European Healthcare Design 2019 | Royal College of Physicians London

Models of Care

Comparative Evaluation of Ophthalmology Outpatient Clinic Design by Digital Simulation

Nirit Putievsky Pilosof

Faculty of Architecture and Town Planning, Technion - Israel Institute of Technology

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Research Team

Prof. Yehuda E. Kalay	Principal Investigator
Prof. Jacob Yahav, MD	Medical Consultant
DR. Efrat Eizenberg	Co-Investigator
Kartikeya Date	PhD candidate
Nirit Putievsky Pilosof	PhD candidate
Davide Schaumann	PhD candidate
Hadas Sopher	PhD candidate
Michal Gath Morad	MSc Student
Einat Zinger	MSc Student

Hospitals

Bnai Zion Medical Center, Haifa
Meir Medical Center, Kfar Saba
Rabin Medical Center, Petah Tikva
Rambam Health Care Campus, Haifa
Tel Aviv Sourasky Medical Center

Architecture Firms

Faten Kattouf Architects
Mochly-Eldar Architects
Ranni Ziss Architects
Sharon Architects
Spector Amisar Architects

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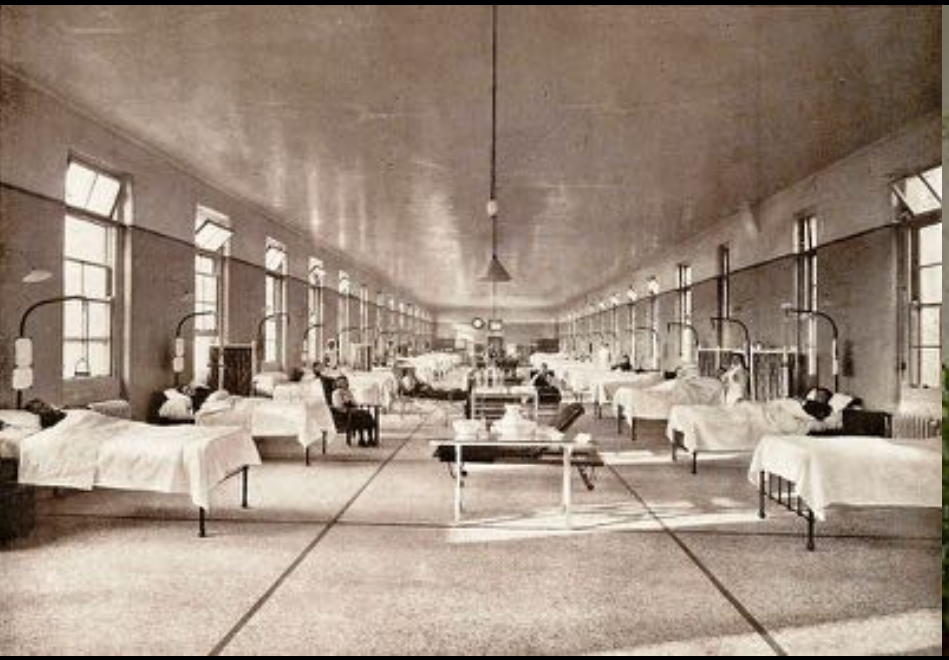
Surgical Amphitheater, 1890

De Vinci robotic Surgical System, 2010

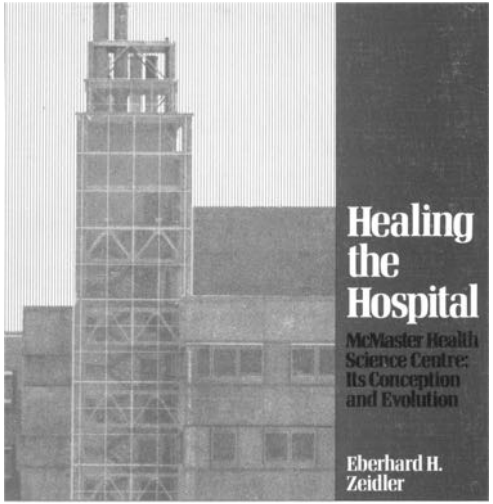


Nightingale Ward, 1940

Private patient room, 2014

Planning for Change: Hospital Design Theories in Practice

McMaster Health Sciences Centre, Hamilton, Ontario, Canada. Craig, Zeidler, and Strong Architects, 1972



Pilosof, N.P. (2005). Planning for Change: Hospital Design Theories in Practice.
The AIA Academy of Architecture for Health (AAH) Journal, No. 8, 13-20. Washington DC.

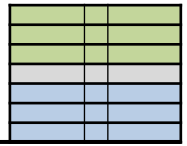
The Evolution of a Hospital Planned for Change

The Sammy Ofer Heart Building, Sourasky Tel Aviv Medical Center, Israel. Sharon Architects & Ranni Ziss Architects, 2012

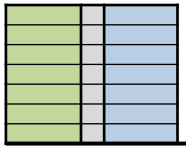
Pilosof, N. P. (2018). The evolution of a hospital planned for change. In S. H. Kendall (Ed.), Healthcare Architecture as Infrastructure (pp. 91–107). London and New York: Routledge.

Comparative Study of Hospital Design Strategies

Tel Aviv Sourasky Medical Center and Rambam Health Care Campus I Sharon Architects & Ranni Ziss Architects I Mochly Eldar Architects



Design for Flexibility



Design for Functionality

Pilosof, N. P. , Kalay Y.E. (2018). Open Building in Practice : Comparative Study of Hospital Design Strategies for future change. The Council on Open Building for Resilient Cities (pp. 199–206). LA, USA.

Egypt Divided / Qatar's Ambition / Rot in the ANC

TIME

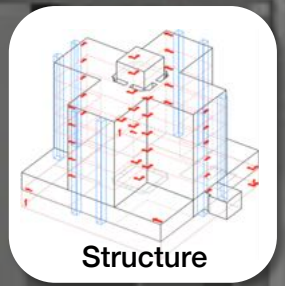
Want to Know My Future?

