

Application of Computer-aided Facility Simulation on Layout Design to Improve Patient Flow, Thermal Comfort and Safety

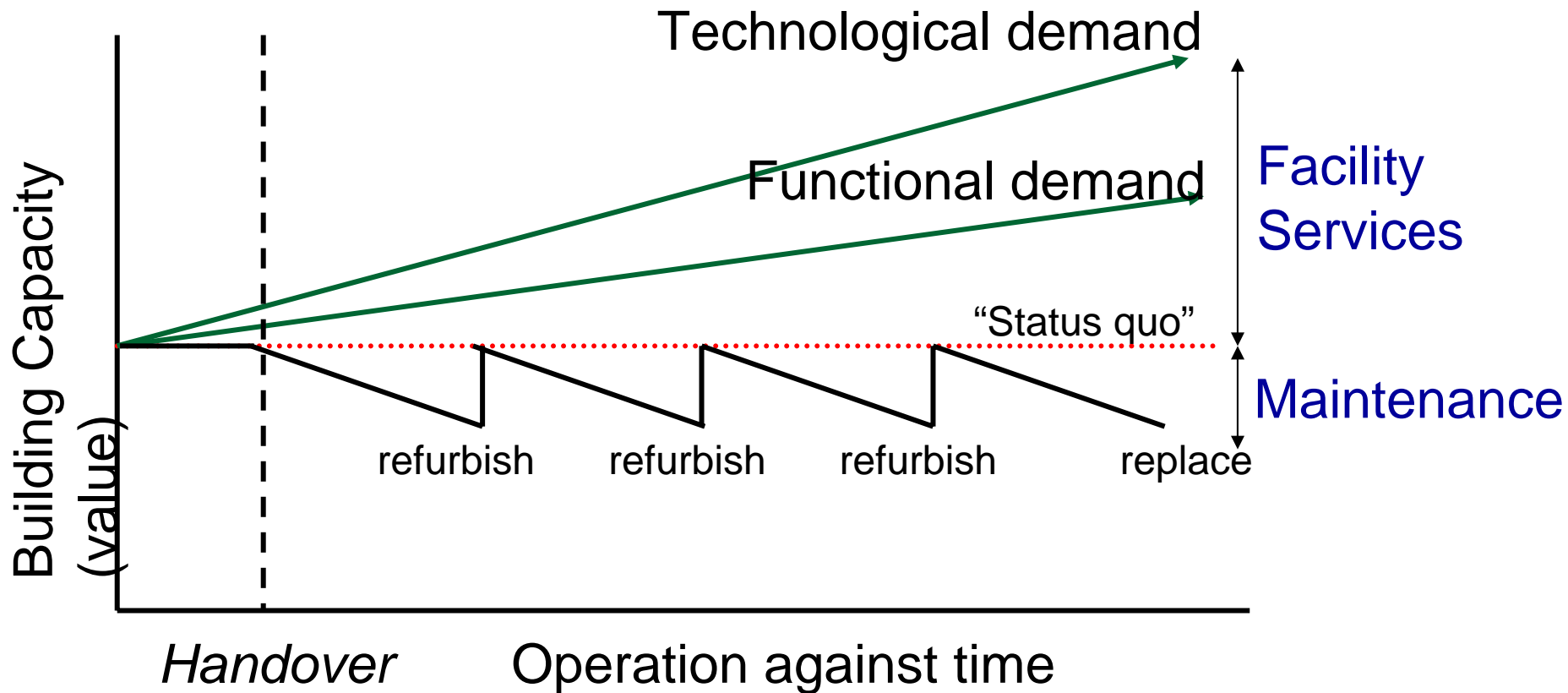
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Sustainable Facility Design Management

- Ever-changing / Ever-increasing Demand / Need
 - Change in Service functions
 - Change in Technology requirement
 - Change in Workflow
 - Change in Capacity
 - Change in Standard
 - Change in Space requirement
 - Change in User / Customer; etc

Sustainable Facility Design Management

“Fit for Purpose” of a Building diminished with time.



