A REPORT TO PROVIDE SOLUTIONS TO REDUCE THE RISK OF MISDIAGNOSIS OF CANCER AT KTU FARABI HOSPITAL

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Contents

- 1) Introduction
- 2) Problem Definition
- 3) Proposed Solutions
- 4) Criteria for Assessing Solutions
- 5) Research Methodology
- 6) Results And Analysis
- 7) Conclusion And Recommendations
- 8) References

1) Introduction

Approximately 10%-20% percent of all cancer cases are misdiagnosed or missed. Most mistakes are life threatening or life altering [1].

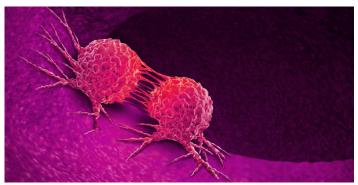


Figure 1: Rendition of 2 cancer cells Source: [2]

1) Introduction

5 year survival rates rapidly diminish as the state of detection increases [3].

Colorectal Cancer 1 year survival rate $97.7\% \rightarrow 43.9\%$ [3]

Lung Cancer 1 year survival rate $87.3\% \rightarrow 18.7\%$ [3]

1) Introduction

- Purpose: To investigate three solutions to reduce the risk of misdiagnosis of cancer at KTU Farabi hospital
- Impact: To reduce the rate of misdiagnosis and missed diagnosis of cancer by technical solutions
- Significance: To increase the lifespan of cancer patients and improve patients' health outcomes

2) Problem Definition

The problem is the misdiagnosis of cancer caused by the following root causes:

Doctors sometimes make mistakes and misdiagnose or miss cancers.

The imaging equipment might not produce a detailed enough image to diagnose certain cancers.

Patients might not visit hospitals for screening regularly

3) Proposed Solutions

- 3.1) Use more advanced imaging equipment
- 3.2) Implement AI software to double check every diagnosis
- 3.3) Implement an app to remind people to come back for regular screenings

3.1) Use More Advanced Imaging Equipment



Figure 2: Siemens Symphony 1.5T MRI machine Source: [5]



Figure 3: A 3T MRI machine Source: adapted from [4]

3.1) Use More Advanced Imaging Equipment



Figure 5: Two brain MRIs Source: [6]

3.2) Implement AI Software To Double Check Every Diagnosis

CNN's are successful at identifying cancers and AI methods are getting better everyday [7].

The AI software has to integrate with the old PACS (Picture Archiving and Communications System) system currently in use

3.3) Implement an app to remind people to come back for regular screenings

Sending reminders to patients might increase the percentage of patients who are getting screenings for cancer

4) Criteria for Assessing Solutions



✓ Feasibility

Adherence to Standards

4.1) Cost

- 1. Solution) The cost of the MRI machine was checked. Installation costs and employee training costs were calculated.
- 2. Solution) The cost of the servers required to run the Al software was calculated. The cost of implementing the software was analysed
- 3. Solution) The cost of implementing and running the app was examined

4.2) Feasibility

- 1. Solution) Whether the hospital can afford to buy or lease equipment was investigated. It might not be currently feasible to buy or lease imaging equipment.
- 2. Solution) The feasibility of integrating the AI software with the existing software infrastructure was checked.
- 3. Solution) The feasibility of implementing the app using patient data was checked. Patient data is private information and it might be illegal to implement targeted recommendations

4.3) Adherence to Standards

- 1. Solution) The room for the imaging equipment must adhere to standards. The room must be shielded with lead walls if the machine produces harmful radiation.
- 2 & 3 Solutions) The patients must consent to their data being used by the software. The software must use the data in accordance with Protecting Personal Data Act and Patient Data Privacy Act [9].

5) Research Methodology

Market Research

Expert Opinion

Literature Review

5.1) Market Research

Market research was conducted to approximate the cost of buying or leasing newer more advanced imaging equipment

Different AI cancer detection software providers were compared

Server hardware costs were investigated

5.2) Expert Opinion

Doctors' expert opinion were consulted for the model and brand of the new imaging equipment.

Department Chair's expert opinion was consulted for the budget for the new equipment.

University's IT department's opinion were consulted to investigate the feasibility of implementing the software.

5.3) Literature Review

Literature review was conducted to find the optimal specs for the new imaging equipment.

Literature review was conducted compare different DL architectures for the AI software.

Literature review was conducted to compare the effectivity of different nudging mechanisms for the mobile app.

6) Results and Analysis

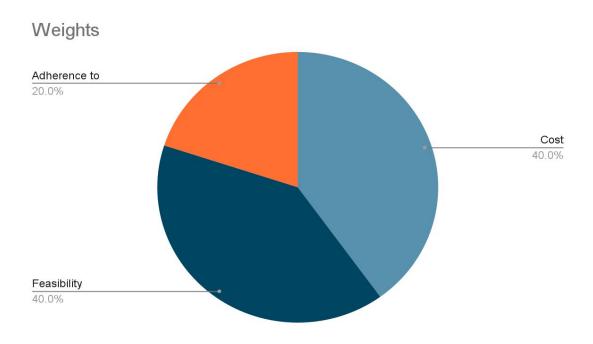


Fig. 6: Pie chart showing the weights of the criteria

6.1) Cost Analysis

The most recent MRI machine KTU bought cost them 6 million liras [10].

