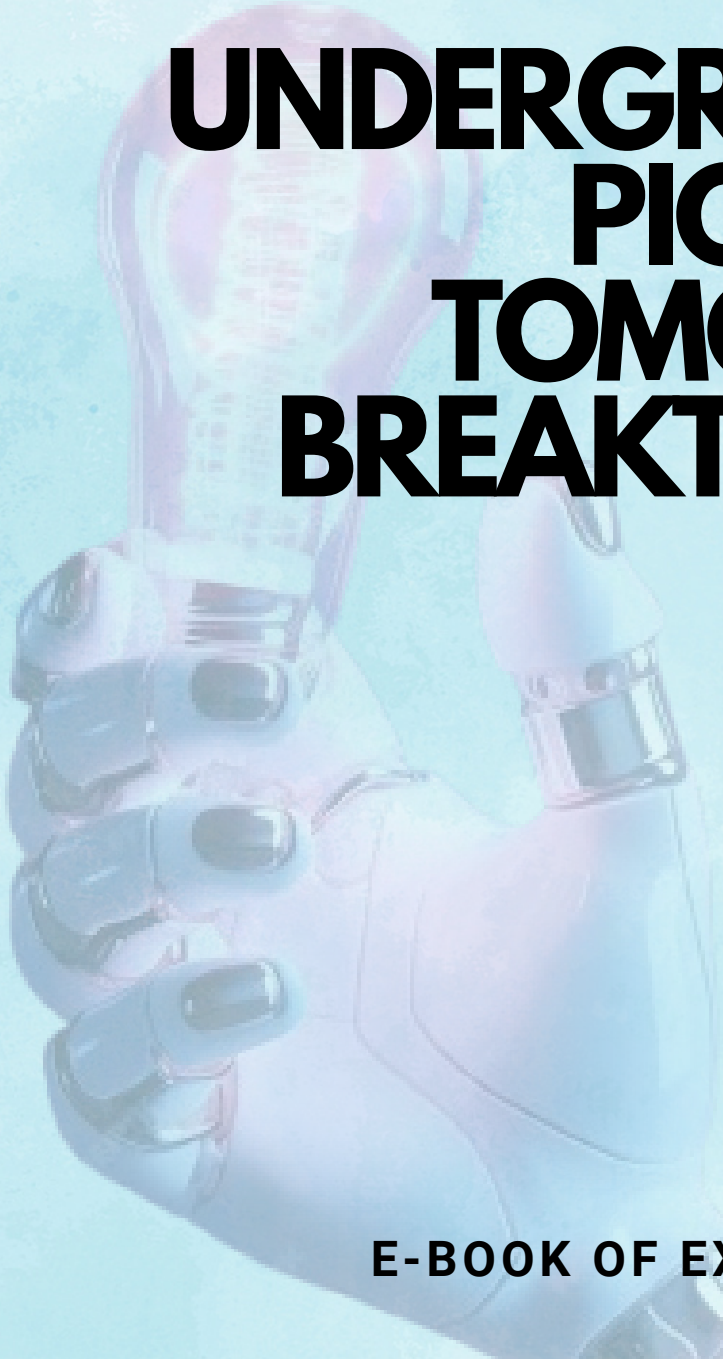




I-URIP 2025

INTERNATIONAL UNDERGRADUATE RESEARCH
INNOVATION, INVENTION AND DESIGN



UNDERGRADUATES PIONEERING TOMORROW'S BREAKTHROUGH

E-BOOK OF EXTENDED ABSTRACTS

A NURSE SCHEDULING SYSTEM USING 0-1 GOAL PROGRAMMING TECHNIQUE

Siti Nur Izzah Mohd Azimin, Abdullah Yahya*, and Noor 'Ain Mohd Asri

College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Negeri Sembilan Branch, Seremban Campus, Persiaran Seremban Tiga/1, Seremban 3, 70300 Seremban, Negeri Sembilan

*abdullahyahya@uitm.edu.my

ABSTRACT

Scheduling plays a crucial role in optimising workforce management, particularly in healthcare sectors where efficiency and fairness directly impact service quality. This study focuses on developing an optimised nurse scheduling system for Hospital Alor Gajah (HAG) using the 0-1 Goal Programming technique. Primary data were collected from the male adult ward at HAG, and a mathematical model was formulated to integrate hospital rules as hard constraints and nurse preferences as soft constraints. LINGO software was utilised to generate feasible shift patterns, which were further refined to produce a proposed two-week schedule. The results showed significant improvements in workload distribution, compliance with minimum staffing requirements, and accommodation of nurse preferences. This scheduling approach demonstrates its potential as a practical decision-support tool to replace traditional manual scheduling, thereby enhancing operational efficiency and nurse satisfaction.

Keywords: Nurse Scheduling, Goal Programming, Workforce Optimisation, LINGO Software, Hospital Management

INTRODUCTION

Nurse scheduling is essential for ensuring effective hospital operations while maintaining nurse well-being. Manual scheduling practices at Hospital Alor Gajah (HAG) often led to issues such as biased shift allocation, unfair workload distribution, and insufficient off days, resulting in potential burnout and decreased job satisfaction. To address these problems, this study aims to formulate a nurse scheduling system using 0-1 Goal Programming that integrates hospital regulations and nurses' preferences. The objectives of the study are to evaluate the current scheduling system at HAG by interviewing the head nurse in male adult ward, develop a Goal Programming model, and produce an optimised two-week nurse schedule that balances operational requirements and staff satisfaction.

