



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

SUBMITTED

BY

DR HIMANSHU ASHWINKUMAR SHAH (0990)

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UNDER SUPERVISION AND GUIDANCE

OF

DR MONIKA CHAUDHARY

Radiscan Diagnostics Organizational Profile

It provides radio imaging and pathology laboratory services.

Two branches in Ahmedabad- Akhbarnagar and Shahibaug



Akhbarnagar branch provides CT scan , MRI , X-ray , Mammography and Ultrasonography services in its imaging centre along with pathology laboratory services.

Affordable diagnostics services with state of the art technology and equipment is the mission of the imaging centre.

To deliver world class diagnostic services with quality and integrity is the vision of the Radiscan Diagnostics

-Dr. Rajendra Solanki (MBBS ,MD-Radiology) is the Managing Director of Radiscan Diagnostics.

He is Professor and Post-graduate teacher in medical college and post-graduate teacher for Diplomate of National Board in Gujarat Imaging Centre & Research Institute.

He has special interest in Head & Neck Imaging with research focus in Musculo-Skeletal and Cochlear Imaging.

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

He is author of number of research articles in Radio imaging. He has presented research papers at Radiology society of North America , European Congress of Radiology and Korean Congress of Radiology.

Two of his books as co-author are to be published in short time . Elsevier Publications , USA is going to publish one of the two.

-In Akhbarnagar branch ,12 Radiologists with different specializations provide services.



1. Introduction

Demand for Radio imaging services in medical diagnostics is increasing day by day.

With ever increasing patients' demand, clinics have not matched pace of infrastructure enhancement due to great fixed and activity costs.

With increasing demand , variability in flow arises from the community through various entry points , changing constantly through each day, week and season.

Variability in patient flow leads to variability in service utilization and mismatch between patient inflow and outflow.

To match demand and capacity in radiology unit, managers have to put extraordinary attempts to improve process flow-oversee patient flow and improve asset utilization.

Dynamically matching dynamic demand with dynamic capacity is difficult, sometimes leading to poor quality of services in terms of delay and eroding value of the organization.



Problem statement

Radiscan Diagnostics has to manage patients with prior appointment and a large portion of patients who visit imaging centre as Walk-in patients.

-Unscheduled walk-in patients also important for service/business point of view but may lead to crowding. Due to high fixed cost , capacity of imaging centre remains fixed and crowding leads to long waiting time due to demand-capacity mismatch. Long waiting time is associated with lack of patient satisfaction and with causing staffing issues may lead to loss of business in long run.

Large numbers of patients lead to stress among healthcare professionals which may decrease operational effectiveness and quality.

-Corona pandemic has somewhat decreased demand for imaging modalities like Ultrasonography, Mammography and MRI with increase of demand for CT scan for chest. To cater needs of corona positive and corona negative patients with following infection control guidelines is a tricky issue for Radiscan Diagnostics with high patient flow.

-Patients have tendency to visit Imaging centre on same day after visiting primary physician in the morning. Referring primary physicians also have habit of examining patients' imaging report on the same day for better care of patients.

As mentioned earlier, patients have tendency to visit imaging centre in the morning hours which coincides with referring physicians OPD timings. So, there was queues at registration, billing , scanning and delay in reporting too.

Taking care of combined lot of “walk-in patients and patients with prior appointment” is a managerial Achilles heel. Emergency acute patients create delay and long queue for diagnostic services.

Radiscan Imaging also provides tele-radiology services to so many hospitals, which causes workload on Radiologists and Radiology Technicians.

Why study was important for organization ?

From patients entry to exit from the imaging centre, it was felt that patient movement was prolonged with long waiting time at each point.

Time taken for actual radiological examination was fixed and impossible to reduce . By understanding flow at upstream and downstream of the scanning procedure , it was possible to manipulate time spent by a patient in the imaging centre. By understanding causes of delay or waiting time , it was possible eliminate reasons of delay and patient satisfaction could have been improved.



Research Questions

How patient flow took place in diagnostic centre?

What were the causes of delay or waiting time in imaging centre, any correlation with patient flow?

What could be the possible solutions and any impact on patient satisfaction?

