

TABLE OF CONTENTS

LIST OF TABLES	i
LIST OF FIGURES	ii
LIST OF SYMBOLS	v
CHAPTER I INTRODUCTION	1
1.1 Research Background and Motivation.....	1
1.2 Research Objective	2
1.3 Research Scope	3
1.4 Organization of Dissertation.....	5
CHAPTER II LITERATURE REVIEW	6
2.1 Traditional Project Management.....	6
2.1.1 Critical Path Method (CPM).....	6
2.1.2 Program Evaluation and Review Technique (PERT).....	6
2.2 Undesired Effect of Traditional Project Management.....	8
2.2.1 Excessive Activity Duration Estimates.....	8
2.2.2 Student Syndrome.....	9
2.2.3 Parkinson’s Law.....	10
2.2.4 Multitasking	10
2.2.5 No Early Finishes.....	11
2.3 Critical Chain Project Management Theories.....	12
2.3.1 Theory of Constraints (TOC).....	12
2.3.2 Common and Special Cause Variation	13
2.3.3 Statistical Laws Governing Common Cause Variation	14
2.4 Critical Chain Project Management: Single Project Case	15
2.4.1 Identify the Constraint–Critical Chain.....	15
2.4.2 Exploit the Constraint–Project Activity Estimates.....	17
2.4.3 Subordinate Everything Else to the Above Decision.....	18
2.4.3.1 Subordinate Non Critical Chain Paths	18
2.4.3.2 Subordinate to The Constraint–Project Buffer (PB).....	18
2.4.3.3 Subordinate Merging Paths–Feeding Buffer (FB).....	18
2.4.4 Roadrunner Mentality	19
2.4.5 Elevate Activity Performance by Eliminating Multitasking.....	20
2.4.6 Buffer Management Process	20
2.4.7 Project Buffer and Feeding Buffer Sizing Approaches	21
2.4.7.1 Cut and Paste Method (C&PM).....	22
2.4.7.2 Root Square Error Method (RSEM)	22
2.4.7.3 Buffer sizing in single project case.....	24
2.5 Critical Chain Project Management: Multi Project Case.....	27
2.5.1 The Impact of Multitasking	27
2.5.2 Resource Leveling	29
2.5.3 Resource Buffering	30
2.5.4 Multi-Project Critical Chain Methodology.....	30
2.5.5 Exploit Multi Project Resource Allocation.....	31
2.5.6 Buffer sizing in multi project case.....	32

CHAPTER III RESEARCH METHODOLOGY.....	35
3.1 Research Framework and Model	35
3.2 Research Methodologies and Tools	36
3.3 Steps of The Research Process	40
3.3.1 Set-up of the Computational Experiment	40
3.3.2 Random Sampling	41
3.3.3 Data Analysis	44
3.3.4 Running a One-way Repeated-Measures ANOVA in SPSS	46
3.4 Expected Research Outcomes.....	47
3.5 Research Limitations	48
CHAPTER IV RESEARCH RESULT	49
4.1 Special Case (3 subproject).....	49
4.1.1 Case S1: 3 subprojects are identical.....	49
4.1.2 Case S2: 3 subprojects are different (subprojects might not be in the same level)	55
4.2 Case 1-1: The subprojects are identical and low level.....	84
4.3 Case 1-2: The subprojects are identical and medium level.....	92
4.4 Case 1-3: The subprojects are identical and high level.....	100
4.5 Case 2-1:The subprojects are different and low level.....	108
4.6 Case 2-2: The subprojects are different and medium level.....	116
4.7 Case 2-3:The subprojects are different and high level.....	124
CHAPTER V CONCLUSIONS AND FURTHER RESEARCH	132
5.1 Conclusion	132
5.2 Further Research	137
REFERENCES.....	138
APPENDIX A : GENERATING PROJECT NETWORK INSTANCES	143
APPENDIX B : EXAMPLE OF PROGRAM	146

