

Reallocating Operating Room Time Among Surgical Services

Luísa Lubomirska, Inês Marques

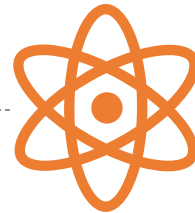
Starting Point



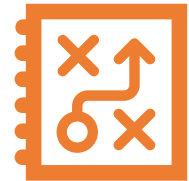
General Problem



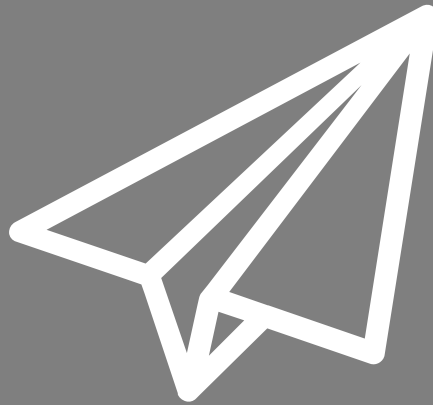
Existing Solutions
Vs
Approach



Results



Starting Point



1. Starting Point



Central Hospital of Évora



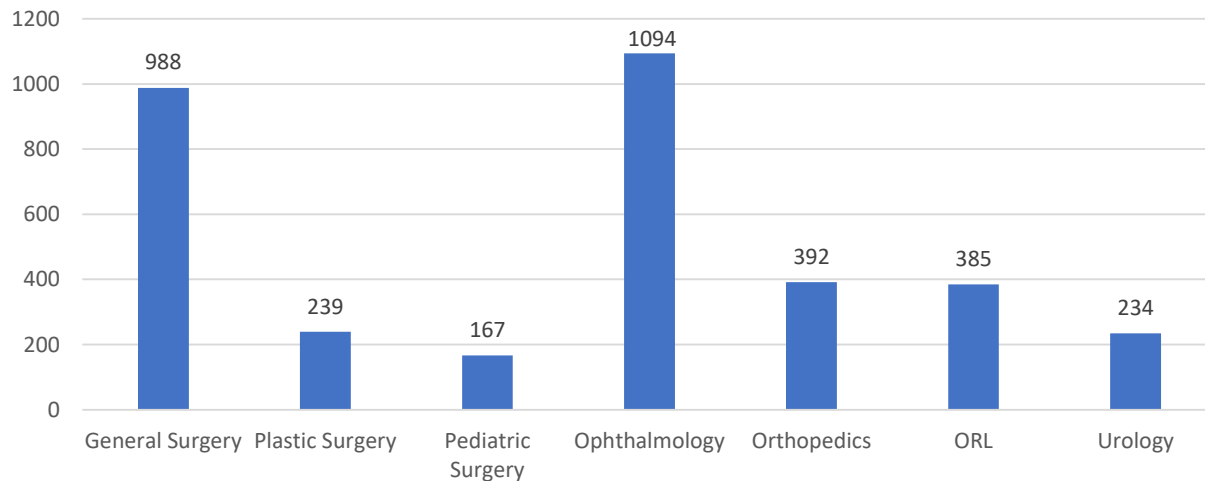
- Major public hospital of the region
- Serves 325.237 people
- 6 operating rooms
- 8900 surgeries 2016



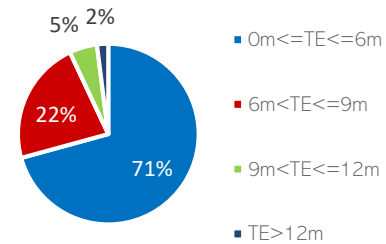
1. Starting Point



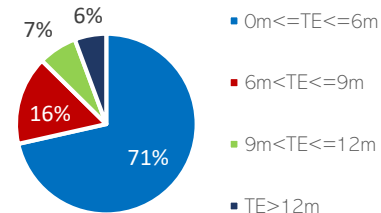
Number of patients waiting by surgical specialty
(December 2017)