Research Objectives

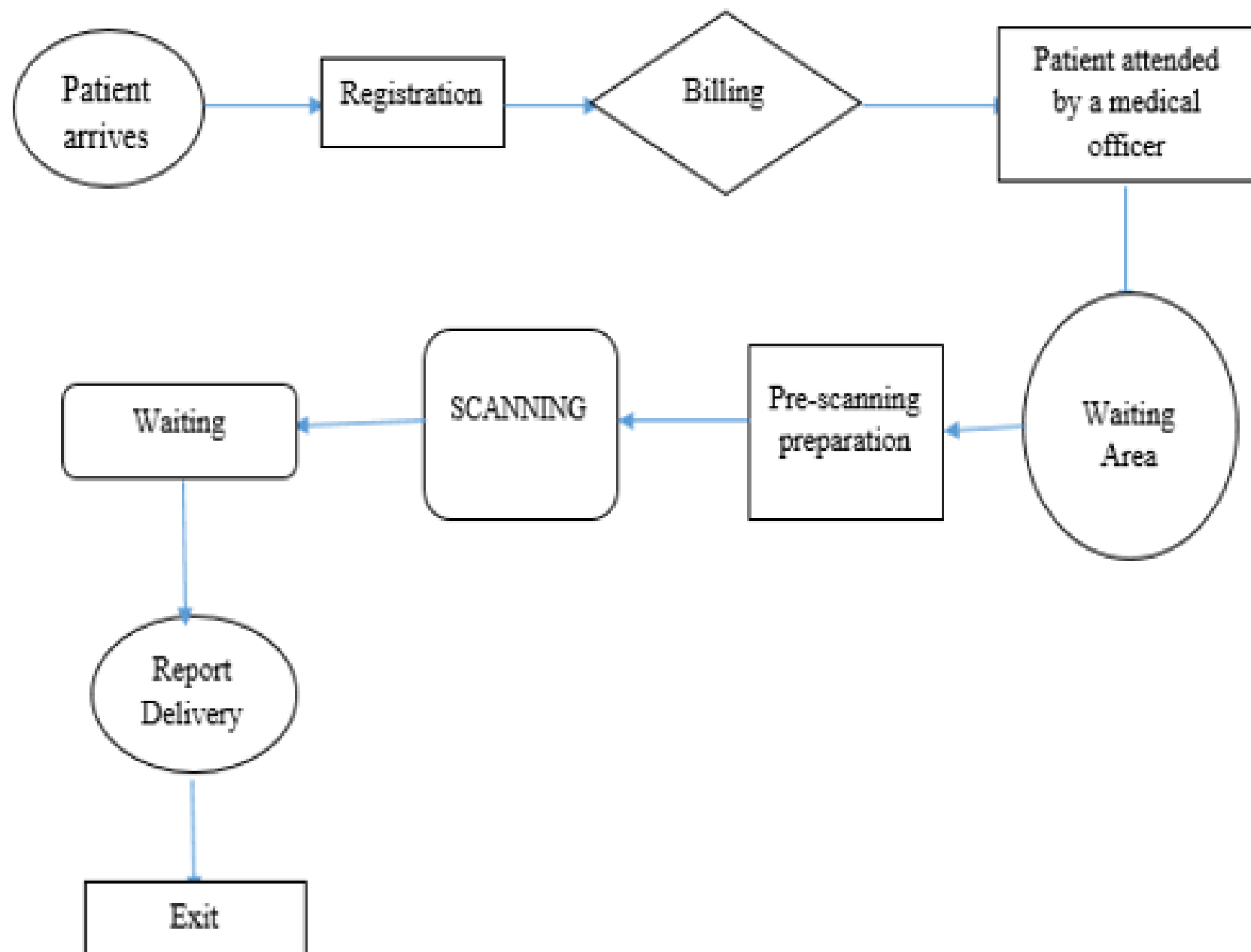
Broad Objective

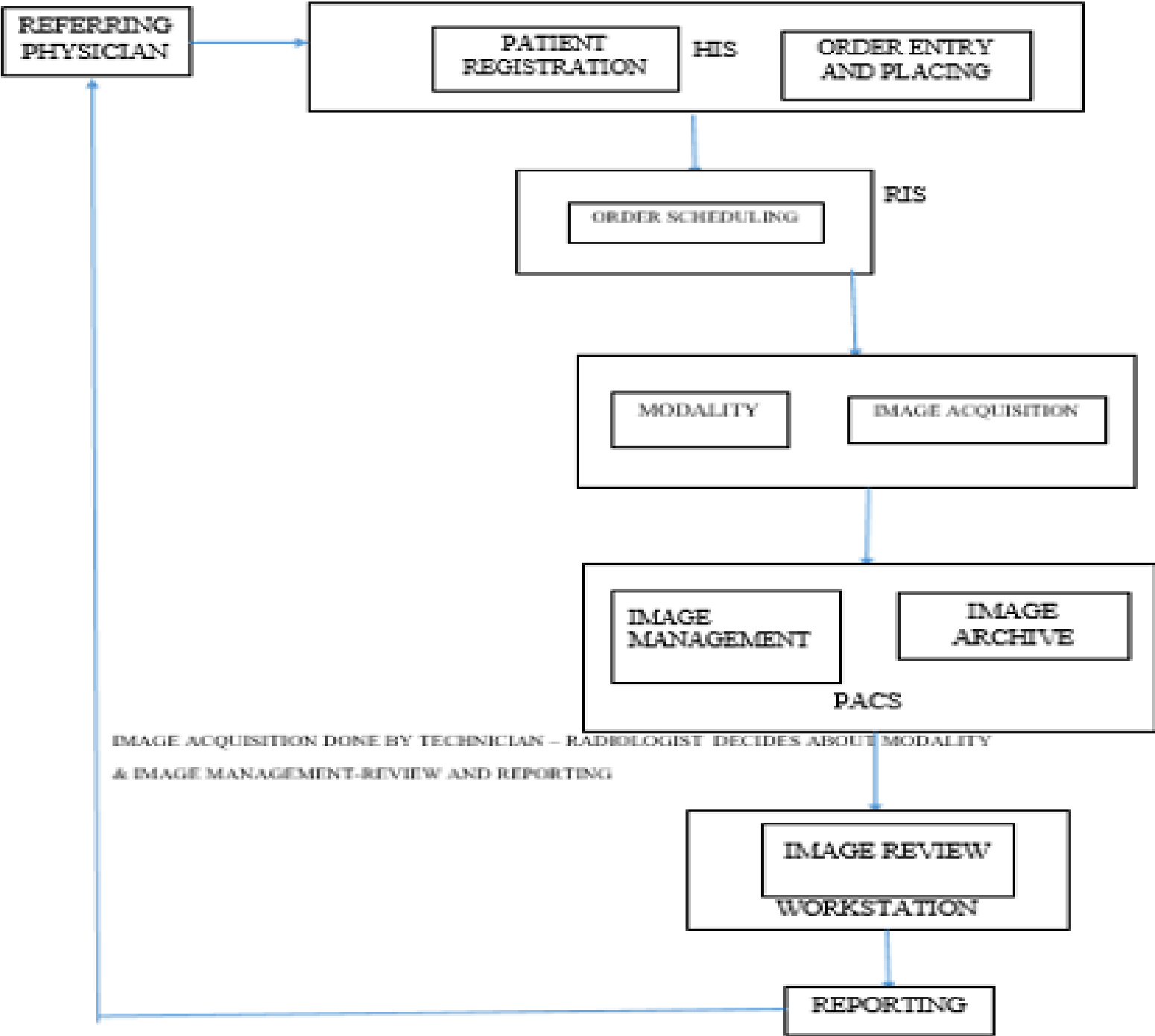
To study patient flow in radio imaging centre. Our goal was to find out reasons behind waiting time in radiology centre and solutions for the same. Whether waiting time had any impact on patient satisfaction or not?

Specific Objectives

1. To understand patient flow for utilisation of the radio imaging services.
2. Identify each of the steps involved in completing diagnostic imaging investigations
3. Identify points of delay in the process and know average waiting time at each point.
4. Identify root causes of long waiting time .
5. How to streamline patient flow, improve scheduling so to reduce patient waiting time, recommendations to reduce waiting times and at what extent recommendations implemented reduced waiting time.
6. Impact of implementation of solutions on patient satisfaction.

Patient Journey in imaging centre





Waiting Time in Radio-imaging

Patient waiting time is the time a patient takes at each service point before being served .

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 till patient receives report.



Measure of waiting time can thus cover the time the patient is registered for the investigations , till the time patient finally collects his/her diagnostic report.

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

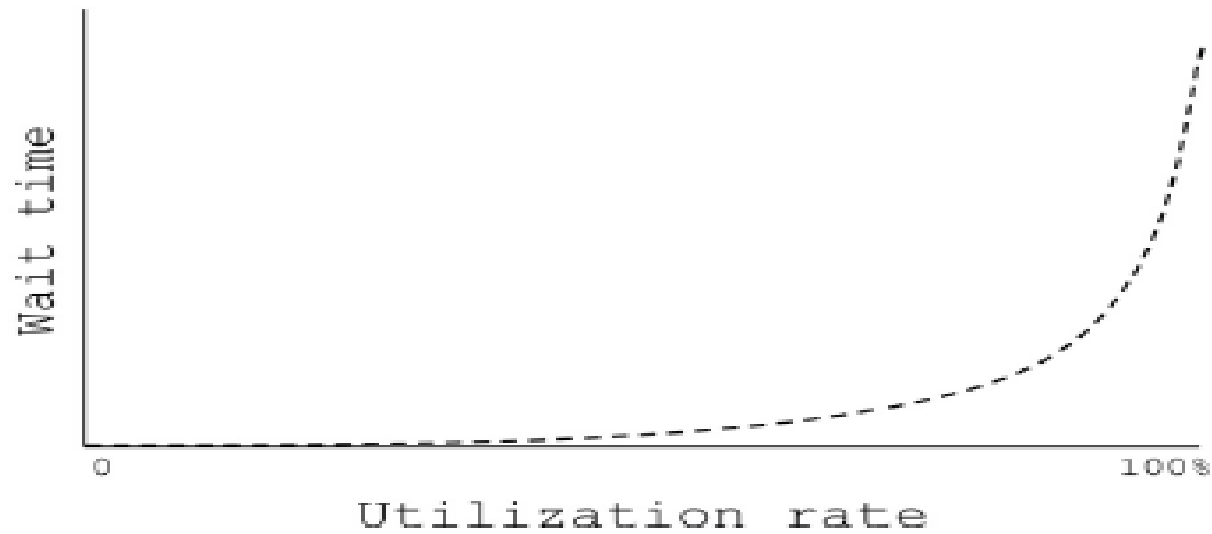
$$W = T_s (U / 1 - U) \times [(CV_a^2 + CV_s^2) / 2]$$

Where W = mean wait time , T_s = service time , U = Utilization rate

CV_a = coefficient of variation regarding customer arrival

CV_s = coefficient of variation regarding service time of the servers

Several key points can be drawn from Kingman's formula for a theoretical understanding of queues. First, wait times are directly proportional to service time, which is intuitive. Second, wait times increase exponentially with utilization rate. Third, wait times are directly proportional to variability in customer arrival and service time.