LIST OF TABLES

Table 2-1 Data for example project	16
Table 2-2 Critical path analysis.....	17
Table 2-3 show the excluded contingency duration for project network example in Figure 2-5.....	17
Table 2-4 Excluded contingency duration by using C&PM and RSEM	25
Table 2-5 project buffer and feeding buffers which used C&PM 50%, 40%, 30%, 20%, 10% and RSEM	25
Table 2-6 comparison among project due date corresponding with C&PM 50%, 40%, 30%, 20%, 10% and RSEM.....	26
Table 2-7 Estimated duration of each activity in subproject.....	33
Table 2-8 The excluded contingency duration by C&PM and RSEM.....	33
Table 2-9 The project buffer and feeding buffers calculated by C&PM and RSEM..	33
Table 2-10 Master project due date corresponding to each buffer sizing method	34
Table 3-1 Parameter setting for experiment.....	36
Table 3-2 The order number of 100 networks instance which obtained from random sampling.....	42
Table 3-3 Example results of a one-factor within subject experiment.....	44
Table 4-1 The within-Subject Factor list and Descriptive Statistics table (3 subprojects Identical Low).....	49
Table 4-2 Mauchly's test of Sphericity and value of epsilon for more conservative test (3 subprojects Identical Low).....	50
Table 4-3 ANOVA summary table (3 subprojects Identical Low).....	51
Table 4-4 The results of the pairwise comparisons (3 subprojects are identical and low level)	52
Table 4-5 Descriptive Statistics table (3 subprojects are identical and medium level)	52
Table 4-6 The results of the pairwise comparisons (3 subprojects are identical and medium level)	53
Table 4-7 Descriptive Statistics table (3 subprojects are identical and high level)	54
Table 4-8 The results of the pairwise comparisons (3 subprojects are identical and high level)	55
Table 5-1 Experiment result conclusion (special case: 3 subprojects)	133
Table 5-2 Experiment result conclusion (Identical case).....	134
Table 5-3 Experiment result conclusion (different case)	136
Table 5-4 Experiment result conclusion (mix case).....	137

LIST OF FIGURES

Figure 1-1	Overview of Project Management Knowledge Areas and Project Management Process.	3
Figure 1-2	Project Time Management Overview.	4
Figure 2-1	Model of the Probability distribution of activity times for the PERT three-estimate approach	7
Figure 2-2	Typical Project Activity Performance Time Probability Distributions.....	9
Figure 2-3	People perform most activities, and most people follow the student syndrome performance curve.....	10
Figure 2-4	Multitasking Extend Activity Duration.....	11
Figure 2-5	Network for example project	16
Figure 2-6	Baseline schedule using CPM.....	16
Figure 2-7	Comparison between PERT and CCPM with regard to safety time.	18
Figure 2-8	The location of Feeding Buffer.	19
Figure 2-9	Critical chain representation of project network example in figure 2-5 .	19
Figure 2-10	Buffer penetration provides the essential measurement for CCPM project control.	21
Figure 2-11	For long projects, it may prove useful to plot buffer penetration vs. time.	21
Figure 2-12	An example using Cut and Paste Method (C&PM).....	22
Figure 2-13	An example using the root square error method (RSEM).....	24
Figure 2-14	Two project schedules, no resource conflicts	24
Figure 2-15	Gantt chart showed a comparison among project due date corresponding with each buffer sizing method.....	26
Figure 2-16	Two project schedules, no resource conflicts	27
Figure 2-17	Two project schedules, limited resource, multi-tasking.....	27
Figure 2-18	A Two project schedules, limited resource, no multi-tasking.....	28
Figure 2-20	A single-project schedule after resource-leveling.	29
Figure 2-19	A single-project schedule with a proposal for resource assignments ...	29
Figure 2-21	A resource buffer warns the PM of a potential resource conflict.	30
Figure 2-22	A Multi-project critical chain scenario	31
Figure 2-23	Network for the example of master project.....	32
Figure 2-24	Net Network for each subproject.	32
Figure 2-25	Gantt chart showing master project duration corresponding to C&PM 50%	34
Figure 3-1	The precedence of an example master project	35
Figure 3-2	Network instance by setting $n = 10$, $OS = 0.2$, $RF = 0.3$ and $RC = 0.3$. (Low level).....	37
Figure 3-3	Network in Figure 3-2 viewing in Patterson format	37
Figure 3-4	Editplus could compile Java code.	38
Figure 3-5	Editplus include color coding for most programming languages..	39
Figure 3-6	SPSS for Windows: A software system for data management and analysis.....	39
Figure 3-7	Three subprojects case II (all the subprojects are different).	41
Figure 3-8	Analyze>General Linear Model>Repeated Measure.....	46