New genetic tests can point to risks—but not always a cure

BY BONNIE ROCHMAN

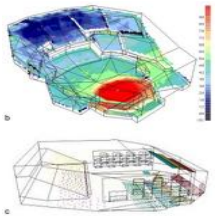

Interventional Unit Rooms 316 - 325


EXIT
EXIT

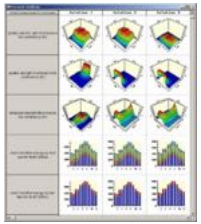


Structure

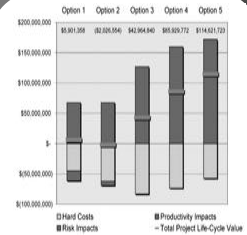
Energy



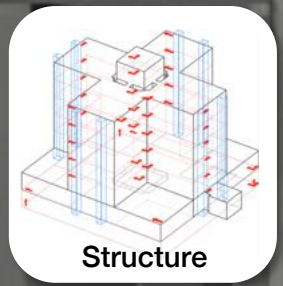
Acoustics



Light



Cost



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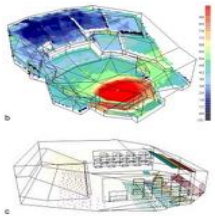
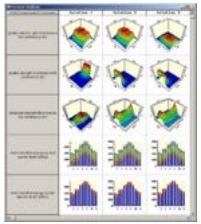
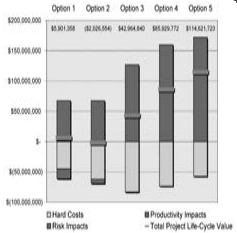


Acoustics

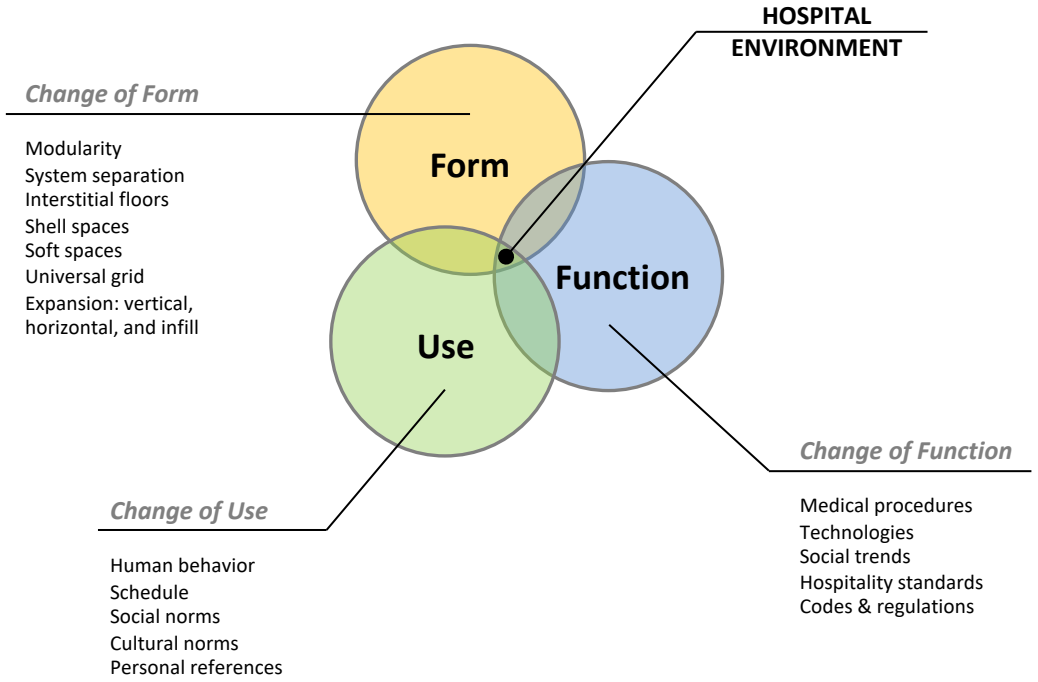


Light

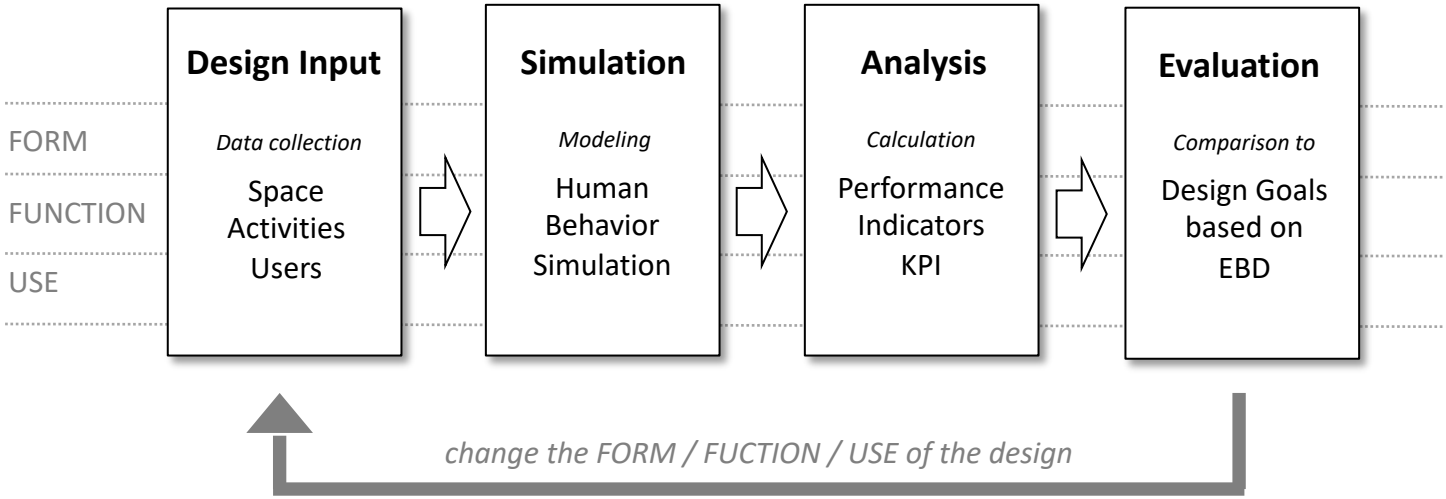


Cost

Predicting hospital design performance



Evaluation by Simulation



Evaluating Change

Design Options of Patient room Configuration in a Medical Unit

Nirit Putievsky Pilosof, Prof. Yehuda E. Kalay, Prof. Jacob Yahav
Faculty of Architecture and Town Planning, Technion Israel Institute of Technology

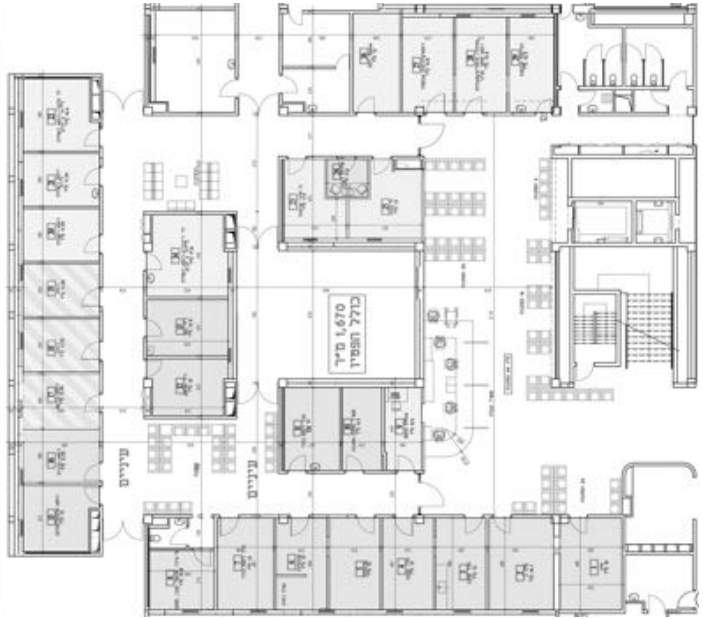
Evaluating Change

Evaluating Design Options of a Family-Centered Inpatient Unit

Nirit Putievsky Pilosof, Prof. Yehuda E. Kalay, Prof. Jacob Yahav
Faculty of Architecture and Town Planning, Technion Israel Institute of Technology