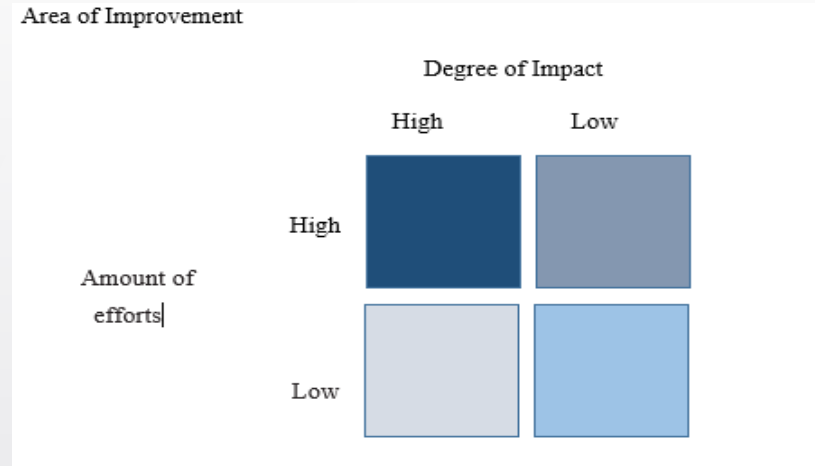


A queue is a waiting line of customers requiring service from one or more servers. A queue forms whenever existing demand exceeds the existing capacity of the service facility; that is whenever arriving customers cannot receive immediate service due to busy servers.



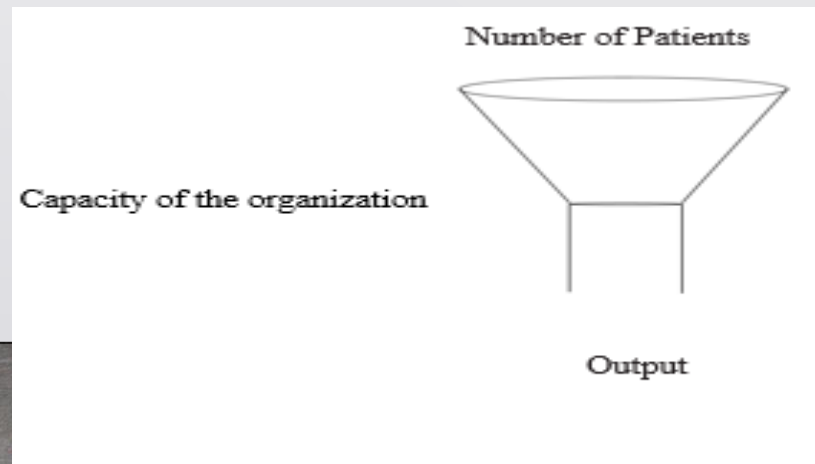
Waiting Time Reduction

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

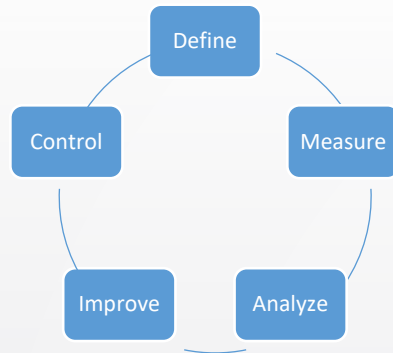


Concept of bottleneck

- (a) For same level of output, one needs to manage patient arrival or to manage crowding
- (b) System needs to enhance capacity which will increase output also.



→ Six Sigma Theory is utilised to reduce variation. It is a problem focused



→ Lean thinking theory is utilised for eliminating unnecessary processing and waste.

It is a flow-focused theory.

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

→ The Theory of Constraints is a methodology for identifying the most important limiting factor (i.e. constraint) that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor.



2. Review of Literature

Year	Author	Title	Study Design	Purpose	Results	Conclusion
2021	Kenneth K Agwu et al	Improving patient flow: A case study of a tertiary care hospital's radiology department	Cross Sectional Study.	Analysing patient flow and studying how to optimize scheduling of patients	Mean arrival rate of patients was 7 ± 5.4 , peak arrival rate of 12 patients / hour and peak arrival in between 7 am to 10 am. Overall mean waiting time was 116 minutes.	Service bottlenecks was addressed through good patient flow management with an optimal scheduling system.
2014	L. Hofman	Capacity management at the radiology department of Isala- Managing the variability of scheduled and unscheduled patient arrivals	Analytical study	To reduce the variability of the utilisation of the radiology department by a) generating insight in the factors affecting the variability and b) analysing interventions to increase the match between demand and supply	By improving, the block schedule and using off-peak scheduling, improvements for the access time (2 days), same-day access ratio (48%), and patients served within their time window (38%) could be achieved.	It was possible to reduce the variability by changing the scheduling process at the radiology department . However, more fruitful to reduce the variability of requests at their origin at the outpatient clinics
2014	Rebecca Bisanju Wafula	Factors associated with patient waiting time in outpatient clinic of Nairobi Health Services	Cross-sectional study	To determine wait time and associated factors among outpatients attending senior staff clinic at University of Nairobi health services.	Average waiting time was 55.3 minutes. At doctor's office waiting time was 13.1 minutes.52% of respondents had suggested to increase staff to reduce wait time.	Identifying area of delay and mean waiting time is the first step in implementing needed changes. Majority opined that increasing availability of health workers reduces waiting time.

Year	Author	Title	Study Design	Purpose	Results	Conclusion
2016	Dr (Brig). A. P. Pandit, Ms.Tanima Debmallik	A lean six sigma approach to reduce waiting and reporting time in the radiology department of a tertiary care hospital in Kolkata	Interventional study	To find the bottlenecks in the process of scanning and reporting of CT scan and MRI for outpatients and implement solutions..	1. Average Pre-test waiting time before implementation was 41 minutes. 2. Average Pre-test waiting time after implementation was 18 minutes.	Lack of information given to the patient regarding preparations for the test was the major cause of delay and increased pre-test waiting time. . The Written communication system was an unmanned process that successfully reduced the Per-test waiting time by 23 minutes
2016	Anna Holbrook	Shorter perceived outpatient MRI wait times associated with higher patient satisfaction	Observational Study	The aim of this study was to assess differences in perceived versus actual wait times among patients undergoing outpatient MRI examinations and to correlate those times with patient satisfaction.	The mean actual wait time between patient arrival and examination start was 53.4 ± 33.8 min, whereas patients perceived a mean wait time of 27.8 ± 23.1 min, a statistically significant underestimation of 25.6 min. Both shorter actual and perceived wait times correlated with higher satisfaction scores.	Shorter perceived and actual wait times were both correlated with higher satisfaction scores.
2010	Giles W. L. Boland et al	Radiologist Report Turnaround Time. Impact of Pay for Performance Measures	Analytical study	This study was performed to evaluate impact of pay for performance on Radiology Turnaround Time.	Reduction in mean report turnaround time, mean examination completion time.	A radiologist pay for performance program has marked impact on expediting report turnaround time. Motivation works for improving performance.

3. Research Methodology

Study Design: Exploratory Research

Research Method : Mixed Method (Qualitative and Quantitative)

Study Setting : Study conducted at Radiscan Diagnostics-Imaging Centre, Ahmedabad

Study Period : 3 Months and 15 days

Study Population : 10 % of patients who visited Radiscan Imaging.

Inclusion Criteria: 18 to 65 years of age . Conscious, stable, ambulant patients.

Exclusion Criteria: Patients with history of psychiatric illness , trauma patients excluded from study.

Sampling : Non-probability , purposive sampling

Data Collection :

Patients' form for timings of events , Survey form

Employees' survey

Imaging Centre's computer data system

Personal Observation

Data Analysis tool : MS excel



First Patient Journey and Process Flow in Radio Imaging Centre noted.

Staff scheduling noted.

Daily , weekly and monthly patient flow noted

Participants were given a form for to note down timings of events from entry in to Imaging centre up to getting report and exit.