Figure 3-9	Name the within-subject factor.	46
Figure 3-10	Identify the variable which makes up the within-subject factor.	46
Figure 3-11	Request a table of means and graph of estimated marginal.....	47
Figure 4-1	Profile Plots (3 subprojects are identical and low level).....	51
Figure 4-2	Profile Plots (3 subprojects are identical and medium level).....	54
Figure 4-3	Profile Plots (3 subprojects are identical and high level).....	54
Figure 4-4	SPSS print out (LLL)	56
Figure 4-5	SPSS print out (LLM)	57
Figure 4-6	SPSS print out (LML)	58
Figure 4-7	SPSS print out (MLL).....	59
Figure 4-8	SPSS print out (LLH).....	60
Figure 4-9	SPSS print out (LHL).....	61
Figure 4-10	SPSS print out (HLL).....	62
Figure 4-11	SPSS print out (MMM).....	63
Figure 4-12	SPSS print out (MML).....	64
Figure 4-13	SPSS print out (MLM).....	65
Figure 4-14	SPSS print out (LMM).....	66
Figure 4-15	SPSS print out (MMH).....	67
Figure 4-16	SPSS print out (MHM).....	68
Figure 4-17	SPSS print out (HMM).....	69
Figure 4-18	SPSS print out (LMH).....	70
Figure 4-19	SPSS print out (LHM).....	71
Figure 4-20	SPSS print out (MLH).....	72
Figure 4-21	SPSS print out (MHL).....	73
Figure 4-22	SPSS print out (HML).....	74
Figure 4-23	SPSS print out (HLM).....	75
Figure 4-24	SPSS print out (HHH).....	76
Figure 4-25	SPSS print out (HHL)	77
Figure 4-26	SPSS print out (HLH)	78
Figure 4-27	SPSS print out (LHH)	79
Figure 4-28	SPSS print out (HHM)	80
Figure 4-29	SPSS print out (HML).....	81
Figure 4-30	SPSS print out (MHH)	82
Figure 4-31	SPSS print out (Identical 4L)	84
Figure 4-32	SPSS print out (Identical 5L)	85
Figure 4-33	SPSS print out (Identical 6L)	86
Figure 4-34	SPSS print out (Identical 7L)	87
Figure 4-35	SPSS print out (Identical 8L)	88
Figure 4-36	SPSS print out (Identical 9L)	89
Figure 4-37	SPSS print out (Identical 10L)	90
Figure 4-38	SPSS print out (Identical mix L).....	91
Figure 4-39	SPSS print out (Identical 4M).....	92
Figure 4-40	SPSS print out (Identical 5M).....	93
Figure 4-41	SPSS print out (Identical 6M)	94
Figure 4-42	SPSS print out (Identical 7M).....	95
Figure 4-43	SPSS print out (Identical 8M).....	96
Figure 4-44	SPSS print out (Identical 9M).....	97
Figure 4-45	SPSS print out (Identical 10M).....	98
Figure 4-46	SPSS print out (Identical mix M).....	99
Figure 4-47	SPSS print out (Identical 4 H).....	100

Figure 4-48	SPSS print out (Identical 5 H).....	101
Figure 4-49	SPSS print out (Identical 6 H).....	102
Figure 4-50	SPSS print out (Identical 7 H).....	103
Figure 4-51	SPSS print out (Identical 8 H).....	104
Figure 4-52	SPSS print out (Identical 9 H).....	105
Figure 4-53	SPSS print out (Identical 10 H).....	106
Figure 4-54	SPSS print out (Identical mix H)	107
Figure 4-55	SPSS print out (different 4 L)	108
Figure 4-56	SPSS print out (different 5 L)	109
Figure 4-57	SPSS print out (different 6 L)	110
Figure 4-58	SPSS print out (different 7 L)	111
Figure 4-59	SPSS print out (different 8 L)	112
Figure 4-60	SPSS print out (different 9 L)	113
Figure 4-61	SPSS print out (different 10 L)	114
Figure 4-62	SPSS print out (different mix L)	115
Figure 4-63	SPSS print out (different 4 M)	116
Figure 4-64	SPSS print out (different 5 M)	117
Figure 4-65	SPSS print out (different 6 M)	118
Figure 4-66	SPSS print out (different 7 M)	119
Figure 4-67	SPSS print out (different 8 M)	120
Figure 4-68	SPSS print out (different 9 M)	121
Figure 4-69	SPSS print out (different 10 M)	122
Figure 4-70	SPSS print out (different mix M)	123
Figure 4-71	SPSS print out (different 4 H).....	124
Figure 4-72	SPSS print out (different 5 H).....	125
Figure 4-73	SPSS print out (different 6 H).....	126
Figure 4-74	SPSS print out (different 7 H).....	127
Figure 4-75	SPSS print out (different 8 H).....	128
Figure 4-76	SPSS print out (different 9 H).....	129
Figure 4-77	SPSS print out (different 10 H).....	130
Figure 4-78	SPSS print out (different mix H).....	131

List of Symbols

α	Probability of a type I error, Significant level
A ~ B	A is not different form B at significance level of 5%
A > B	A is more than B at significance level of 5%
C&PM	Cut and paste method
C10	C&PM 10%
C20	C&PM 20%
C30	C&PM 30%
C40	C&PM 40%
C50	C&PM 50%
Ccb	Capacity-constraint buffer
CCPM	Critical chain Project Management
Ccr	Capacity-constraint resource
Fb	Feeding buffer
H	High level
L	Low level
M	Medium level
n	The number of activities in subprojects
OS	The order strength
Pb	Project buffer
P-value	Observed significance level
RC	The resource constrainedness
RF	The resource factor
RSEM	Root square error method
TOC	Theory of Constraints