KTU radiology department chair stated that they do not have a budget specifically for improving diagnostic accuracy but the department can allocate 200,000₺ for the purposes of improving diagnostic accuracy [11].

Table 1: Cost Grading Scale

Grade	Solution Cost
	>200,000₺
\$	80,000₺-200,000₺
\$ \$	10,000₺-80,000₺
\$ \$ \$	2,000₺-10,000₺
\$ \$ \$	<2,000₺

6.1.1) Cost Analysis for Purchasing Better Imaging Equipment

 A new Siemens Magnetom Terra 7T MRI machine costs 6.5 million dollars (121 million liras), shipping and installation included [12].

TOTAL: 121 million liras (0 points)

6.1.2) Cost Analysis for Implementing Al Software

- \$0 for the AI model [13]
- Google Cloud Nvidia K80 server hourly price: \$0.45 [18]
- \$0.45 * 24 * 30 = \$324 per month for the server needed to host the software

TOTAL: \$324 (6,034₺) per month (2 points)

6.1.3) Cost Analysis for Implementing an App to Remind Patients for Screenings

- \$99 Apple App Store Fee (Yearly)
- \$25 Google App Store Fee (One-time only)
- Average Flutter developer hourly rate on Upwork.com: \$40/hour [14]
- Programming will take approximately 120 hours
- Implementing the cross platform mobile app using Flutter: \$40 * 120 = \$4800

TOTAL: \$4,924 (91,688₺) (0 points)

6.2) Feasibility Analysis

How upgradeable is the solution? (1 point)

How effective is the solution? (1 point)

How long can the solution be used effectively? (2 points)

6.2.1) Feasibility Analysis for Purchasing Better Imaging Equipment

- 1) How upgradeable is the solution?
 - → Not upgradeable at all. (0 points)
- 2) How effective is the solution?
 - → A better machine produces much sharpes images which increases diagnostic accuracy (1 point)
- 3) How long can the solution be used effectively?
 - → An MRI scanner has a life of 12.8 years on average [15, 16] (2 points)

6.2.2) Feasibility Analysis for Implementing Al Software

- 1) How upgradeable is the solution?
 - → Upgrading the software is easy and fast. (1 point)
- 2) How effective is the solution?
 - → The AI software currently available is about as good as the human radiologists* [17] (0.66 points)
- 3) How long can the solution be used effectively?
 - → There is no time limit, in fact it will get better with time (2 points)

It was found that there is an ongoing technical support agreement between Akgün and KTU for the PACS software. Therefore it would be feasible to integrate the AI software with the existing PACS system if this solution were to be implemented [10].

^{*}on some cancer types

6.2.3) Feasibility Analysis for Implementing an App to Remind Patients for Screenings

- 1) How upgradeable is the solution?
 - → Adding new features to the app is possible and not too hard (0.66 points)
- 2) How effective is the solution?
 - → Least effective of the three solutions [19] (0.33 point)
- 3) How long can the solution be used effectively?
 - → There is no time limit (2 points)

6.3) Adherence to Standards Analysis

How much effort will be required to comply with the law? (4 points)

6.3.1) Adherence to Standards Analysis for Purchasing Better Imaging Equipment

MRI machines do not produce dangerous levels of radiation.

The hospital only needs to make sure no metal objects are ever near the MRI machine. (4 points)

6.3.2) Adherence to Standards Analysis for Implementing AI Software

The patient has to give consent to make their MRI images available to be used as training data. The hospital can get that consent by making the patients sign a form. The consent forms must be stored securely for many years. (3 points)

6.3.3) Adherence to Standards Analysis for Implementing an App to Remind Patients About Their Screenings

After research it was found that most of the planned functionality for the app was illegal to implement. The app will only record the patient's next screening date to not have to deal with patient data regulations. (1 point)

7) Conclusions and Recommendations

Table 2: Overall solution grades

Solution	Cost	Feasibility	Adherence to Standards	Total
Purchasing better imaging equipment	<mark>0</mark> * 0.4 = 0	<mark>3</mark> * 0.4 = 1.2	<mark>4</mark> * 0.2 = 0.8	2
Implementing Al software	2 * 0.4 = 0.8	3.66 * 0.4 = 1.46	3 * 0.2 = 0.6	2.86
Implementing an app to remind patients about their screenings	<mark>1</mark> * 0.4 = 0.1	<mark>3</mark> * 0.4 = 1.2	1 * 0.2 = 0.2	1.5

7) Conclusions and Recommendations



Best solution: Implementing Al Software



Most cost-effective

Will get better with time

Very fast to implement the solution

Does not require much maintenance

7.1) Action Plan

- 1. Rent a server from GCP (Google Cloud Platform) to host the AI model
- 2. Integrate the AI software into the hospital's PACS (Picture Archiving and Communications System)
- 3. Activate the AI model for a small portion of the MRI images to test the accuracy and sensitivity of the AI model
- 4. Make the system available for all of the MRI images
- 5. Re-train the network every month with the new patient images to make it better.

Table 3: Action Plan

	w1	w2	w3	w4	w5	w6	w7
1							
2							
3							
4							
5							

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