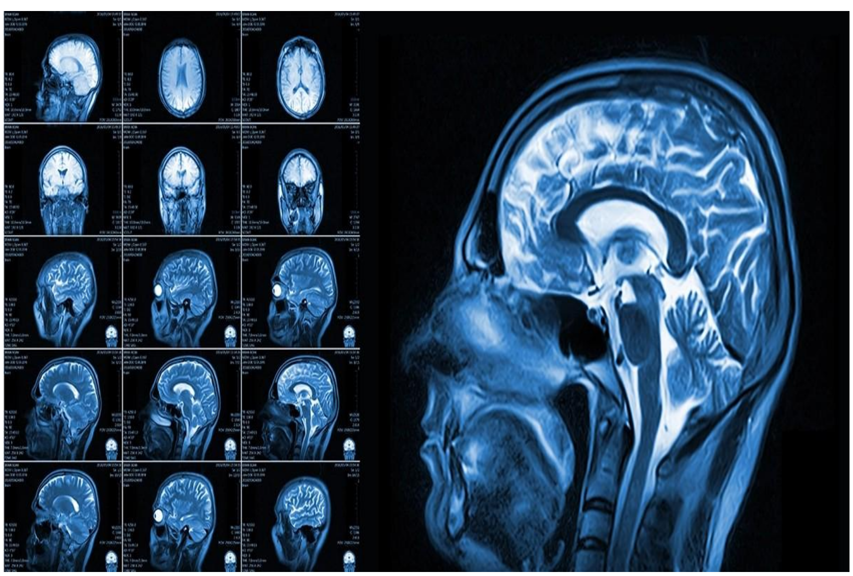
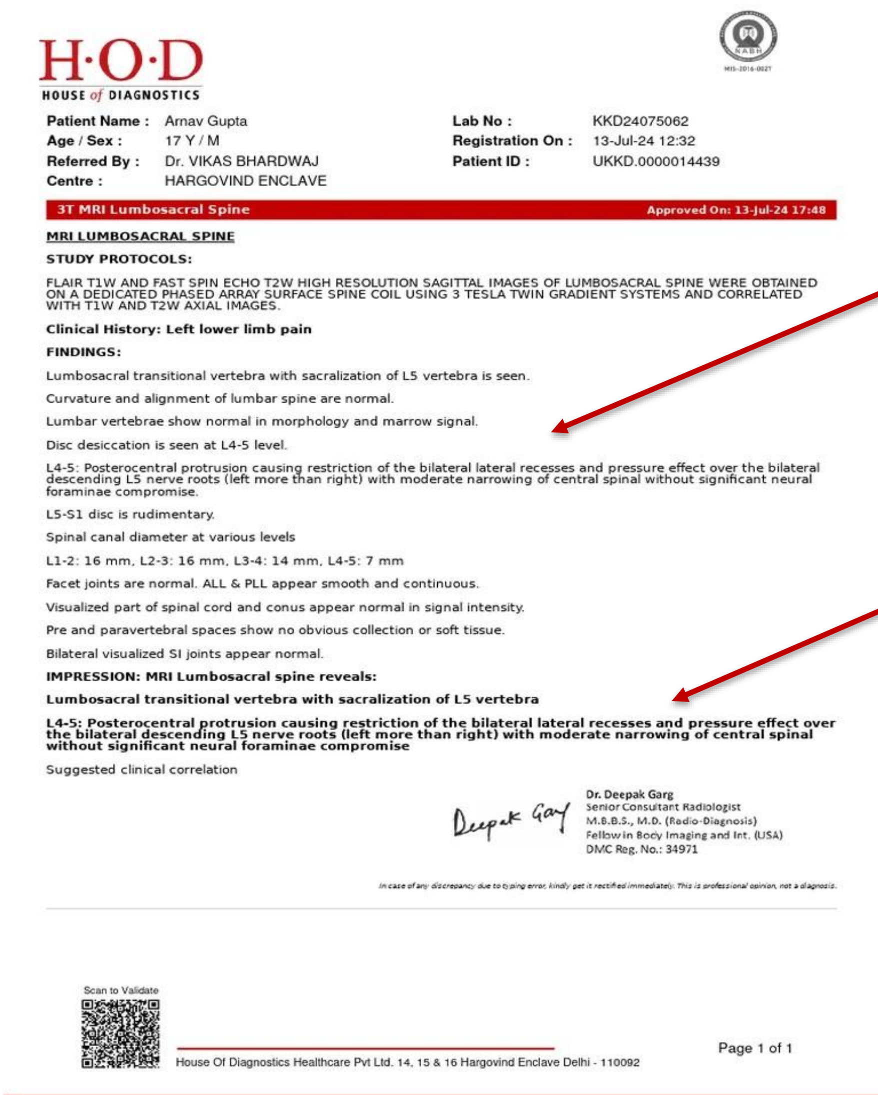
	Marwadi University **Faculty of Engineering and Technology** **Department of Information and Communication Technology**
Subject: Capstone Project (01CT0715)	**Project Definition and Scope - Intermediate Review**