Comparative case study

Design A Rambam Health Care Campus, ophthalmology unit
Mochely-Eldar Architects, 2016



Design B Meir Medical Center, ophthalmology unit
Faten Kattouf Architects, 2016

Program analysis

Design A Rambam Health Care Campus, ophthalmology unit

Design B Meir Medical Center, ophthalmology unit

Program (sq.m. %)	Waiting		Administration		Circulation		Service		Clinical		TOTAL	
Design A	223	18.2%	62	5%	276	22.5%	90	7.3%	577	47%	1228	100%
Design B	272	31.6%	73	8.5%	133	15.5%	39	4.5%	343	39.9%	860	100%

Comparative case study

Centralized waiting area

Design A Rambam Health Care Campus, ophthalmology unit

De-centralized waiting area

Design B Meir Medical Center, ophthalmology unit

Comparative case study

Centralized nurse station

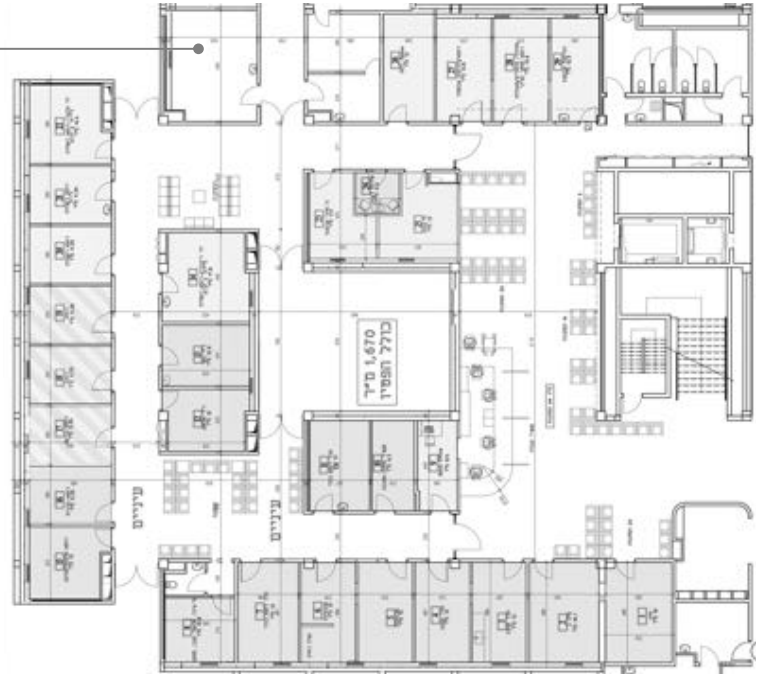
Design A Rambam Health Care Campus, ophthalmology unit

De-centralized nurse stations

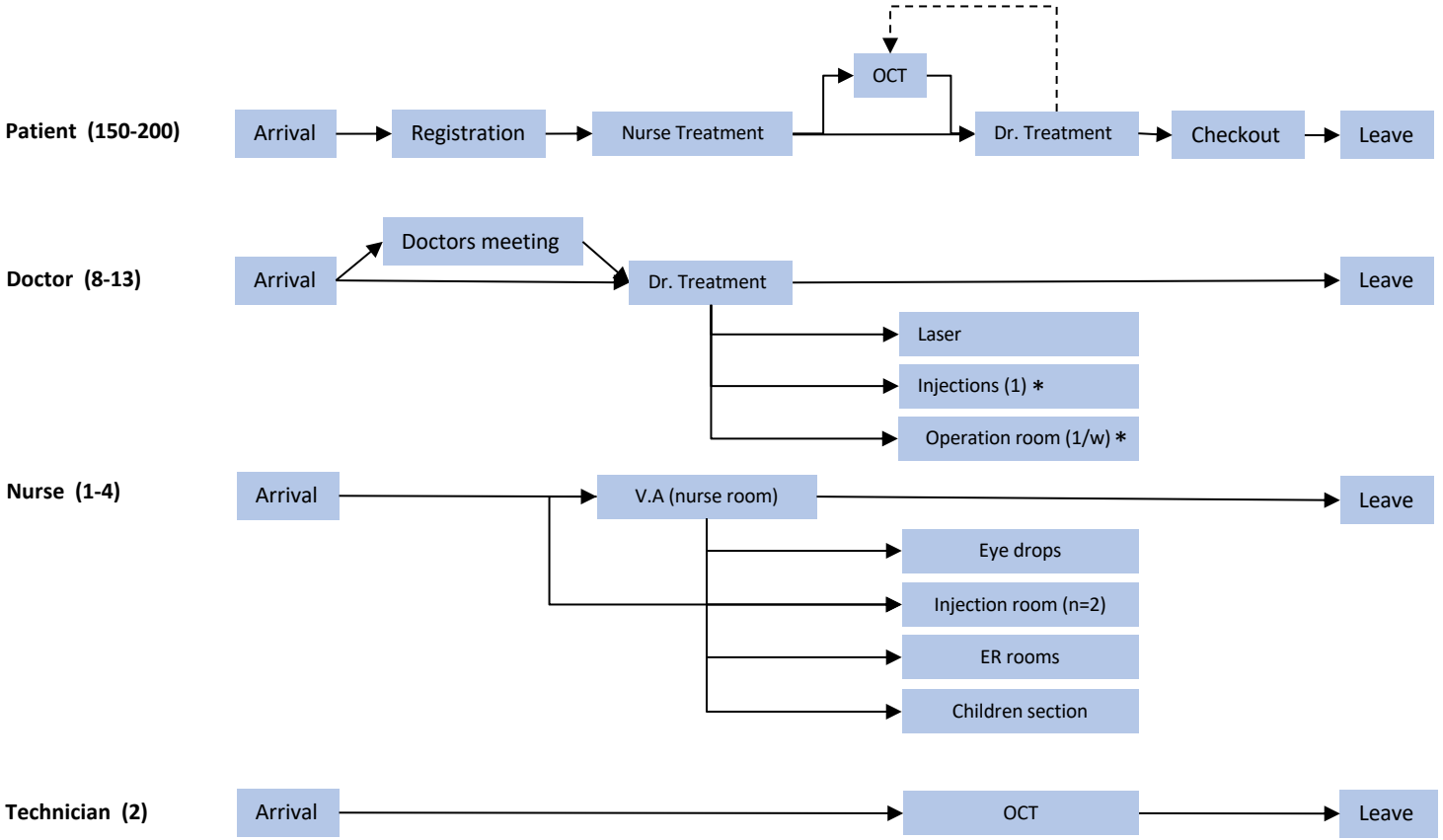
Design B Meir Medical Center, ophthalmology unit