Early Stages and Limitations

- Initial complaint in 2005
 - “Stuffy air” on 3/F **Outpatient Building of KWH** owing to **overcrowding**
- Limitation to cope with overcrowded condition
 - Space (no. of consultation rooms)
 - Clinical staff arrangement
 - Means of escape
 - Vertical transportation; lift, stair case
 - Technical constraints e.g. Headroom, HVAC, power provision, FS provision; etc

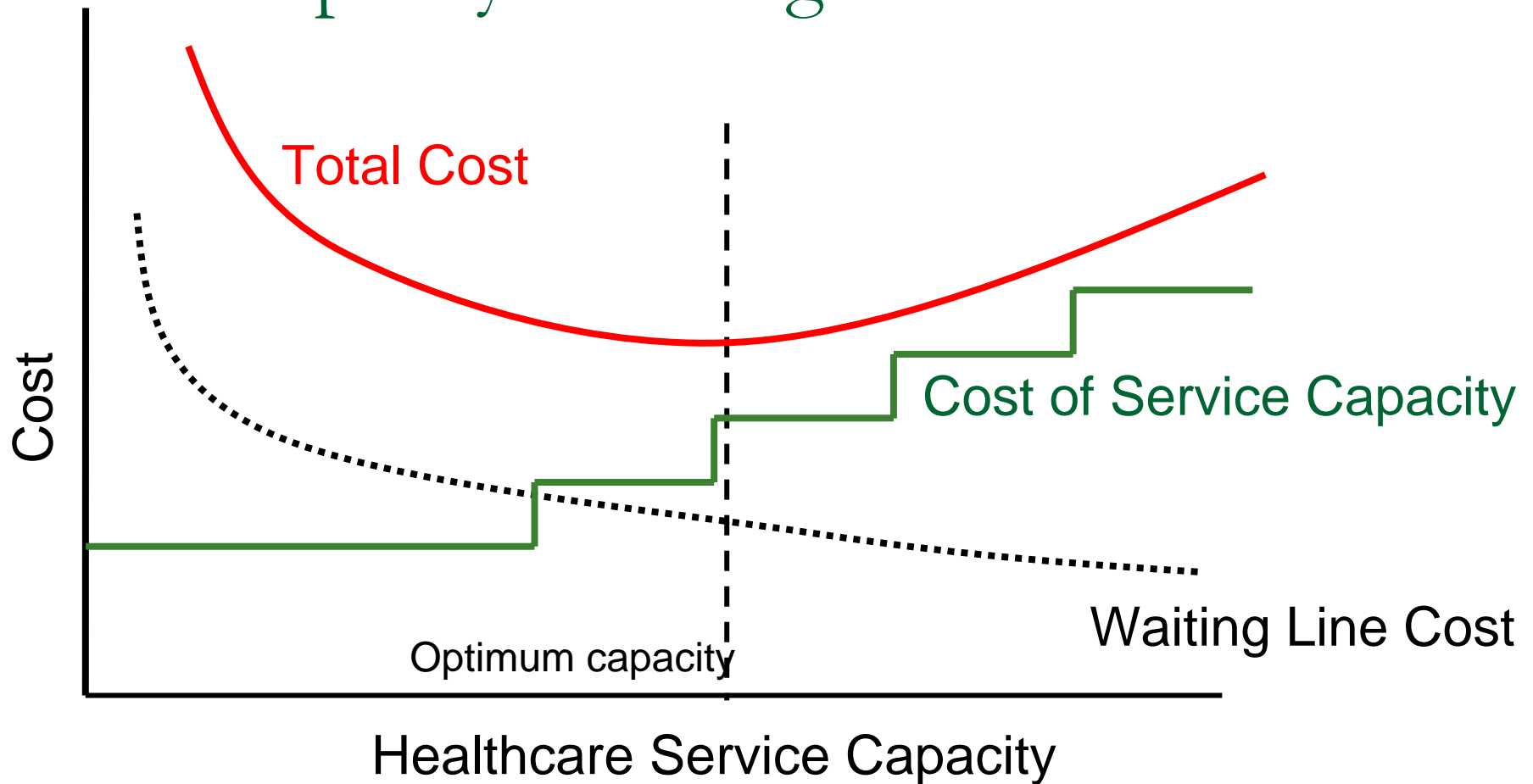
Formation of the Project

- Proposal made in 05/06
- Project Planning
 - Committee formed in early 2006 with all departments heads / representatives of Outpatient Building
 - \$2M bided under 8100MX in 06/07
- Implementation
 - Oct 2006 to Oct 07 in Phases for G/F, 2/F 3/F of Outpatient Building

Objective of the project

- Aims to demonstrate how to apply FM tools in enhancing operational sustainability
 - Quantitative queuing model & capability planning
 - Layout and workflow analysis
- and solve the problems of the Outpatient Department in Outpatient Building which was built in 1999
 - Overcrowding during peak hours
 - Poor air quality
 - Limited capacity of MOE