Project Definition	**Date: 25/09/2025**	**Enrolment No: 92200133018**

Introduction

Magnetic Resonance Imaging (MRI) is one of the most widely used diagnostic imaging techniques in modern healthcare. It produces highly detailed images of soft tissues, such as the brain, spine, and organs, without the use of radiation. Each MRI scan generates hundreds of images, which radiologists carefully analyze. The findings are then documented in a detailed section of the report.





H·O·D
HOUSE of DIAGNOSTICS

Patient Name :	Arnav Gupta	**Lab No :**	KKD24075062
Age / Sex :	17 Y / M	**Registration On :**	13-Jul-24 12:32
Referred By :	Dr. VIKAS BHARDWAJ	**Patient ID :**	UKKD.0000014439
Centre :	HARGOVIND ENCLAVE		

3T MRI Lumbosacral Spine **Approved On: 13-Jul-24 17:48**

MRI LUMBOSACRAL SPINE

STUDY PROTOCOLS:

FLAIR T1W AND FAST SPIN ECHO T2W HIGH RESOLUTION SAGITTAL IMAGES OF LUMBOSACRAL SPINE WERE OBTAINED ON A DEDICATED PHASED ARRAY SURFACE SPINE COIL USING 3 TESLA TWIN GRADIENT SYSTEMS AND CORRELATED WITH T1W AND T2W AXIAL IMAGES.

Clinical History: Left lower limb pain

FINDINGS:

Lumbosacral transitional vertebra with sacralization of L5 vertebra is seen.

Curvature and alignment of lumbar spine are normal.

Lumbar vertebrae show normal in morphology and marrow signal.

Disc desiccation is seen at L4-5 level.

L4-5: Posterocentral protrusion causing restriction of the bilateral lateral recesses and pressure effect over the bilateral descending L5 nerve roots (left more than right) with moderate narrowing of central spinal without significant neural foraminae compromise.

L5-S1 disc is rudimentary.

Spinal canal diameter at various levels

L1-2: 16 mm, L2-3: 16 mm, L3-4: 14 mm, L4-5: 7 mm

Facet joints are normal. ALL & PLL appear smooth and continuous.

Visualized part of spinal cord and conus appear normal in signal intensity.

Pre and paravertebral spaces show no obvious collection or soft tissue.

Bilateral visualized SI joints appear normal.

IMPRESSION: MRI Lumbosacral spine reveals:

Lumbosacral transitional vertebra with sacralization of L5 vertebra

L4-5: Posterocentral protrusion causing restriction of the bilateral lateral recesses and pressure effect over the bilateral descending L5 nerve roots (left more than right) with moderate narrowing of central spinal without significant neural foraminae compromise

Suggested clinical correlation

Deepak Garg

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M.B.B.S., M.D. (Radio-Diagnosis)
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In case of any discrepancy due to typing error, kindly get it rectified immediately. This is professional opinion, not a diagnosis.