Simulation input

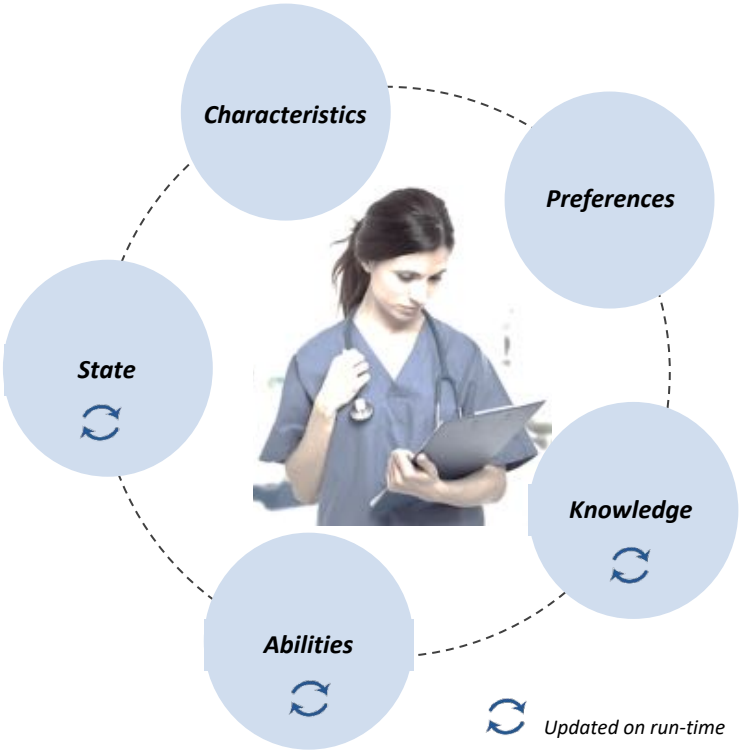
FORM	Architectural layout and Activity Zones modeling Program & area calculation	
FUNCTION	Talking with secretary duration	2.5 min
	Visual Acuity duration	7 min
	Eye dilation duration	30 min
	Patient check duration	20 min
	Social interactions between staff and patient duration	30 sec
	Work interaction between doctor and nurse duration	2 min
USE	Number of patients	150
	Number of doctors	10
	Number of nurses	2
	Number of secretaries	2
	Number of companions per patient	1



Operational data



Users data



Actor N.02 Profile

Characteristics

Role: Nurse
Gender: F
Age group: adult

Abilities

Skills: experienced
Walkability: 5
Leading: Y **Helping**: Y

Knowledge

Group.005 (N. 01,N.03)

Preferences

	Low	High
Density	•	•
Noise	•	•
ER patients	•	•
Assist staff	•	•
Go to corridor	•	•

Actor N.02 Status

10:50 AM

Activity: Treat patient

Target space: Corridor

Used space: Room #011

Walking Distance: 2300 m

Density perceived: 8.5

Noise perceived: 80dB

Needs

Fatigue

Hunger

WC

Behavior Patterns

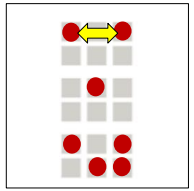
wandering

Standing in queue

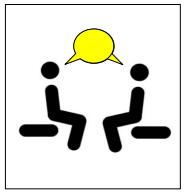
set a new target

individual behavior

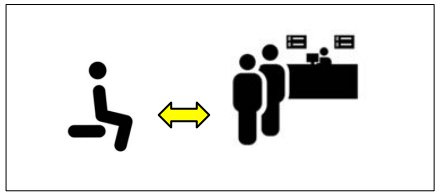
group behavior



sitting preferences



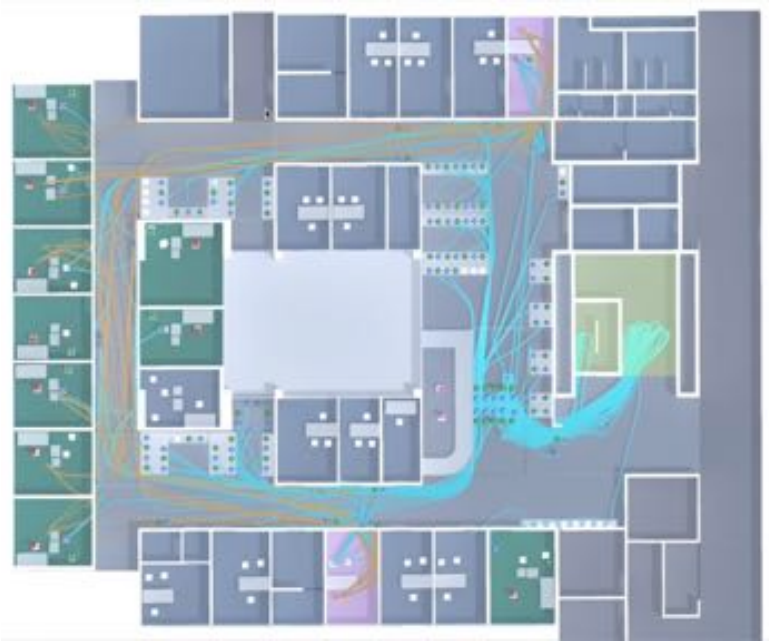
social interaction



sitting next to queue

Simulating use

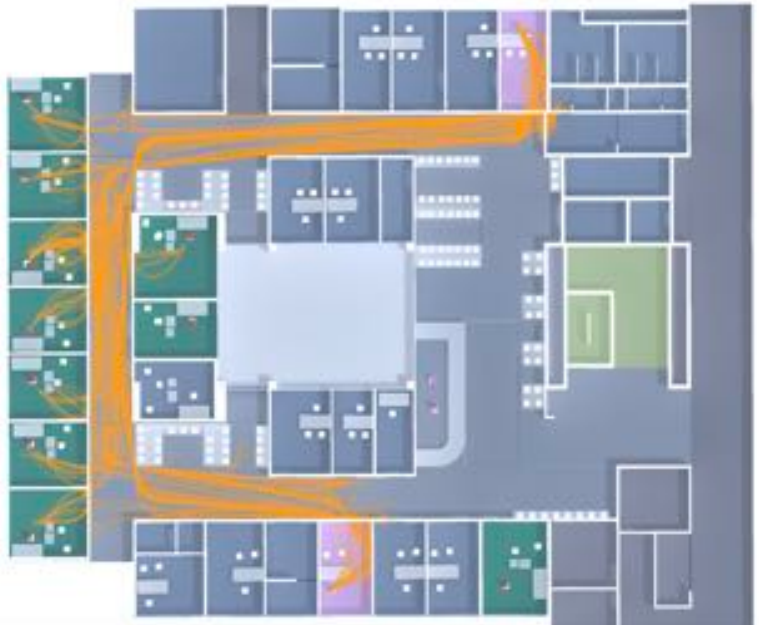
Design A Rambam Health Care Campus, ophthalmology unit



