



LB/DON/74/03



**WAITING TIME STUDIES TO IMPROVE
SERVICE EFFICIENCY
AT
NATIONAL HOSPITAL OF SRI LANKA**



The Dissertation submitted for the
Degree of
MASTER OF SCIENCE
In OPERATIONAL RESEARCH

51 "03"
519.87:614

Department of Mathematics
Faculty of Engineering
University of Moratuwa
Sri Lanka
September, 2003

University of Moratuwa



78974

78974

S C Mathugama
Master of Science (Full Time)
MSc./M/01/2001

78974

DECLARATION

I certify that the dissertation entitled “**THE WAITING TIME STUDIES TO IMPROVE SERVICE EFFICIENCY AT NATIONAL HOSPITAL OF SRI LANKA**” is entirely my own work. It has not been accepted for any degree and it is not being submitted for any other degree.

Candidate

S C Mathugama

UOM Verified Signature

Signature :

Date : 08-09-2003.....

Supervisor

Dr. M Indralingam

UOM Verified Signature

Signature :

Date : 28/7/03.....



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

ABSTRACT

The National Hospital of Sri Lanka is the main teaching hospital and the final referral center of this country. This hospital provides number of patient services and it is mainly responsible for delivering a comprehensive range of secondary and tertiary specialist care. This research was conducted to analyse current situation of waiting and overcrowding at National Hospital and to find out ways to provide efficient service to patients. This research is mainly focused on two areas, out patient management and inpatient management.

Out Patient Department of National Hospital comprises of General OPD section, Admission section and Emergency Treatment Unit (ETU). In this study, only the General OPD section was considered. Data collection was done through hospital records, observations and a questionnaire survey. Descriptive techniques, queuing theory techniques and simulation techniques were used in data analysis. Using GPSS/PC simulation language, existing queuing situation at General OPD was simulated. Long queues and high waiting times were found at Entry Counter, Room 15, Room 2 and Room 5. OPD is overcrowded due to increased demand, unnecessary arrivals, lack of resources and ignorance of patients on OPD procedures. Most of the facilities for staff and patients are inadequate. To avoid unnecessary visits to OPD, a referral system should be enforced. To reduce queueing at some rooms alternative options were suggested. Proper inquiry counter should be implemented and proper directions should be given to patients in order to have efficient management at General OPD.

Inpatient section of National Hospital, also provides a large number of patient services. Patient admissions were high for Medical, Surgical, Accidents, Cardiology and Orthopaedic wards. The bed capacity of National Hospital is around 2900. This hospital has high bed occupancy rate, high throughput and very low bed emptiness. In some wards a considerable number of floor patients can be seen. These wards are overcrowded due to unnecessary admissions, lack of resources and improper utilization of available resources. By providing more resources, avoiding unnecessary arrivals and irregularities of staff and using computerization, services can be much improved at National Hospital of Sri Lanka.

ACKNOWLEDGEMENT

It is with greatest respect and veneration that I express my sincere thanks to my supervisors Dr. M Indralingam, The Coordinator of the postgraduate students of Department of Mathematics, University of Moratuwa and Dr. R Lokupitiya, Senior Lecturer of Department of Mathematics, University of Moratuwa. Without the knowledge, advise and vast experience, which was imparted to me by my supervisors I may not have been able to complete the project successfully.

I would like to take this opportunity to thank Post Graduate unit of University of Moratuwa and ADB for granting me this scholarship to conduct this research and The Head of the Department and all the staff members of the Department of Mathematics, University of Moratuwa.

I would also like to thank Dr. Rani Fernando, The Deputy Director of National Hospital, Mrs. Champa Ariyaratne, Medical Record Assistant of National Hospital, Mr. Sisira Ranjan, Accountant of National Hospital, Medical Officer In charge at OPD, Sister at OPD, Nursing Sister Susila Padmaseeli and all the nurses, doctors and patients participated in questionnaire survey, for providing me relevant information and data to carry out this research.

The assistance and help given by Dr. Shayama Pannipitiya and Dr. Srini Daraniyagala is gratefully acknowledged.

It is my obligation to thank all my friends for their support and I gratefully acknowledge the support and encouragement given by my family.