General Surgery



Ophthalmology



1. Starting Point



Improve the number of
patients operated per year

To balance the waiting list
among the specialties

General Problem

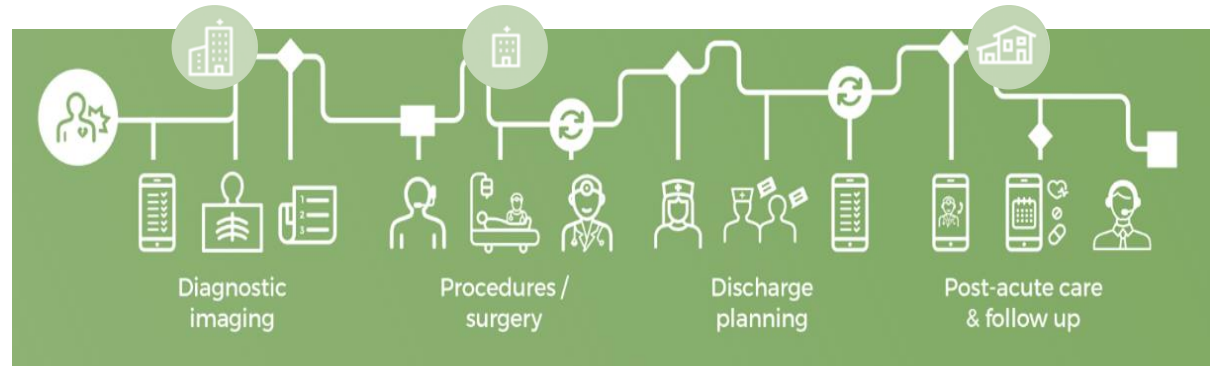


2. General Problem



Health Management

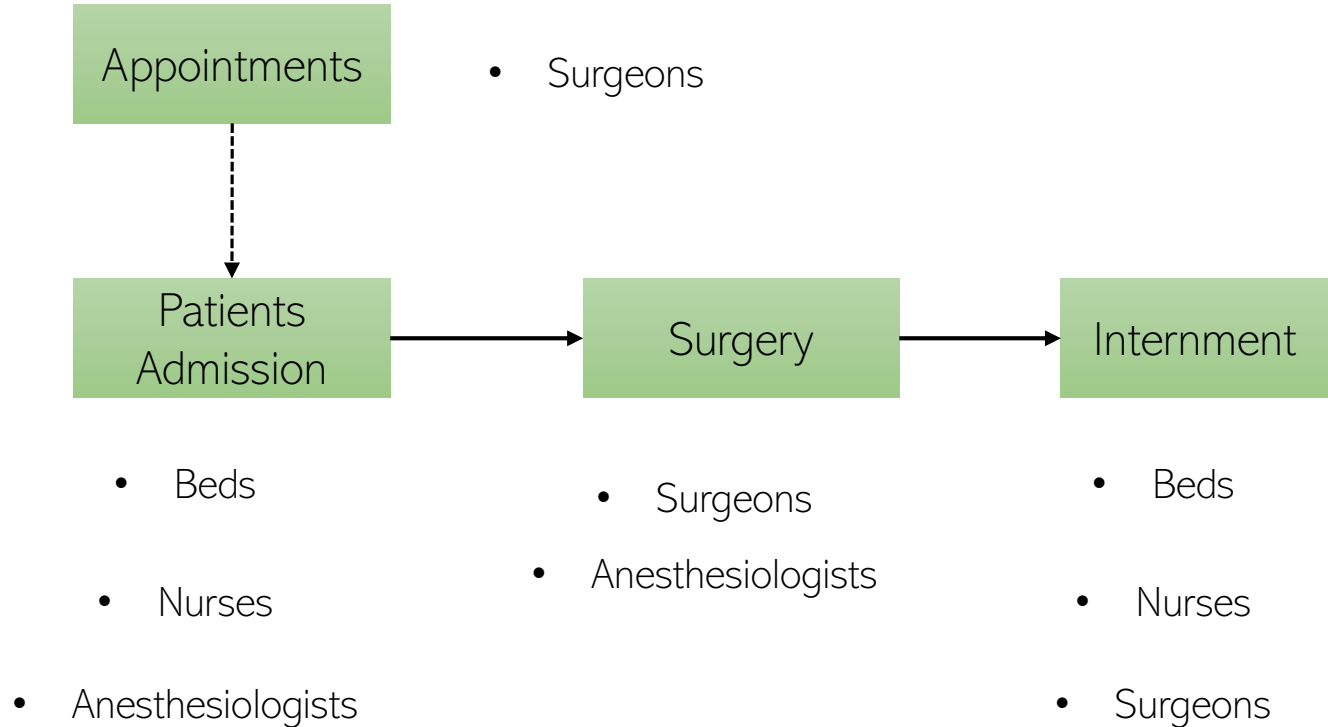
- Increasing demand
- High costs
- Big social impact



