INTERNSHIP TRAINING
AT

TELERAD TECH PRIVATE LIMITED BANGALORE

STUDY ON CONCIERGE RIS/PACS WORKFLOW AUTOMATION IN EMERGENCY REPORTING

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UNDER THE GUIDANCE OF
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ABBREVATIONS

RIS	RADIOLOGY INFORMATICN SYSTEM
PACS	PICTURE ARCGHIVING AND COMMUNICATION SYSTEM
AI	ARTIFICIAL INTELLIGENCE
ER	EMERGENCY REPORTING
TRS	TELERADIOLOGY SOLUTIONS
TAT	TURN AROUND TIME

ORGANIZATION PROFILE

TELERAD TECH PRIVATE LIMITED

Telerad Tech Private Limited was founded on 3rd April 2009 by the group of technology innovators and eminent radiologists. Telerad Tech Private Limited came into existence with an idea of doing something great, affordable and innovative in the country as well as across globe. **Dr. Arjun Kalyanpur (Chief Radiologist) and Dr. Sunita Maheshwari (Paediatric Cardiologist)**, are the main people behind Telerad Tech. They saw a dream and it came true in 2009. Doctors turned into Healthcare Entrepreneurs made it possible with their hard work and dedication. Telerad Tech, a global healthcare IT company which is working in the area of RIS-PACS technology. Telerad Tech is expanding its horizons in the sector of Teleradiology, Artificial Intelligence enabled Radiology Information Systems. Telerad Tech as an organization has a strong academic focus with daily teaching sessions and weekly live e lectures by both its own as well as external faculty using a comprehensive e- learning platform.

Breaking out from boundaries of Radiology Information Systems and PACS, Telerad Tech has developed a unique and revolutionary platform of Radiology Workflow Information Intelligence System called as **RADSpa** with an integrated image management (PACS) and Radiology Information System (RIS).

Telerad Tech Private Limited has the following services in the sector of Radiology:

1. RADSpa
2. VETSpa
3. CLINSpa
4. CARDIOSpa
5. RADSpaAI

Key Principles of Telerad Tech Private Limited: -

- CUSTOMER CENTRICITY
- ACCOUNTABILITY
- INNOVATION
- EXCELLENCE WITH HIGHEST STANDARDS & INTEGRITY
- RESULT DRIVEN
- OPENESS
- PASSION AND CONNECT
- ENTHUSIAM
- DEEP DIVE
- DELEGATE AND COACH
- THINK BIG AND BELIEVE IN THAT
- PROACTIVE AND PRUDENT

VISION:"To be the Preferred Technology Partner for providers in Tele-Health Globally.

MISSION:"To provide Best-in-Class Technology Platforms in Radiology and Tele-Health Space.

"To develop Healthcare AI Technologies at Sustainable Costs to Impact Patient Care".

- Customer Focus: - Pro-actively and continuously listening to customer feedback and reviews & incorporating that to keep improving the products.
- Technology Innovation: - Developing innovative technology solutions to solve the unique challenges of radiology work-flows by investing in the best technical and innovative minds.
- People Focus: The Company believe people that people are their strength and hence strive to recruit the best minds and motivate by providing a vibrant work-place and with technology & business challenges to overcome.

Pushers-Dreamers-Leaders: -

- **Dr. Arjun Kalyanpur: -**He is the Chairman and Managing Director of Telerad Tech Private Limited, situated in Whitefield, Bangalore. Graduated and Trained from AIIMS, New Delhi, Cornell University Medical Centre, USA and Yale University, USA in the field of Radiology. He is visiting faculty in the Department of Diagnostic Radiology at Yale University. He is an active member of the Radiologic Society of North America and the Indian Radiology and Imaging Association and is a reviewer for the journals Emergency Radiology and Acta Radiologica. He was awarded Modern Medicare's Entrepreneur of the year award in 2007 and was named one of the 50 pathfinders in Healthcare in India by Express Healthcare magazine.

- **Dr. Sunita Maheshwari: -** She is the Co-Founder and Board Advisor of Telerad Tech Private Limited, situated in Whitefield, Bangalore. The Chief Dreamer who proved herself as a Woman Entrepreneur in Healthcare. Winner of "Young Clinician Award" from the American Heart Association and "Best Teacher Award" at Yale University. She was Head of Department at Narayana Hrudayalaya for a decade. She has over 200 scientific lectures and 60 scientific publications to her credit. She was nominated one of the Top 20 women achievers in medicine in India in 2009.

- **Mr. Prashant Akhawat: -** He is as COO of Telerad Tech® has overall strategic and operational responsibility for the entire portfolio of the company's offerings. He oversees all key strategic and business enabling functions and oversees the continuous renewal of key processes, systems and policies across the company in client relationship management, technology innovation, governance sales effectiveness, delivery excellence, quality, talent management and leadership development.He has around two decades of experience in enterprise level Information and Technology Engineering, Product Development and Technology Services. Previously, he held post of CEO and Director on Board with Neural Brain Technologies, CTO at AxSys Health Tech Ltd, Chief Architect at Aptara and was responsible for major large-scale Technology implementations which gave Competitive Edge to the Organization. Prashant was also associated with CFC, CSC & Aptech Ltd in his earlier assignments.He continues to be on Board of Neural Brain Technologies Pvt Ltd, India. He holds Master's Degree in Computers and is a Management Graduate from International Management Institute (IMI), New Delhi.

- **Mr. Mohan Mysore: -** Heis responsible for the growth of our business in North American and European territories. Mohan has worked in the Healthcare market for more than decade and comes with a rich experience in sales, business development, and marketing. He has set up companies in India, Singapore and USA and successfully built and nurtured a competent distribution channel.Prior to this assignment, he was involved in managing two companies in the Healthcare solutions segment and prior to that, in the sales and marketing of data storage solutions to the entertainment and healthcare industry.His other interests include writing poetry, playing golf, and tennis.

Key Strengths and Salient Features of Telerad Tech Private Limited

- Telerad Tech awarded "Best Picture Archival and Communications System as a part of prestigious NASSCOM-KPMG Healthcare IT Awards.
- "Medicall Innovation in Healthcare Award 2011" in the Category of Product Innovation in Healthcare.
- Frost and Sullivan for Best PACS Company in India.
- Enables telehealth consultation in remote location with low bandwidth availability.
- Products developed, tested and piloted in the radiology eco-system, hence equipped with most efficient, radiology friendly workflow.
- Integrates and works with existing PACS/EMR/HIS.
- Integrated Management Information System (MIS).
- HIPAA compliant software that follows standards such as DICOM, HL-7 etc.
- Build-in voice recognition reporting.
- Time zone-based reporting.
- MIS Reporting functionalities.
- Provides context-based collaboration between referring physician and cardiologist/radiologist.
- Quality Assurance statistics shows 99.8 % accuracy and quality of reports.

CLIENTS:

1. Telerad Tech clients includes Care providers both in private and government hospitals and Diagnostic centre in India and across the world that includes United States ,Singapore, Canada, Puerto Rico, Croatia, Georgia, Poland, Denmark, China, Tanzania, Maldives, Brazil, Mexico etc.,.

Telerad Tech is suited for all Radiology Needs!

- Radiology Department of Hospitals
- Large Scale Multi-Geography Tele Radiology Centres
- Other Tele-Radiology Centres
- Individual Radiologist Providing Remote Reading Services to Multiple Hospitals.
- Chain of Diagnostic Centres.
- Independent Diagnostic Centre.
- Single Clinics in Veterinary, Orthopaedic and Chiropractic Areas.

KEY LEARNINGS:-

- Understood the workflow of the radiology department in the hospital.
- Learned various features of the RADSpa.
- Worked with the lead generation team for selling the product in various hospitals and diagnostic centres.
- Familiarized with the standards used in radiology department.
- Understand the Teleradiology services and its pros and cons.
- Gathered the requirements from the users for the customization of product.
- Understand the importance of radiology in pre treatment of any diseases.

CONSTRAINTS:-

- There was lesser availability of users for primary data collection**.**
- Unavailability of confidential data.
- Non supportive nature of users towards the feedback form due to busy schedule.
- Understanding the knowledge of software working and its usage.

CONCLUSIVE LEARNING:-

- Radiology act as the key diagnostic tool for monitoring and predicting the outcome of the diseases.
- The introduction of RIS and PACS integrated system has improved the workflow of the radiology department.
- Radiology Workflow Automation has positively impacted timely patient care specifically in Reporting Emergency cases thereby saving lives.
- The new system allows better segregation and prioritisation of cases based on criticality by using colour codes .
- The predefined SLAs helps radiologist in achieving the target mission of timely patient care.

DISSERTATION REPORT

ABSTRACT

Introduction: In daily radiological practice, report generation is a time consuming process which if get delayed can affect the initiation of specific therapy. So, fast delivery of these medical reports not only reduces the patient stay in hospital but also contribute in providing early diagnosis and treatment to many diseases. RADSPA represents the technology that enables the radiologist to provide efficient care to the patient by reducing the report turnaround time thus permits the physicians to provide good quality of diagnostic and therapeutic services.