Design B Meir Medical Center, ophthalmology unit

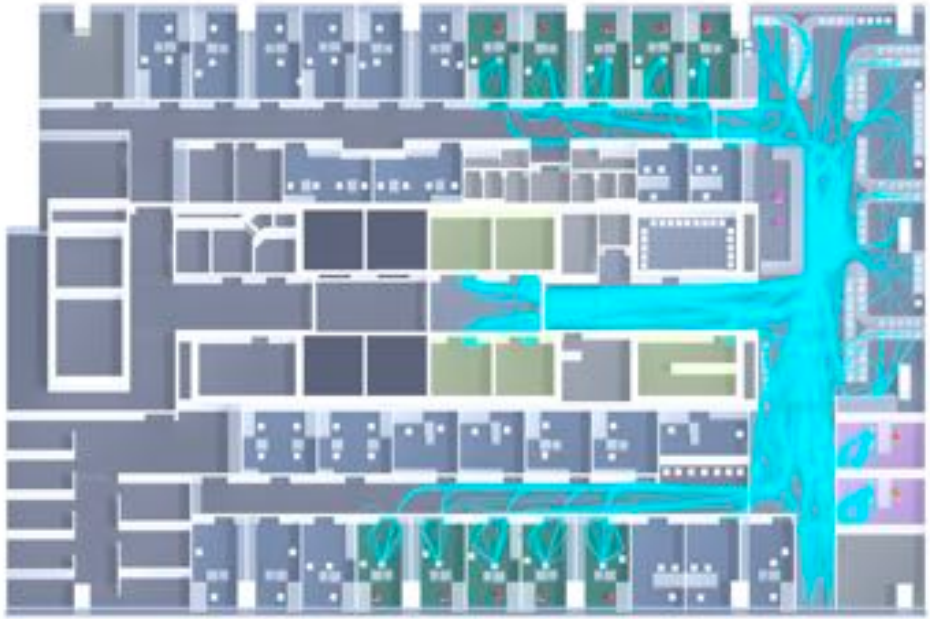
Travel paths – nurses

Design A Rambam Health Care Campus, ophthalmology unit



Design B Meir Medical Center, ophthalmology unit

Travel paths – patients

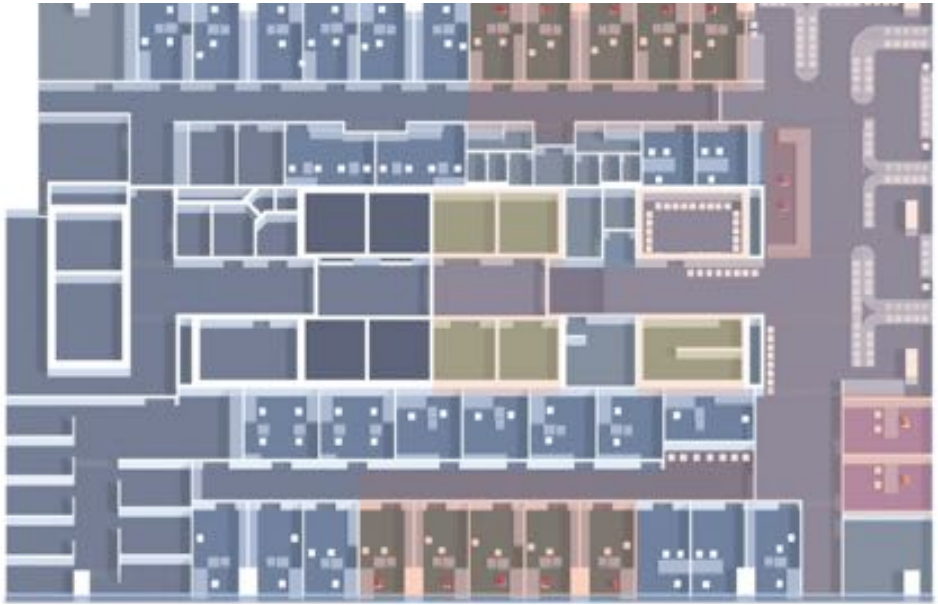


Design A Rambam Health Care Campus, ophthalmology unit

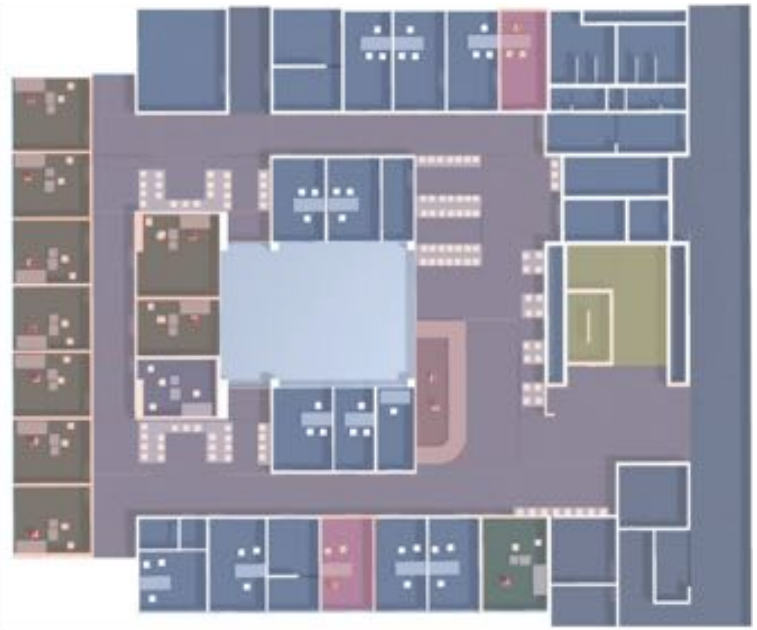
Design B Meir Medical Center, ophthalmology unit

