

PROMETHEE ANALYSIS OF BREAST CANCER IMAGING DEVICES

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1. Introduction
2. Breast cancer imaging devices
3. Decision Making Theory
4. Determining the most desirable imaging devices for the
Breast cancer
5. Conclusions.



- **Breast cancer** is a malignant tumor that starts in the cells of the breast.
- Breast cancer is the **most common** leading cause of **cancer death** in females.
- By finding breast cancer at an **early stage**, women can **survive** and **receive less aggressive** treatments.

Breast Cancer Imaging Devices

- Screen Film Mammography
- Digital Mammography
- Digital Breast Tomosynthesis
- Ultrasound
- Magnetic Resonance Imaging
- Positron Emission Tomography
- Positron Emission Tomography – Computed Tomography
- Positron Emission Tomography – Magnetic Resonance Imaging
- Breast Computed Tomography
- Positron Emission Mammography
- Breast Specific Gamma Imaging
- Single Photon Emission Computed Tomography



Selected Parameters

- Cost of Per Scan
- Cost of Device
- Radiation Dose
- Specificity
- Sensitivity
- Total Scan Time
- Spatial Resolution
- Real 3D
- Compression
- Claustrophobia



Selected Parameters

- **Cost of Per Scan;**

for patients:

for hospitals:



\$

- **Cost of Device;**

Used Technology

X-ray Tube

Gamma Ray Detector

High Performance Magnets



\$

Selected Parameters

- **Radiation Dose;**

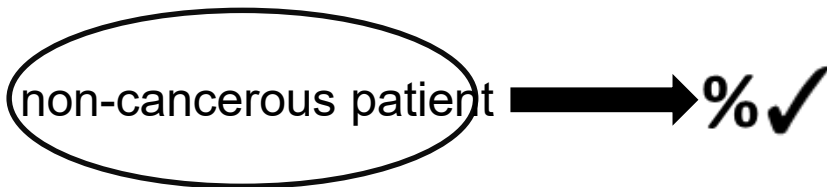
The applied radiation dose units in medical imaging are generally called as a millisieverts (mSv).



Selected Parameters

- **Specificity;**

true negative rate of the cancer



- **Sensitivity;**

true positive rate of the cancer



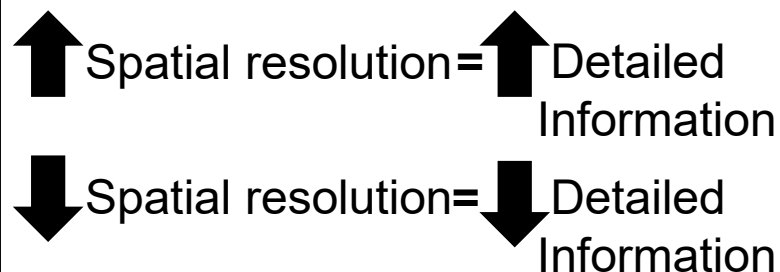
Selected Parameters

- **Total Scan Time;**

Total scan time is the time of spent in each breast cancer imaging operation.

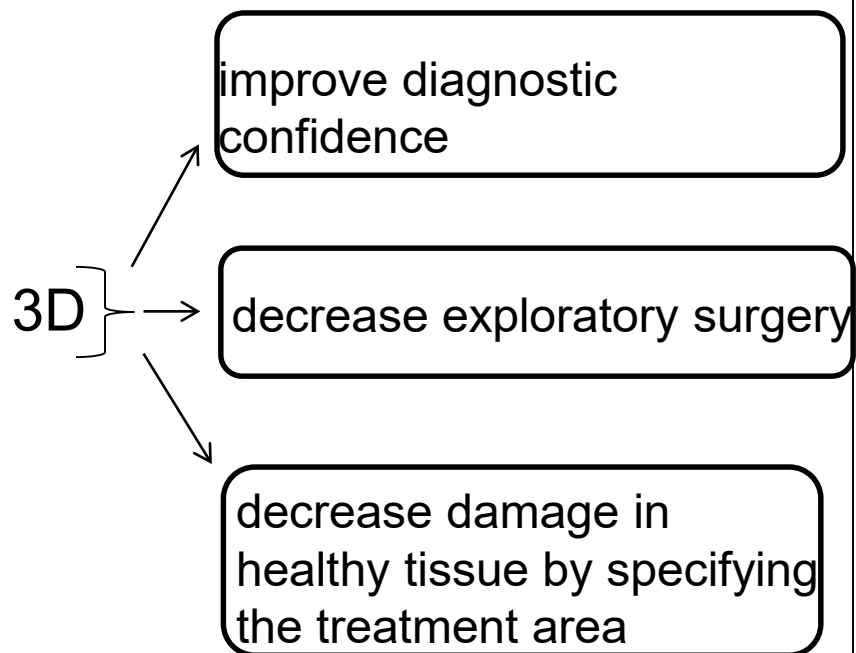
- **Spatial Resolution;**

Spatial resolution is to distinguish between two points source



Selected Parameters

- **Real 3D;**



- **Compression;**

Some of the breast cancers imaging devices are include compression unit to decrease the thickness of the breast.