Rationale: Studies have shown that the shortage of radiologists across the globe has reduced the accessibility of basic healthcare to the people and thus they find difficulty in reporting a large number of cases in a shorter period of time. Considering this, we sought to improve the workflow of the radiology department by assigning the cases to the radiologist automatically which will decrease the time gap between the order creation and order assigning, thus providing cases to the radiologist in a much faster rate which will reduce the TAT in report generation.

Objective: The main objective of this study is to analyse the impact of concierge workflow automation capabilities of RADSpa.

Method: The methodology used to study was conducted in Telerad Tech Bangalore with the collaboration Teleradiology Solutions where the entire population of the Teleradiology team participated to analyse the customer satisfaction level of the users for the auto-assignment feature on the basis of the feedback form provided to them. A sample size of 45 respondents consisting of 37 American Board of Radiologist, 6 coordinators and 2 PACS administrators were selected on the basis of convenience sampling. To analyse the turnaround time in report generation secondary data of the medical reports before the implementation and after the implementation of the feature was collected from the database of the TRS.

Result: Major findings that come out of the program were 80% of the respondents agreed that RADSpa's Concierge Workflow automation helped them to reduce the TATs and increase productivity. Statistical analysis of 6 months of logs before and after automation indicated 35% improvement in overall TAT for emergency cases. Also an increase in productivity of Radiologist per case improved by 82% as every case is auto-validated for images prior it is assigned. Coordinators reported a massive 83% reduction in effort which used to go in manually eliminating errors, and there by more time in hand for handling greater workloads.

Conclusion: It was concluded that the Radiology Workflow Automation has positively impacted timely patient care specifically in Reporting Emergency cases and thereby saving lives. The no of mismatches and other errors while assigning case to the radiologists by coordinators (assigners) was reduced to Zero error and also the assigners follow up process improved since they have better data of un-attended cases which the can easily re assign to reduce patient's care time. The new system allow better segregation and prioritization of cases

based on criticality by using colour codes to define priority. These predefined SLAs helps Radiologists in achieving the target mission of timely patient care.

Recommendations:

- Radiologists should receive an alert about the cases assigned to them in their worklists.
- AI algorithims should be used for early detection of abnormalities.
- A quality check of the reports should be done.

CHAPTER-1

INDRODUCTION

Information technology is perceived as a potential panacea for healthcare organizations to manage pressure and to improve services in the face of increased demand. Over the last decade, there has been a series of changes in medicine, technology and healthcare services that assist the healthcare professionals to provide better treatment to the patients. The conversion from analog to digital methods in the medical imaging world and the emergence of widely available mechanisms for the transmissions of digital data over large distances have fuelled the rapid growth of radiology in the healthcare field. Radiology now has become the diagnostic tool for monitoring, treating and predicting the outcomes of the diseases.

India with a population of more than a billion people, is struggling to bridge the vast gap of patient and radiologist ratio. There is approximately 1 radiologist for every 100000 population. Therefore, it is a constant challenge for radiologist to cater to the people in the remotest of areas. Research conducted across the globe states highlighted two important issues i.e. the lack of adequate staff for providing interpretative coverage and the lack of technologies and infrastructure services. The introduction of Radiology Information System and Picture Archival Communication System in radiology has reformed their work practice. Implementation of RIS works as a database that medical professionals used to keep the track of patient data and to store enormous image files by integrating it with the PACS. PACS can be described as an application for electronic storage, retrieval, distribution, communication and processing of data associated with medical imaging. With this integrated system of RIS-and PACS in radiology promise the clinicians to reduce the turnaround time through immediate availability of images.

With this **Teleradiology Solutions** forms a collaborative project with **Telerad Tech** product i.e. AI enabled RADSpa to enhance efficiency and reduce TAT in radiology through implementation of Concierge workflow automation.

Teleradiology Solutions (TRS), providing Emergency Teleradiology Reporting for more than 100+ hospitals in USA and many more in other countries is in process to improve their productivity, efficiency and turnaround time (TAT) in Emergency Radiology (ER) Reporting to improve patient care.

CONTEXT: -

Telerad Tech implement its artificial Intelligence Enabled Radiology workflow Platform with an integrated RIS-PACS solution for meeting the requirements of Teleradiology Providers, Hospitals, Imaging centres and Mobile Imaging Providers all size globally.

RADSpa provides a single RIS-PACS integrated platform for radiology workflow management. It can be easily integrated with the existing standards EMR, EHR and HIS. This integrated system will transmit the data from the RIS to PACS which produces the digital images with patient data. Now the doctor no longer waits or need to collects the information from the RIS and process it, they can easily access the images with patient information. This system allows the radiologists to access the clinical reports and prior or current images from a distant location through the bi-directional system built in the RIS/PACS. PACS streaming or DICOM routing capabilities can be used for real-time distribution of images. Thus it provides the radiologist with complete availability of information, maintains consistency, reduces medical errors, improves the workflow, allow a single desktop efficiency and thus maintains patient care.

***Figure 1**:- RADSpa: Next generation AI Integrated Radiology platform.*

RADSpa can be used to share, archive, transmit, view, diagnose, upload, annotate and can be used to transfer the medical images and reports across the borders. This integrated system can

be connected to all different standard modality machines like X-ray, ultrasound, computed tomography, Positron emission topography, magnetic resonance imaging and mammogram. It is a seamless and intuitive platform which offers features for integrated platform, better diagnosis and fast distribution of the images and reports.

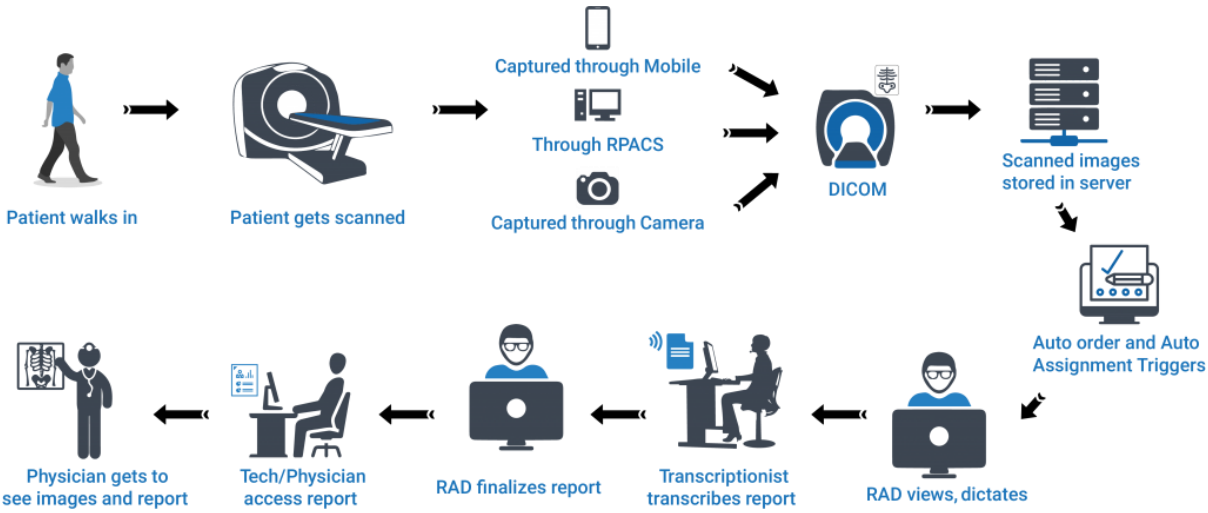


***Figure 2**:- RADSpa workflow in radiology department.*

RADSpa has following features: -

- Real time worklists
- Web Based Reporting
- HIPAA compliant
- Multilingual software
- Application workability at low internet bandwidth
- Integrated RIS and PACS functions with inbuilt intelligent workflow
- Scalable Architecture
- Platform agnostic web Server
- CD burning feature
- Multi user application access
- Multi monitor support
- Vendor Neutral Archive
- HIS/EMR implementation with or without HL7

- Support all DICOM modalities
- Advanced application supporting MIP/ MPR/2D/3D viewer
- FDA and CE approved

DESCRIPTION ABOUT AUTO ASSIGNMENT

The auto assign feature of the Orchestration workflow of RADSpa automatically assigns the studies according to the convenience and availability of the radiologist. The studies are assigned according to the type of cases (stroke cases, neuro cases etc.), types of orders (elective or emergency), types of modalities, availability of radiologist, scan timings, type of hospitals and institutions, on the basis of criticality and the type of procedure. This auto-assign feature will automatically alert the radiologist about the task that was assigned to him thus reducing the delay in task assignment. It works as an alternative of auto assigners thus improving the workflow of the radiology department and increasing the productivity of diagnostic services. It also provides an opportunity to a radiologist to pause the auto assign function whenever they are busy with some other cases.

