TIME EFFICIENCY AND FUNCTIONAL OUTCOME IMPROVEMENTS IN RADIOLOGY DEPARTMENT PERFORMANCE. A COMPARATIVE STUDY OF TWO RADIOLOGY INFORMATION SYSTEM MODELS

Dissertation Submitted to

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By

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Under the Supervision and Guidance of

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Narayana Health

NH/HRSDC/2024/IOL-17

28th June 2024

Certificate of Successful Completion of Internship

To whomsoever it may concern

Ms. Himani Sharma *has completed her internship in athmâ, at the Software Development Centre, Narayana Health, Bangalore, in the period of* **1st April 2024** to **28th June 2024.**

During her internship, she worked with the Product team, and her project was **"Radiology Department Performance: Time Efficiency and Functional Outcome Improvements with Product a Compared to Product M".**

Himani's contributions include:

1. The enhancements and additional features offered by Product A in comparison to Product M.
2. The feedback received from users regarding the usage of Product A in contrast to Product M.
3. The existing constraints experienced by Product A that have potential for improvement.

Her performance is satisfactory, and we wish her the best for her future endeavors.

Yours faithfully,

for **Narayana Hrudayalaya Limited.,**

Deepashree J
Deputy General Manager - Human Resources

DECLARATION BY STUDENT

I hereby declare that this dissertation titled **Time Efficiency and Functional Outcome Improvements in Radiology department performance. A Comparative study of two Radiology Information System Models**

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 Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Himani Sharma
(Signature)

Name of Student Himani Sharma

Date: 04/07/2024

Time 10:30 am

IIHMR UNIVERSITY

CERTIFICATE

This is to certify that dissertation titled **Time Efficiency and Functional Outcome Improvements in Radiology department performance. A Comparative study of two Radiology Information System Models** is a record of the research work undertaken by HIMANI SHARMA in partial fulfilment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.

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ABSTRACT

Today medical imaging is an essential component of the entire health-care continuum, from wellness and screening, to early diagnosis, treatment selection, and follow-up. The radiology workflow refers to the series of steps involved in providing radiology services, including patient scheduling, procedure management, image acquisition and interpretation, and reporting. A well-designed workflow ensures that radiologists, technicians, and administrators work together seamlessly to deliver high-quality patient care.

This study aims to comparatively evaluate the impact of Radiology Information system (RIS) on workflow efficiency across various Radiology modalities, contrasting it with traditional paper-based systems. The research will analyse if the benefits of RIS are uniform across modalities (e.g., X-ray vs. MRI) or if specific workflows see a greater improvement.

Objectives:

Objective 1: To compare time taken from patient registration to the completion of radiology procedures of two RIS Models-Model M and Model A.

Objective 2: Determine the improvement outcomes across different functions of radiology Department after adoption of Model A.

Methodology: This study will compare the time taken for radiology procedures using Model M vs. Model A (1 month each) via RIS data analysis. Additionally, it will assess the impact of model A on departmental functions after implementation through a combination of quantitative data and qualitative surveys/interviews.

Results: Our analysis compared workflow efficiency in Narayana Health's radiology department after transitioning from model M (external RIS) to their in-house model A. While initial staff unfamiliarity and limitations in turnaround time (TAT) calculations impacted results, the findings suggest potential benefits of model A. The interconnected functionalities of the in-house system offer promise for improved departmental efficiency beyond just time reduction. Further detail investigation is explained in the results section of the study.

Discussion: Narayana Health's radiology department (Approximately 30,000 patients monthly) recently switched from model M (external RIS) to their in-house model A. This study aims to compare procedure times and departmental improvements after the switch. Challenges with model A included staff unfamiliarity and non-standardized TAT calculations (including doctor nighttime). Despite these hurdles, the study will determine the impact of model A on efficiency and potential benefits of its interconnected functionalities.

Conclusion: This study found that transitioning Narayana Health's radiology department from model M to their in-house Model A required staff adjustment and exposed limitations in TAT calculations. Despite these hurdles, model A's potential for streamlined workflows and future development suggests long-term efficiency gains beyond just time reduction. Further investigation is warranted to fully evaluate these benefits.

Keywords: Radiology Information System, PACS, DIACOM, TAT, Modality, NICS, MSMC,

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ABBREVIATIONS

ADT	Admission, discharge, transfer
ATHMA	Advance Total Health Management Application
CT	Computed Tomography Scan
DIACOM	Digital Imaging and Communications in Medicine
EHR	Electronic Health Record
HIPPA	Health Insurance Portability and Accountability Act
HL7	Health Level Seven
LIS	Laboratory Information System
MRI	Magnetic resonance imaging
PACS	Picture archiving and communication system
USG	Ultrasound Sonography

CHAPTER- 1

INTRODUCTION

CHAPTER 1: INTRODUCTION

Hospital Management Information System (HMIS)-This is a software system used by hospitals to manage all aspects of their operations, including patient care, administration, and finances. It often includes features for appointment scheduling, billing, lab results, pharmacy dispensing, and more. An HMIS helps hospitals streamline operations, improve efficiency, and provide better service to patients.

HIS-The rise of HIS- Hospital Information System represents a digital revolution in healthcare. These systems have transformed from basic administrative tools into secure central platforms for managing a patient's entire medical journey. This digital transformation empowers healthcare professionals with a unified view of patient data, leading to improved communication and ultimately, better patient care. HIS extends beyond the hospital walls, allowing for communication with external providers and offering patients online access, creating a more collaborative and efficient healthcare ecosystem.

Difference between HMIS and HIS

HMIS	HIS
This typically emphasizes the administrative aspects of running a hospital. Scheduling appointments, billing, managing patient demographics, and streamlining workflows.	This term can be broader and encompass both administrative functions and some clinical aspects. It might include features for managing patient medical records, tracking medications, and lab results.