Density

7:00

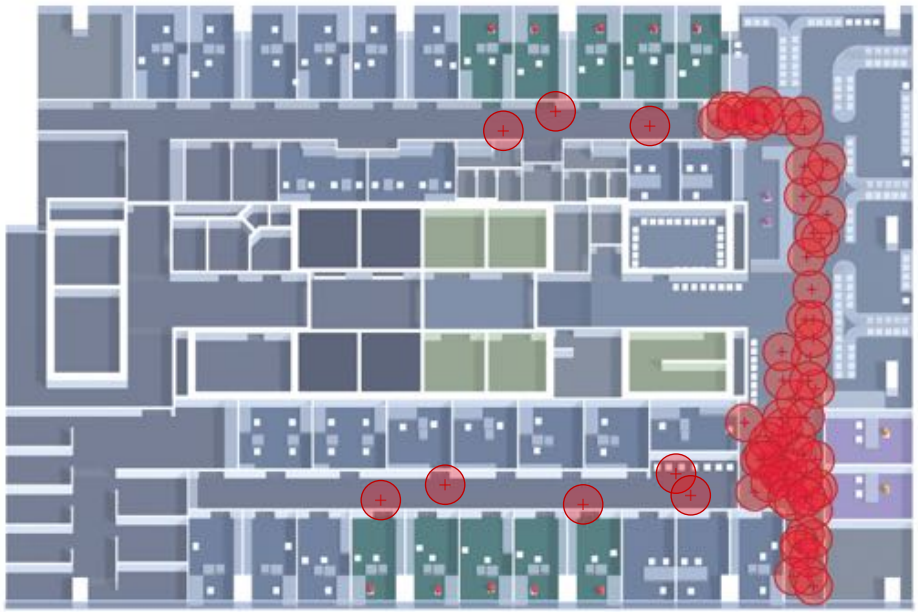


Design A Rambam Health Care Campus, ophthalmology unit

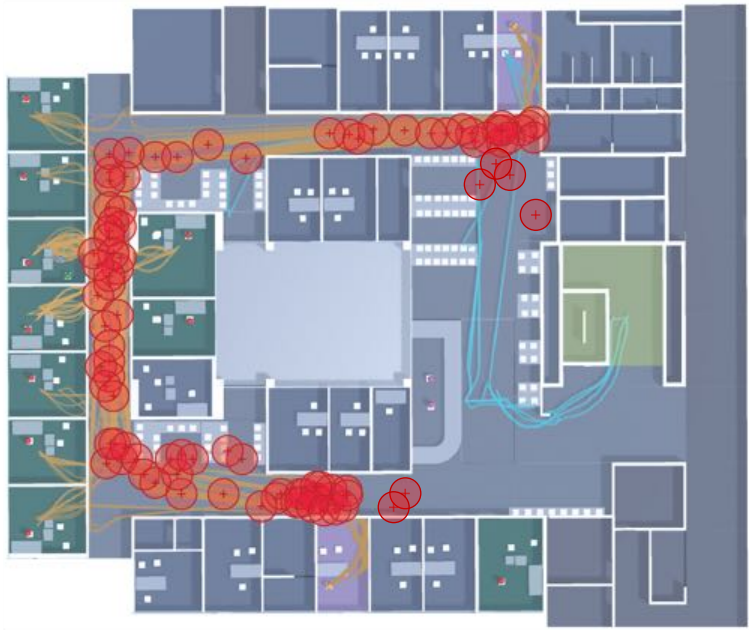


Design B Meir Medical Center, ophthalmology unit

Social interactions



Design A Rambam Health Care Campus, ophthalmology unit

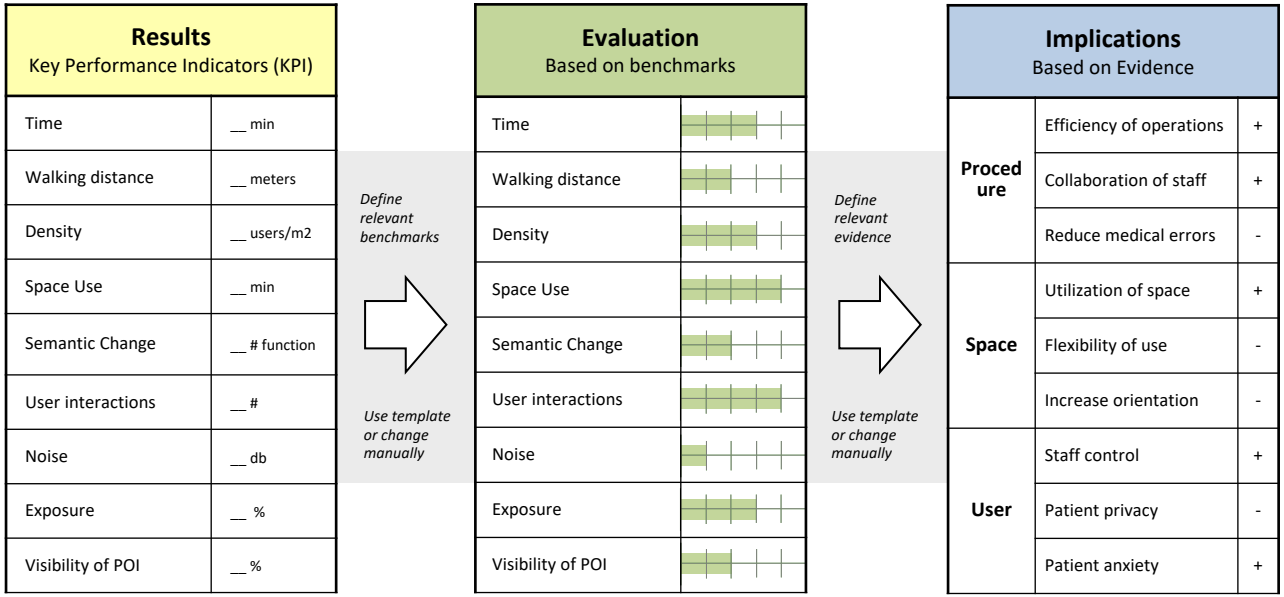


Design B Meir Medical Center, ophthalmology unit

Simulation results

Key Performance Indicators (KPI)		Design A	Design B
Nurses Walking Distance	Max	2,620 m	3,069 m
	Average	2,399 m	2,548 m
Patients Walking Distance	Max	568 m	197 m
	Average	146 m	117 m
Patients' Length of Stay	Max	4h 11 min	4h 34 min
	Average	3h 00 min	3h 26 min
Overall patients throughput	Max	9h 05 min	9h 39 min
Staff-patient social interactions	Max	112	119

Evaluation process



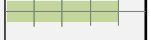
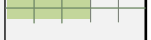
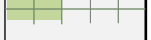
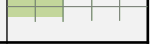
SIMULATION RESULTS