Selected Parameters

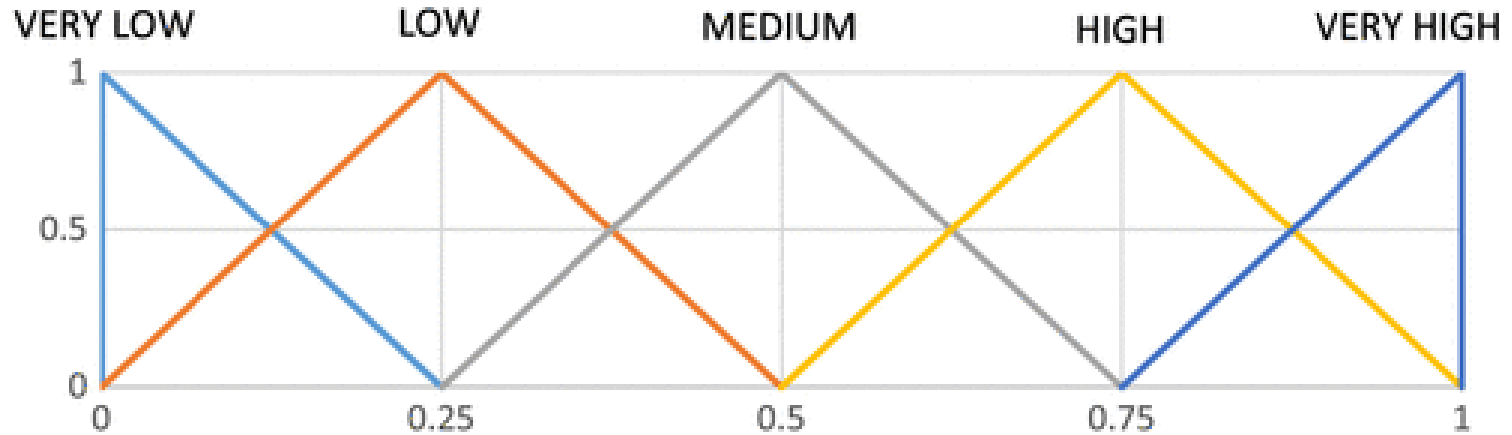
- **Claustrophobia;**
- Claustrophobia is one of the very common phobias in worldwide (15 to 37 percent of people) for both men and women.
- It is seen more likely to be claustrophobic in women than men.
- Claustrophobic devices are; MRI, PET, PET/CT, PET/MRI and SPECT



Data

Device / Parameter	SFM	DM	DBT	U/S	MRI	PET	PET/ CT	PET/MRI	BCT	PEM	BSGI	SPECT
Cost of Per Scan	\$45	\$155.76	\$215.94	\$155	\$2,611	\$4,500	\$5,000	\$3,500	\$1,500	\$1,100	\$450	\$3,950
Cost of Device	\$240,000	\$273,940	\$462,010	\$45,000	\$400,000	\$1,900,000	\$2,000,000	\$4,500,000	\$1,000,000	\$700,000	\$500,000	\$500,000
Radiation Dose (mSv: millisievert)	0.56 mSv	0.44 mSv	1.0 mSv	No Radiation	No Radiation	6.7 mSv	17.6 mSv	9.3 mSv	1.39 mSv	6.65 mSv	9.15 mSv	6 mSv
Specificity	%98.5	%96.9	%80.7	%88.5	%89.7	%85	%89	%71.4	%87	%96	% 59.5	%71
Sensitivity	% 66.1	%69.1	%92	%72.6	%82	%90	%95	%100	%91	%95	% 96.4	%87
Total Scan Time	5sec.	6 sec.	4 sec.	15 min.	30 min.	25 min.	30 min.	30 min.	10 sec.	5 min.	10 min.	30 min.
Spatial Resolution (lp/mm: line pairs per millimeter)	16 lp/mm	5.0 lp/mm	2.65 lp/mm	2.0 lp/mm	1.5 lp/mm	1.5 lp/mm	1.1 lp/mm	0.3 lp/mm	0.32 lp/mm	1.5 lp/mm	1.6 lp/mm	2.0 lp/mm
Comparison of Natural Radiation Exposure (3 mSv)	10 weeks	8 weeks	4 months	No Radiation	No Radiation	2.3 years	5.8 years	3.1 years	5.5 months	2.2 years	3 years	2 years
Real 3D	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
No Compression	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✓
Not Claustrophobic	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗

- ❑ Multi-criteria decision making technique based on mutual comparison of each alternative pair with regard to each of selected criteria.
- ❑ User friendly outranking method
- ❑ Been successfully implemented to the real life planning problems
- ❑ Requires only two types of information
- ❑ The information on the weights of the criteria considered
- ❑ The decision-maker's preference function when comparing the contribution of the alternatives in terms of each separate criterion



Linguistic Term	Triangular Fuzzy Number
Very Low	[0.0 0.0 0.25]
Low	[0.0 0.25 0.5]
Medium	[0.25 0.5 0.75]
High	[0.5 0.75 1.0]
Very High	[0.75 1.0 1.0]

<https://ascelibrary.org/doi/full/10.1061/%28ASCE%29CO.1943-7862.0001395>



Weight of the parameters for Patients

Linguistic scale for evaluation	Triangular fuzzy scale	Importance ratings of criteria
Very High (VH)	(0.75, 1, 1)	Specificity, Sensitivity, Spatial Resolution, Real3D
Important (H)	(0.50, 0.75, 1)	-
Medium (M)	(0.25, 0.50, 0.75)	Cost of Per Scan, Radiation Dose, Total Scan Time, No Compression, Claustrophobia
Low (L)	(0, 0.25, 0.50)	Comparison of Natural Radiation Exposure
Very Low (VL)	(0, 0, 0.25)	-

Weight of the parameters for Hospitals

Linguistic scale for evaluation	Triangular fuzzy scale	Importance ratings of criteria
Very High (VH)	(0.75, 1, 1)	Cost of Per Scan, Specificity, Sensitivity, Spatial Resolution, Real 3D
Important (H)	(0.50, 0.75, 1)	Cost of Device
Medium (M)	(0.25, 0.50, 0.75)	Radiation Dose, Total Scan Time
Low (L)	(0, 0.25, 0.50)	Comparison of Natural Radiation Exposure, No Compression, Claustrophobia
Very Low (VL)	(0, 0, 0.25)	-

Complete Ranking of Breast Cancer Imaging Devices for Patients

Complete Ranking	Devices	Positive Outranking Flow	Negative Outranking Flow	Net Flow
1	PEM	0.3400	0.1451	0.1949
2	BCT	0.3034	0.1641	0.1394
3	DBT	0.3078	0.1796	0.1283
4	DM	0.3293	0.2149	0.1145
5	U/S	0.2761	0.2131	0.0630
6	SFM	0.3317	0.2940	0.0377
7	MRI	0.2357	0.2477	-0.0120
8	BSGI	0.2239	0.3050	-0.0811
9	PET/MRI	0.2130	0.3151	-0.1021
10	PET	0.1865	0.2992	-0.1128
11	PET/CT	0.1775	0.3033	-0.1258
12	SPECT	0.1300	0.3739	-0.2438