RIS-In the intricate world of hospital operations, efficiency is paramount, especially within the bustling radiology department. Prior to Radiology Information Systems (RIS), managing X-rays, ultrasounds, and other scans relied heavily on paper records. This

resulted in a chaotic system riddled with problems. Locating past exams became a time-consuming task, misplaced folders posed a risk of losing crucial images, and delays in diagnoses were a frequent occurrence. Furthermore, fragmented paper records often left physicians with an incomplete view of a patient's radiology history, hindering their ability to provide optimal care. Communication breakdowns were also commonplace, with reports misplaced or shuffled between departments.

The limitations of this paper-based approach became a significant roadblock in delivering efficient and effective patient care. This pressing need for a streamlined and reliable system paved the way for the invention of RIS, ushering in a new era for radiology departments.

Radiology workflow process has many steps, each one is crucial for a successful outcome. Here's what goes into a typical radiology workflow:

- **First things first:** The doctor decides you need an imaging test and sends a request to the radiology department.
- **Appointment Scheduling:** The radiology department schedules the appointment.
- **Getting ready for the test:** When patient arrive, the radiology technologist will prepare patient for the examination.
- **Taking the images:** The technologist uses specialized equipment to capture the images which doctor needs for diagnosis.
- **Radiologist review:** Once the images are taken, a radiologist, a doctor specially trained in reading these images, will carefully examine them to find any abnormalities.
- **Reporting the results:** The radiologist then writes a report describing their findings and sends it to doctor.

This completes the RIS process flow in a hospital.

RIS emerged as a revolutionary solution, offering a centralized digital platform to manage all aspects of radiology workflows. This innovation addressed the pre-existing problems by facilitating efficient scheduling of exams, tracking patient history, and ensuring secure

storage and retrieval of digital images. With RIS, the era of misplaced folders and wasted time searching for past scans came to an end, paving the way for improved communication, faster diagnoses, and ultimately, a new era of efficient and effective patient care.

Some key features of an effective RIS are:

- **Patient Management**
    - Secure storage of patient demographics and medical history
    - Appointment scheduling and tracking
    - Online patient portal for appointment management and communication
- **Order Management**
    - Ordering, tracking, and managing radiology exams
    - Predefined protocols for various exam types
    - Integration with referring physician systems
- **Image Management**
    - Secure storage and retrieval of digital radiology images

The Indian healthcare sector is experiencing a period of rapid transformation. As patient volumes rise and technology advances, healthcare providers face the ongoing challenge of optimizing efficiency and quality of care. Radiology departments, in particular, play a critical role in diagnosis and treatment planning, yet they can be susceptible to workflow bottlenecks that impact turnaround times and overall patient experience.

This study focuses on Narayana Health, a large hospital network in Bangalore, India. With over 30,000 patients visiting their radiology departments monthly, streamlining workflow is essential. Recently, Narayana Health transitioned from Model M, an external Radiology Information System (RIS), to their own in-house developed Model A. This study aims to analyze the impact of this switch on departmental workflow efficiency, focusing on potential improvements in procedure times and overall function.

1.1 Research problem:

In today's healthcare landscape, efficiency is paramount. This is especially true in radiology departments, where timely diagnoses can significantly impact patient outcomes. However, streamlining the workflow from patient registration to procedure completion can be a complex challenge. This research aims to address this by comparing two radiology workflow Models, Model M and Model A. Model M is a software only for RIS department, which has two screen from where radiology order of a patient can be processed whereas Model A is a complete HMIS software, in this RIS workflow is more segregated into various screens which makes user to navigate for various functionalities of RIS easy.

While Model A has been implemented in the radiology department, we will look at the improved outcomes across different functions after adoption of Model M and its limitations.

1.2 Objectives:

Objective 1: To compare time taken time taken from patient registration to the completion of radiology procedures of two Models- Model M and Model A.

Objective 2: To determine improvement in outcomes of differ function after adoption of Model A.

1.3 Aim:

The aim of the study is to determine if either Model leads to a statistically significant reduction in the total time taken to complete radiology procedures. This involves measuring the average time it takes for a patient to journey from registration to the completion of their exam for both Model M and Model A. By analysing these time differences, we can gain valuable insights into the effectiveness of each Model in optimizing patient throughput within the radiology department. Following the implementation of Model A, this research explore its impact on various departmental functions. We aim to identify specific improvement outcomes associated with Model A across critical areas like scheduling, technologist workflow, and radiologist interpretation.

CHAPTER- 2

LITERATURE REVIEW

CHAPTER 2: REVIEW OF LITERATURE

S.No.	Author and Year	Title/ Objectives of the study	Study	Key Findings
1.	Nam et al., 2018	Medical Imaging: From Roentgen to the Digital Revolution, and Beyond	Historical Review Study	**-Reduced Report Turnaround Time:** The web-based RIS led to a significant decrease in report turnaround times compared to the previous paper-based system. This indicates faster reporting and potentially quicker diagnosis for patients. **-Improved Staff Modelivity:** The study found that radiologists and technologists experienced increased Modelivity due to the streamlined workflow and easier access to information within the web-based RIS. **-Enhanced Communication:** The web-based system facilitated better communication between radiologists and referring physicians by providing a centralized platform for sharing reports and images.