After scanning , Imaging centre's computer data utilized for to find out time of processing images , review of images by radiologist.

Patients' feedback form and employees' interview used for root cause analysis of delay.

Causes and possible solutions discussed by management. Multivoting used for selecting solution for implementation.

Again, daily patient flow, time spent for each activity noted.

Survey measured satisfaction before and after implementing recommendations.



Form for time taken for each step – start time, end time

1. Arrival time 2. Registration 3. Billing 4. Case Review and consent 5. Waiting Area 6. Scanning Preparation Procedure- Changing clothes -Venous line insertion -Patient takes 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

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

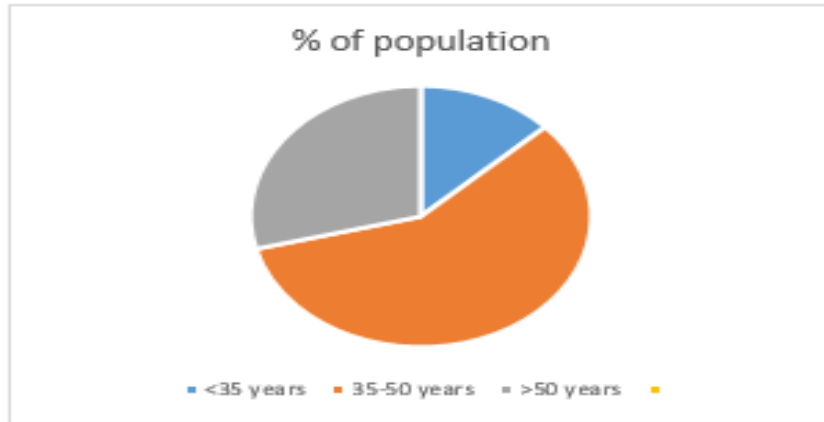
General appearance of the diagnostic centre

Value for service

Will you recommend or visit radiscan imaging again?



4. Observations



Sample had

13 % of study sample below 35 years of age

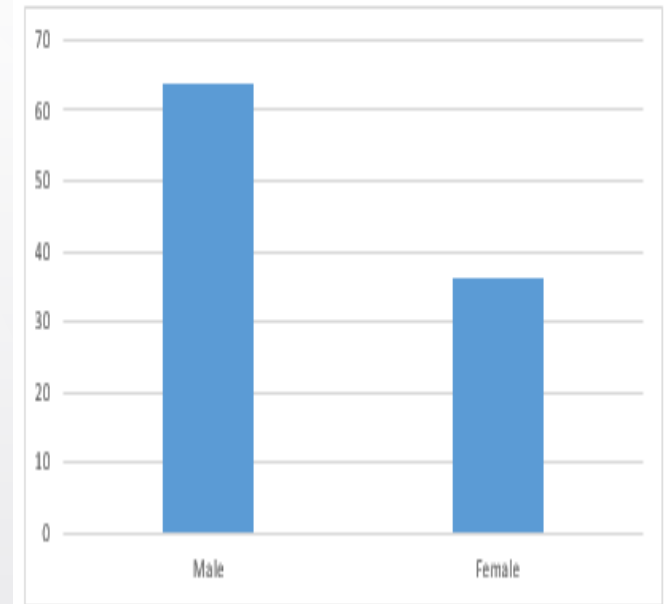
58 % of study sample between 35 to 50 years of age

29 % of study sample above 50 years of age

Demographic data

Age

Sex



Study had 64 % male participant and 36% female participant

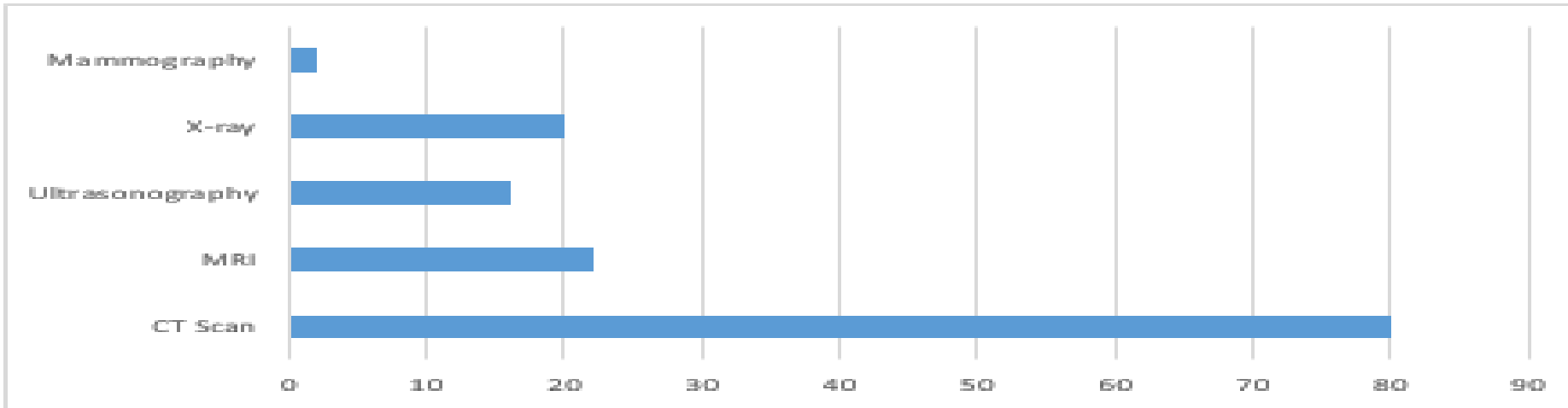
Image modality	Positive	Negative
CT Scan	79%	21%
USG , MRI ,X-ray ,Mammography	5%	95%