KPI	Description	Result	
Time	Duration from activation till completion (*patient* max)	04:11	hours
Walking distance	Meters walked during permanence in ward (*nurse* max)	2620	meters
Density	Number of users per square meter calculated by zones (waiting area max)	4.2	users/m2
Space Use	Duration of activities per zone (mean)	3:25	hours
Semantic Change	Number of activities change per zone during clinic work (mean)	2	# function
User interactions	Number of unplanned interactions between users during clinic work	112	#
Noise	Level of noise in decibel an actor is exposed to (mean in waiting area)	70	db
Exposure	Percentage of time a user is in a public zone (max)	88	%
Visibility of POI	Percentage of time a user is in a zone visible of his point of interest (mean)	35	%
Travel Paths	Number of circulation lines per user per zone (max)	9	#

Define benchmarks for evaluation based on:

- *organization goals*
- *organization policy and culture*
- *norms and regulation*
- *professional guidelines*
- *evidence based design (EBD)*

EVALUATION of KPI

Benchmark		Reference		Score	
03:00	hours	Hospital goal for ophthalmology units	-	0.72	
1500	meters	Nurse union guidelines	-	0.57	
1.5	users/m2	Environmental psychology standards	-	0.36	
9:00	hours	Hospital goal to maximize use of resources	+	0.38	
3	# function	Design program for multi-use rooms	+	0.66	
20	#	Organization policy and culture	-	0.18	
60	db	Acoustic recommendation for ambulatory units	-	0.86	
50	%	Ethnographic research	-	0.57	
90	%	Research on users orientation and circulation	+	0.38	
4	#	Guidelines for ophthalmology procedures	-	0.45	

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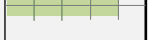
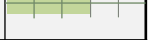
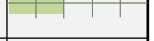
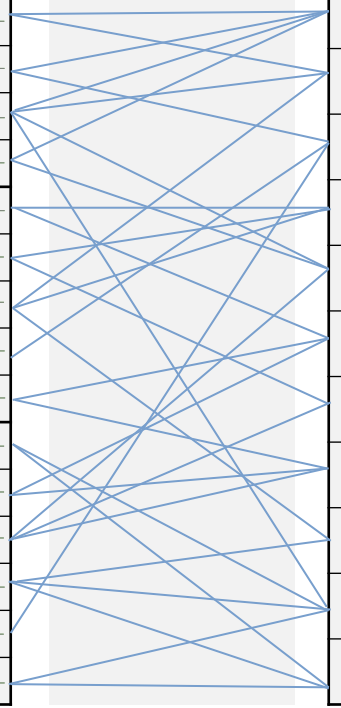
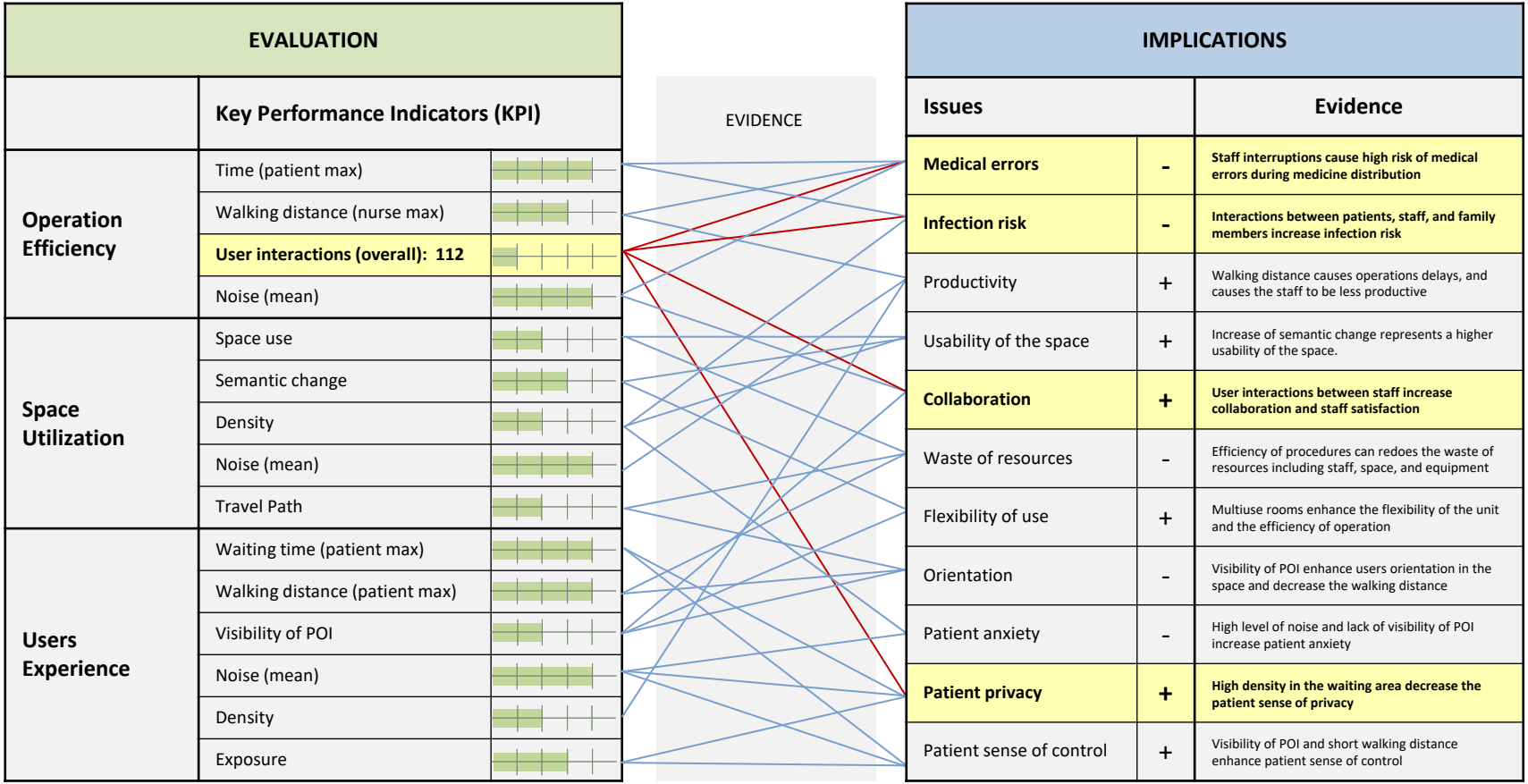
60	db	Acoustic recommendation for ambulatory units	-	0.86	
50	%	Ethnographic research	-	0.57	
90	%	Research on users orientation and circulation	+	0.38	
4	#	Guidelines for ophthalmology procedures	-	0.45	

EVALUATION		
	Key Performance Indicators (KPI)	
Operation Efficiency	Time (patient max)	
	Walking distance (nurse max)	
	User interactions (overall)	
	Noise (mean)	
Space Utilization	Space use	
	Semantic change	
	Density	
	Noise (mean)	
	Travel Path	
Users Experience	Waiting time (patient max)	
	Walking distance (patient max)	
	Visibility of POI	
	Noise (mean)	
	Density	
	Exposure	