Scan to Validate

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Findings of mri scan

The most crucial part of an MRI report is the Impression – a concise, clinically relevant summary that highlights the key abnormalities and answers the referring physician's clinical question. Preparing impressions requires both expertise and time. However, radiologists today face increasing workloads, long reporting hours, and variability in reporting styles. These challenges open the door for AI- and NLP-based solutions that can assist radiologists by generating professional draft impressions, ensuring accuracy, speed, and consistency.

Problem Statement

Magnetic Resonance Imaging (MRI) is one of the most widely used diagnostic techniques in modern healthcare. After each scan, radiologists must prepare an **impression** — a concise summary of the key abnormalities and clinical relevance. However, this process comes with several challenges:

- **High Workload**: Radiologists are required to handle a large number of cases daily, which increases pressure and reduces time available for each report.
- **Complexity of Findings**: MRI reports are often lengthy and technical, making it difficult to summarize important details quickly.
- **Inconsistency**: Impressions can vary between radiologists, which sometimes causes miscommunication or delays in diagnosis.
- **Shortage of Radiologists**: In many countries, including India, there is a low ratio of radiologists to patients, adding to the reporting burden.

These challenges highlight the need for a **technological solution** that can assist radiologists in summarizing MRI findings more efficiently and consistently. With recent progress in **Artificial Intelligence (AI), Natural Language Processing (NLP), and Generative AI**, it is possible to build systems that automatically generate clinically accurate and professional impressions. Such a system can save time, reduce variability, and support radiologists in improving diagnostic outcomes.

Objectives

1. **Develop an AI-based tool** that can automatically generate MRI impressions from raw radiology findings using NLP and generative .
2. **Reduce the time required** for radiologists to draft impressions by at least **30%**, by providing an AI-generated draft impression that can be reviewed and finalized quickly.
3. **Ensure clinical accuracy and consistency** by integrating validation mechanisms (e.g., GPT refinement) to minimize errors and reduce variability in impressions across different reports.

4. **Evaluate the system's feasibility** by testing it with sample MRI reports, measuring accuracy against radiologist-prepared impressions, and ensuring ethical considerations such as data privacy and confidentiality are met.

5. **Deploy a prototype application** (web-based or desktop) with a user-friendly interface that allows uploading MRI reports, generating impressions, and exporting them, demonstrating practical applicability in healthcare environments.

6. **(Optional) we can also** scan reports and the findings as well as impressions both can be generated from the image .

Relevance to ICT Domain

The proposed project is highly relevant to the field of **Information and Communication Technology (ICT)** because this combines advanced techniques from **Artificial Intelligence, Natural Language Processing (NLP), and Generative-AI** to solve a real-world healthcare challenge.

ICT is increasingly shaping the future of healthcare by enabling automation, intelligent decision support, and efficient communication of medical data. Radiology, being highly data-intensive, is one of the areas of it. This project directly aligns with these advancements by:

- **Applying NLP techniques** (such as transformer-based models like BioBART) to process and understand unstructured medical text from MRI reports.
- **Leveraging Generative AI** to produce professional-quality impressions that can assist radiologists in faster decision-making.
- **Integrating software development and deployment tools** (e.g., Streamlit, cloud APIs, Python frameworks) to create a practical, user-friendly application.
- **Contributing to digital healthcare transformation**, where ICT systems reduce human workload, improve consistency, and enable scalable solutions.

The project contributes to ict such as:

- The adoption of **AI/ML in healthcare** for clinical decision support.

- Increasing reliance on **NLP systems** to process domain-specific knowledge (biomedical text, reports, and records).

This project demonstrates the role of ICT in bridging healthcare and technology. It highlights how ICT-driven innovations can enhance efficiency, reduce errors, and contribute to better patient outcomes.

Feasibility Analysis

1. Technical Feasibility

The project is technically feasible because it leverages well-established AI and ICT frameworks:

- **Model Availability**: Pre-trained biomedical NLP models such as **BioBART** and **BioBERT** are freely available through Hugging Face, ensuring reliable baselines.
- **Programming Environment**: The system can be implemented using **Python**, with support from libraries like **Transformers from (Hugging Face), PyTorch, ScispaCy, and Streamlit**.
- **Deployment Tools**: Platforms like **Streamlit, Flask, or FastAPI**, along with cloud services (Azure/GCP/AWS), can host the application for real-world use.
- **Hardware Support**: Training requires GPUs (Google Colab/T4, or local NVIDIA cards), but inference can be done efficiently on mid-level cloud servers, making it implementable within academic and research settings.