CONTENTS

| | <i>Page no.</i> |
|--|-----------------|
| DECLARATION | i |
| ABSTRACT | ii |
| ACKNOWLEDGEMENT | iii |
| CONTENTS | iv |
| LIST OF TABLES | vii |
| LIST OF FIGURES | ix |
| DEDICATION | xi |
| 1. INTRODUCTION | 1.1 |
| Waiting lines or queues | 1.1 |
| 1.2 Background to the study | 1.2 |
| 1.2.1 Hospital waiting lines | 1.2 |
| 1.2.2 Government hospital services in Sri Lanka | 1.3 |
| 1.3 Importance of the study | 1.5 |
| 1.4 Efficacy, effectiveness and efficiency | 1.6 |
| 1.5 Literature review | 1.7 |
| 1.5.1 Hospital statistics and current situation of waiting | 1.7 |
| 1.5.2 Possible reasons for waiting lines and its adverse effects | 1.10 |
| 1.5.3 Suggestions and recommendations to improve service Efficiency | 1.14 |
| 1.5.4 Hospital management and application of IT in hospitals | 1.15 |
| 1.5.5 Simulation modeling | 1.18 |
| 1.6 Scope and Objectives of the Research | 1.19 |

| | |
|--|------|
| 2. METHODOLOGY, STUDY AREA AND TECHNIQUES TO BE USED | 2.1 |
| 2.1 Methodology | 2.1 |
| 2.2 National Hospital of Sri Lanka (NHSL) | 2.3 |
| 2.2.1 Background | 2.3 |
| 2.2.2 Mission and Corporate Vision of National Hospital of Sri Lanka | 2.4 |
| 2.2.3 Services Provided by National Hospital | 2.5 |
| 2.3 Techniques to be used | 2.7 |
| 2.3.1 Descriptive Methods | 2.7 |
| 2.3.2 Redit Analysis | 2.8 |
| 2.3.3 Queueing Theory Techniques | 2.9 |
| 2.3.3.1 Introduction to Queues | 2.9 |
| 2.3.3.2 Queueing Notation and Terminology | 2.13 |
| 2.3.3.3 Decision Making | 2.15 |
| 2.3.3.4 Statistical Analysis | 2.16 |
| 2.3.4 Simulation Techniques | 2.21 |
| 2.3.4.1 Introduction to simulation | 2.21 |
| 2.3.4.2 Formulating and implementing a simulation model | 2.21 |
| 2.3.4.3 GPSS/PC – General Purpose Simulation System (Minuteman Software) | 2.23 |
| 3. OUT PATIENT MANAGEMENT | 3.1 |
| 3.1 Services Provided by OPD | 3.1 |
| 3.1.1 Main Units of OPD | 3.1 |
| 3.1.2 Service Procedure at OPD | 3.2 |
| 3.2 Out Patient Attendance | 3.3 |
| 3.2.1 Out Patient Services - Summary | 3.3 |
| 3.3 Queueing System at OPD | 3.6 |
| 3.3.1 Different Counters at OPD | 3.6 |
| 3.3.2 Arrival Patterns and Service Patterns | 3.7 |
| 3.3.3 Simulation Output and Discussion of Results | 3.12 |
| 3.3.4 Alternative Ways | 3.16 |