2.	Lahiri & Seidmann 2018	Analysing the Differential Impact of Radiology Information Systems Across Radiology Modalities	Comparative Cross-Sectional Study	RIS implementation did not have a uniform positive impact on all modalities. There was a significant decrease in report turnaround times for mammographic studies after implementing the RIS. The study suggests that the additional steps and information gathering required by the RIS might have **increased interpretation cycle times for radiologists** in some cases (although not statistically significant).
3.	Johnson, M. and Davis, K. 2020	Enhancing Radiology Department Performance: Outcomes of Implementing a New Radiology Information System	Longitudinal Cohort Study	**Improved Workflow Efficiency** <u>Reduced Processing Time:</u> The study observed a significant reduction in the time taken from patient registration to the completion of radiology procedures. This improvement was attributed to streamlined workflows and better coordination facilitated by the new Radiology Information System (RIS). <u>Automation Benefits:</u> The automation of scheduling, reporting, and image

				management tasks decreased manual entry errors and increased overall processing speed. **Enhanced Patient Throughput** <u>Increased Capacity:</u> The new RIS allowed the radiology department to handle a higher volume of patients without compromising on the quality of care. This was due to more efficient scheduling and resource allocation. **3. Quality of Patient Care** <u>Improved Accuracy:</u> Enhanced imaging and reporting accuracy were noted, leading to more precise diagnoses and better patient outcomes. The integration with Picture Archiving and Communication Systems (PACS) played a critical role in this improvement. <u>Enhanced Reporting:</u> The system provided comprehensive and timely reporting capabilities, allowing for faster clinical decision-making.

				Future Prospects Scalability: The RIS demonstrated scalability, suggesting that similar improvements could be realized in other departments or facilities. Technological Integration: Future integrations with other hospital information systems and electronic health records (EHR) were anticipated to further enhance departmental performance and patient care continuity.
4.	Brown, L. and Nguyen, P. 2021	Assessing Radiology Throughput: A Comparative Study of Digital Radiography Systems	Comparative Cross-Sectional Study	**Throughput Efficiency** Higher Patient Volume: Digital radiography systems significantly increased the number of patients processed daily compared to conventional radiography systems. This was due to faster image acquisition and processing times. Reduced Turnaround Time: The study found a marked reduction in the turnaround time for radiographic examinations, from image capture to availability for interpretation.

				Image Quality and Diagnostic Accuracy -Enhanced Image Quality: Digital radiography systems provided superior image quality, which led to more accurate and reliable diagnoses. Improved image resolution and contrast were key factors. -Fewer Repeat Examinations: The high quality of digital images resulted in fewer repeat examinations, thereby increasing department efficiency and reducing patient exposure to radiation. **Workflow and Operational Improvements** -Streamlined Workflow: The implementation of digital systems streamlined the workflow by integrating image acquisition, processing, and storage into a cohesive process. This integration reduced the need for physical film handling and manual data entry. Enhanced Data Management:

				Digital systems facilitated better data management through easier storage, retrieval, and sharing of images. This improved collaboration among radiologists and other healthcare providers. **Technological Integration** <u>PACS Integration:</u> The integration of digital radiography systems with Picture Archiving and Communication Systems (PACS) was crucial for seamless image management and accessibility. <u>Future-proofing:</u> The study suggested that digital systems were more adaptable to future technological advancements, ensuring the department remained at the forefront of radiographic technology.
5.	Lee, S. et al. 2022	Impact of New Radiology Software on Departmental Operations and Patient Care	Comparative Longitudinal Study	**Operational Efficiency** <u>Streamlined Workflow:</u> The introduction of new radiology software streamlined various operational processes, including scheduling, image

				acquisition, and reporting. This led to a more efficient workflow, reducing the time required for each radiology procedure. Automated Scheduling: The software's automated scheduling feature minimized appointment overlaps and optimized resource allocation, enhancing the department's overall efficiency. **Quality of Patient Care** Enhanced Diagnostic Accuracy: The new software provided advanced image processing capabilities, which improved the accuracy and clarity of radiological images. This led to better diagnostic outcomes and more precise treatment planning. Timely Reporting: Faster and more accurate reporting improved the speed of clinical decision-making, directly benefiting patient care and outcomes. **Data Management and Accessibility** Improved Data Integration: The software facilitated better integration with existing Hospital Information Systems

				(HIS) and Electronic Health Records (EHR), ensuring seamless data flow and accessibility. <u>Enhanced Image Storage and Retrieval:</u> Efficient image storage and retrieval mechanisms allowed for quick access to patient imaging histories, aiding in more comprehensive patient evaluations. **Staff Modelivity and Satisfaction** <u>Reduced Administrative Burden:</u> Radiology staff experienced a reduction in administrative tasks, such as manual data entry and report generation, due to the automation features of the new software. <u>Increased Job Satisfaction:</u> Improved workflow and reduced manual workload contributed to higher job satisfaction among radiology staff, including technologists and radiologists.

CHAPTER- 3

METHODOLGY

CHAPTER 3: METHODOLOGY

To determine if either Model leads to a statistically significant reduction in overall procedure time, we will embark on a retrospective data analysis. This involves gathering historical data from the radiology department's information system (RIS) for a one month of both the Models (Model M and Model A). The data will focus on the time taken for a patient to complete their radiology procedure, measured from the moment of registration to the finalization of the exam. Once the data is collected, we will utilize statistical analysis techniques to compare the average time taken to complete procedures under Model M and Model A.

Following the implementation of Model A, By combining quantitative data from departmental records with the qualitative insights obtained from surveys and interviews, we can create a comprehensive picture of how Model A has affected the radiology department. This analysis will identify specific improvements across functions, such as scheduling efficiency, technologist workflow optimization, and potential reductions in radiologist interpretation time.

3.1 Research Methodology:

3.1.1 Research Question:

1. Is there a difference in the average time taken from patient registration to the completion of specified radiology procedures when comparing model A and M.

2. Does implementation of Model A lead to improvement in efficiency within various functions of the radiology department?

3.1.2 Study Design: This study is a Descriptive and Analytical study.

Two approaches were used in the study to collect data of radiology orders for two Models.