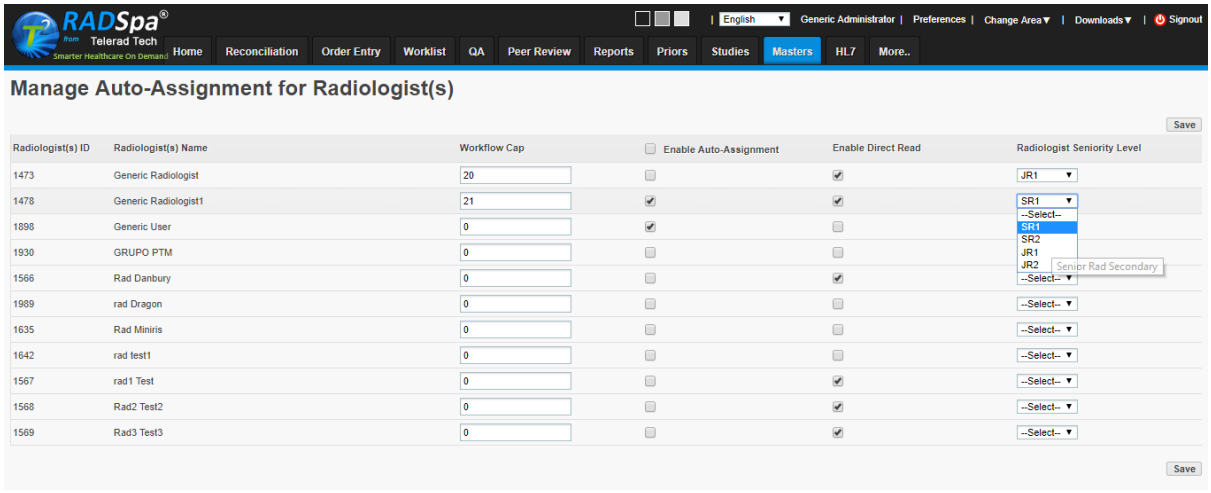


***Figure 3**:- Case limitation and Radiologist Seniority management dashboard*

The above mentioned dashboard will help the co-ordinators to configure the number of cases to be auto-assigned to the radiologist based on predefined workflow parameter.

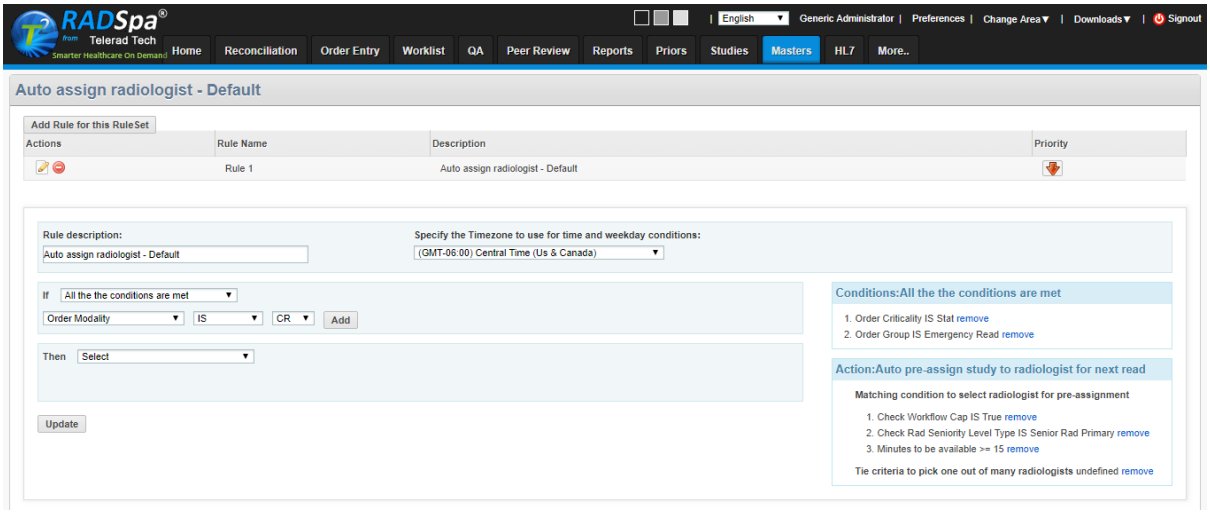


***Figure 4**:- Auto- Assignment Rule creation dashboard.*

The above mentioned dashboard helps in setting custom conditions for studies to be assigned.

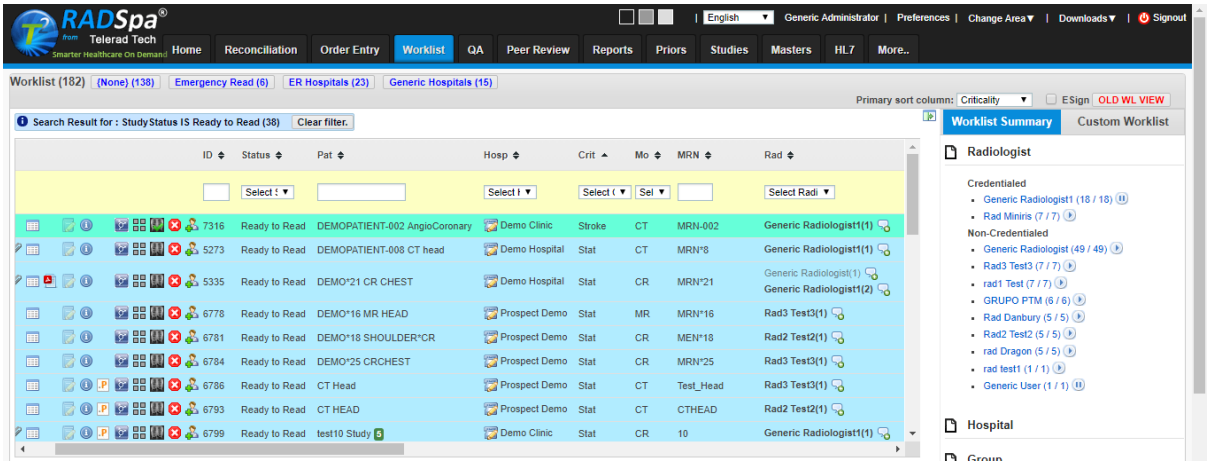
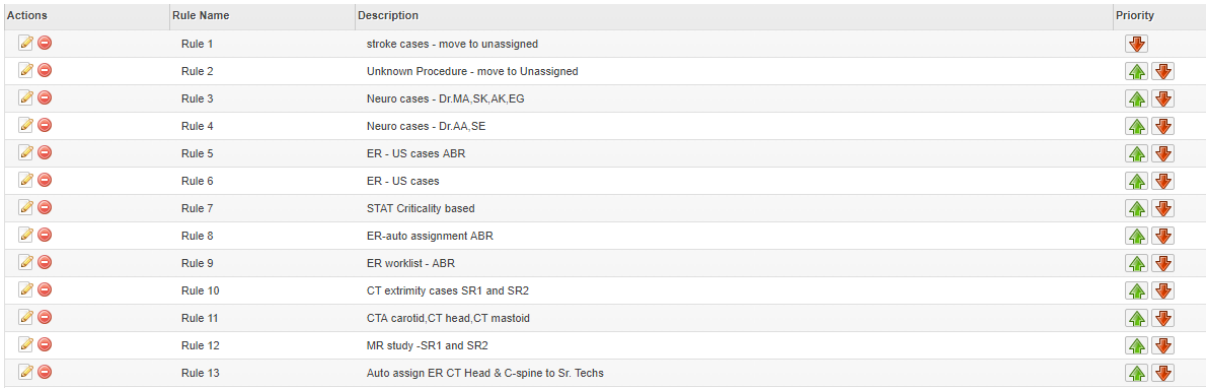


***Figure 5:-** Auto- Assignment worklist summary to pause and resume auto-assignment*

The above mentioned dashboard provides colour distinction feature to the users which help them to assign the cases on the basis of study type, criticality etc., along with a feasibility to pause and resume the auto assign the cases to radiologist.



Actions	Rule Name	Description	Priority
	Rule 1	stroke cases - move to unassigned	
	Rule 2	Unknown Procedure - move to Unassigned	
	Rule 3	Neuro cases - Dr.MA,SK,AK,EG	
	Rule 4	Neuro cases - Dr.AA,SE	
	Rule 5	ER - US cases ABR	
	Rule 6	ER - US cases	
	Rule 7	STAT Criticality based	
	Rule 8	ER-auto assignment ABR	
	Rule 9	ER worklist - ABR	
	Rule 10	CT extrimity cases SR1 and SR2	
	Rule 11	CTA carotid,CT head,CT mastoid	
	Rule 12	MR study -SR1 and SR2	
	Rule 13	Auto assign ER CT Head & C-spine to Sr. Techs	

Figure 6:-*Custom Rule sets of the Auto-Assignment*

The above mentioned dashboard will help the coordinators to prioritize and manage the case assignment according to the pre-set rules configured

RADSpa auto-assign feature works on the following rules:-

- Cases with no Images and unknown procedure status orders should not be auto-assigned.
- Neuro & Body studies should be equally distributed to Junior RAD and Sr RADs during both First and Second read assignment.
- RAD Max Cap Limit: Auto assigning should stop once the case reaches max threshold.
- Follow up studies reported on same day should get assigned to same RAD.
- Studies get assigned to Radiologist once his/her shift time begins.
- Specific modalities should not get assigned to certain RAD.
- Studies from a particular hospital to be assigned to certain RAD.
- Extremity study should not get assigned to Jr level RAD.

CHAPTER-2

LITERATURE REVIEW

A literature review provides us with the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. It is the first step for any research work. Literature review brings us at par with the current status of our research as well as provides us with the problems left unsolved laying the ground work for new research.