2. Economic Feasibility

The project is economically viable because it minimizes cost while maximizing value:

- **Free and Open-Source Tools**: Most of the software stack (Python, Hugging Face, Streamlit) is open-source.
- **MIT radiology gold standard dataset**: Is there with which we can fine tune our mimic data on biobart that is a encoder-decoder and llm helpful in summarization. Otherwise if this is not there one has to bring their own private dataset from the clinic , and the permission to share the data is a issue .

- **Low-Cost Deployment**: Its hosted for free on hugging face and training shall be done on (Colab, MIMIC 4 DATSET) can be used for training. Deployment can be done on cost-effective servers.For project we can get student azure version free where we can get the api as well , and to complete the data and specimen course as well to access mimic 4 data
- **Value Addition**: Automating MRI impression generation can reduce radiologist workload, saving hospitals time and costs in the long term.
- **Scalability**: Once deployed, the system can serve multiple hospitals or diagnostic centers with minimal additional cost.

Hence, the project is **cost-effective** and has a **favorable cost-benefit ratio**.

3. Ethical Feasibility

Since this project deals with healthcare data, ethical considerations are crucial:

- **Patient Privacy**: No personally identifiable data is used; only MRI report texts are processed, ensuring compliance with **HIPAA/GDPR-like standards**.
- **Bias Reduction**: Using domain-specific biomedical models reduces bias compared to general-purpose LLMs.
- **Human Oversight**: The system is designed as a **decision-support tool**, not a replacement for radiologists. Final interpretation always rests with a qualified doctor.
- **Transparency**: The generated impressions will be traceable to input data, ensuring accountability in medical contexts.

Thus, the project is **ethically sound** and aligns with global standards for AI in healthcare.

Market / User Needs Analysis

The primary users of this system are **radiologists, healthcare providers, and diagnostic centers** that generate and interpret MRI reports. Current practices show that radiologists spend significant time manually summarizing lengthy “Findings” sections into concise “Impressions,” which delays diagnosis and increases workload.

Key needs identified:

- **Efficiency**: Faster generation of impressions without sacrificing accuracy.
- **Consistency**: Standardized impressions to reduce variability between radiologists.
- **Decision Support**: An AI-generated draft that radiologists can validate instead of starting from scratch.
- **Scalability**: A solution that can be deployed across hospitals and diagnostic centers without heavy infrastructure.

Existing research in radiology report summarization focuses mostly on **general summarization models** (e.g., BERT, GPT) or rule-based systems. This approaches often lack **domain-specific knowledge** and fail to capture medical nuances.

- **Domain-Specific Model (BioBART)** →our model Can be Fine-tuned on biomedical data, unlike general LLMs, ensuring higher medical accuracy.
- **Hybrid Pipeline** → Combines BioBART (for technical correctness) with GPT refinement (for readability), which is not widely explored in prior literature.
- **ICT Contribution** → Provides a deployable prototype that integrates NLP, generative ai, deployement , use of LLMs and user-centered design, bridging AI with practical ICT applications in healthcare.

Supporting References

1. Yuan et al., *BioBART: Pretraining and evaluation of a biomedical generative language model*, *Bioinformatics*, 2022 – demonstrates BioBART's advantage for biomedical summarization.
2. Huang et al., *ClinicalBERT: Modeling clinical notes for improved clinical NLP*, *ACL*, 2019 – shows how domain-specific models outperform general NLP.

Conclusion

This project addresses the real-world challenge of manually preparing MRI impressions by radiologists. Using **AI, NLP, and Generative AI**, it aims to generate accurate, consistent, and efficient impressions. The objectives are **smart**, the scope aligns with ICT, and the solution meets market needs while considering ethical standards. Overall, it is a **feasible, innovative, and impactful solution** for improving radiology workflows.