Qualitative approach -This method entails obtaining input from radiologists who have experience with both RIS Model M and Model A systems regarding the process and their experiences. Questions with open-ended questions on process-flow, were asked from radiologist, technicians, and front office staff.

Quantitative approach - In this method, particular metrics for radiology orders to final reports are collected of both the Model Such as Time taken from exam completion to report availability for physicians, Number of errors in reports, and Radiologist workload (studies interpreted per day).

3.1.3 Type of study: secondary research

3.1.4. Study Setting:

This study was conducted in the Narayana health, Bangalore.

NH has three units-

- Narayana institute of cardiac sciences (NICS),
- (MSMC) and
- International wing.

NICS and MSMC have radiology department. The data on radiology is collected from NICS unit of NH Bangalore.

3.1.5 Research Procedures/Approach:

This study will utilize a retrospective analysis design to assess the impact of transitioning Narayana Health's radiology department from Model M (external RIS) to their in-house Model A. Data will be collected from the department's existing information systems for defined periods before and after Model A implementation. Key data points will include patient demographics (anonymized), timestamps for registration and procedure completion, modality types, and staff involved.

This research approach acknowledges limitations such as dependence on existing data quality and a timeframe that may not capture long-term benefits. However, this design provides a framework to analyse the impact of Model A on departmental efficiency, including procedure times, potential function improvements, and areas for further investigation and optimization of the in-house system.

3.1.6 Study Populations:

As we are comparing two Models so the data for Model M was gathered from historical data from the radiology department's information system (RIS) for NICS unit total 10,987 patients visited in the month of June,2023.

For Model A In NICS, approximately total 11765 patients visited radiology department in the month of April 2024.

3.1.7 Sample Size:

674 patients from Model A and 963 patients from Model M from three modalities i.e CT abdomen, MRI Brain, and USG Abdomen were taken to complete the study based on feasibility considering the limited period of study. The date set collected from radiology department.

3.1.8 Study Tools: Process Mapping, Staff Interviews,

3.1.9 Duration of study: 3 months (1st April 2024 to 28th June 2024)

3.1.10 Sampling Technique:

Simple random sampling was done for both the Model A and Model B

3.1.11 Data Analysis Plan:

- **Spreadsheets:** Microsoft Excel is used to calculate basic statistics and visualize the data with charts to compare completion times between Models.
- **Descriptive Statistics:** Descriptive statistics will be used to summarize the characteristics of the study sample

3.1.12 Data Collection and Management:

Data collection was done in the NICS unit of NH with the help of hospital staff-front office, radiologists, technicians, coordinators and PG Interns. An observation and interview was conducted to collect information from the process patient radiology order to completion of radiology process and the process flow of two Models.

Data Analysis:

Historical data on patient registration and radiology procedure completion times was collected from hospital radiology department records for both Model M and Model A. data of both the Models was transferred to an excel sheet.

Process Mapping: Flow of both the Models was done by observation of every steps of radiology.

3.2 Hypothesis:

- Null Hypothesis (H0): there is no significant difference between the two Models, it assumes that both Models take, on average, the same amount of time from patient scheduling for RIS order to completion of radiology procedures.
- Alternative Hypothesis (H1): there is a difference in the average times between the two Models. This difference could be that Model A is faster or slower than Model M.

3.3 Operational Definitions:

- **Radiology Information System:**

  A Radiology Information System (RIS) is a software program designed specifically to manage and organize patient data and workflow within a radiology department . It acts as the central hub for all radiology-related activities, streamlining processes and improving efficiency.

- **Radiology Modalities:**

  Radiology modalities, also known as medical imaging modalities, are the different techniques and technologies used to capture images of the inside of the body. These images provide valuable information to help doctors make accurate diagnoses and develop effective treatment plans.

- **PACS**:

  "A picture archiving and communication system (PACS) is a medical imaging technology which provides economical storage and convenient access to images from multiple modalities."--- Picture archiving and communication system - Wikipedia

- **DIACOM**:

  Digital Imaging and Communications in Medicine (DICOM) is a worldwide standard for the storage and transmission of medical imaging. The standard therefore defines both a file format and a networking protocol.

- **HIPPA:**

  The Health Information Privacy and Accountability Act (HIPAA) requires healthcare practitioners to take steps to secure health information against security risks.
  Surgeons, radiologists, and other healthcare professionals that use medical images (X-rays, CT scans, etc.) must comply with Health Information Privacy and Accountability Act (HIPAA) standards.

- **HL7**

  HL7, an international body, establishes and sustains protocols for the seamless exchange, integration, sharing, and retrieval of medical data. It is widely employed for transmitting non-image data among various systems. Integrating HL7 with the electronic health record (EHR) enables healthcare professionals to access patient medical histories for informed decision-making. Without HL7, effective information exchange would be impossible, thereby preventing the creation and utilization of electronic health records (EHRs).

3.4 Ethical Considerations:

Patient Privacy and Confidentiality:

To safeguard participant privacy, all data will be anonymized and securely stored. Only authorized researchers will have access, ensuring patient information remains confidential.

Data Ownership and Sharing:

The data collected from radiology department of the hospital, the clarification on data ownership and access protocols has been properly authorized.

Research Bias:

The research methods used in the study is designed to minimize bias. This involved using standardized data collection procedures.

Fairness and Transparency:

The research design used in the study is fair and avoids including advantages or disadvantages to either Model.

CHAPTER- 4

RESULTS

CHAPTER 4: RESULTS

This section will present the findings about 674 patients from Model A and 963 patients from Model M from three modalities in the NICS unit of Narayana heath, Bangalore.

