated waste of time (3.77 ± 1.66)taken to deliver report to the desk.

4.9 (C) Feedback survey and patient satisfaction

Table 4.9(c)1

Questions	Response	
	Before implementing solution in % (in affirmative)	Schedule change for a week in % (in affirmative)
Was there any delay in service	55	10
Staff was helping, courteous	89	97
Doctor's interaction good	98	98
Precautions for corona infection taken properly or not	88	96
Diagnostic procedure uneventful	100	100
Privacy/confidentiality maintained	97	99
General appearance of diagnostic centre	85	86
Value for service	90	97
Would you recommend radiscan to your know	93	98

Reducing waiting time increases patient's satisfaction

5. Discussion

Patient satisfaction is associated with how quickly he or she gets the service. There is inverse relationship between waiting time and patient satisfaction. Several studies have shown that waiting time is the most contributing factor to satisfaction with services[8].

Turnaround time is important for any service provider. By reducing the waste and improving throughput, organization can increase the revenue. A study conducted by Evelyn C Brown in a general hospital had stated that reducing turnaround time in clinical set up increases revenue and profit[9].

Why patient flow, waiting time study is important for patient perspective? There are numerous studies which show that delay in laboratory and imaging services associated with adverse patient outcome .A study by S Cournane et al. in a study of Radiological imaging delays as independent predictors of length of hospital stay showed that delay is associated with longer hospital stay and reducing time delay was associated with reduced hospital stay and reduced costs[10].

Reason behind conducting the study was to find out reasons of long waiting time, suggest solutions and by reducing turnaround time, increase throughput for the hospital.

Observations in brief

-In the study, it was observed that at registration desk, registration process took mean time of 5.04 minutes and there was average delay of around 1.50 minutes experienced by every patient. Billing process time was averagely 3.97 min and there was per patient delay of 1.15 minute at the billing desk.

Walk-in CT scan patients experienced mean waiting time of 37.07 minutes and for walk-in MRI patients mean waiting time was 19.40 minutes. For scheduled patients, waiting time for CT scan and MRI was less. Average procedure time for CT scan was 4.93 minutes and average procedure time for MRI was 19.96 minutes.

Value stream mapping of process flow in scanning room showed that there was not much scope in eliminating waste or reduce delay.

Once scan is completed, images were processed. There average delay of 14.18 minutes before processing took place. So, it was possible to eliminate waste of time by

recruiting staff for executing work and avoid delay. Capacity planning needed financial management which itself was matter of budget allocation

Once images were processed, radiologists on duty had taken considerable time for examining images for generating report. There was mean delay of 9.82 minutes before radiologist started reviewing image for diagnosis..

Feedback received from patients and interviewing employees revealed that unscheduled patient arrival, registration delay and reporting delay were main reasons for prolonged waiting time, which needed attention of management.

-Just by managing examination schedule of the patients, delay at registration and billing desk, waiting time for CT scan and MRI examination, delay in processing and delay in reviewing reports by radiologists reduced significantly.

-To examine the effect of online registration , diagnostic centre mimicked online registration process with e-registration process at nearby computer desk and showed that even just 25% of patients opt for online registration , registration /billing time could be reduced along with decrease in waiting time at registration and billing desk.

- Lean principles can identify and remove waste. By working on lean principles, we found that there was unnecessary time delay for delivering report from printer to the reception desk. Institute installed a printer at reception desk and time delay due to that was eliminated.

How study was conducted

Study was quantitative and qualitative, both.

For to map patient flow, we documented arrival of patients by observation. Imaging centre witnessed 135 to 145 patients per day, on average.

In study, we had decided to include 10 % of patients who arrive in imaging centre. From day one, we included patients at the interval of 10, process continued until the end of the study. If any patient refused to be part of the study. We included next patient in to our study. Every day, we gathered data of around 15 patients.

Data was analysed in the meeting. All the suggestions discussed. The solutions which were considered as non-disruptive for business were accepted and implemented in phased manner on pilot project basis.

Limitations

Staff and doctors do rotating duties. There was variability in speed and efficiency for doing given task. That could have affected result of the study. For to bring uniformity in study, study could have been conducted in homogenous environment.

Time noted by the patients might not be genuine as there was no check and balance over inputs from patients. Patient, who was under stress due to underlying disease condition, sometimes failed to register timings of each step and then might have filled up the form with guesswork for time spent on each activity. Whatever data was given, considering it as true, further research process was done.