2. General Problem



Surgery

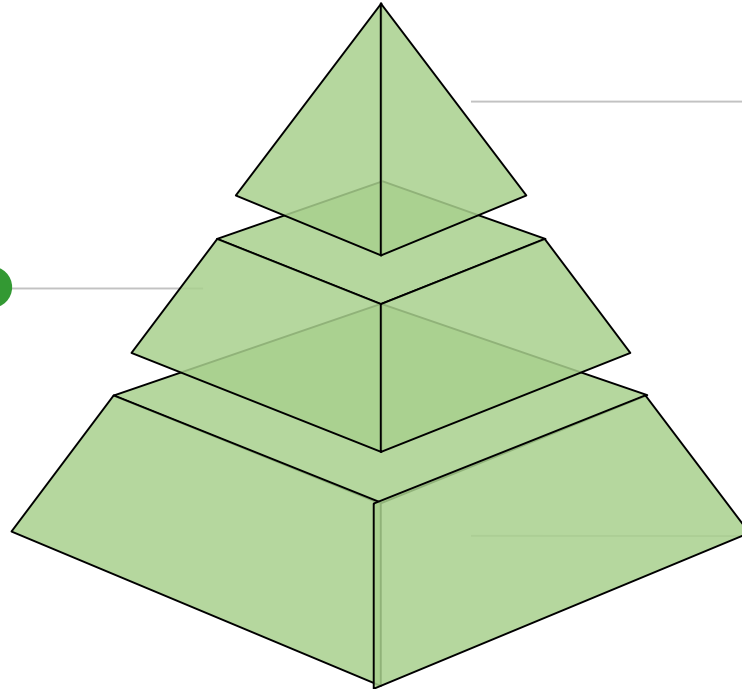




Decision Levels

Tactical – Master Surgical Schedule

- Number and type of available ORs and to whom the OR time is assigned



Strategic – Case Mix Planning

- Defining the case mix – number of hours that a specialty has

Operational – Surgical Schedule Problem

- Assignment of patients to the ORs
- Order of surgeries or the starting scheduled time

2. General Problem



- Balance the number of patients on the waiting list
- Improve the number of patients operated per year

Strategic

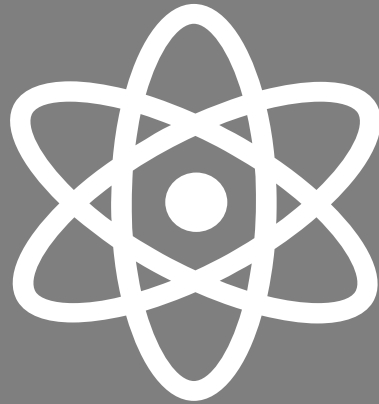
Defining the number of hours each specialty should operate

Tactical

Building a new Master Surgical Schedule (MSS)