Basic theory & methodology in Health Care Capacity Planning



Basic theory & methodology in Health Care Capacity Planning

- Parameters in planning capacity
 - Arrival rate (a)
 - Service rate (s)
 - Average no. of patients waiting for service (Lq)
 - Average no. of patients in the building (L)
 - Average time patients wait in line (Wq)
 - Average time patients spend in the building (W)
 - Service time ($1/s$)
 - Building utility (p)
- No. of patient in waiting area: $L = Lq + a/s$
where $Lq = a^2 / (u(u-a))$

Assumptions for Capacity Forecast

- No. of patients at each timeslot rely on the patients' quota
- Waiting time at each counter accords with the survey conducted at peak hour
- All patients arrived on time
- No relatives/ friends accompany the patients (based on actual observation)
- Duration of "Waiting for registration" is shortened to 0 min when the smart card is used
- *Sample size = 10 patients were followed to observe the average waiting time per day (for procedures with short waiting time, over 100 data was collected)*

Patient Flow Analysis

- **Registration (2/F or 3/F)**
 1. Travel to SOPD from main entrance (lift / staircase)
 2. Waiting for registration (queue)
 3. Registration & patient identification (queue)
- **Clinical Consultation (2/F or 3/F)**
 4. Waiting for consultation (waiting hall)
 5. Receive consultation (consultation room)

Patient Flow Analysis

- **Appointment & Payment (2/F or 3/F)**
 6. Travel to appointment counter (waiting hall)
 7. Make appointment (queue)
 8. Travel to Shroff (waiting hall)
 9. Pay for medication (queue)
 - **Receiving Medication (G/F)**
 10. Travel to G/F (lift / staircase)
 11. Present payment receipt and prescription at Pharmacy (queue)
 12. Wait for dispensary (waiting hall)
 13. Get the medication (queue)
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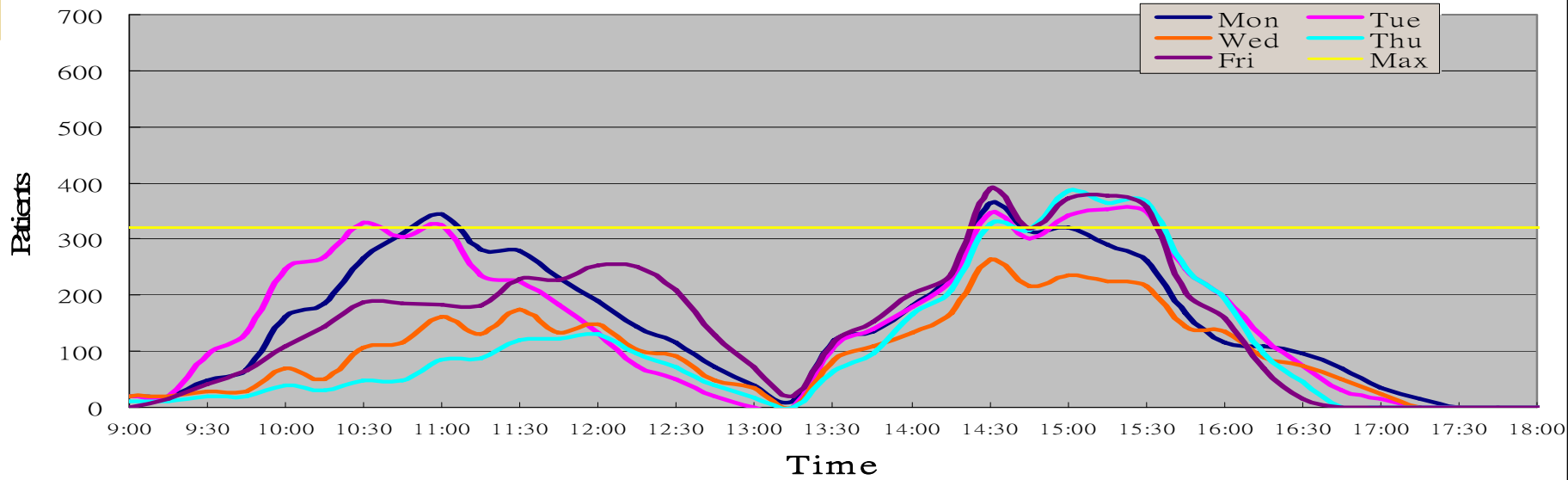
Patient Flow Analysis (waiting time)

Previous (Jan 06)