Covid 19
status

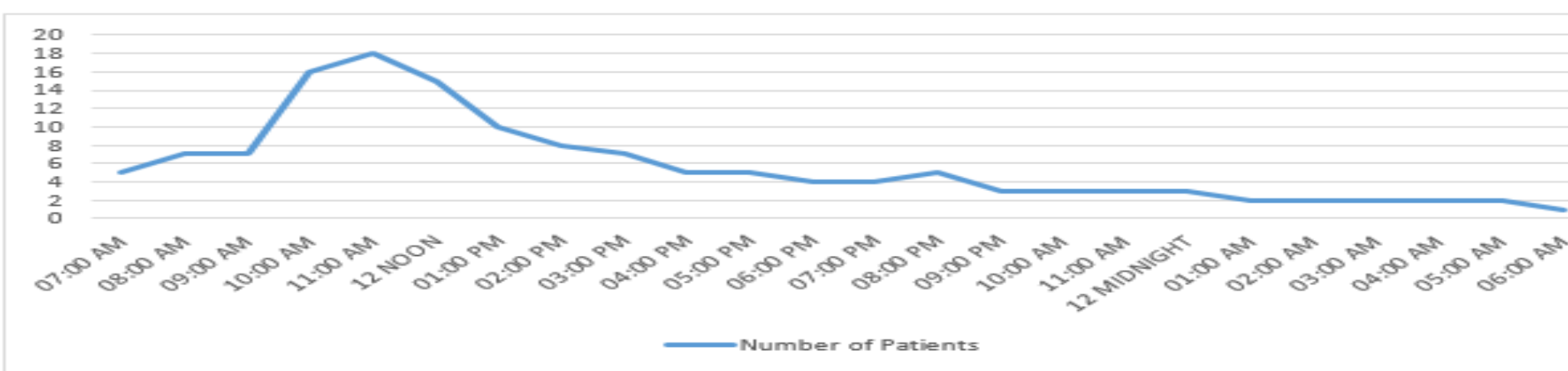
Scheduling
status

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

Average number of patients per modality per day



Daily Patient Flow

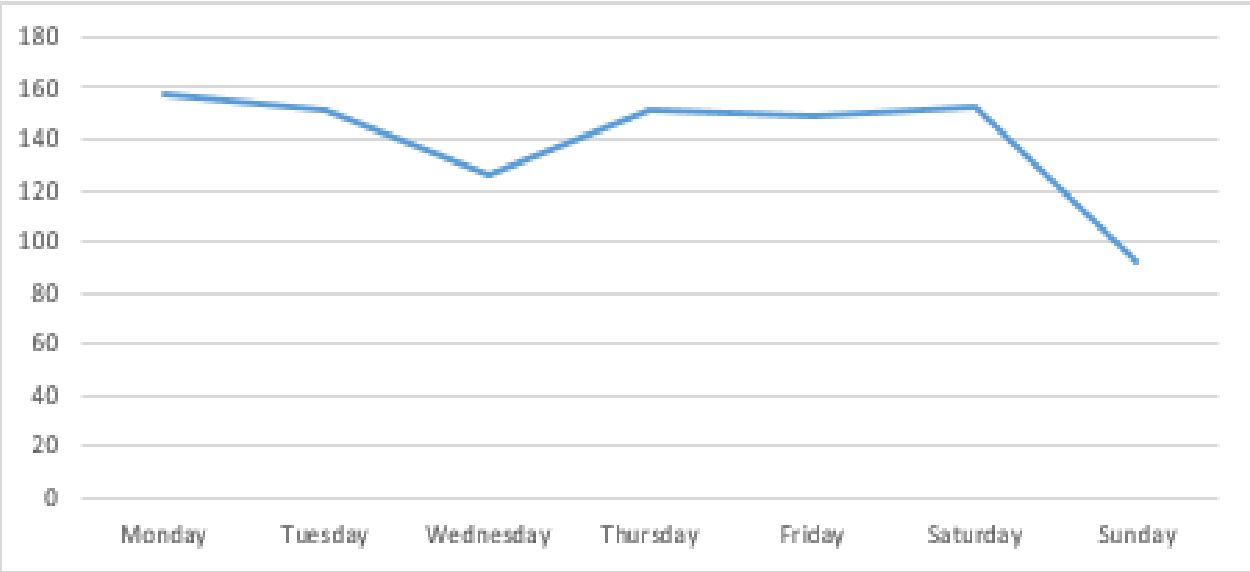


Maximum patient flow registered in between 9 am to 2 pm and it coincided with OPD timings of the referring physicians. In the graph, you can correlate number of patients with “m” of am or pm.

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



Weekly Patient Flow



↓ Time taken at each point in radio imaging



(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

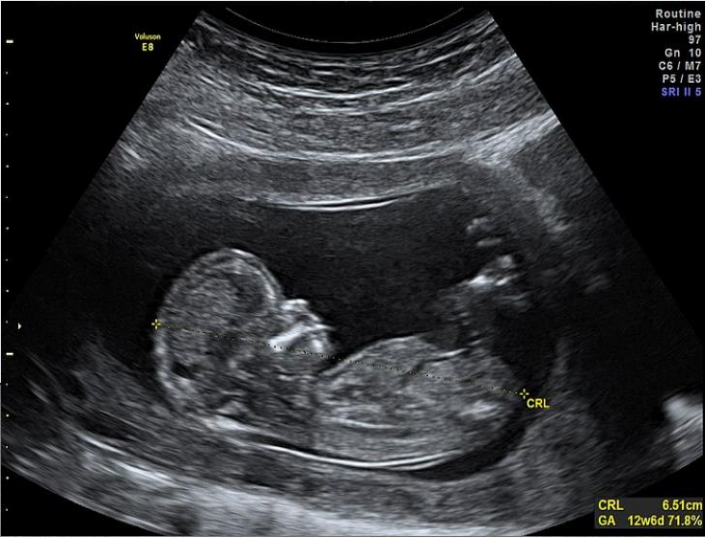
(2)

- For X-ray, USG and Mammography; there was no significant time lapse between registration/billing and radiological examination
- 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

- 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



(3)Time taken for scanning in 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

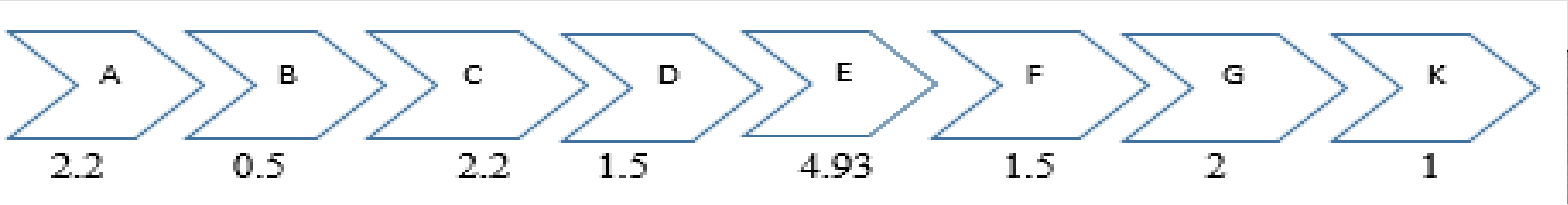


Value Stream mapping for each imaging modality for actual procedure

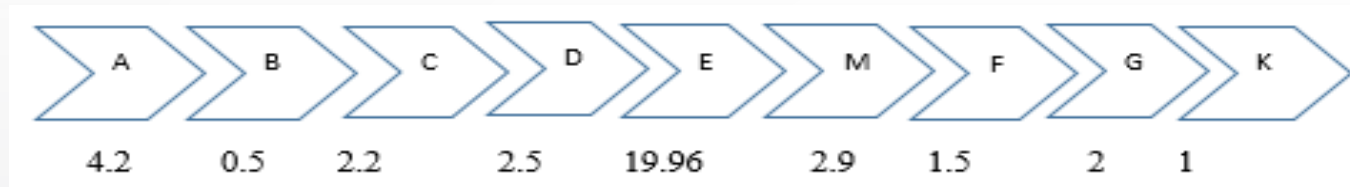
For CT and MRI

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

(i)Value Stream Mapping of CT scan



(ii)Value Stream Mapping of MRI process

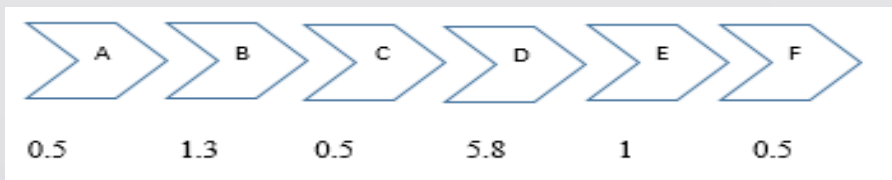


For MRI examination, M represents time delay or wastage due to patient movement.