EVIDENCE



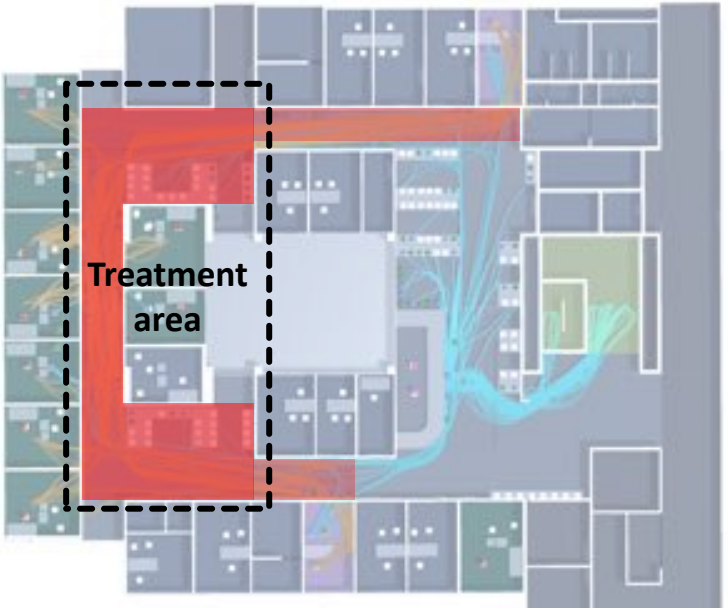
IMPLICATIONS		
Issues		**Evidence**
Medical errors	-	Staff interruptions cause high risk of medical errors during medicine distribution
Infection risk	-	Interactions between patients, staff, and family members increase infection risk
Productivity	+	Walking distance causes operations delays, and causes the staff to be less productive
Usability of the space	+	Increase of semantic change represents a higher usability of the space.
Collaboration	+	User interactions between staff increase collaboration and staff satisfaction
Waste of resources	-	Efficiency of procedures can redoes the waste of resources including staff, space, and equipment
Flexibility of use	+	Multiuse rooms enhance the flexibility of the unit and the efficiency of operation
Orientation	-	Visibility of POI enhance users orientation in the space and decrease the walking distance
Patient anxiety	-	High level of noise and lack of visibility of POI increase patient anxiety
Patient privacy	+	High density in the waiting area decrease the patient sense of privacy
Patient sense of control	+	Visibility of POI and short walking distance enhance patient sense of control


EVALUATION
Key Performance Indicators (KPI)
Operation Efficiency
Time (patient max)
Walking distance (nurse max)
User interactions (overall): 112
Noise (mean)
Space Utilization
Space use
Semantic change
Density
Noise (mean)
Travel Path
Users Experience
Waiting time (patient max)
Walking distance (patient max)
Visibility of POI
Noise (mean)
Density
Exposure
EVIDENCE
IMPLICATIONS
Issues
Evidence
Medical errors
-
Staff interruptions cause high risk of medical errors during medicine distribution
Infection risk
-
Interactions between patients, staff, and family members increase infection risk
Productivity
+
Walking distance causes operations delays, and causes the staff to be less productive
Usability of the space
+
Increase of semantic change represents a higher usability of the space.
Collaboration
+
User interactions between staff increase collaboration and staff satisfaction
Waste of resources
-
Efficiency of procedures can redoes the waste of resources including staff, space, and equipment
Flexibility of use
+
Multiuse rooms enhance the flexibility of the unit and the efficiency of operation
Orientation
-
Visibility of POI enhance users orientation in the space and decrease the walking distance
Patient anxiety
-
High level of noise and lack of visibility of POI increase patient anxiety
Patient privacy
+
High density in the waiting area decrease the patient sense of privacy
Patient sense of control
+
Visibility of POI and short walking distance enhance patient sense of control

Evaluation of Design Goals		Design A		Design B	
Operation Efficiency	Doctors efficiency	↑	Doctors work in the treatment area have low exposure, less noise, fewer users interactions that can cause interruptions and errors.	↓	Doctors work in the treatment area have high exposure, more noise and users interactions that can cause interruptions and errors.
	Nurse efficiency	↓	Nurse work near the central waiting area with high exposure, density, noise, and social interactions, and longer walking distance.	↑	Nurse work near distributed waiting area with less exposure, lower density, noise, and social interactions, and shorter walking distance.
	Staff collaboration	↓	Nurses and doctors are located in separate areas. Walking distances are longer with low visibility and exposure.	↑	Nurses and doctors are located in the same area. Walking distances are shorter with higher visibility and exposure.
Space Utilization	Waiting area utilization	↑	Higher density in the central waiting area, more space use, more social interactions, more semantic change.	↓	Lower density in the main waiting area, less space use, less social interactions, less semantic change.
	Treatment area utilization	↓	Lower visibility of point of interest, less travel paths for circulation, less semantic change and space use.	↑	Higher visibility of point of interest, more travel paths for better circulation, more semantic change and space use.
	Spatial orientation	↓	Lower visibility of point of interest, higher density, more travel paths, longer patient walking distance.	↑	Higher visibility of point of interest, lower density, clear travel paths, shorter patient walking distance.
User Experience	Patients sense of control	↓	In waiting area lower visibility of point of interest, higher density, more noise, more travel paths, longer patient walking distance.	↑	In waiting area higher visibility of point of interest, lower density, less noise, clear travel paths, shorter patient walking distance.
	Patients sense of privacy	↑	In treatment area lower exposure, less noise, less density, less social interactions, shorter waiting time and LOS.	↓	In treatment area more exposure, more noise, higher density, more social interactions, longer waiting time and LOS.
	Nurse sense of control	↓	In waiting area lower visibility of point of interest, more noise, higher density, longer nurse walking distance.	↑	In treatment area higher visibility of point of interest, less noise, less density, shorter nurse walking distance.

Design A Rambam Health Care Campus, ophthalmology unit

Design B Meir Medical Center, ophthalmology unit



Bottleneck in the waiting area might cause:

- Reduction in the **nurses** efficiency
- Reduction in the staff & patients sense of **control**
- Reduction in the utilization of the **treatment** area
- Reduction in the satisfaction of the **patients**

Bottleneck in the Treatment area might cause:

- Reduction in the **doctors** efficiency
- Reduction in the staff & patients sense of **privacy**
- Reduction in the utilization of the **waiting** area
- Reduction in the satisfaction of the **staff**

Conclusions

Evaluation by simulation

represents the dynamic changing use of the hospital.

The system can be used to:

- Evaluate the design goals.
- Compare alternative designs.
- Demonstrate future use scenarios.

The system illustrates the outcome of the design:

- Operations efficiency
- Space utilization
- Users’ experience

The system supports:

- Optimization of the design.
- Communication in co-design processes.
- Development of smart real-time operations.


Thank you