Size of the samples for to study waiting time and impact of implementing solutions was different. Further comparative study required to have fruitful statistical data.

Discussion on observations

M O Oche & H Adamu had conducted a study on determinants of patient waiting time in the general outpatient department of a tertiary centre of Nigeria. They had opted for cross sectional research pattern to identify factors causing delay[11]. Study was cross sectional because they just wanted to take a brief view of causes of delay in that particular period without associating it with patient flow. Study at Radiscan had exploratory research design over period of three and half months because we wanted to study variability in patient flow, impact of variability on waiting time along with finding out other causes of delay and suggesting solutions for the same. The study design was exploratory because in different institutes there could be different reasons of delay, each institute had different management view on problem and its solutions. Implementation of solutions was mainly dependent on its benign nature in terms of affecting revenue. Any organization will not allow implementing any change, which affects revenue. Therefore, we took this research as a preliminary study for further research.

87 % of our study population was above 35 years of age. Age related diseases and propensity of corona virus to create morbid condition in patients in elderly population resulted in to middle and old aged population to seek medical help.

In our study, we had more of CT scan and slightly reduced number of ultrasonography and MRI imaging procedures. Before corona pandemic, imaging centres had higher demand than during corona pandemic time. Corona virus has disrupted healthcare dynamics globally. It had overall reduced patient footfall in the hospital for non-covid health services. A study conducted by Keval D Parikh et al. had shown that imaging service utilization has reduced in March and April 2020[12]. Thereafter reports were published that CT scan can catch lung involvement even in RT-PCR negative patients and high prognostic value in corona infection. Imaging centres were flooded with corona positive CT scan patients. With overall slight reduction in imaging centre workload, imaging centres were experiencing huge CT scan workload during corona pandemic[13]. During corona pandemic, number of patients seeking CT chest was very high and number of patients seeking imaging services for other modalities had decreased with overall steady state patient flow before and during corona pandemic.

Imaging centres or radiology department workflow associated with OPD service of the referring physician. After visiting physician, patients visited imaging centre and returned to the referring physician on the same day in evening with the report. A part of patients visited radiology centre next day in the morning, got the test done and then visited referring physician with the report. In both the scenario, imaging centres experienced higher rush of patients in the morning hours. A study by Felicitas U.Idgo had similar findings[14]. He noted overall mean average arrival rate of 12 patients per hour in the morning. Same study had shown average patient arrival rate of 7 ± 5.4 patients/ hour/day. A study by Ellis R I et al. had shown peak registration time in the morning from 8 am to 12 noon with slightly decreased arrival up to 3 pm. He had noted gradual decline in patient flow in evening time[15]. Due to corona pandemic, CT scan patients visit imaging centre at any time and few of the non-covid patients opted to visit imaging centre when there was less crowding in evening time.

Imaging centres had less patients on Sunday as referring physicians are not there to feed imaging centres.

Unscheduled care can be defined as healthcare demand, which cannot reasonably be foreseen or planned in advance of contact with the relevant professional. We had noted only 10% of patients /physicians had booked appointment before visiting diagnostics centre. Combining unscheduled, scheduled and acute emergency patients was a really a nightmare for imaging centre. Arrival of single patient for MRI on emergency basis had disrupted scheduled and unscheduled workflow. Unscheduled arrival of patients

consume many resources with disrupting work life balance of already overburdened staff. A study by Fiona A Hawke had shown similar findings in her study in 2011[16].

In our study, we observed that scheduled appointment decreased waiting time in comparison to those who entered in to diagnostic centre as walk-in patients.

An article published by Diffen.com has stated that CT scan took around 5 to 10 minutes and MRI could take usually between 15 to 20 minute[17]. This website had mentioned that MRI lasted up to 120 minutes depending upon complexity of the procedure. In the study at Radiscan, similar findings regarding CT scan and MRI procedure durations noted. In our study, CT scan was done in 4.93 minutes and MRI took around 19.96 minutes.

In the same way as our study, Dave Pearson had published a study in Health Imaging Insights in 2017. He had elaborated value stream mapping of CT scan and had mentioned time delay for CT scan and time taken for CT scan examination. He had stated that process mapping cuts wait time by one third[18]. In the study, we had mapped process for all the procedures. Inside the scanning room, study did not find steps, which could be eliminated. But still we had identified points where time spent on steps could be cut short, which we have mentioned in separate suggestion chapter.