The sample collected for both the Models are graphically represented below:

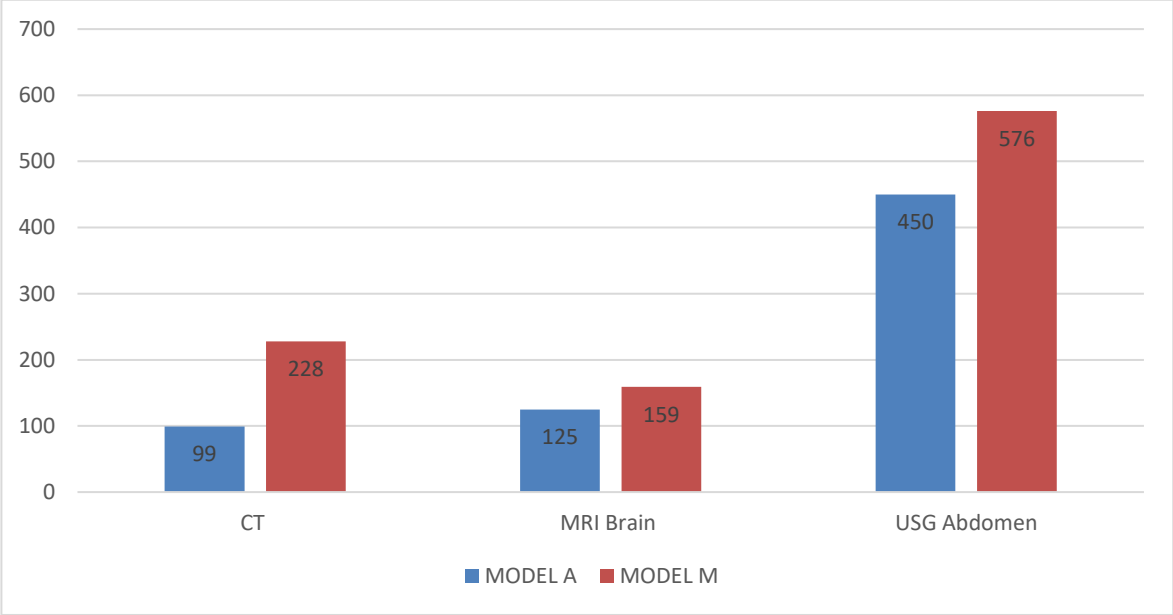

Figure 4.1.1 SAMPLE DIVISION FOR BOTH RIS MODEL

For Model A-

99 Patients visited for CT abdomen & pelvis contrast, 125 patients for MRI brain, and 450 patients for USG Abdomen month of April,2024.

For Model M-

228 Patients visited for CT abdomen & pelvis contrast, 159 patients for MRI brain, and 576 patients for USG abdomen in the month of June 2023.

Therefore, the total sample of Model A is 674 for NICU unit of NH for three modalities and for Model M is 963 for NICU unit of NH for three modalities, which makes total of 1637 patients.

For the feasibility of study average time for all the patients is calculated between the patient radiology scheduled time and the reporting time of two Models for 3 modalities CT abdomen & pelvis contrast, MRI brain and USG abdomen.

The below table shows the difference of average time taken of two Model -

Table 4.1.3: Average time taken for CT Abdomen & pelvis contrast, MRI Brain, and USG Abdomen for Model M and Model A-

S.no	Modalities	Average time for Model M	Average time for Model A
1.	CT Abdomen	05Hour:01 Minutes:59Seconds	10 Hours:56 Minutes:46 Seconds
2.	MRI Brain	03Hour:40Minutes:57Seconds	3 Hours:59 Minutes:15 Seconds
3.	USG Abdomen	03Hour:23Minutes:02Seconds	02 Hours:13 Minutes:47 Seconds

From the table above it can be seen that, Model A has better TAT in USG abdomen, similar in MRI Brain and Model M has better TAT in CT Abdomen & pelvis contrast than Model A.

The Model A was implemented in the NH hospital, earlier in radiology department they were using Model M which is specifically made for Radiology department.

Table 4.2.1.1: Benefits of Model A

Model A	**Model M**
Interconnected Functionalities: better integration between radiology and other hospital departments.	Only used for RIS department
Customization Potential	No customization potential
Automation Capabilities	Only manual scheduling
Reduced Vendor Fees	High vendor fees
Addendum and amend option- helps to add or change patient at any point of time	No options for addendum and amend
Improved Data Security	Risk of data security
Scalability	Problem in Scalability

Table 4.2.1.2: Benefits of Model M

Model A	**Model M**
New adoption- difficulty in using	Older software- Familiarity with the functionality of software
TAT increased because of new software adoption	TAT time was better as the users were familiar with the software
New Model-will take some years for complete development	Proven Track Record- might have a longer history of development and refinement specifically for radiology workflows.

Narayana Health (NH) hospital recently implemented their in-house developed Model A within the radiology department. This shift comes after a period of using Model M, a specialized Radiology Information System (RIS) designed specifically for radiology workflows. The decision to transition to Model A reflects a strategic move by NH to potentially leverage the benefits of an in-house system. While Model M offered a tailored solution for radiology needs, Model A represents an opportunity for NH to explore potential advantages like:

- **Integration:**

  Model A, being an in-house development, might offer greater potential for seamless integration with other hospital information systems. This could streamline data flow across departments, potentially improving overall efficiency.

- **Customization:**

  NH can potentially customize Model A to better suit their specific departmental needs and workflow preferences. This level of control might not be readily available with an external Model like M.

- **Cost-effectiveness:**

  Developing and maintaining an in-house system like Model A may offer long-term cost benefits compared to ongoing licensing fees associated with an external RIS like Model M.