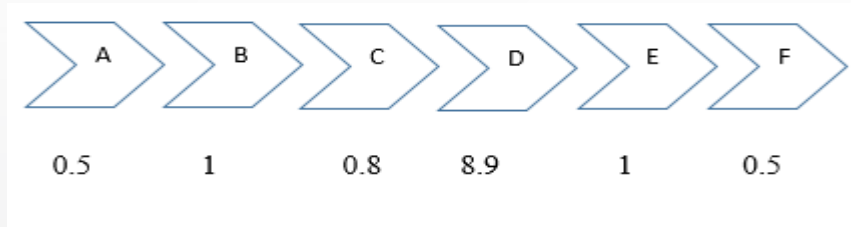
For USG, X-ray and Mammography

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

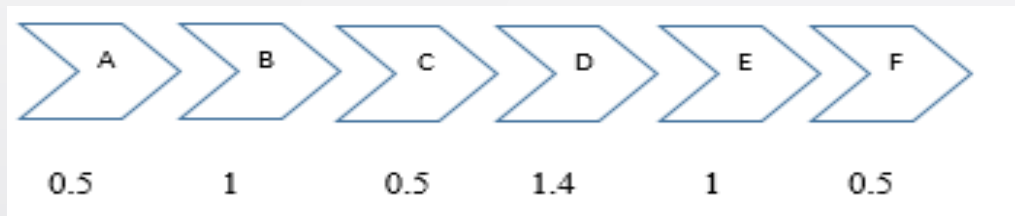
(iii)Value Stream Mapping of Mammography



(iv)Value Stream Mapping of Ultrasonography



(v)Value Stream Mapping of X-ray



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)Waiting time before processing images

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



(5)Time taken for processing image in different modalities

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

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

	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



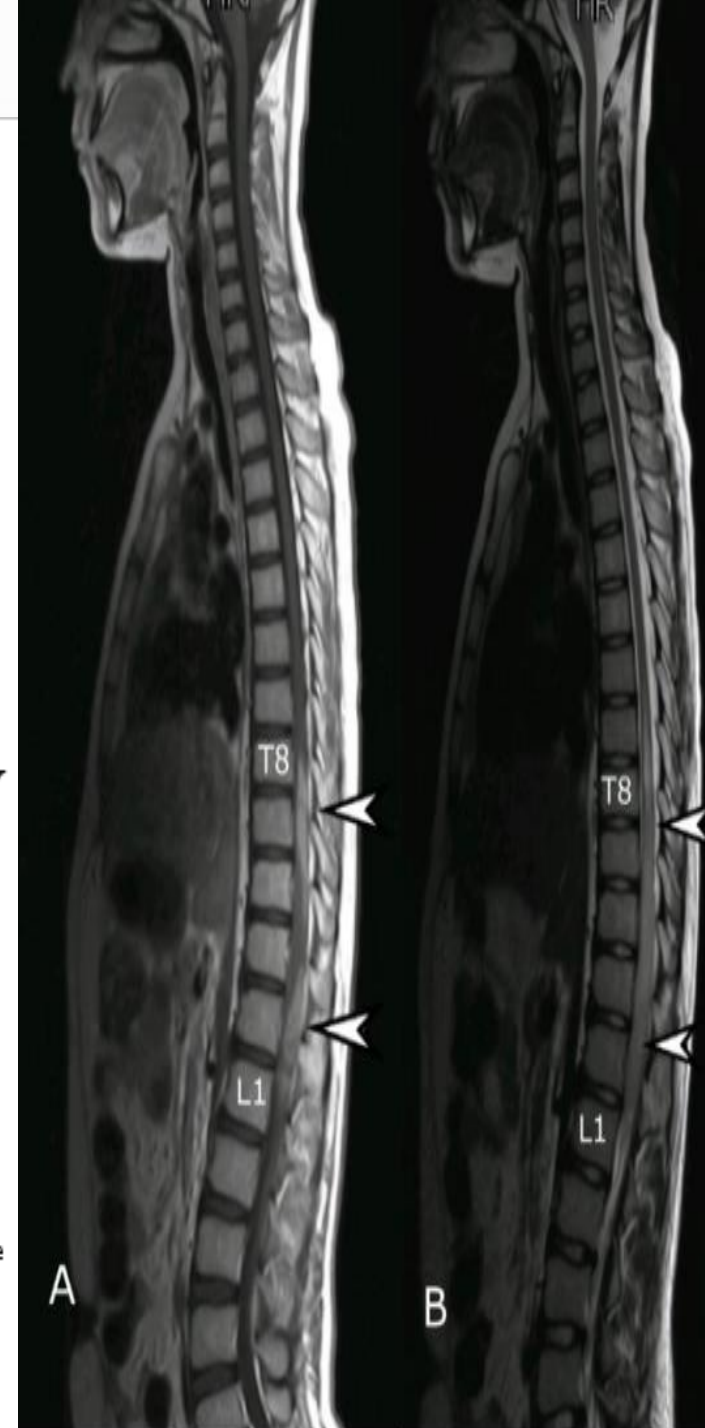
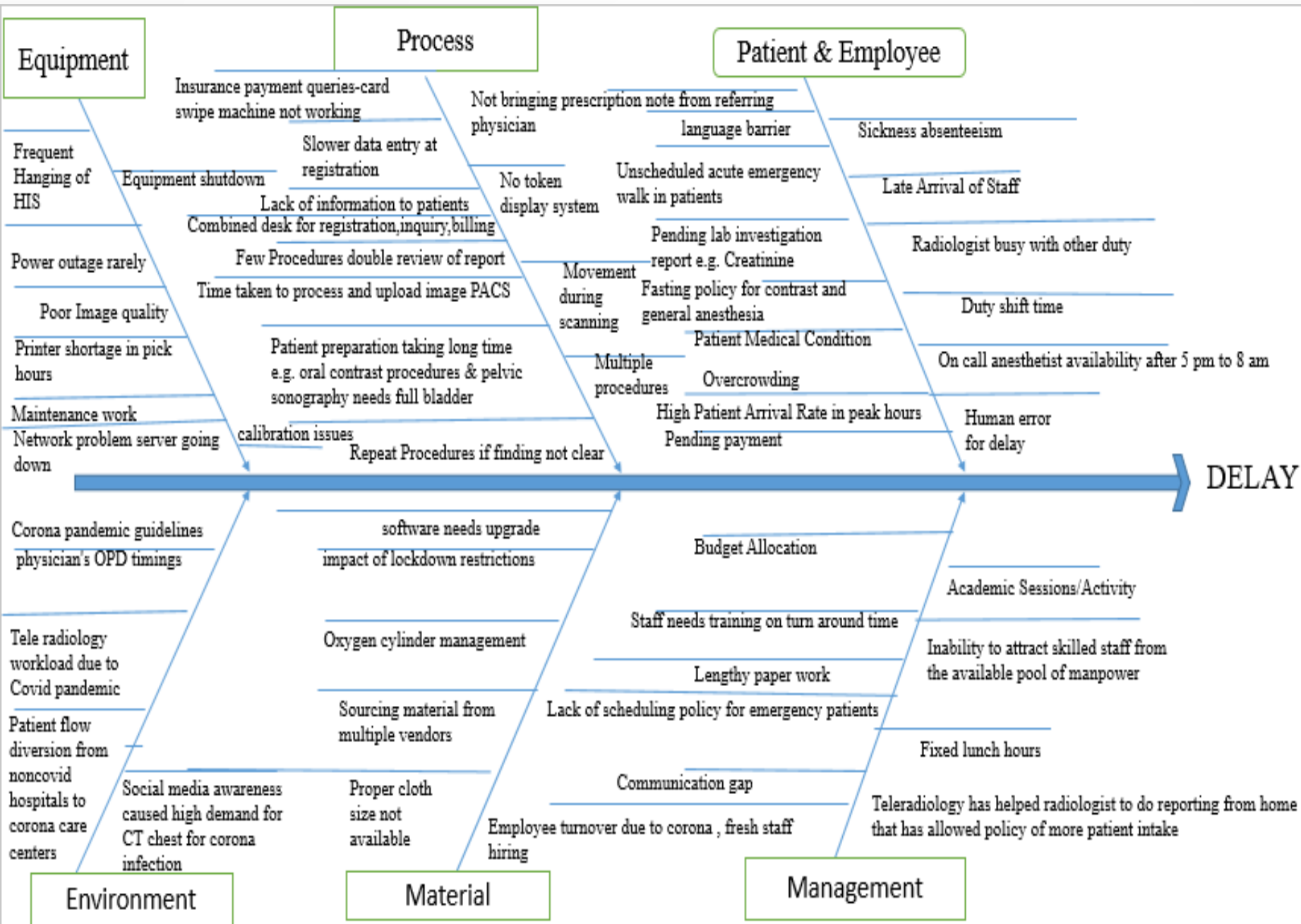
Patients feedback as per scheduling status