Day/Room	1	2	3	4	5
Mon	General Surgery	Urology	Urgency	Orthopedics	Ophthalmology
	General Surgery	General Surgery			
Tue	General Surgery	General Surgery	Urgency	Orthopedics	Ophthalmology
	General Surgery (Breast Surgery)	Plastic Surgery			
Wed	Plastic Surgery	Pediatric Surgery	Urgency	Orthopedics	Ophthalmology
	General Surgery (Varices)	Urgency			
Thu	General Surgery	General Surgery	Urgency	Orthopedics	Ophthalmology
	Urgency	Urology			
Fri	General Surgery	Stomatology General Surgery (Implantofix)	Urgency	Orthopedics	
Sat					
Sun	Urgency				

Existing Solutions Vs this Approach



3. Existing Solutions vs This Approach

Strategic
and
Tactical
Level of
decision

Patient Characteristics

In and outpatients
Elective and non-electives patients

Performance Measures

Throughput
Balance btw supply and demand
Up- and downstream utilization
Stakeholders satisfaction

Up- and downstream
facilities

Pre-wards
ICU
Post-wards

Operations Research
Methodology

MILP

Uncertainty

Demand
LoS

3. Existing Solutions vs This Approach

Performance Measures

1. Balance between supply and demand
2. Throughput
3. Up- and downstream utilization
4. Stakeholders satisfaction
5. MSS stability

- Balance the number of patients on the waiting list
- Improve the number of patients operated per year
- Implications that a surgery can have on other activities
- The will to implement the model

3. Existing Solutions vs This Approach



Objectives	Blake et al. (2002)	Fügener et al. (2014)	Adan et al. (2009)	Penn et al. (2017)	Agnētis et al. (2012)
1. Balance between supply and demand	✓				
3. Up- and downstream utilization		✓	✓		
4. Stakeholders satisfaction				✓	
5. MSS stability					✓

3. Existing Solutions vs This Approach



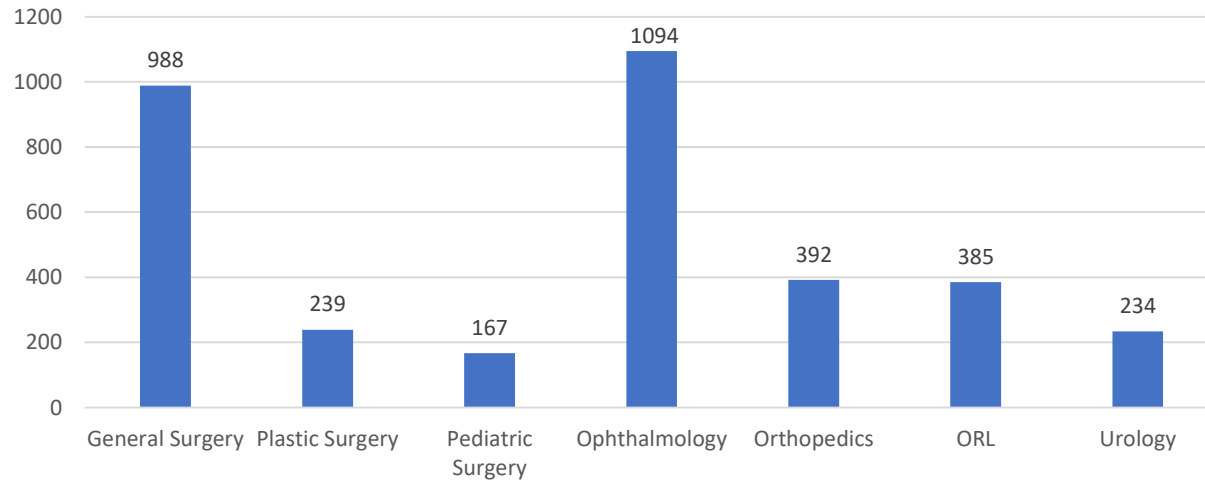
1. Balance between supply and demand



3. Existing Solutions vs This Approach



Number of patients waiting by surgical specialty
(December 2017)