Value stream mapping is an important hospital management technique and it has been called as “Gemba walk”. In this technique, a staff member observes a process from beginning to end to get aware of the steps involved in the process[19]. By studying flow process, Rebecca J. tried to improve patient flow by increasing efficiency, improving adaptive workflow and decreasing wait time. In our study, we had mapped the process to understand steps and make value stream map for to identify waste and area of improvement.

Whitney L Jackson in 2015 published an article and stated that it has been possible to reduce radiology turnaround time from 30 minutes to 2 hours as RIS/PACS system with closely integrated tools of voice, intelligent display protocols, 3 D visualization and other clinical applications have immensely helped in reducing reporting time[20]. In our study, turnaround time at diagnostic centre was almost same. Image processing is time consuming and needs to be completed without delay for shorter turnaround time.

Mussa Kumwembe in his research study had stated waiting time or delay in registration process. He had suggested increase in number of receptionist for to tackle delay at registration desk[21].

As per lean methodology, smart organizations have opted for digital signature on report paper rather than wasting time on signing the report[22]. Once radiologist prepares a report, it is printed with digital signature and it saves wastage of time. Radiscan diagnostics used electronic signature from beginning of the centre and has successfully shortened report turnaround time.

A report in radiology business magazine had shown that by letting patient schedule their own exams, it is possible to end imaging delay. In another article by Biswita C Mozumdar, it was concluded that online scheduling applications are becoming the preferred scheduling method[23]. Augmenting their capabilities and availability can simplify the scheduling process, improve referring physician satisfaction, and provide a competitive advantage. Referring doctors opt to change imaging centre if scheduling expectations are not met. Many of imaging centres have adopted online scheduling and so many are reluctant for online scheduling method as arrival of acute-emergency patients disrupts whole of the schedules throughout the day and it makes scheduled patients unhappy.

Scope of future research

We had conducted our study without putting extra burden on organizational resources. We had taken views of the entire stakeholder in to account and had tried to analyse the situation, bringing out the facts and had recommended suggestions. Solutions, which we had put in to practice, were totally cost free. Moreover, we had got good results without disrupting business. On basis of findings, I suggest that future studies on impact of online scheduling-cost effectiveness and real time tracking of patients with patient flow dashboard will be more helpful in managing patient flow and waiting time.

6. Conclusion

Walk-in unscheduled patients with increased demand for imaging services in the morning hours resulted in to crowding and long waiting time at various steps of imaging services. Scheduled patients had lower waiting time than walk-in patients.

By smoothening registration and billing process by online appointment and payment system, turnaround time can be reduced.

Scheduling procedures smartly with prior appointment can eliminate waiting time from the system.

Reducing waiting time increases patients' satisfaction.

Impact of scheduling on revenue due to "no show" or "missed appointment" needs to be studied before implementing scheduling procedures. Further research is required on how to accommodate scheduled and unscheduled patients in the system.

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7 Suggestions for reducing wait time

- Maintain a real time dashboard for patient flow.
- Hospital can float a patient portal on which patient can fill up all the details and pay online with mentioning tentative time of examination to the patient. On the day of examination, patient just has to mention registration number at reception. It reduces a lot of time at the registration and billing desk.
- Patients should be given instructions by referring physician's office that wear "examination friendly" clothes without buttons, metal clips. Patient should go without wearing ornaments.
- Patient should be informed in advance by referring physician about need of family member to sign consent form in case contrast media or anaesthesia needed for the procedure.
- Patient should be told to carry requisition slip for particular imaging and old medical reports to imaging centre.
- Those with possibility of kidney disease should be given instructions by referring physician to get Creatinine done before undergoing contrast CT or MRI imaging. Contrast study needs 4 to 6 hours of fasting before the procedure; referring physician should inform it to patients in advance.
- Pregnancy should be revealed and discussed with referring physician before going for X-ray, CT scan or Mammography.
- Report can be e-mailed; it saves lots of time for patients.
- Entry point or waiting area should have signboard regarding procedure conducted, so that patients get prepared to take position and they have proper knowledge of maintaining position without movement for examination.
- Imaging centres should launch YouTube videos for to give idea about position required for particular imaging procedure and how procedure is conducted from first step to last step. Referring physicians can suggest to patients to go through these videos for better understanding. So, that their journey through imaging process become smooth and without facing much delay.

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