Development of an Automated Nurse Rostering System for the Emergency Department in the Singapore General Hospital

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Introduction

The dynamic working environment in the emergency department **poses many challenges to creating rosters**, due to the **wide range of rules and** requirements, such as skill and gender mixes. These difficulties hamper the current manual rostering process, which requires more than 100 nurses to be scheduled within a 2 week period. Hence, the objective of this project is to develop an efficient system in order to reduce the time taken and effort **needed** to produce monthly rosters for nurses in the emergency department.

Staff Requirements

Schedule Requirements

Monthly Rosters

Skill Mix

- Triaged trained nurses
- **Resuscitation trained nurses**
- Overall in-charge capability

Workforce Mix Η

- Male vs female nurse ratio
- Senior vs junior nurse mix
- Minimum nurse to patient ratio

Methodology

Work Policies

- 2 rest days per week
- No more than 5 work days in a row
- 3 consecutive night shifts
- Nurse Preferences
- Satisfy requests for shifts
- Allocate unfavorable shifts equally

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Roster Creation

- 2 week circulating rosters
- Continuous production over rostering period
- Difficulty in enforcing all requirements



–AIMMS Ratios

Manual Ratios

Demand Sensitive

for manpower allocation

Shift Equity

for undesirable shifts

Results

Interviews with nurse clinicians and analysis of **patient arrival data** were conducted to determine the rostering operational requirements.

Mathematical model with 4 key performance metrics was developed in order to reflect these objectives and measure roster quality and performance.





The rosters created through the automated system were compared with manually created rosters for similar time periods based on key performance indicators used in the mathematical model.

Key Results:

- **1.** Efficient allocation of manpower in response to patient demand
 - 2. More equitable distribution of undesirable shifts
 - 3. High number of approved requests
- 4. Reduction of long working stretches by distributing non-working days

Nurse Patient Ratio Comparison

Shift i of Day c



Implementation

System Development and Usage

- Automated rostering system based on a **mathematical optimization model**
- Flexible response to changes in patient arrival patterns and staff requirements
- Based on Microsoft Excel and AIMMS (optimization software)

1.Input

User enters in three initial inputs for the model:

- 1. Expected daily patient demand
- 2. Nurse skill levels

Pa	tient Dema	nd	For ea	For each day and shift, key in the expected patient arrivals (obtained from historical data)								
_		D1	D2	D3	D4	05						
	Day	129	129	120	105	105						
	Evening	215	215	200	175	175						
	Night	86	86	80	70	70						
	Overall	430	430	400	350	350						

Management & Staff Support

System Integration

<30 mins

to create full rosters

Better Patient Outcomes

with better nurse patient ratios

- **1. Excel dashboards** for monitoring **manpower** allocation and staff welfare
- 2. Mobile apps for nurses to have easy access to rosters and to make requests
 - or feedback

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E	Ang Boon Yew Staff Nurse	
STOP 1	EXXXX920D	
Roster	Request Feedback	



- 3. Applied leaves and special cases

AIMMS 2. Optimization

Shifts are then assigned through AIMMS in order to achieve the desired objectives while adhering to the strict scheduling requirements

> **3. Output**

Raw solver outputs from AIMMS are translated into rosters for deployment in Excel.

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Roster Summary

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Nurse Patient Ratio

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N1	6	12	18	3	
N2	12	7	19	6	
N3	12	3	15	0	
N4	13	8	21	3	
N5	7	10	17	3	
N6	11	15	26	0	1
N7	9	10	19	3	
N8	11	6	17	3	
N9	8	9	17	5	
N10	7	10	17	6	
N11	5	13	18	3	1
N12	7	12	19	3	
N13	8	10	18	3	
N14	10	11	21	5	
N15	9	13	22	3	
N16	9	9	18	3	
N17	9	9	18	3	
N18	6	11	17	3	
N19	10	8	18	3	
N20	13	5	18	3	
N21	10	13	23	3	
N22	10	8	18	3	
N23	14	5	19	3	
N24	9	10	19	3	
N25	10	7	17	0	1
N26	10	9	19	3	
N27	10	8	18	3	
N28	11	10	21	3	U
N29	10	-11	21	2	₩

Assigned Previous Total Nurse Undesirable Undesirable Undesirable Shifts

Conclusion

The automated rostering framework **reduces the time and effort needed** to create monthly rosters, **improving manpower allocation** in response to patient demand and maximizing staff satisfaction through more equitable shift allocations. It also has the potential for future modifications and extensions to be made in lieu of policy changes, demonstrating it's flexibility in use for operations.