RESULTS AND DISCUSSION

The proposed nurse scheduling model incorporated hard constraints such as minimum staffing requirements (six nurses for morning and evening shifts, four for night shifts), ensuring each nurse works only one shift per day, and guaranteeing two off days within a two-week cycle. Soft constraints included scheduling each nurse for approximately 10 days while minimising rapid shift transitions that could cause fatigue. The implementation of LINGO software facilitated the generation of shift patterns satisfying these constraints stated in Figure 1 and Figure 2.

```

Feasible solution found.
Infeasibilities:                                0.000000
Total solver iterations:                        347
Elapsed runtime seconds:                       0.19

Model Class:                                  LP

Total variables:                              1344
Nonlinear variables:                          0
Integer variables:                           0

Total constraints:                            392
Nonlinear constraints:                        0

Total nonzeros:                              2688
Nonlinear nonzeros:                          0

```

Figure 1: LINGO result after input constraints

Number of Nurse, k	Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	O	E	E	E	E	O	N	N	NE	M	M	M	M	O
2	N	N	NE	M	M	M	M	M	O	O	E	O	N	N
3	N	N	NE	E	E	E	O	O	M	M	M	O	N	N
4	O	M	M	M	O	E	E	O	N	N	NE	M	M	M
5	M	M	M	O	N	N	NE	O	E	E	O	E	E	E
6	M	O	N	N	NE	E	E	E	E	E	O	M	M	O
7	E	E	O	E	E	O	N	N	NE	O	M	M	M	M
8	O	M	M	M	M	O	E	O	N	N	NE	M	M	M
9	E	E	E	O	M	M	M	O	N	N	NE	O	M	M
10	E	E	E	O	N	N	NE	E	E	E	O	M	M	O
11	M	M	M	O	N	N	NE	M	M	O	E	E	E	E
12	M	M	M	O	E	E	E	E	E	O	N	N	NE	E
13	M	M	O	E	O	E	E	E	E	O	N	N	NE	M
14	E	E	O	M	M	O	E	E	E	O	N	N	NE	M
15	M	M	M	O	E	O	N	N	NE	E	E	O	E	E
16	M	O	N	N	NE	M	M	M	O	E	E	O	O	M
17	E	O	N	N	NE	M	M	O	M	M	O	E	E	E
18	N	N	NE	M	M	M	O	O	E	E	E	O	N	N
19	E	E	E	O	M	O	N	N	NE	E	E	O	O	M
20	N	N	NE	E	E	E	O	M	O	M	M	O	N	N
21	E	O	E	O	N	N	NE	M	M	M	M	O	E	E
22	M	O	E	E	O	M	M	O	N	N	NE	E	E	E
23	M	M	M	M	O	E	E	E	O	O	N	N	NE	E
24	O	O	N	N	NE	M	M	M	M	M	O	E	E	E

Figure 2: Proposed schedule with the helps from LINGO

Comparative analysis revealed that the proposed schedule improved workload equity among nurses, eliminated undesirable consecutive shifts, and enhanced adherence to hospital policies compared to the existing manual schedule. This approach demonstrates the effectiveness of Goal Programming in addressing multi-objective scheduling problems within the healthcare sector.

CONCLUSION

This study successfully developed a nurse scheduling system using 0-1 Goal Programming for Hospital Alor Gajah. The proposed model ensured fair shift distribution, compliance with hospital regulations, and consideration of nurse preferences. The novelty of this study lies in integrating both operational constraints and human preferences into a single mathematical framework, moving away from manual trial-and-error methods towards a structured, data-driven solution. Implementing such optimisation techniques in scheduling can enhance operational efficiency and workforce satisfaction, thus supporting better healthcare service delivery. Future studies are recommended to extend the model with real-time adjustments to accommodate unforeseen staffing changes.

ACKNOWLEDGEMENT

The author would like to express sincere gratitude to Universiti Teknologi MARA for the continuous support and to En. Abdullah Bin Yahya for his invaluable guidance throughout this project.

REFERENCES

- Azaiez, M., & Sharif, S. A. (2004). A 0-1 goal programming model for nurse scheduling. *Computers & Operations Research*, 32(3), 491–507. [https://doi.org/10.1016/s0305-0548\(03\)00249-1](https://doi.org/10.1016/s0305-0548(03)00249-1)
- D'souza, B., Rao, S. S., Muthana, C. G., Bhageerathy, R., Apuri, N., Chandrasekaran, V., Prabhavathi, D., & Renukaradhya, S. (2021). ROTA: A system for automated scheduling of nursing duties in a tertiary teaching hospital in south India. *Health Informatics Journal*, 27(2). <https://doi.org/10.1177/14604582211001426>
- Ismail, Wan Rosmanira & Jenal, Ruzzakiah & Liong, C.-Y & Muda, Mohd. (2009). Periodic rostering for nurses using 0-1 goal programming method. *Sains Malaysiana*. 38. 233-239.