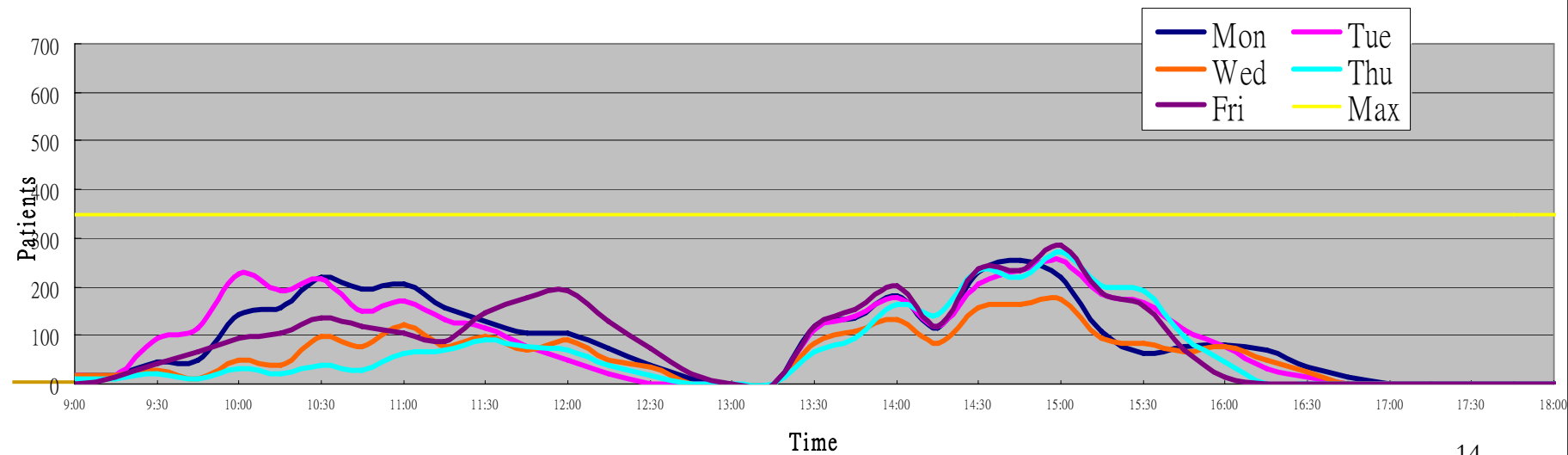
Expected

Procedure	Location	Duration	Procedure	Location	Duration
Waiting for registration	2/F or 3/F	0:22:36	Waiting for registration	?	0:00:00
Registration & patient identification	2/F or 3/F	0:00:16	Registration & patient identification	?	0:00:16
Waiting to receive consultation	2/F or 3/F	0:28:13	Waiting to receive consultation	?	0:28:13
Receive consultation	2/F or 3/F	0:07:35	Receive consultation	?	0:07:35
Move to appt & shroff	2/F or 3/F	0:00:28	Move to appt	?	0:00:28
Make appt for next visit	2/F or 3/F	0:00:54	Make appt for next visit	?	0:00:54
Shroff – Pay for Medication	2/F or 3/F	0:00:42	Travel to shroff on G/F	?	0:02:16
Travel to G/F	G/F	0:02:16	Shroff – Pay for Medication	?	0:00:42
Present receipt & prescription	G/F	0:00:10	Present receipt & prescription	?	0:00:10
Get a number card	G/F	0:00:04	Get a number card	?	0:00:04
Waiting for the drug	G/F	0:32:43	Waiting for the drug	?	0:32:43
Get the drug from counter	G/F	0:00:28	Get the drug from counter	?	0:00:28
Time spent on 2/F or 3/F		1:00:44	Time spent on G/F		?
Time spent on G/F		0:35:41	Time spent on 2/F or 3/F		?
			Time spent on G/F		?
Total		1:36:25	Total		?