3. Existing Solutions vs This Approach

1. Balance between supply and demand

Strategic Objective: Case mix - Number of hours that each specialty should have



Number of patients on
the waiting list

Average duration of a
surgery of each specialty



Available operating
room time



- Target of operating
room time



3. Existing Solutions vs This Approach

Example

18 slots

Specialties	S1	S2	S3
Demand	150	90	90
Average surgery time	k	k	k
Percentage demand	45%	27%	27%
Target	8	5	5



Day 1	Room 1	Room 2	Room 3
Morning	S3	S2	S2
Afternoon	S3	S1	S3

Day 2	Room 1	Room 2	Room 3
Morning	S1	S2	S1
Afternoon	S1	S3	S1

Day 3	Room 1	Room 2	Room 3
Morning	S1	S1	S2
Afternoon	S1	S2	S3

3. Existing Solutions vs This Approach

MSS stability



3. Existing Solutions vs This Approach

Week 1

		Room 1	Room 2	Room 3	Room 4
Monday	Morning	Orthopedics	General	Plastic	
	Afternoon	Ophthalmology		Ophthalmology	General
Tuesday	Morning		Ophthalmology	Urology	General
	Afternoon	General	Plastic		

Week 2

		Room 1	Room 2	Room 3	Room 4
Monday	Morning		ORL	General	Urology
	Afternoon	General	Stomatology		General
Tuesday	Morning	Urology	Ophthalmology	General	General
	Afternoon	Orthopedics	General	Stomatology	Urology

3. Existing Solutions vs This Approach

Week 1

		Room 1	Room 2	Room 3	Room 4
Monday	Morning	Orthopedics	General	Plastic	
	Afternoon	Ophthalmology		Ophthalmology	General
Tuesday	Morning		Ophthalmology	Urology	General
	Afternoon	General	Plastic		

Week 2

		Room 1	Room 2	Room 3	Room 4
Monday	Morning		ORL	General	Urology
	Afternoon	General	Stomatology		General
Tuesday	Morning	Urology	Ophthalmology	General	General
	Afternoon	Orthopedics	General	Stomatology	Urology

3. Existing Solutions vs This Approach

Week 1		Room 1	Room 2	Room 3	Room 4
Monday	Morning	Orthopedics	General	Plastic	
	Afternoon	Ophthalmology		Ophthalmology	General
Tuesday	Morning		Ophthalmology	Urology	General
	Afternoon	General	Plastic		

Week 2		Room 1	Room 2	Room 3	Room 4
Monday	Morning		ORL	General	Urology
	Afternoon	General	Stomatology		General
Tuesday	Morning	Urology	Ophthalmology	General	General
	Afternoon	Orthopedics	General	Stomatology	Urology

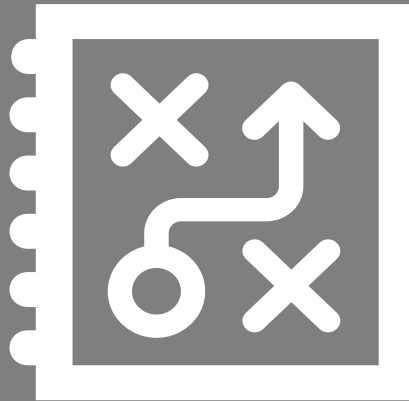
Auxiliary Variables

j – to count the amount of changes from a week to another
 k – to count the amount of changes from a month to another