Crabbe et al. discussed the use of an integrated system created to form an important component of quality management process in the radiology department. The system allows continuous monitoring of radiology workflow and thus opportunities to apply interventions. They identified 7 key steps in the work flow process that if not monitored or checked properly can lead to large delays in the system. There system allowed continual monitoring of workflow.

Onwuzu et al. assessed the patients lengthy waiting time which is a major cause of dissatisfaction of patients with healthcare providers. They tried to find various steps in patient registration process that significantly contribute to the increased length of time spent by patients in the radiology department. A total of 131 patients were part of the story there in and out time were recorded. Time differences between processes were measured to estimate time spent during each process. The study concluded the amount of time taken by all the patients on average was 2hrs. 40mins ± 1hr. 16mins. Chest cases spent the least time 2hrs. 29mins ± 1hr. 9mins, while those with extreme cases spent 3hrs. 36mins ± 21mins. Other than these processes excluding film assessment by radiographers affects the length of time patients spent. Thus a review of the registration process has to be made in order to reduce the time spent by patients and provide an effective fast service.

Liew et al. discussed the involvement of Artificial Intelligence/deep learning technology and its implementation into routine clinical imaging. They provide an insight to achieve a smooth transition through the practice of augmented radiology where radiologists-in-the-loop ensure the safe implementation of Artificial Intelligence systems. As per there research the roadmap for the future depends on strategies such as reduction of overall cost of imaging by increasing productivity which is a direct result of automation of time-consuming and low cognitive value

tasks. Augmented radiology increases the value of radiologist, economically, as well as socially.

Towbin et al. conducted a study to evaluate use of quality improvement techniques to decrease the variability in turnaround time (TAT) for radiology reports on emergency department (ED) radiographs. Statistical process control charts were used to evaluate for improvement in mean TAT for ED radiographs, percentage of ED radiographs read within 35 minutes, and standard deviation of the mean TAT. Quality improvement techniques were used to decrease mean TAT and the variability in TAT for ED radiographs. This change was associated with an improvement in ED throughput. Significant improvements were made by means of increased transparency, feedback, and individual coaching in a setting where workflow and electronic systems had already been redesigned to optimize TAT. The improvements in radiology TAT have had a direct effect on the overall ED patient flow, as shown by a decrease in the time from when the ED staff first meet with the patient to the time of case disposition.

Rade R. et al. discussed the importance of information system in healthcare field in today's era. They try to describe the features of Radiology Information System which has improved the workflow of the radiology department. RIS is a technology which involves complete computerization and modernization of the work of radiology department where the information is always available in right place at the right time. It describes that the RIS should follow all the radiology standards such as HL7, DICOM and PACS for storing and transmitting of medical reports. As per the research these information system in healthcare will reduce medical errors, increases diagnostic and therapeutic quality, lower the costs for materials, increases efficiency and saves time.

Natasha Gulati in his paper discussed the challenges faced by Australian radiologist while working with workflow solutions stated that the current PACS solutions in their workplace did not meet performance expectations such as speed of response and availability to pull relevant patient data from the system which is further compounded with the lack of imaging visualising techniques and the inability of information system to communicate with each other for the transmission of images to other radiologist. Thus the radiologist wants platform agnostic solutions not only for their enhanced data aggregation and interoperability but also for potential to aid mobility. Radiology wants a tool for improving the efficiency of radiology in healthcare sector.

Rahimi et al. discussed the importance of user participation the factors affecting them and their effect on the development of radiology information system. In his study the participation rate of users for different stages of RIS development was measured. Along with the factors that affect that. A total of 140 RIS participants were chosen with different professions including physicians, nurses, laboratory, radiology and RIS staffs. A self-structured questionnaire was used to record data which was estimated as both reliable and valid. The data was analysed sing an SPSS software descriptive statistics and analytical statistics (t-test and chi-square). The study revealed that the need of health care administrators to have a detailed plan for user participation prior to the development and purchase of RIS is an absolute must. This is required to distinguish the genuine needs and increment their dedication and inspirations to develop, maintain and upgrade the system, and along these lines, the achievement of the system will be guaranteed.

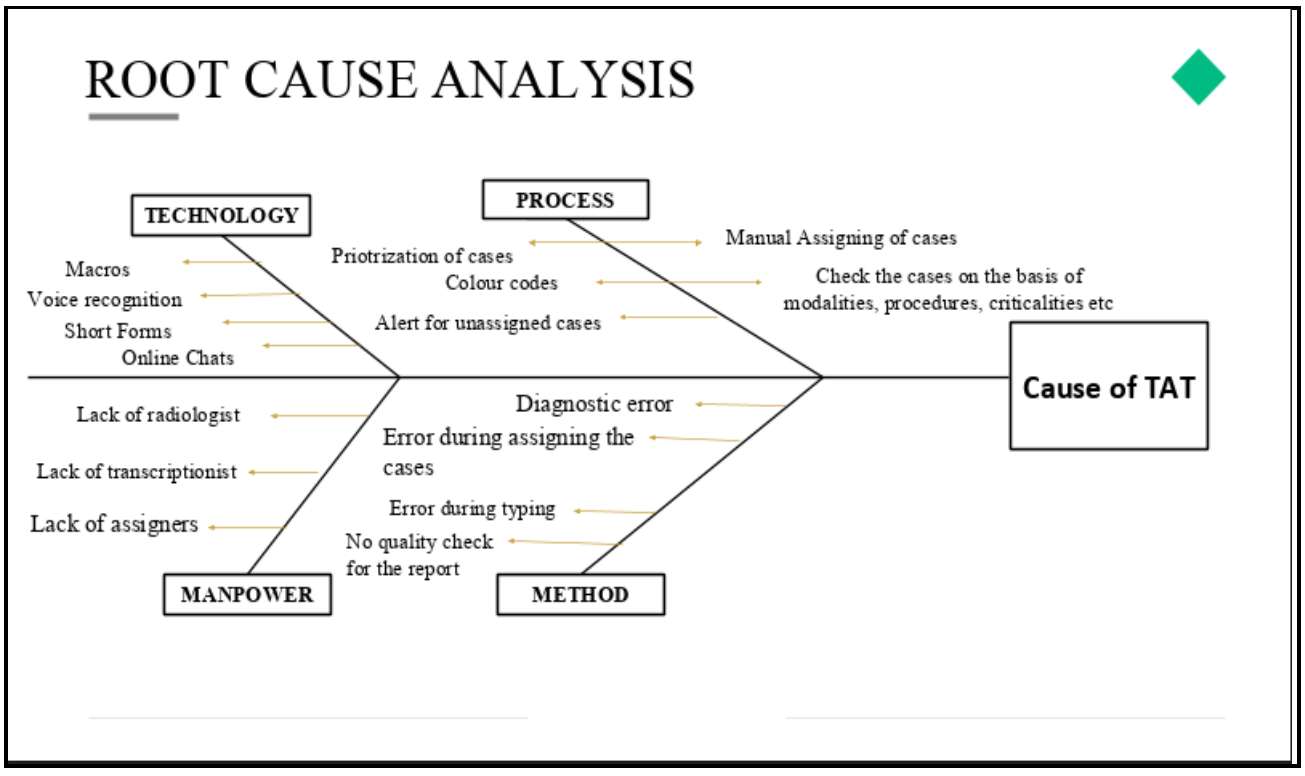
Zikos et al. discussed the experiences while implementing RIS system in Greek Hospitals the barriers and success they faced. They investigated the types of Information Systems (IS), the level of integration and the barriers during the implementation phase in three Greek public hospitals. The method used employed a questionnaire to investigate the types of information systems, the level of integration, the factors that led to success or failure in the implementation process and the assessment of the existing services. A second step included semi-organized meetings with the head and the previously mentioned workers in the three chose clinics keeping in mind the end goal to detail a general angle on the above specified issues. A final step tended to one of the three chose doctor's facilities and concerned the perception of usage procedure of Integrated RIS. The examination accumulated additional data, by means of a semi-organized meeting, dialog and perception of four staff gatherings. The study indicated the problems related to standards and encodings, underfunding, lack of skilled personnel, denial and indifference by the users and inadequate training may be overcome, if the hospital administration is committed to the success of the of the project. The management support, coupled with the efficiency of employees in the computer departments and education offices, have been found to result to success stories regarding the above mentioned obstacles.

CHAPTER-3

PROBLEM FORMULATION

Radiology is now the key diagnostic tool used for monitoring and predicting the outcome for many diseases. There is a need of highly stable and advanced technologies to fasten the delivery of medical services to the patients. While going through the literature some of the problems are found which is limiting the generation of medical report in a shorter period of time which results in TAT in reporting. Some of them are:-

- As there is a shortage of radiologists across the globe, which has reduced the accessibility of basic healthcare to the people.
- Radiologist faces difficulties in reporting the large amount of cases in a shorter period of time.
- The coordinators/assigners take more time in monitoring and then assigning the cases to the radiologist.



CHAPTER-4

AIM AND OBJECTIVE

AIM: -

The aim of this study is to analyse the impact of concierge workflow automation capabilities of RADSpa to improve Turnaround Time (TAT) in ER Reporting

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OBJECTIVE: -

To identify and reduce the turnaround time in report generation according to the workflow of teleradiology / radiology department

CHAPTER-5

METHODOLOGY

The study is conducted in Teleradiology Solutions Bangalore with the collaboration of Telerad Tech where the entire population of the teleradiology team participated to analyse the customer satisfaction level of the users for the auto-assignment feature on the basis of the feedback form which will be provided to them.