Record of Previous No of Patient Waiting on 3/F



Forecast No of Patient Waiting on 3/F



Waiting Times according to Workflow

Previous (Jan 06)

Expected

Procedure	Location	Duration	Procedure	Location	Duration
Waiting for registration	2/F or 3/F	0:22:36	Waiting for registration	G/F	0:00:00
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Get a number card	G/F	0:00:04	Get a number card	G/F	0:00:04
Waiting for the drug	G/F	0:32:43	Waiting for the drug	G/F	0:32:43
Get the drug from counter	G/F	0:00:28	Get the drug from counter	G/F	0:00:28
Time spent on 2/F or 3/F		1:00:44	Time spent on G/F		0:00:16
Time spent on G/F		0:35:41	Time spent on 2/F or 3/F		0:37:10
			Time spent on G/F		0:36:23
Total		1:36:25	Total		1:13:49

Project implementation by Phases

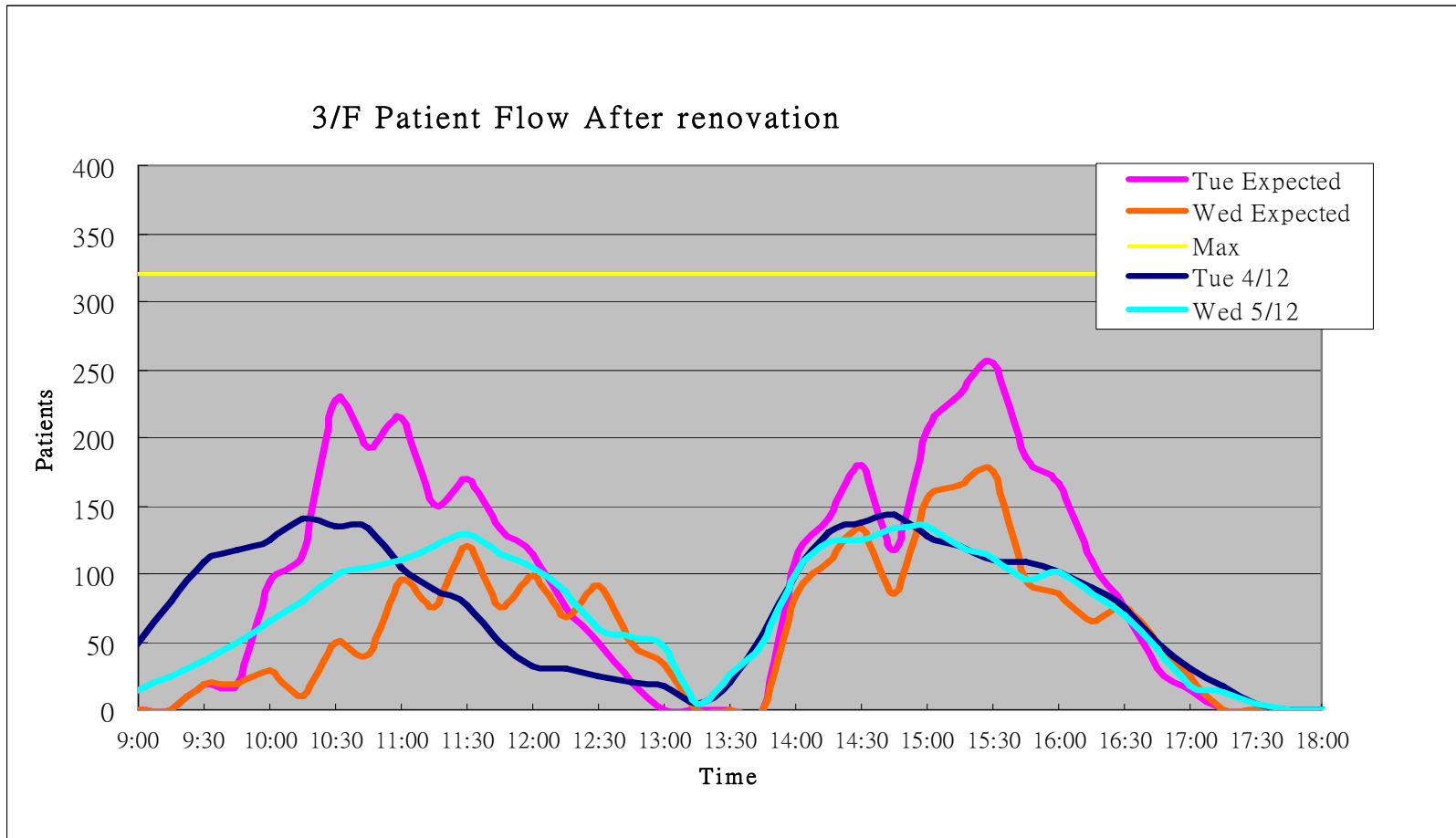
Phase I on 3/F completed on 9 July 2007.

Phase II on 2/F completed on 22 Oct 2007.



3/F waiting hall after works.