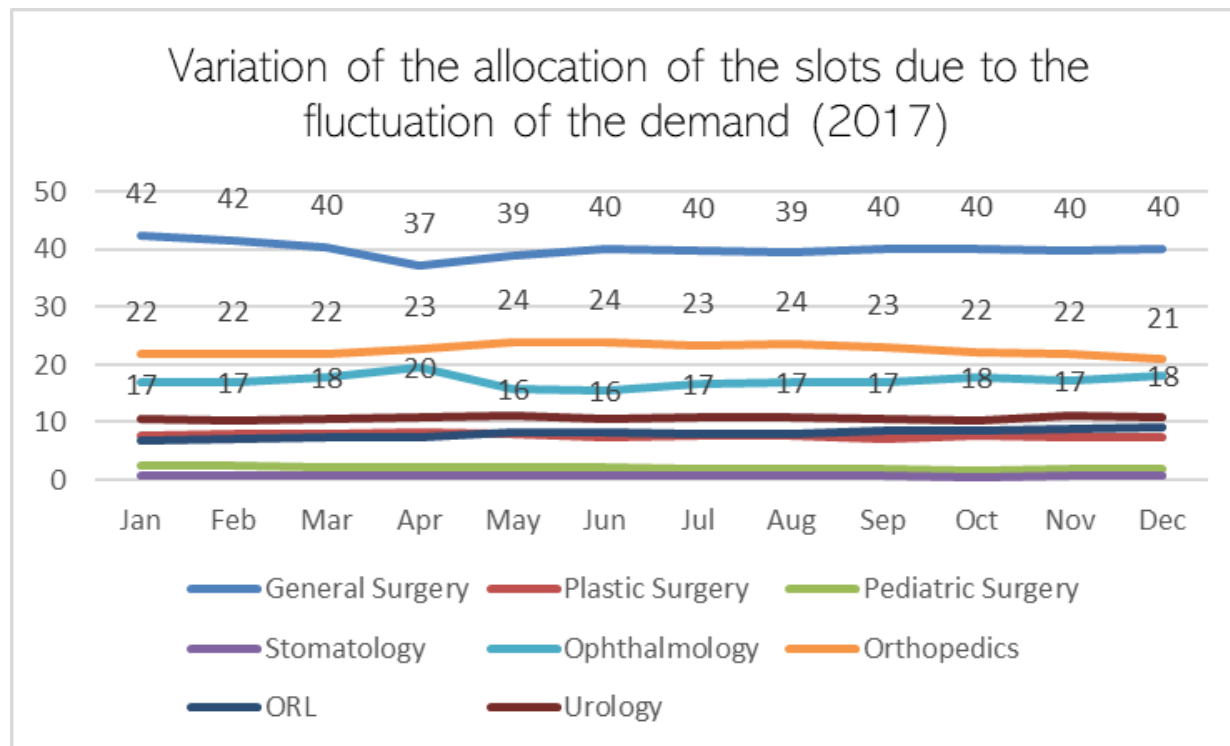
Parameter

Δ_w – number of allowable changes from a week to another
 Δ_m – number of allowable changes from a month to another