4.2.1 Improved Outcomes of Model A-

HMIS Software-

Model A goes beyond a simple radiology tool. It's a comprehensive Hospital Management Information System (HMIS) that fosters collaboration and efficiency across the entire healthcare spectrum. This interconnectedness leads to streamlined workflows, faster service delivery, and improved data accuracy.

Auto/ Manual schedule-

Model A recognizes the difference between radiology modalities. For fixed-time procedures like X-rays and ultrasounds, the software can automate scheduling, optimizing efficiency. However, for modalities like CT scans and MRIs, where scan times depend on patient-specific factors, Model A allows for manual scheduling to accommodate these variations.

Tumor board-

Model A's Electronic Health Record (EHR) module streamlines collaboration within the Tumor Board. By centralizing patient information in a single software platform, all stakeholders involved in the patient's care can access relevant data with just a click. This eliminates the need for information gathering from disparate sources and facilitates a more efficient and faster process.

Patient Chart-

Model A empowers authorized doctors with seamless access to patient medical records. Doctors can directly view a patient's entire chart within the EHR module, eliminating the need to switch between different systems. This streamlined access fosters a more interconnected workflow and enhances patient care.

Teleradiology-

Model A's tele-radiology screen shatters departmental boundaries within a hospital with multiple units. It treats both in-house and outsourced radiology orders equally, fostering a collaborative environment that prioritizes quality reporting. This unified platform also simplifies report segregation, enabling clear analysis of caseloads handled by healthcare staff for both in-house and outsourced cases.

Less Downtime-

Downtime, when a software program becomes unavailable, can be highly disruptive, especially with third-party vendors. These outages can incur significant direct and indirect costs. In contrast, Model A, being an in-house developed system, avoids these external vendor costs. The development team can directly address any downtime issues, minimizing both wasted time and additional financial burdens.

Operational Efficiency

-Streamlined Workflow:

In Model A every patient information is interconnected with various modules, which helps in easy scheduling, order management, and reporting reduces manual errors and speeds up processes.

Improved Compliance and Reporting-

-Regulatory Compliance:

Model A ensure adherence to regulatory requirements it is compliant with HIPPA, HL7.

-Accurate Reporting:

Enhanced accuracy in report generation and data handling.

4.2.2 Process Mapping

Process Mapping is done for both the Models, to understand the steps of both the Model A and Model M.

4.2.2.1 Model A-

Model A boasts a robust suite of integrated modules, including Electronic Health Records (EHR), Laboratory Information Systems (LIS), Radiology Information Systems (RIS), Pharmacy Management, Inventory Control, Blood Bank Management, and Admission, Discharge, and Transfer (ADT) functionalities, among others.

Focusing specifically on the RIS module within Model A, it provides healthcare professionals involved in the radiology process with a comprehensive set of tools. These functionalities include modality worklists, reporting worklists, order processing, scheduling requests, a study browser, tele-radiology capabilities, invoicing, and report generation. This streamlined approach empowers staff to complete radiology tasks efficiently.

Post registration

After patient registration, the patient consults the doctor and the doctor order the radiology test to a patient, which is reflected in the **RIS Order Worklist** to view the list of Radiology orders for OP and Day care patients.

Front office staff can schedule the patient appointment from this screen only

Modality worklist

Next comes modality worklist, in this screen can manage the scheduled RIS Orders of the patient. Then patient arrive, get ready for study and completes the study/radiology test, which can be automatic (in case of Xray and ultrasound) and manual (in case of CT and MRI).

Reporting & Approval

After study completion report can be seen in reporting worklist screen and can be assigned to team (consists of doctors, radiologist, PG students/Interns), then senior doctor certifies the report.

Report delivery

The report is published to patient app or printed copy is given to patient.

The process flow of Model A for radiology comes to an end after the report is published on application and given to the patient.