The entire population of Teleradiology Solutions for ER reporting is selected. There were 45 respondents consisting of 37 American Board of Radiologist, 6 coordinators and 2 PACS administrators.

To analyse the turnaround time in report generation secondary data of the medical reports before the implementation and after the implementation of the feature is collected from the database of the TRS which is being compared to measure the improvement in turn around time in report generation.

STUDY AREA	Telerad Tech Private Limited
STUDY DURATION	February- May
STUDY POPULATION	There ere 45 respondents consisting of:- • 37 American Board of Radiologist • 6 Coordinators • 2 PACS Administrators
SAMPLE SIZE	Primary Data- 45 Respondents Secondary Data- Medical reports of the Patients from the TRS Database.
SAMPLING TECHNIQUE	Purposive Sampling
STUDY DESIGN	Descriptive

Mode for Data Collection: -

The secondary data of patient medical images reports are collected from the logs of TRS which is being analysed to study the impact of TAT in ER reporting.

PERFORMANCE MEASURE	DATA SOURCE	SAMPLE SIZE		WHO WILL COLLECT	WHEN DATA WILL COLLECT
		Before Automation	After Automation		
Auto assign	Logs	20169	24501	T2 Team	1 Nov- 30 Nov 2018
Auto assign	Logs	19860	25095	T2 Team	1 Dec -31 Dec 2019
Auto assign	Logs	21654	23168	T2 Team	1 Jan- 31 Jan 2019
Auto assign	Logs	18900	25102	T2 Team	1 Feb-28 Feb 2019
Auto assign	Logs	22409	22016	T2 Team	1 Mar-31 Mar 2019
Auto assign	Logs	22301	23156	T2 Team	1 Apr- 30 Apr 2019

Questionnaire: -

Information regarding the smoothness of the auto assign feature was collected from the 45 respondents through questionnaire.

CHAPTER-6

ORGANIZATIONAL PLAN

NEED FOR IMPLEMENTATION: -

This phase begins with determining and addressing the gaps between the current conditions and the desired condition i.e. wants. It gives an organization an opportunity to analyse their current state and to define the need of the project.

The main important needs to reduce turnaround time are: -

- To provide effective care to the patient at right time and in the right way.
- To reduce the time needed to generate the reports of medical images.
- To improve the workflow of the radiology department.
- To alert the radiologists about the unassigned and critical cases so that timely diagnosis could occur.

PRE IMPLEMENTATION: -

INITIATION: - This phase marks the beginning of the project. In this phase the goal and scope of the project is decided and decisions are made regarding who will carry out the project, who will be the stakeholders in the project and forming the budget of the project implementation. This phase contains the following steps: -

PROJECT CHARTER

PROJECT TITLE:- CONCIERGE RIS/PACS WORKFLOW AUTOMATION IN EMERGENCY REPORTING
PROJECT START DATE- 1 November 2018 **PROJECT END DATE-** 31 April 2019
BUDGET INFORMATION:- Can't be disclosed
PROJECT MANAGER:- Shrinivas L. Bhatt
PROJECT OBJECTIVE:- To analyse the feature of auto assign in reducing the turnaround time in report generation according to the workflow of teleradiology / radiology department.
MAIN PROJECT SUCCESS CRITERIA:- the project should be completed in one year.
APPROACH:- To study the turn around time in ER reporting in radiology department before implementation. • To study the feature of auto assign and its benefits in reducing TAT • To gather the data from the logs of TRS to evaluate the TAT in ER reporting after implementation. • Develop the survey to evaluate the satisfaction level of the users regarding the auto assign feature. • Provide training to the users

PLANNING PHASE:- This phase provides solutions to the projects objectives. It includes the following steps:-

REQUIREMENT GATHERING

STEP 1: -In this, the lead generation team made customers to understand the interest or enquiry of their product i.e. RADSpa and providing them a detailed overview of how their product can help them in the growth of the organization. It follows with scheduling the demo of the product by the product team so that they can practically overview their product.

STEP 2: - After the approval of the customer the requirement sheet is send to gather the needs and expectations of the customer for product development. This phase includes gathering the requirements from the users for the auto assign feature in RADSpa. It will gather the requirement for setting the pre set rules such as the type of hospitals, type of modalities, type of cases and procedures and on the basis of criticality.

STEP 3: -In this phase, a proposal is sent which includes the description about the business plans, product features, hardware specifications, commercials and other deliverables

SCOPE STATEMENT

A project plan is created outlining the activities, tasks, dependencies, and timeframes i.e. a scope statement.

Telerad Tech	**Prepared By:- Kajol Agrawal**
Statement of project scope	**Date:-**
General Project Information Project Name:- Concierge RIS/PACS workflow automation in ER Reporting Project Manager:- Shrinivas L. Bhatt	
Problem Statement:- • Radiologist face difficulties in reporting the large amount of cases in a shorter period of time. • The coordinators/assigners take more time in monitoring and then assigning the cases to the radiologist.	
Project Objective:- To analyse the feature of auto assign in reducing the turnaround time in report generation according to the workflow of teleradiology / radiology department	
Project Description:- The auto assign feature of the Orchestration workflow of RADSpa automatically assigns the studies according to the convenience and availability of the radiologist which will reduce the time required in assigning the studies manually	
Business Benefits:- Reduces the manpower Increases study read rate Reduces the time in report generation	
Project Deliverables:- Implementation of auto-assign feature in RADspa • Monitoring the feature • Providing training to the users • Setting the pre set rules	
Project Duration:- 6 months Duration	

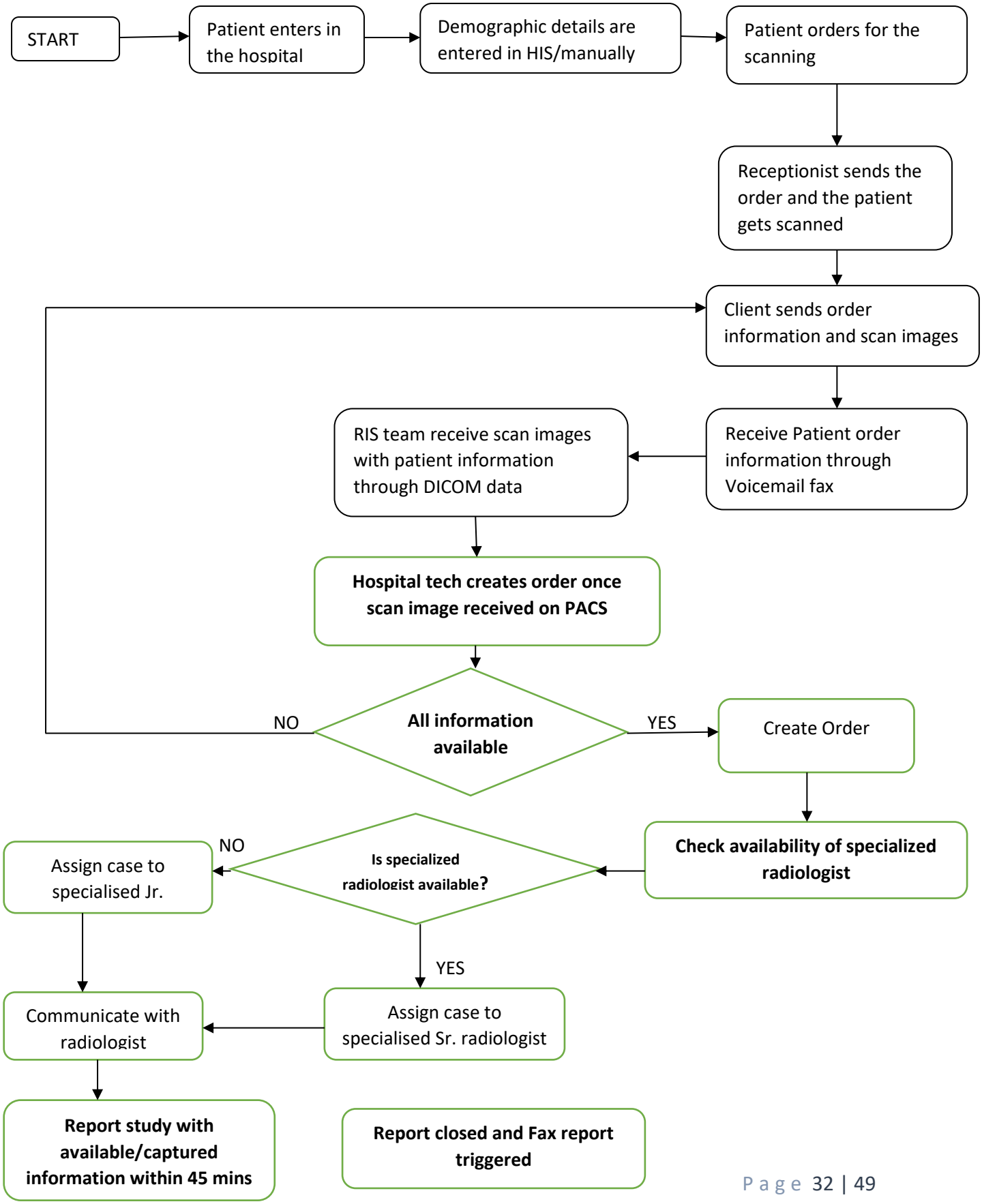
IMPLEMENTATION: -

In this phase the auto-assign feature is tested priory by the technical team and then implemented in various hospitals and diagnostic centres where the studies will be assigned according to their requirement of the type of cases, modalities, procedure and on the basis of criticalities. After the implementation one personnel client from Telerad Tech with IT knowledge will be nominated who will provide training to the users for a total of 80 hours.