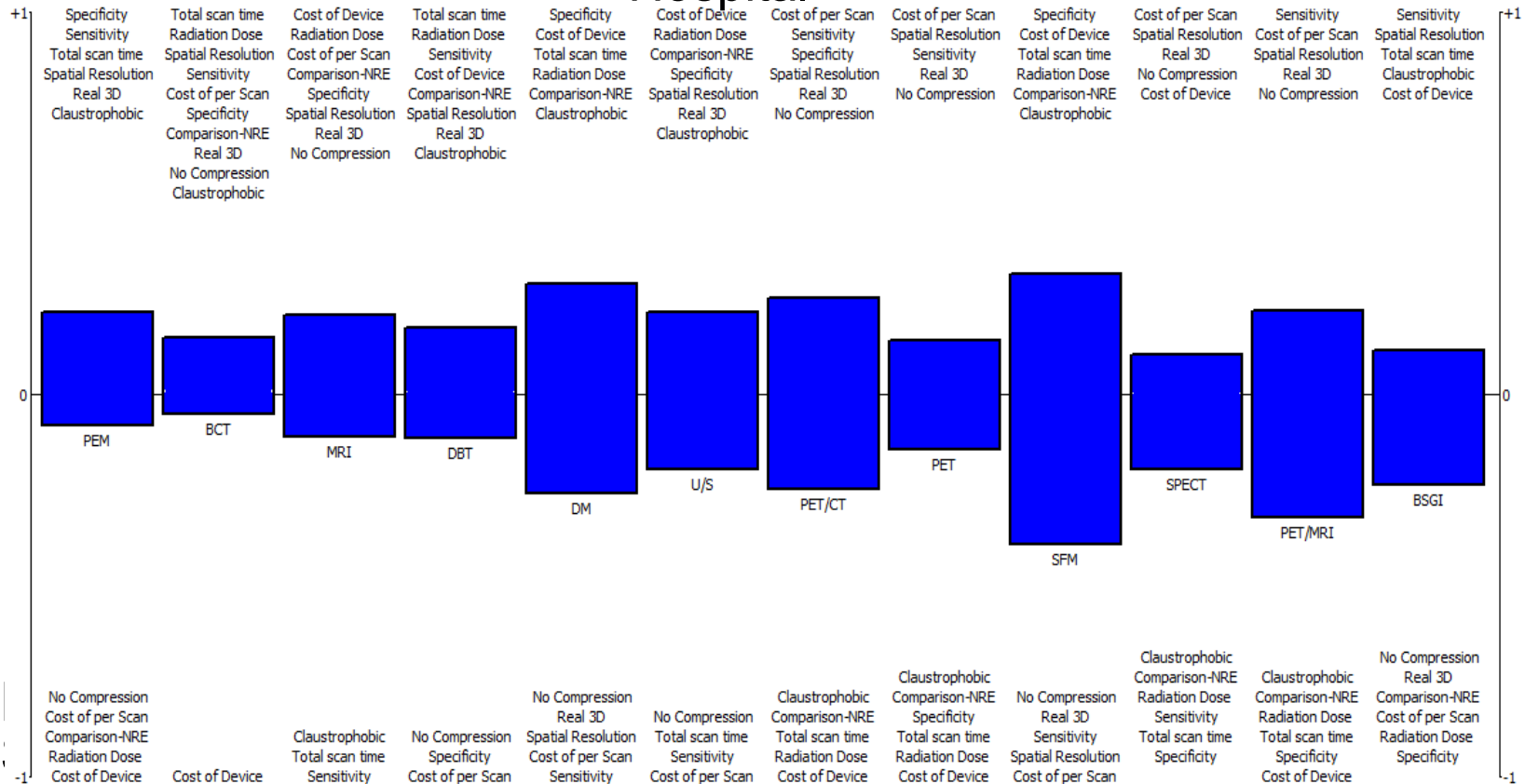


Complete Ranking of Breast Cancer Imaging Devices for Hospital

Complete Ranking	Devices	Positive Outranking Flow	Negative Outranking Flow	Net Flow
1	PEM	0.3660	0.2363	0.1297
2	BCT	0.3404	0.2459	0.0945
3	MRI	0.3461	0.2542	0.0919
4	DBT	0.3293	0.2750	0.0542
5	DM	0.3386	0.3120	0.0266
6	U/S	0.3087	0.2922	0.0165
7	PET/CT	0.2989	0.2991	-0.0002
8	PET	0.2985	0.3040	-0.0055
9	SFM	0.3252	0.4044	-0.0793
10	SPECT	0.2580	0.3513	-0.0934
11	PET/MRI	0.2669	0.3739	-0.1070
12	BSGI	0.2522	0.3800	-0.1278



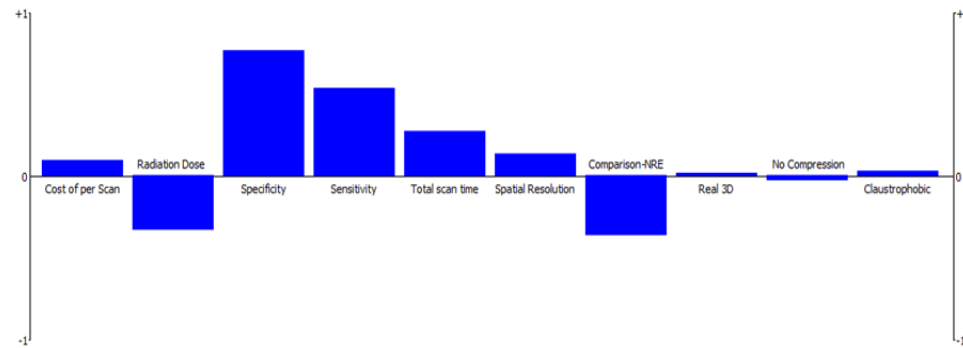
Strengths and Weaknesses of the Breast Cancer Imaging Devices for Hospital