Process flow chart of Model A-

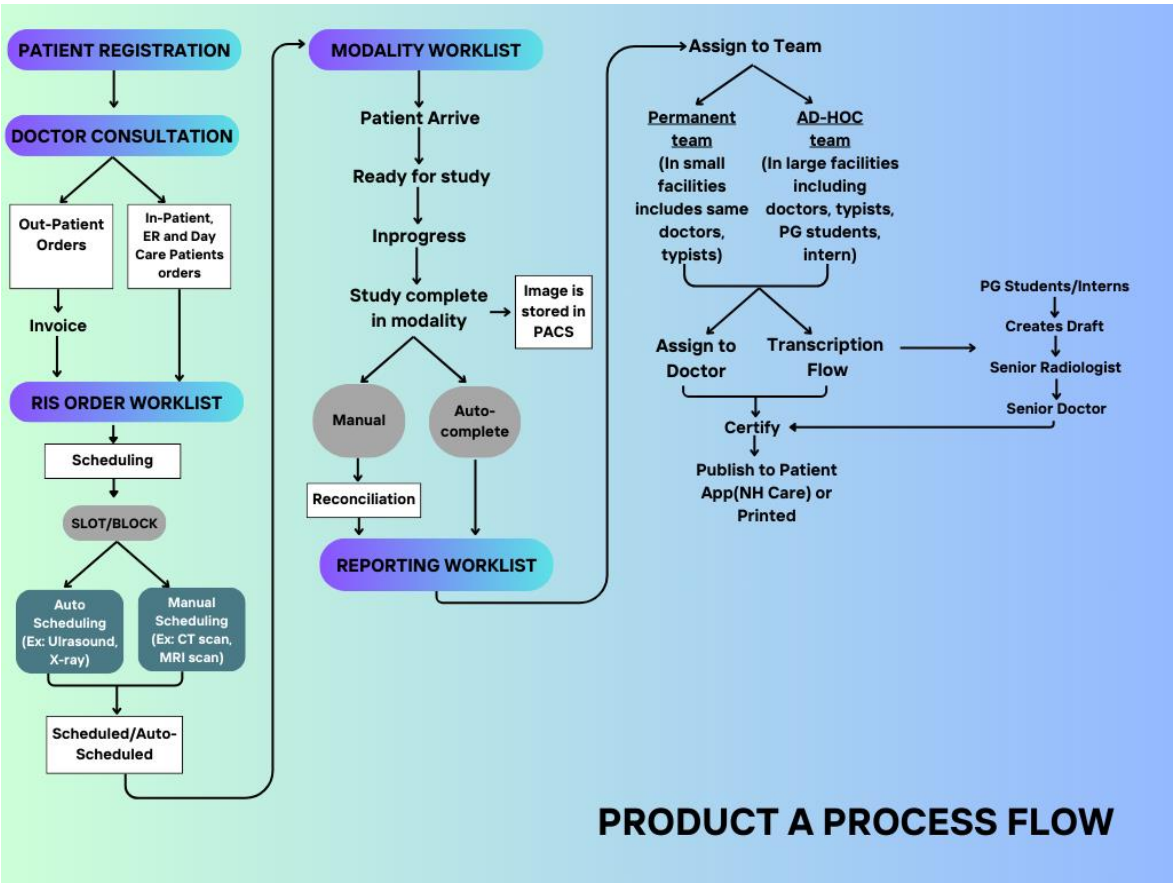

Diagram 4.2.2.1: Process flow of Model A

Model M-

Model M is a software for RIS, consists of Models and services that streamline the medical image scanning operations of a hospital. The solution offers seamless viewing to Radiologists and Clinicians across the hospital.

Scheduling and Modalities:

After patient consultation front office staff schedule the appointment of a patient for a radiology test. Patient name will reflect in the modalities screen- used by technicians to manage upcoming scans.

Image Transfer and Report Assignment:

After the scan is complete, image is transferred to coordinator list. Coordinators will assign the report of a patient to a particular doctor, then doctor receives the request of a patient and after careful examination doctor certify the report.

Report Certification and delivery:

The certified patient report is ready to collect which can be seen in reporting worklist screen. Search for patient through MRN (medical record number) number of a patient.
The patient report can be printed and given to the patient in the form of hardcopy.

The process flow of Model M comes to an end after the report is published in the software and given to the patient.

Process Flow Chart of Model M-

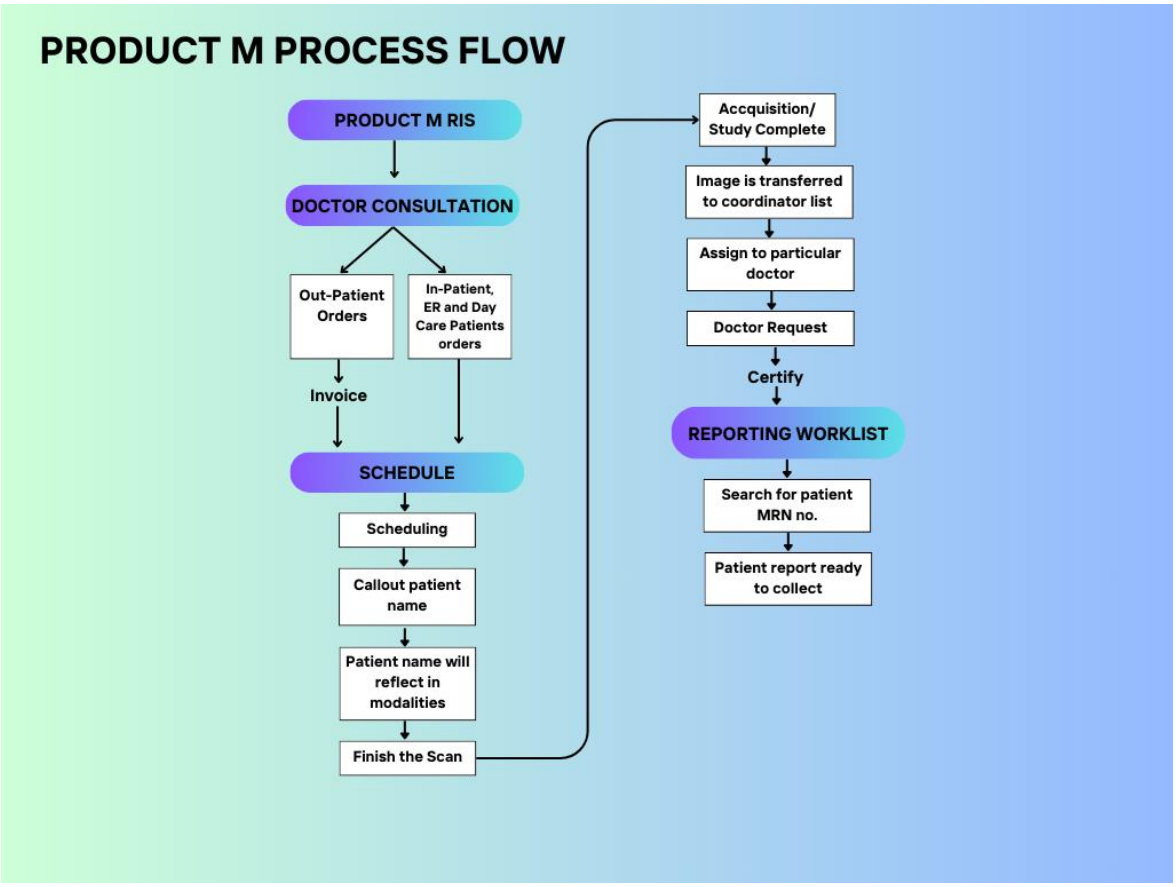

Diagram 4.2.2.2: Process flow of Model M

CHAPTER- 5

DISCUSSION

CHAPTER 5: DISCUSSION

Narayana Health, Bangalore is a large hospital with three units, the two units (NICS & MSMC) have radiology department. Almost 30,000 patients visit radiology department in both the units. From last five years RIS-Model M was used in both the unit and recently five-six months before Model A was implemented.