POST IMPLEMENTATION: -

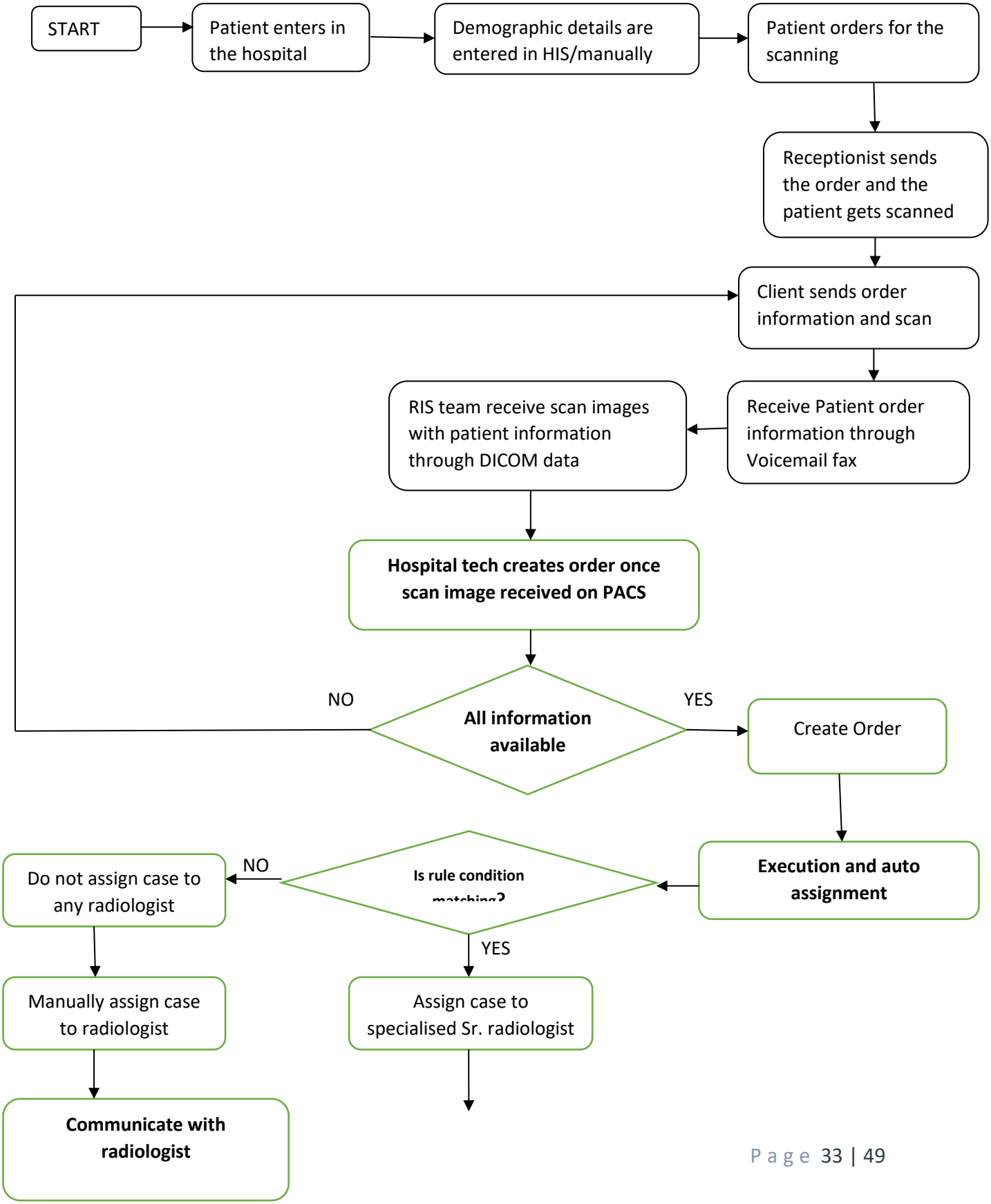
After the successful implementation of RADSpa evaluation is done to verify whether the defined criteria are met and reviewing the performance of the product. The detailed documentation (Signoff document) is prepared and feedback of the users is documented for future reference.

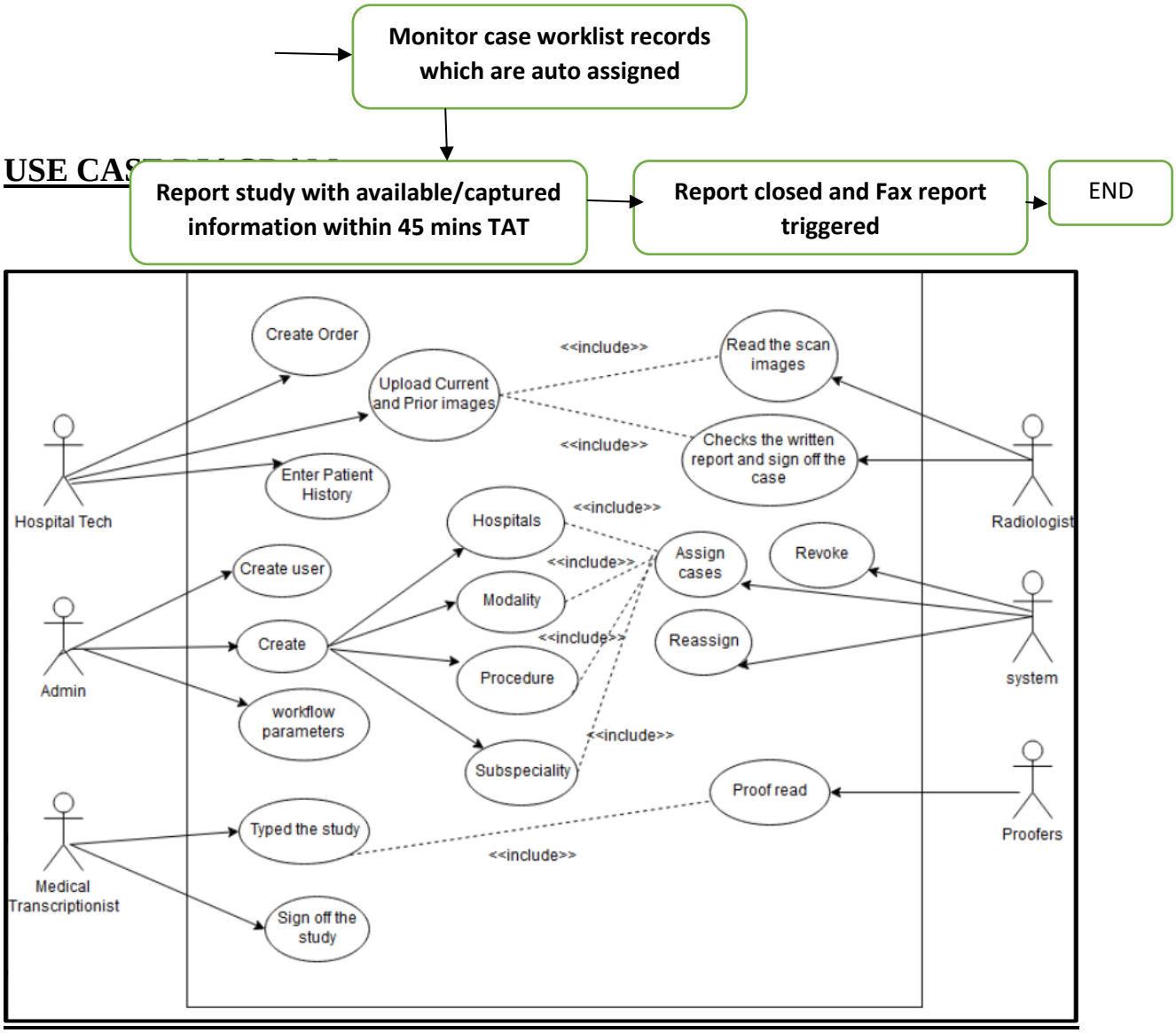
WORKFLOW OF THE PROCESS BEFORE IMPLEMENTATION



END

WORKFLOW OF THE PROCESS AFTER AUTOMATION





USE CASE DESCRIPTION:-

1. Create Order

Use case name	Create Order
Actor	Hospital Tech
Trigger	Request for image study and report generation
Pre-Condition	The DICOM images should be stored
Post- Condition	Images should be available
Main sequence	1. The Hospital tech login the system 2. The user will go to **Order Enter** which will direct to order entry page.

	3. Enter all the demographic details of the patients which is mandatory. 4. Click on **Create Order** button. 5. Study will display as an unassigned status in worklist.