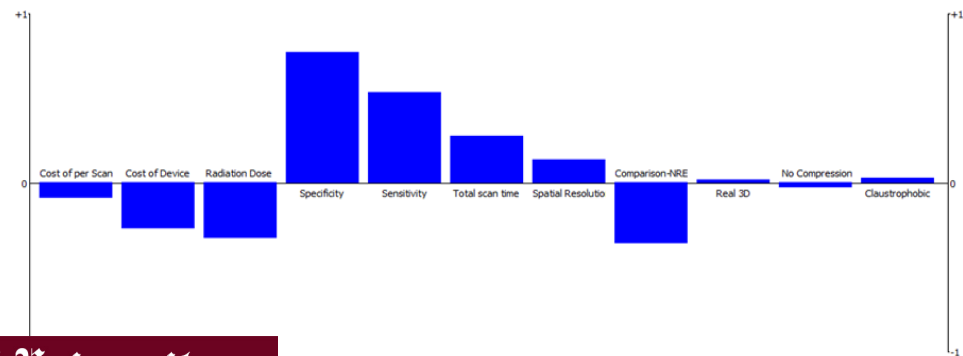
- The analysis of these study shows that Positron Emission Mammography (PEM) clearly outclassing other imaging devices of Breast Cancer for both patients and hospitals.



- Action Profile of PEM for Patients



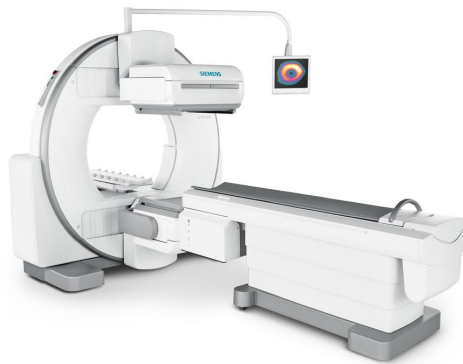
- Action Profile of PEM for Hospitals



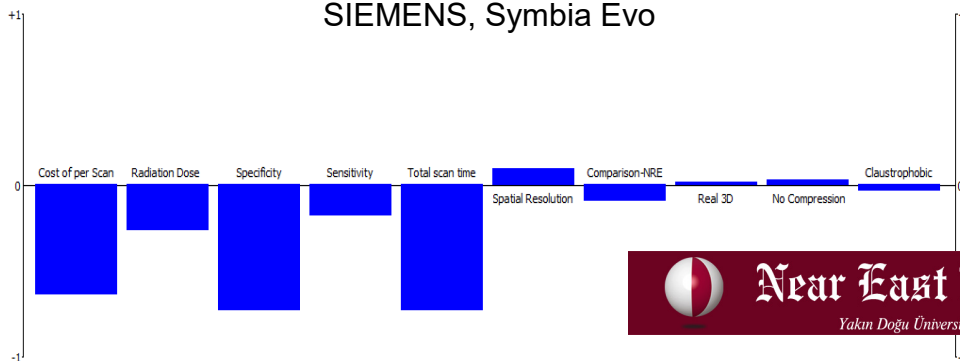
CMR Naviscan, EYMSA



- The last option for the patients; SPECT according to the selected criteria and their importance weights



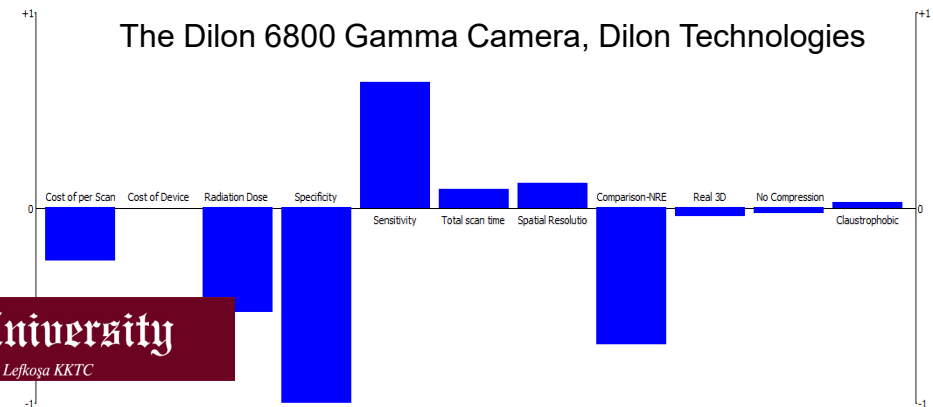
SIEMENS, Symbia Evo



- The last option for the hospitals; BSGI according to the selected criteria and their importance weights



The Dilon 6800 Gamma Camera, Dilon Technologies



**THANK YOU FOR YOUR
ATTENTION!!!**