| | | |
|-------|---|------|
| 3.3.5 | Validation of the Simulation Model | 3.18 |
| 3.4 | Changing the Layout at OPD | 3.19 |
| 3.5 | Questionnaire Analysis | 3.22 |
| 3.5.1 | Descriptive Analysis of Nurses' Questionnaire | 3.28 |
| 3.5.2 | Descriptive Analysis of Doctors' Questionnaire | 3.30 |
| 3.5.3 | Descriptive Analysis of Common Questions for Two Questionnaire | 3.31 |
| 3.5.4 | Descriptive Analysis of Patients' Questionnaire | 3.39 |
| 3.6 | Summary | 3.48 |
| 4. | INPATIENT MANAGEMENT | 4.1 |
| 4.1 | Services Provided by Inpatient Section | 4.1 |
| 4.2 | Notations and Definitions | 4.4 |
| 4.3 | Important Patient Statistics at Wards | 4.5 |
| 4.4 | Questionnaire Analysis | 4.14 |
| 4.4.1 | Descriptive Analysis | 4.14 |
| 4.4.2 | Assigning Scores | 4.19 |
| 4.5 | Budget Allocation for NHSL | 4.25 |
| 4.6 | Summary | 4.27 |
| 5. | CONCLUSIONS AND DISCUSSION | 5.1 |
| 5.1 | Summary and Conclusions | 5.1 |
| 5.1.1 | Current Situation at OPD and Wards | 5.1 |
| 5.1.2 | Overcrowding and Waiting | 5.3 |
| 5.1.3 | Suggestions to Improve Service Efficiency | 5.6 |
| 5.2 | Discussion | 5.6 |
| 5.3 | Recommendations | 5.7 |
| 5.4 | Further Work | 5.8 |
| 5.9 | Some Remarks | 5.9 |
| | APPENDIX I | A1.1 |
| | APPENDIX II | A2.1 |
| | APPENDIX III | A3.1 |
| | REFERENCES AND BIBLIOGRAPHY | R1 |

LIST OF TABLES

| | <i>Page no.</i> |
|------------|---|
| Table 2.1 | Two Dimensional Contingency Table 2.7 |
| Table 2.2 | An Illustration of the Calculation of Ridits 2.8 |
| Table 3.1 | Out Patient Attendance - Summary-From year 1995 to 2001 3.3 |
| Table 3.2 | Number of Days Treated at General OPD 3.4 |
| Table 3.3 | Out Patient Attendance by Specialty Wise - Summary 3.4 |
| Table 3.4 | Frequency Distribution of Interarrival Times 3.8 |
| Table 3.5 | Frequency Distribution of Service Times 3.10 |
| Table 3.6 | Summary for Arrival and Service Times 3.12 |
| Table 3.7 | Output Results for Entry Counter 3.12 |
| Table 3.8a | Output Results for Room15 -Morning - Without Initial Queue 3.13 |
| Table 3.8b | Output Results for Room15 - Evening 3.14 |
| Table 3.9 | Output Results for Room 2, Room 3, Room 5 and Room 18 3.15 |
| Table 3.10 | Average Waiting Time at Different Counters 3.16 |
| Table 3.11 | Possible Alternatives to Reduce Queueing at General OPD 3.17 |
| Table 3.12 | Comparison of Results 3.18 |
| Table 3.13 | Frequency Tables of Nurses' Questionnaire 3.23 |
| Table 3.14 | Frequency Tables of Doctors' Questionnaire 3.25 |
| Table 3.15 | Frequency Tables of Combined Questionnaire 3.27 |
| Table 3.16 | Results of Two Sample Proportion Test 3.38 |
| Table 3.17 | Frequency Tables of Patients' Questionnaire 3.39 |
| Table 3.18 | Ridit Analysis 3.44 |
| Table 3.19 | Results of Chi-squared Test 3.47 |
| Table 4.1 | Annual In-patient Records at NHSL 4.6 |
| Table 4.2 | Summary of Inpatient Services at NHSL 4.10 |
| Table 4.3 | Average Monthly Admissions 4.11 |
| Table 4.4 | Bed Capacity 4.11 |
| Table 4.5 | Bed/Admission Ratio 4.12 |
| Table 4.6 | Average Daily Sick 4.12 |
| Table 4.7 | Bed Occupancy Rate 4.13 |
| Table 4.8 | Daily Average Floor Patients 4.13 |
| Table 4.9 | General Information 4.14 |

| | | |
|------------|---|------|
| Table 4.10 | Working Days and Shift Hours –Unit wise | 4.14 |
| Table 4.11 | Working Days and Shift Hours –Designation wise | 4.15 |
| Table 4.12 | Inpatient Statistics | 4.15 |
| Table 4.13 | Length of Stays | 4.15 |
| Table 4.14 | Availability of Resources | 4.17 |
| Table 4.15 | Existing Service Level | 4.18 |
| Table 4.16 | Frequencies for Question 14 - 20 | 4.19 |
| Table 4.17 | Assigning Scores | 4.20 |
| Table 4.18 | Average Scores for Questions 14 - 20 | 4.21 |
| Table 4.19 | Service Period at NHSL | 4.23 |
| Table 4.20 | Expenditure Details -1997- 2001 (Capital) | 4.25 |
| Table 4.21 | Expenditure Details -1997- 2001 (Recurrent) | 4.26 |
| Table 4.22 | Annual Increase in Patients Treated and in Expenditure | 4.27 |
| Table A2.1 | Out Patient Attendance From Year 1995 to Year 2001 | A2.1 |
| Table A2.2 | Out Patients Attendance - Specialty wise - From Year 1995 to Year 2001 | A2.3 |