Results and Future Steps



3. Results and Future Steps



3. Results and Future Steps



Objectives

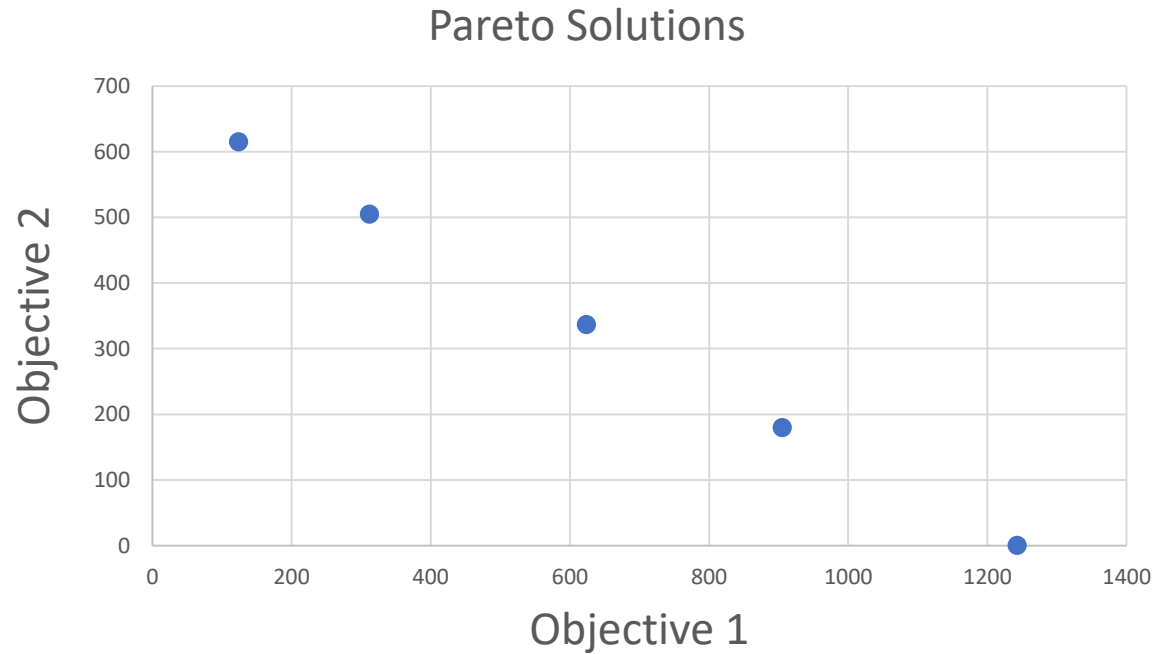
1. Balance between supply and demand
2. Throughput
3. Up- and downstream utilization

3. Results and Future Steps



Hip.	α_1	α_2	Relative Gap	Absolute Gap	Objective Function Value	Number of Iterations	Execution Time	Δ_w, Δ_m
1	1	0	0.004006	5.000000	1243.0000	3471	0.344 s	4, 12
2	0,5	0,5	0	0	287.5000	34152	0.531 s	4, 12
3	0,7 5	0,25	0.054705	42.000000	725.750000	9008	0.375 s	4, 12
4	0,25	0,7 5	0	0	-192.7500	29811	0.437 s	4,12
5	0,1	0,9	0.019971	9.800000	-490.7000	20589	0.547 s	4,12

3. Results and Future Steps



3. Results and Future Steps



Number of slots per specialty

Specialty	H1	H2	H3	H4	H5	Target
General S.		36	38	44	41	40
Plastic S.		12	9	4	9	7
Pediatric S.		4	3	1	1	2
Stomatology		4	1	1	1	1
Ophtalmology		20	20	21	18	16
Orthopedics		8	8	5	7	10
ORL		4	9	4	7	7
Urologiy		12	8	17	11	10
Total		100	96	97	95	100

3. Results and Future Steps



Future Steps

- Understand which should be the workforce in the hospital to match better the supply and the demand;
- To develop a better demand forecast;
- Implementation of the model in the real life case

Thank you

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Starting Point

- Balance the number of patients on the waiting list
- Improve the number of patients operated per year

Strategic

Defining the number of hours each specialty should operate

Tactical

Day/Room	Shift	1	2	3	4
Mon	Morning	General Surgery	Urology	Urgency	Orthopedics
	Afternoon	General Surgery	General Surgery		
Tue	Morning	General Surgery	General Surgery	Urgency	Orthopedics
	Afternoon	General Surgery	Plastic Surgery		
Wed	Morning	Plastic Surgery	Pediatric Surgery	Urgency	Orthopedics
	Afternoon	General Surgery	Urgency	O.R.L.	
Thu	Morning	General Surgery	General Surgery	Urgency	Orthopedics
	Afternoon	Urgency	Urology	O.R.L.	
Fri	Morning	General Surgery	Stomatology	Urgency	Orthopedics
			General Surgery		
	Afternoon				