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

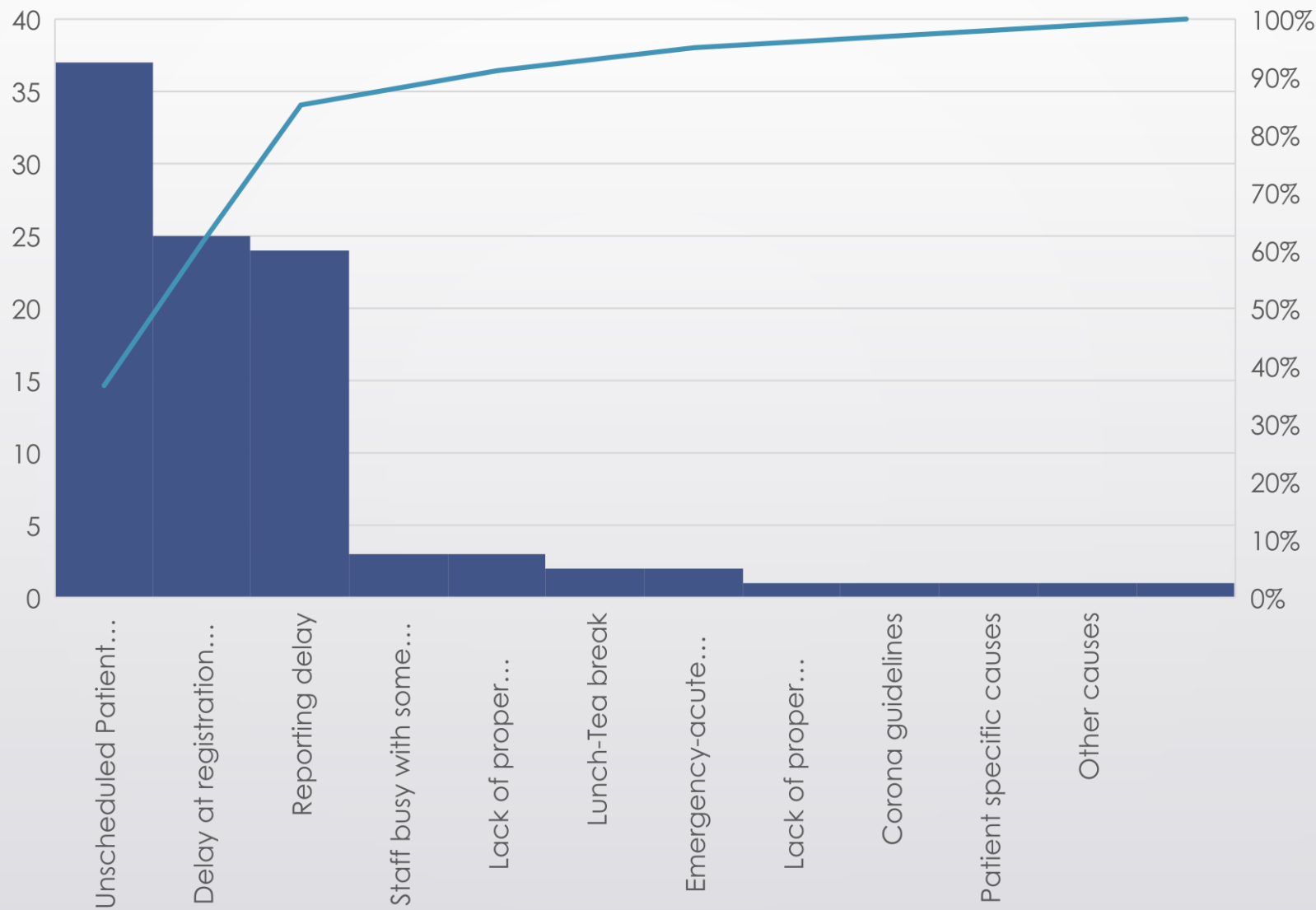
Unscheduled patients had complaints about registration process, billing delay, scanning and reporting delay.

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

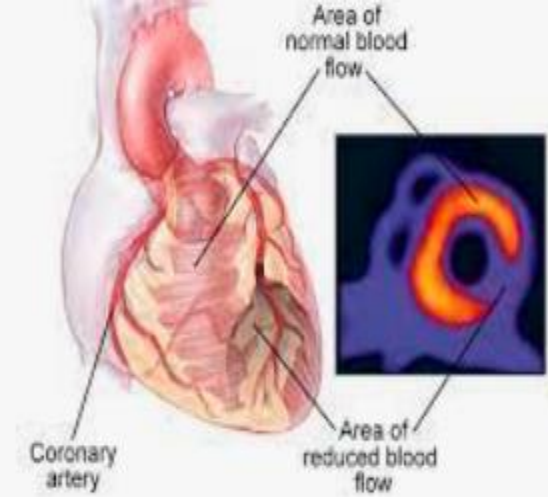
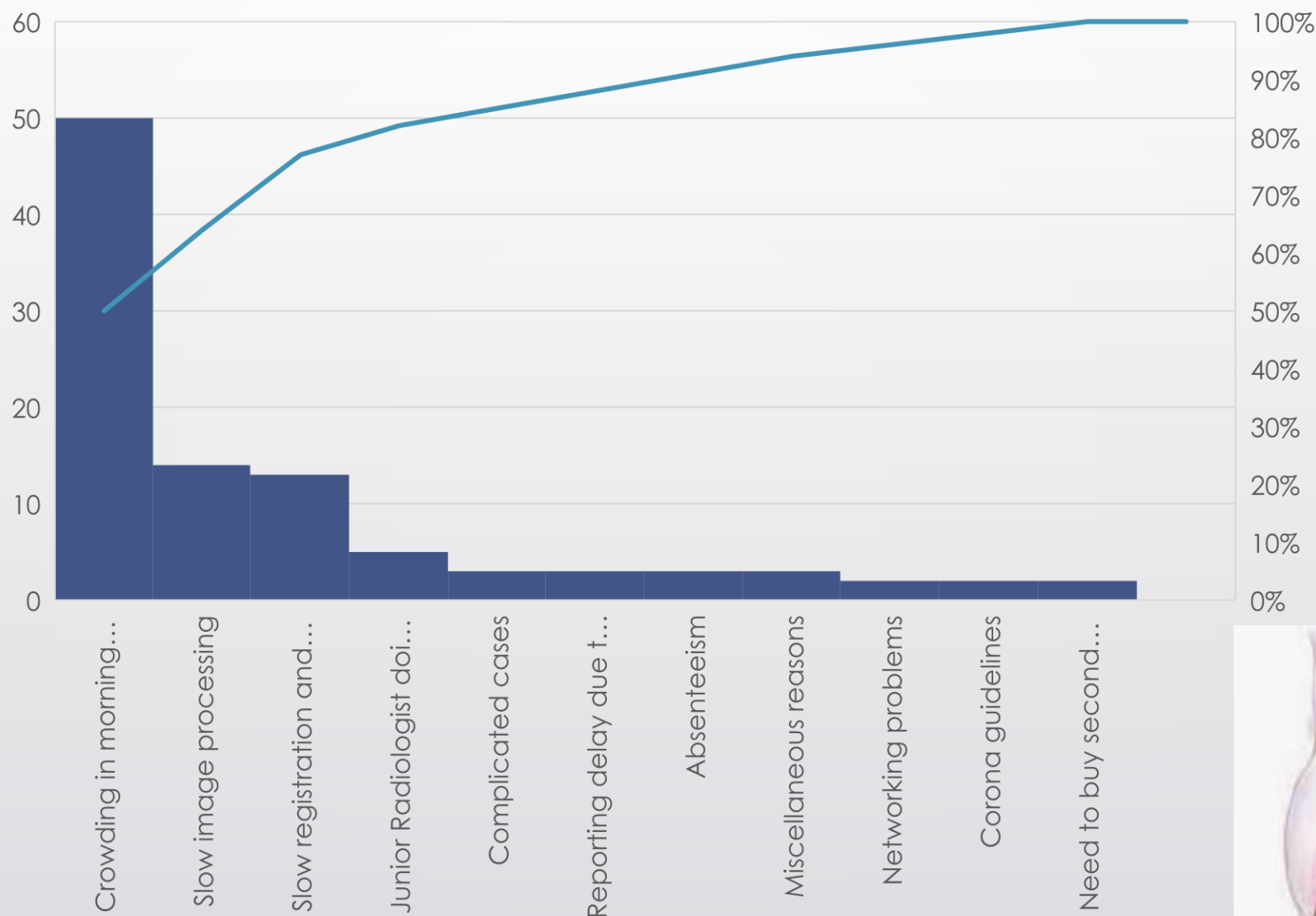
Root Cause Analysis