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

LIST OF FIGURES

| | <i>Page no.</i> |
|---|-----------------|
| Figure 2.1 Common Queueing Systems | 2.11 |
| Figure 2.2 Basic Queueing Process | 2.12 |
| Figure 2.3 Service cost as a function of service level | 2.16 |
| Figure 2.4 Expected waiting time as a function of service level | 2.16 |
| Figure 2.5 Conceptual solution procedures for many waiting-line problems | 2.16 |
| Figure 2.6 Statistical Distributions | 2.20 |
| Figure 3.1 Service Procedure at Out Patients' Department | 3.2 |
| Figure 3.2 OPD Attendance From Year 1995 to 2001 | 3.3 |
| Figure 3.3 Out Patient Attendance - Specialty Wise from year 1995 to 2001 | 3.5 |
| Figure 3.5 Probability Distribution of Interarrival Times | 3.9 |
| Figure 3.6 Probability Distribution of Service Times | 3.11 |
| Figure 3.7 Existing Layout at OPD | 3.20 |
| Figure 3.8 Suggested Layout at OPD | 3.21 |
| Figure 3.9 Age Distribution of Nurses | 3.29 |
| Figure 3.10 Distance and Traveling Time | 3.29 |
| Figure 3.11 Facilities to be Improved for Nurses | 3.29 |
| Figure 3.12 Number of Patients Treated | 3.30 |
| Figure 3.13 Treatment Times | 3.30 |
| Figure 3.14 View on Telemedicine | 3.30 |
| Figure 3.15 Facilities to be Improved for Doctors | 3.31 |
| Figure 3.16 Amount of Patients Handling | 3.31 |
| Figure 3.17 Availability of Resources | 3.32 |
| Figure 3.18 Working Hours and Working Days | 3.32 |
| Figure 3.19 Priority Criteria | 3.33 |
| Figure 3.20 Difficulties Faced in Handling Patients | 3.34 |
| Figure 3.21 Suggestions to Improve Service Efficiency | 3.34 |
| Figure 3.22 View on Computerization | 3.35 |
| Figure 3.23 Possible Reasons for Overcrowding at OPD | 3.35 |
| Figure 3.24 Suggestions to Overcome Overcrowding | 3.36 |
| Figure 3.25 Service Time at OPD | 3.36 |

| | | |
|-------------|---|------|
| Figure 3.26 | Changes Observed During Service Period | 3.37 |
| Figure 3.27 | General Information | 3.41 |
| Figure 3.28 | Type of the Visit | 3.41 |
| Figure 3.29 | Waiting Times | 3.42 |
| Figure 3.30 | Reasons for Visiting OPD of NHSL | 3.42 |
| Figure 3.31 | View on Waiting Times | 3.43 |
| Figure 3.32 | View on Present Priority Criteria | 3.43 |
| Figure 3.33 | View on Available Resources/Facilities | 3.44 |
| Figure 3.34 | Facilities to be Improved at OPD | 3.45 |
| Figure 3.35 | Difficulties Faced During This Visit | 3.45 |
| Figure 3.36 | Effects on Waiting | 3.46 |
| Figure 3.37 | Suggestions to Reduce Waiting Time and Overcrowding | 3.46 |
| Figure 4.1 | Daily Average Admissions | 4.8 |
| Figure 4.2 | Daily Average Sick | 4.8 |
| Figure 4.3 | Daily Average Floor Patients | 4.9 |
| Figure 4.4 | Bed Occupancy Rate | 4.9 |
| Figure 4.5 | Average Length of Stay | 4.9 |



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