Comparison 3/F Patient Flow (Expected VS Outcome)



Summary of Patient Flow after Changing the Layout Design

Location	Normal Period		Peak Hour (2-4pm)		Maximum Record	
	Actual	Expected	Actual	Expected	Actual	Expected
G/F	70	110	180	270	255	350
2/F	55	70	95	120	130	120
3/F	65	80	120	155	150	250

* Patient number round up to 5 persons

Summary of Air Quality after Changing the Layout Design

CO ₂ Concentration (ppm)			
Location	Average (9:00-17:00 total 8 hrs)		
	* Actual	Before Renovation	Standard
G/F	973.60	985.28	1000
2/F	897.45	968.67	1000
3/F	947.21	968.54	1000

* 10 pts at waiting area for sampling on each floor

Outcome of the Project

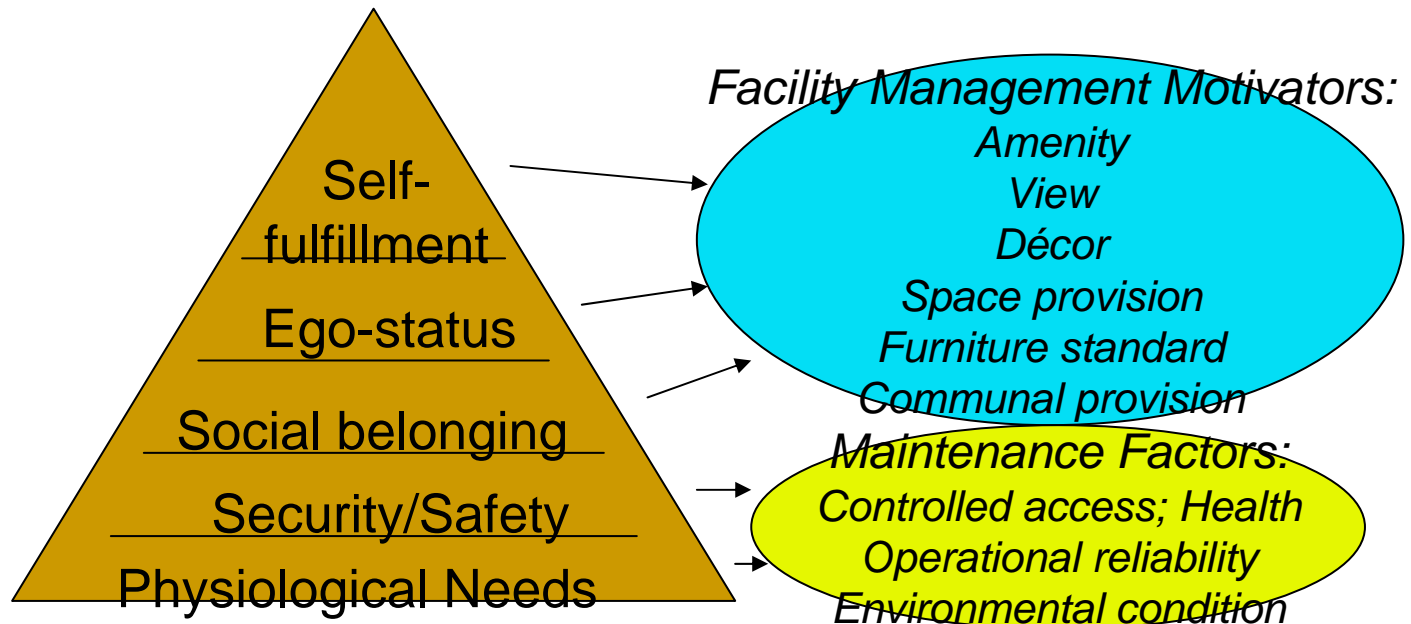
- 20% increase in patient seating capacity
- Shifting of patient flow pattern in Outpatient Building
- Reduce 15-60% patients' staying on same floor during peak hours
- 5% reduction of average Co2 concentration

Application of Quantitative Forecasting Tools in Facility Planning

- Demonstrate a successful application in outpatient facility
- Application in Healthcare Service Planning
 - Layout planning in outpatient buildings, inpatients buildings say AED, public waiting halls, Pharmacy, cashier, etc;
 - Rationalization existing workflow with outdated layout & limited space but rising demand on service capacity

Application of Quantitative Forecasting Tools in Facility Planning

- Optimum solution for management decision
- Select Right Approach to Guarantee Quality Outcome to meet the Demand



Demand of Building Users

Facility Management

- *“the process by which an organization delivers and sustains support services in a quality environment to meet strategic needs”*
 - Centre for Facilities Management

Thank you