1.1 **Uploading DICOM images**:-

Use case name	How to upload DICOM images
Actor	Hospital Tech
Trigger	Attachment of images for study
Pre Condition	The study has to be selected from the worklist
Post Condition	Images get attached with the study
Main Sequence	1. The user will login using user credentials. 2. Click on **Worklist Tab** and then click on **Edit Order** 3. Click on **Images Upload** button to upload the images for the study. 4. An Image uploader window will popup and then click on **Select Images** button. 5. Click on **OK** after selecting the images. 6. Pop up window will appear which shows the patient details and DICOM image details and click accept to upload. 7. A confirmation message will popup after successfully uploading the DICOM images. 8. The study will be found in the worklist with the attached images under unassigned status.

1.2 Editing the Order:-

Use case name	How to edit order
Actor	Hospital Tech
Trigger	Changes in worklist
Pre Condition	The study need to be present in the worklist
Post Condition	Changes edited in the order
Main Sequences	1. The user will login to the RADSpa using credential. 2. Click on **Worklist Tab** and click on edit order.

	3. Enter all the mandatory details and make the changes as required and click on update order. 4. Study will display in the worklist with unassigned status.

1.3 Upload Files:-

The Upload Files option is provided so while creating an order if the patient has some records of his clinical history those records can be scanned and attached along with the study.

Use case diagram	How to upload files
Actor	Hospital Tech
Trigger	Request to attach clinical history
Pre Condition	The user need to login the RADSpa
Post Condition	New files will be uploaded in the order
Main Sequences	1. The user will login the RADSpa using credentials. 2. Click on **Order Entry** to fill the mandatory fields 3. Click on choose file to **Upload** the files. 4. Select the file to be uploaded and click on **Create Order.** 5. Uploaded file will be shown alongside the study in worklist as attachment.

2. Create Roles:-

User case name	Create Roles
Actor	Hospital Administrator
Trigger	Request for roles generation
Pre Condition	The Hospital Admin needs to login the RADSpa
Post Condition	Users with RADSopa credentials are created
Main Sequences	1. Login the RADSpa using credentials for it. 2. Click on **Masters Page** for roles creation. 3. Click on **Roles** in **Masters Page** and create roles by clicking the **Create** button. 4. Editing and deletion of any role can be done through the **Edit** and **Delete** button. 5. User roles will be created.

2.1 Create Users:-

Use case name	To create users
Actor	Hospital administrator
Trigger	Request for user generation
Pre Condition	Login to RADSpa
Post Condition	Creation of users
Main Sequences	1. Login the RADSpa using credentials for it. 2. Click on **Masters Page** for user creation. 3. Click on **Users** in **Master Page** and create users ID from the **Create** button. 4. Editing and deletion of any user can be done through the **Edit** and **Delete** button. 5. Users will be created.

2.2 Create Hospitals

Use case name	To Create hospitals
Actor	Hospital Administrator
Trigger	Creation of new hospitals for reporting
Pre condition	Login to RADspa
Post Condition	New hospitals for ER reporting will be created
Main Sequences	1. Login the RADSpa using credentials for it. 2. Click on **Masters Page** for hospitals creation. 3. Click on **Hospital** on **Master Page** and click on **Add Hospital Button** to add the hospital. 4. The new hospital is created . 5. For editing and deletion of existing hospitals**, Edit** Button and **Delete** button is used.

2.3 Create Modalities:-

Use case name	To create modalities
Actor	Hospital Administrator
Trigger	Request for modalities creation
Pre Condition	Login to RADSpa
Post Condition	Generation of modalities
Main sequences	1. The user will login to the RADSpa using credentials. 2. Click on **RIS/PACS** section in **Masters.** 3. Click on **Create Modality** option to create new modalities. 4. Enter the code name, modality display name and standard modality code. 5. To edit or delete the existing modalities create on **Edit** or **Deletion** option. 6. A new modality will be created.

2.4 Create Procedures:-

Use case name	To create procedures
Actor	Hospital administrator
Trigger	Request for creation of new procedures
Pre Condition	Login to RADSpa
Post Condition	Creation of new procedures
Main sequences	1. The user will login to the RADSpa using credentials. 2. Click on **RIS/PACS** section in **Masters.** 3. Click on **Create Procedures** option to create new procedures. 4. Fill all the field such as modality, name, code etc. 5. For editing or deletion of existing procedure click on **Edit** button or **Delete** button. 6. A new procedures will be created.

2.5 Create Sub-Specialities:-

User case name	To create sub-specialities
Actor	Hospital Administrator
Trigger	Request to create new sub specialities
Pre Condition	Login to RAdSpa
Post Condition	New sub specialities created
Main sequences	1. The user will login to the RADSpa using credentials 2. Click on **RIS/PACS** section under **Masters Page.** 3. Click on **Create Subspeciality** to create new sub-specialities. 4. Enter the new sub speciality and click on **Add button** to save 5. The ID for the new sub-speciality will be auto generated by the system when it saved. 6. Click on **Edit or Delete** button for creation or deletion of existing sub speciality.

Workflows:-

The workflows module has two more sections i.e. Auto assign Radiologist section and workflow parameters.

2.6 Create Auto assign Radiologists:-

This section is used to define rules to assign studies to radiologists based on study source, modality, number of images, radiologist's availability, specialty, study priority, etc.

User case name	To create auto assign rules
Actor	Hospital administrator
Trigger	Request to create new auto assign rules
Pre Condition	Login to RADSpa
Post Condition	New auto assign rules are set
Main sequences	1. The user need to login to RADSpa using credentials. 2. Click on **Workflow Section** under **Master Page.** 3. Click on **Add Rule** set for specific study source. 4. Enter the rule name

	5. Select the type of condition from the drop down list and click on **Add Button.** 6. Once all the sections have been listed, select the action to be taken. 7. Select the conditions for the selected radiologists for the radiologists to be taken. 8. Once the actions are specified, click on Add auto assign radiologist.

2.7 Create Workflow Parameters:-

The workflow parameter is used to set the additional workflow rules like the service level agreement, radiologist acceptance time out for a "ready to be read" to "read in progress" status, physician approval timeout, study reconciliation timeout, Setting total reads for a study based on each of the study source etc.

User case name	To create new workflow parameters
Actor	Hospital Administrator
Trigger	Request to create new workflow rules
Pre Condition	Login to RADSpa
Post Condition	Creation of new workflow rules
Main sequences	1. The user will login to RADSpa using the credentials. **2.** Click on **Workflow rules** in **Master Page.** 3. Click on **Add Rule** set for specific study source. 4. Enter the rule name **5.** Select the type of condition from the drop down list and click on **Add Button.** 6. Once all conditions have been listed, select the workflow parameters according to the options available. 7. Once the parameters are selected click on **ADD button**. 8. To save the rule click on **Add Workflow Parameters** button to schedule the rule.

3.1 Read the studies:-

User case name	How radiologist read the studies
Actor	Radiologists
Trigger	Unassigned studies in worklist
Pre Condition	Studies need to unassigned in the worklist
Post Condition	Radiologist completes the study
Main sequences	1. The radiologist will login the RADSpa using credentials. 2. Click on the **Worklist Tab** and select the study 3. Once the study is selected, click on **Accept Study option**. 4. A confirmation dialog pop ups, click on **OK** option. 5. The selected study is displayed in the radiologist worklist with **Ready to Read status.**

3.2 Add Macros:-

Use case name	To add macros
Actor	Radiologist
Trigger	Addition of pre set macros in reports
Pre Condition	Pre set macros should be present for the procedures
Post Condition	Addition of macros
Main Sequences	1. The radiologist will login to the RADSpa using credentials. 2. Click on **Worklist Module** and then click on patient name of a study to report a case 3. Right click on report and click on **Add** as macro 4. Add as macro dialog box appears, type the name for macro and click **OK** 5. Once the macro is added, click on the select macro to add the macro.

3.3 Add short forms:-

Use case name	To add short forms
Actor	Radiologist
Trigger	Request for short forms
Pre Condition	Reports should be in Ready to Read progress
Post Condition	Short forms will be added in the report
Main Sequences	1. The radiologist will login to the RADSpa using credentials. 2. Click on **Worklist Module** and then click on patient name of a study to report a case 3. Select the phrase and right click on the phrase. 4. Click on **Add Shortforms** 5. A shortform dialog box will pop up and then write the name of the shortform 6. Click on **OK** button. 7. A preset short form related to that will be displayed.

3.4 Sign Off the Report:-

Use case name	To sign off the report
Actor	Radiologist
Trigger	When report is completed
Pre condition	Report status should be Read completed
Post condition	Report is completed
Main sequence	1. The radiologist needs to login the RADSpa using the credentials. 2. Click on **Worklist Module** and then click on patient name of a study to report a case 3. Click on the complete report option. 4. Once the report is signoff it will be removed from the worklist. 5. Report will be display in the Report module.

4. PROOF READ:-

Use case name	To Proof read the report
Actor	Proof reader
Trigger	Completion of the report
Pre Condition	Report should be completed
Post Condition	Proof reading of the report
Main sequence	1. The user will login to the system 2. Click on **Worklist Module** and select the study for proof read 3. Click on **Proof Read** option. 4. After clicking on Proof read, a dialog box will open 5. Click on **OK** button. 6. The status will changed to Proof read in progress.