As Model A is the in-house Modelion of NH, therefore it has various advantages over Model M. However, there were many challenges faced by front office staff and radiologist to get familiar with Model A.

The study is done to understand the average time taken starting from patient Scheduling to final reporting for two Model A and Model M & to understand the process flow and analysis the improved outcomes after implementation of Model A.

It has been observed and analysed that the TAT of modalities has not been drastically improved because of various reasons-

- The calculation to calculate TAT is not in standardized form

- The calculation of TAT was calculating the doctor night time also i.e after 8pm, which resulted in increased TAT.

- Unfamiliarity with the software was also an issue for high TAT.

This study helps us determine that difference between the two Models and how after adoption of Model A what are the benefits/improved outcome in the radiology department of the hospital.

Major difference in both the Model is that the Model A is in-house software which has various different functionalities and all of modules are interconnected with each other which makes patient data flow across department efficient, whereas in Model M, it is a third party and only used for RIS.

4.3 CHALLENGES AND SOLUTIONS-

Data Quality and Availability:

- Missing or Incomplete Data:

  Relying on existing departmental records reveal missing or incomplete data entries for specific procedures or time points. This can limit the sample size or introduce bias in the analysis.

- Data Accuracy:

  Inaccuracies in data entry within the RIS can affect the validity of the results.

Limitations:

- Confounding Variables:

  External factors unrelated to Model A, such as changes in staffing levels or patient mix, could influence workflow efficiency and potentially skew the results.

Learning Curve and User Experience:

- Staff Adjustment Period:

  As mentioned in the study design, staff may require time to adapt to Model A. Data collected shortly after implementation might not reflect the system's full potential efficiency.

- User Interface Challenges:

  Model A's user interface might be less intuitive than Model M, leading to initial user frustration and potentially impacting workflow during the adjustment period.

Standardized TAT Calculations:

- Shifting Work Patterns:

  Doctor nighttime hours might not be the only factor affecting non-standardized TAT. Fluctuations in staff schedules or workload distribution could also contribute to inconsistencies.

Addressing these challenges will be crucial for the study to provide a reliable and objective assessment of Model A's impact.

Here are some potential solutions:

- **Data Cleaning and Validation:**

  Data cleaning procedures to identify and address missing or inaccurate data entries can improve data quality.

- **Sensitivity Analysis:**

  Conducting sensitivity analyses can help assess the impact of potential confounding variables on the study's conclusions.

- **Extending Data Collection Period:**

  Collecting data for a longer timeframe after staff adjustment to Model A can provide a more accurate picture of its long-term efficiency gains.

- **User Feedback Integration:**

  Gathering staff feedback on Model A's interface and functionalities can highlight areas for improvement and inform future system development.

By acknowledging these potential challenges and outlining strategies to mitigate them, the study can ensure a more robust and reliable analysis of the transition to Model A in Narayana Health's radiology department.

CHAPTER- 6

CONCLUSION

CHAPTER 6: CONCLUSION

Narayana Health's radiology department, handling approximately 30,000 patients per month across two units (NICS & MSMC), recently underwent a significant change. After utilizing Model M, an external Radiology Information System (RIS), for five years, the department transitioned to their in-house developed Model A.

This study aims to analyse the impact of this switch on departmental workflow and identify any improvements achieved with Model A.

Objectives:

- Compare procedure times:

  The study was conducted to compare the average time taken for completing radiology procedures using Model M versus Model A. This involved analysing historical data from a specific timeframe (one month) for both systems.

- Functional improvements of Model A :

  Beyond time reduction, the study assess the broader impact of Model A on various functions. This might include aspects like scheduling efficiency, technologist workflow optimization, and potential reductions in radiologist interpretation time.

Limitations and Future Research:

- The study acknowledges limitations, including a relatively short timeframe post-implementation and potential issues with data quality or missing entries.
- Future research with a larger sample size and a longer observation period is recommended to definitively assess Model A's long-term impact on departmental efficiency and patient care delivery.
- In-depth user experience evaluations could provide valuable insights into staff satisfaction and identify areas for further improvement within Model A's RIS module.

By addressing the limitations, we can gain a more comprehensive understanding of Model A's impact on workflow efficiency, data quality, and ultimately, patient care delivery at Narayana Health. This knowledge can be instrumental in guiding future optimization efforts and ensuring that Model A empowers the radiology department to deliver high-quality care in the ever-evolving healthcare landscape.

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ANNEXURES

1. Data Collection Form

This form outlines the data points collected from the Radiology Department Information System (RIS) for both Model M and Model A.

Patient Information (Anonymized):

- Unique Patient Identifier

Procedure Information:

- Service name-Modality Type (e.g., X-ray, MRI)
- Ordered date time
- Billing date time
- Scheduled date time
- Study start date time
- Assigning date time
- Drafted date time
- Reported date time

Timeframe:

- Model M: Data is collected from historical information of patient's data for a period of one month-June 2023, for NICS unit of Narayana health.
- Model A: Data is be collected for a period of one month- April 2024 after Model A implementation.

Due to time limitation of the study, the sample size and timeframe is taken according to the feasibility of study.

2. Standardized Turnaround Time (TAT) Calculation

The standardized TAT calculation method implemented for both Model M and Model A data are-

- Start Time: The official registration time of the patient in the RIS i.e .
- End Time: The time the radiology procedure report is finalized in the RIS.

Formula Used:

TAT (in hours) = End Time - Start Time