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



Reasons in % for long waiting time as per employees' interviews



5. Solutions implemented

Observations which were taken in to account while planning solutions

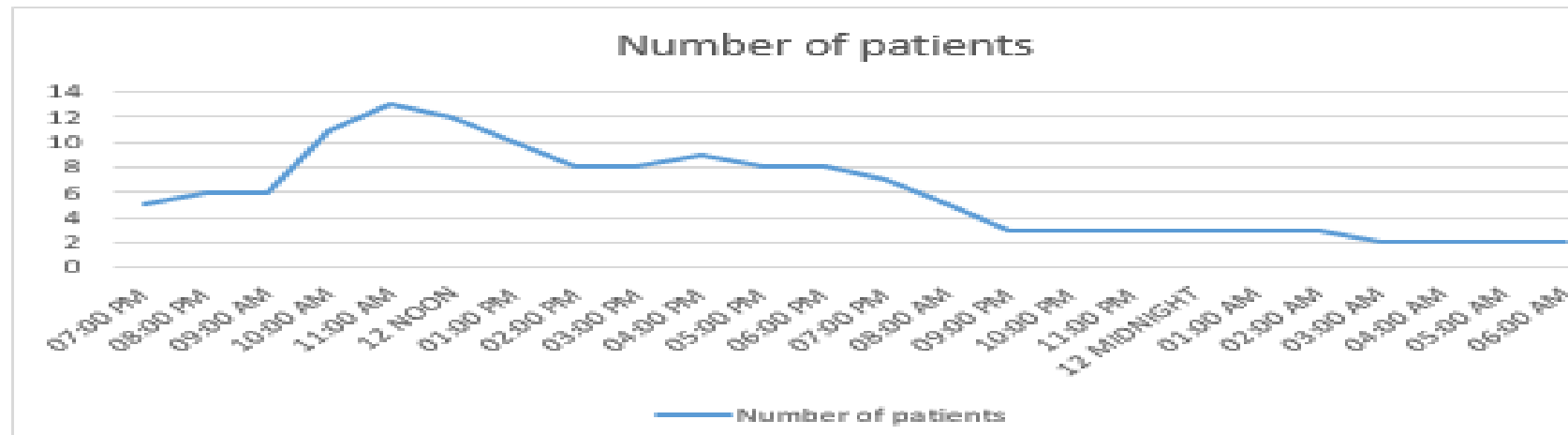
- 63 % of patients visited imaging centre in between 6 am to 2 pm.
- Waiting period was longest for patients arriving before 2 pm.
- Feedback from patients suggested that registration process and reporting also needed attention.



(a)As per Kingman's formula mentioned earlier, wait time directly proportional to variability in customer arrival rate and it increased with utilization rate. so, first attempt should be to match arrival rate with service rate during peak hours.

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.

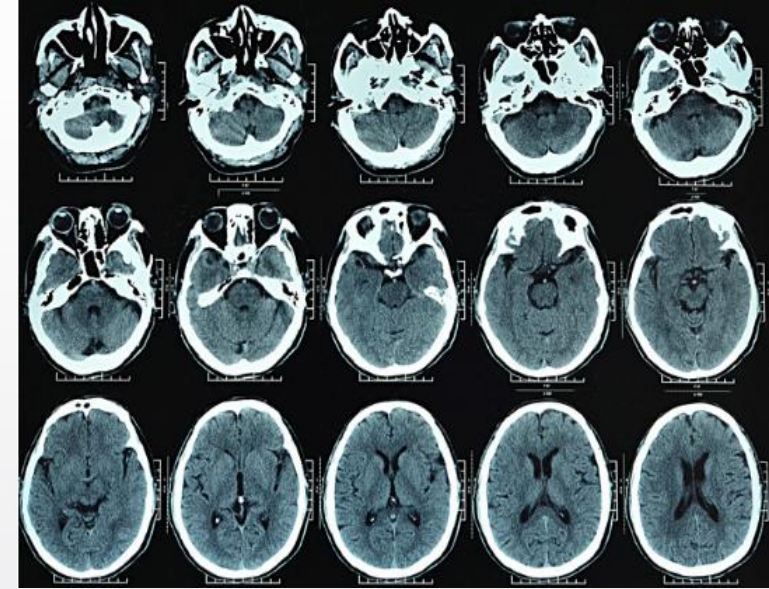
Daily patient flow was as below:



- Registration delay mean 0.44 minutes and billing delay came to 0.40 minutes
- There was a remarkable change in waiting for CT scan, mean was 2.93 minutes with SD of 3.68 minutes. Maximum delay was 15 minutes, minimum delay was 0 minutes.
- For MRI, mean delay was 4.13 with SD of 6.3 minutes. Maximum delay was 20 minutes 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 put diagnosis reduced to mean of 7.20 minutes with SD of 1.34 minutes

(b) E-registration process

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 patients 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.

(c)Staff scheduling –duty shift

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

(d) Elimination of waste of time

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.

Survey- Patient Satisfaction

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 survey and patient satisfaction	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



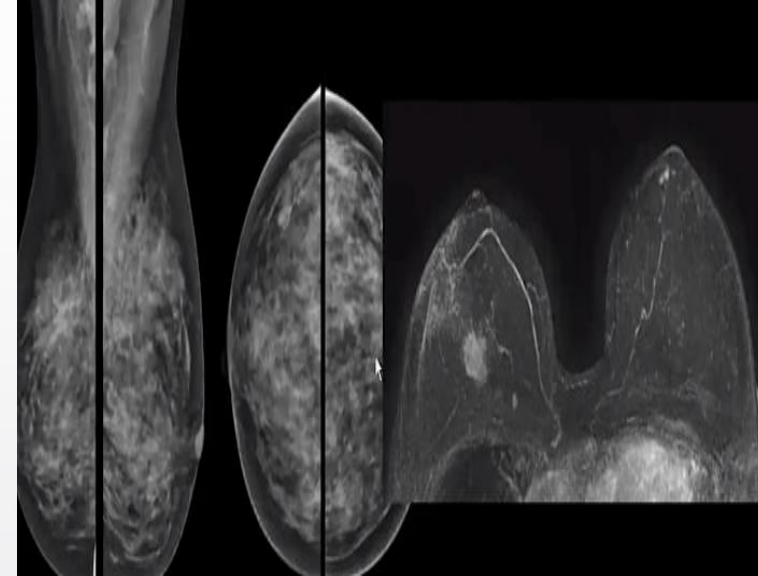
6. Suggestions for reducing wait time

- 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 along with reducing waiting time at each point of the service .
- 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,



2D ECHO

- 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 sign board/images regarding how the procedure is 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.



7. 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.

Patients with prior appointment 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 patients' arrival can eliminate waiting time from the system.

Patient satisfaction increases with decrease in waiting time.

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.



THANK YOU

IIHMR