CHAPTER-7

FINDINGS

MONTH	AVERAGE NO. OF STUDIES	BEFORE AUTOMAMTION (TAT IN MINUTES)	AFTER AUTOMATION (TAT IN MINUTES)
Month 1	22335	45.21	32.21
Month 2	22477.5	44.3	30.3
Month 3	22411	43.12	29.59
Month 4	22001	43.3	29.3
Month 5	22212.5	44.5	28.4
Month 6	22728.5	44.25	29.1

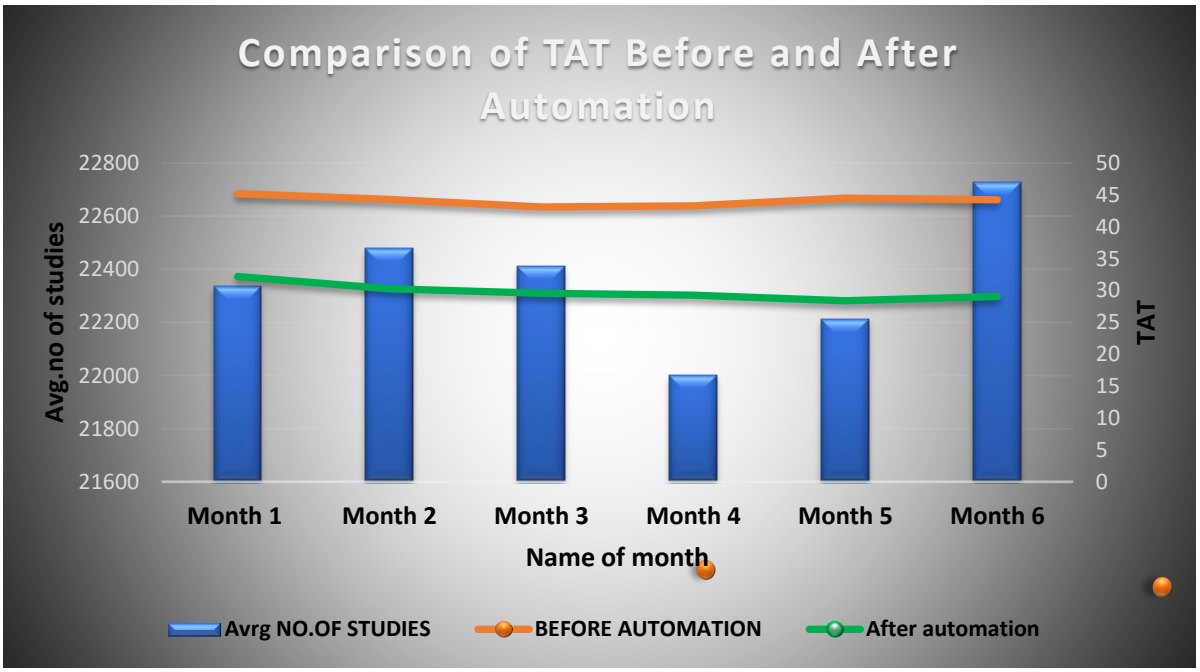


Figure 7: *Comparison of TAT before and after Automation of Concierge workflow in ER reporting.*

- Before automation of concierge workflow in ER reporting, the TAT was 44.28 min due to the delays in assigning the studies to the specific radiologist.
- After the automation, the TAT in ER reporting reduces to 29.66 min

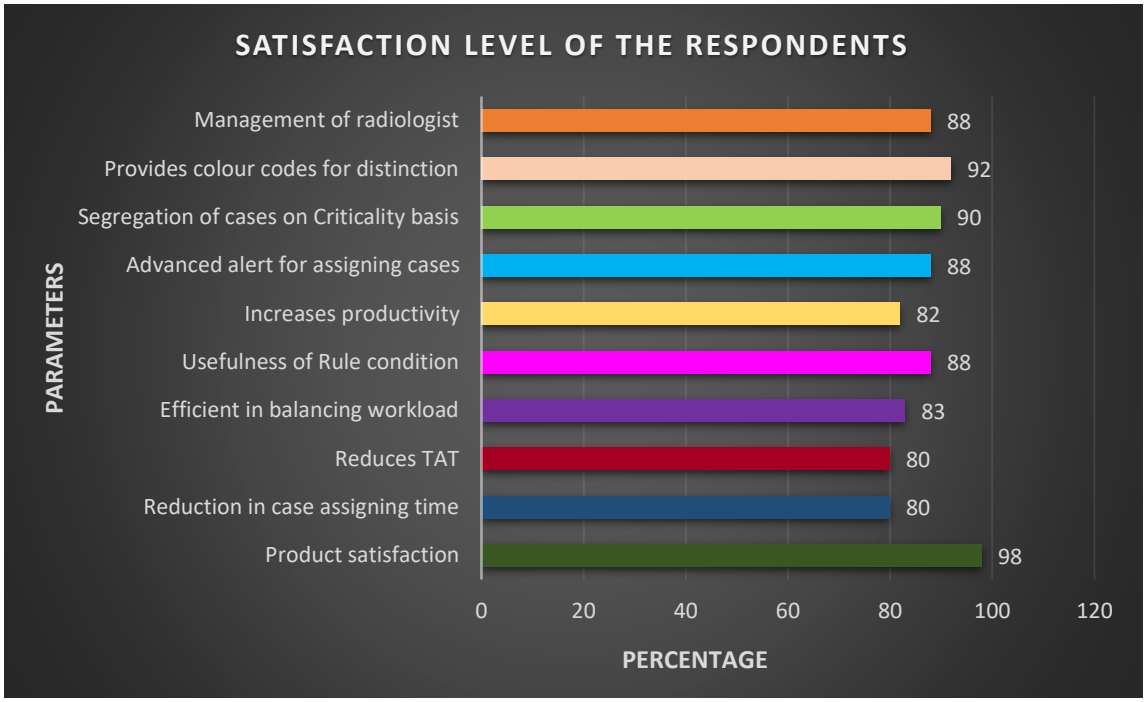


***Figure 8**: The above mentioned graph shows the satisfaction level of the respondents for Auto-Assignment feature.*

KEY FINDINGS: -

- Almost 80% of the respondents agreed that RADSpa's Concierge Workflow automation helped them to reduce the TATs and increase productivity.
- Statistical analysis of 6 months of logs before and after automation indicated 20% improvement in overall TAT for emergency cases.
- Radiologist productivity per case improved by 82% as every case is auto-validated for images prior it is assigned.
- Coordinators reported a massive 83% reduction in effort which used to go in manually eliminating errors, and there by more time in hand for handling greater workloads.

CHAPTER-8

DISCUSSION

In daily radiological practice, report generation is a time consuming process which if get delayed can affect the initiation of specific therapy. So, fast delivery of these medical reports not only reduces the patient stay in hospital but also contribute in providing early diagnosis and treatment to many diseases. Advancement in digital in digital information system offer the potential for faster delivery of radiological reports. RADSPA represents the technology that enables the radiologist to provide efficient care to the patient by reducing the report turnaround time thus permits the physicians to provide good quality of diagnostic and therapeutic services. Orchestrated Workflow Management feature helps error free assignment of the studies to designated radiologist where the admin can assign the reports according to the hospitals, study type or can transmit it to the radiologist they want. Almost 85% of respondents were agreed that this concierge automation workflow helps them in the reduction of 98% of effort which they used before manually in eliminating the errors. PACS integrated dashboard function provides a snapshot of analytical information that converts the complex form of data into simple and actionable visual reports. Thus through this Orchestrated workflow management feature, the workflow of the radiology can be monitored and will also improve the efficiency and availability of reports to physician to act as a central role for the integrated patient care.

CONCLUSION

It was concluded that the Radiology Workflow Automation has positively impacted timely patient care specifically in Reporting Emergency cases and thereby saving lives. There was a significant reduction in Manual errors. While allocation time is reduced by 82%, TAT is improved 35% and RAD's productivity by 80%. The no of mismatches and other errors while assigning case to the radiologists by coordinators (assigners) was reduced to Zero error. Radiologists were able to receive advance alert regarding their work list. Also assigners follow up process improved since they have better data of un-attended cases which the can easily re assign to reduce patient's care time. The new system allow better segregation and prioritization of cases based on criticality by using color codes to define priority. These predefined SLAs helps Radiologists in achieving the target mission of timely patient care.

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ANNEXURE- 1

FEEDBACK FORM

Feedback form for auto assign

Thank you for experiencing our product.

We want your feedback about the auto assign features and services of our RADSpa.

* Required

1. **How satisfied are you with the product?**
   Mark only one oval.

	1	2	3	4	5	
Extremely poor	◯	◯	◯	◯	◯	Excellent

2. **How this feature helps in the Reduction in cases assigning time**
   Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

3. **How this feature reduces TAT?**
   Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

4. **How this feature efficient in balancing workload?**
   Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

5. **Does rule condition helpful in ER reporting?**
   Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

6. **Does this feature increases the productivity?**
Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

7. **Does this feature sends advanced alert for unassigned cases?**
Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

8. **How this feature helps in the segregation of cases on the basis of criticality?**
Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

9. **How this feature provides color codes for distinction?**
Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent

10. **How this feature help the PACS administrator for managing the radiologist?** *
Mark only one oval.

	1	2	3	4	5	
Extremely Poor	◯	◯	◯	◯	◯	Excellent