A FIETHODOLOGY FOR SELECTING AND ASSIGNING CONTRACTORS FOR CONSTRUCTION PROJECTS IN THE MAHAWELI DEVELOPHENT PROGRAMME

by

H.H.PADMASIRI PREMAKUMARA BSc Eng(Hons), CEng, MIE(SL), MICE(London)

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ENGINEERING IN CONSTRUCTION MANAGEMENT

500000 ලාකාම්ත වස්ව විද්යාලය. ම් ලංකාම මොරටුව. February 1995

670182

Supervised by Dr. N.D.Gunawardena

624 "95" 69.003.2

MRA "

DEPARTMENT OF CIVIL ENGINEERING FACULTY OF ENGINEERING UNIVERSITY OF MORATUNA

67986

10

ABSTRACT

Most of the construction works in the Mahaweli Development Project have been carried out through crash programmes. Even though, the project planning is vital for the economical and successful completion of any construction project this important aspect has not been given due recognition during the execution of downstream development works of the Mahaweli project. Instead of the proper project planning, the experience and knowledge of the Engineering staff with regard to the works and the performance of the allocating contractors have been used for works for the contractors. Although, this has resulted in achieving the targets of the scheduled programme, in many cases there have been failures too.

University of Moratuwa, Sri Lanka.

Three models were developed for selecting and assigning contractors for three types of contracts used in the Mahaweli Development Project namely, Tendered Contracts, Fixed Rate Contracts and Labour Contracts.

So far, no action has been taken to measure the performance level of the contractors and the performance standards to be maintained in respect of construction works in achieving the targets which are the main factors considered in the above models. As these are the most significant factors used in planning a construction project, this study reveals that the collection of performance data of contractors will be very useful in carring out future projects of similar nature.

This research project also investigates the ways and means of determining the performance standards of different contractors as well as the standards of performance required by different construction activities for timely completion of the projects.

11

Furthermore, recommendations are made regarding the planning techniques that could be adopted for various types of contracts encountered in projects of a similar nature.

.



7. Y

s.

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

ACKNOWLEDGEMENTS

ļ

Author wishes to express his sincere gratitude to all those who assisted him in his challenging task of producing this dissertation with much success. Undoubtedly, this dissertation would not have been a possibility if it were not for their valuable assistance. Particular mention has essentially to be made on

(1). Dr. Neranjan Gunawardana, who is the project supervisor for this dissertation and whose guidance, knowledge, interest and above all his dedication constituted a blessing for a better product.

(2). Dr. A. K. W. Jayawardena, the project coordinator for the post graduate course 92/93, for his continuous encouragement and valuable advices for the completion.

(3). Generally, Senior Engineers of Mahaweli Development Project who contributed their invaluable suggestions and specially Mr. K.A.D.S. Chandrasiri, Mr. Mahinda Panapitiya, Mr X.V. Coonghe, Mr. G.A. Kumaranayaka, Mr R.B. Tennakoon, who spent their invaluable time for expressing their views and opinions on the content of this dissertation.

(4). The MECA Contract Branch for granting permission to use the relevant contract data.

(5). Mr. K.A.D.S. Chandrasiri and Mr. P.D.S. Perera for their kind help and assistance in preparing the report.

(6) Finally, I am grateful to my wife, Kumari, who always encourage me in numerous ways to achieve my goals. All other well wishers, who provided necessary courage in making this dissertation a reality.

iv

TABLE OF CONTENTS.

3

Ľ

.

		Page
Abstract		i i
Acknowledgemen	ts	iv
Table of Conte	nts	v
List of Abbrev	iations	viii
List of Tables		ix
List of Figure:	S	xiii
Chapter One	1.0 Introduction	2
	1.1 Background	2
	1.2 Objectives	7
	1.3 Methodology	7
	1.4 Collection Of Data	8
	1.5 Main Findings	8
Chapter Two	2.0 Literature Surveyions	11
-	2.1 Introduction	11
	2.2 Methods Used for Selection of	11
	Contractors for Mahaweli Works	
	2.3 Determination of Productivity of	25
	Contractors	
	2.4 Optimization Techniques Available	28
	for Selection of Contractors	
Chapter Three	3.0 Construction Work and Existing	35
	Practice of Selection of	
	Contractors for Mahaweli Downstream	
	Development Norks	
	3.1 Introduction to the Project	35
	and Construction Works	
	3.2 Method Of Construction	36
	3.3 Existing Practice of Selecting	36
	Contractors for Mahaweli Works	

.

•

v

		Page
	3.4 Introduction of Crash Programme for	39
	Zone 03 and Zone 4A Areas	
Chapter Four	4.0 Development of Selection Model for	42
	Tendered Contracts, Fixed Rate	
	Contracts & Labour Contracts	
	4.1 Formulation of a Better Selection	42
	Model for Tendered Contracts	
	4.2 Formulation of a Better Model for	48
	Assigning Contractors to Different	
	Packages under Fixed Rate Contracts	
	4.3 Formulation of a Better Model for	49
	Assigning Contractors for Labour	
	Contracts	
Chapter Five	5.0 Data Collection & Data Analysis	53
	5.1 Data Collection	53
	5.2 Data Analysis for the Computation of	56
	Productivity Rates	
	5.3 Data Analysis for Developing a	61
	Better Selection Model for	
	Tendered Contracts	
	5.4 Analysis of Data for the Model	80
·	used in Assigning Contractors to	
	Fixed Rate Contracts	
	5.5 Analysis of Data for the Model	86
	used in Assigning Contractors to	
	Labour Contracts	
	5.6 The Consistency of Data	90
Chapter Six	6.0 Views of Experts	97
	6.1 The Views of Expert No. 01	97
	6.2 The Views of Expert No. 02	99
	6.3 The Views of Expert No. 03	101

r

vi

		Page
	6.4 The Views of Expert No. 04	103
	6.5 The Views of Expert No. 05	104
	6.6 Comment on the Experts' Views	106
Chapter Seven	7.0 Conclusions and Recommendations	109
	7.1 Conclusions	109
	7.2 Recommendations	112
References		114
Appendix A :	Area Maps of the Mahaweli Programme	115
	System B	
Appendix B :	Observation Forms for Earthwork Operations	120
Appendix C :	Shadow Prices and Conversion Factors	149
	used in Sri Lanka	

r

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



List of Abbreviations

7

4

BOQQ.	- Bill Of Quantities
Bu.	- Bushels
CECB	- Central Engineering Consultancy Bureau
CF	- Conversion Factor
Cu.	- Cubes
DRE	- Divisional Resident Engineer
Не	- Hectare
M	- Million
MASL	- Mahaweli Authority Of Sri Lanka
MCM	- Million Cubic Metre
MECA	- Mahaweli Engineering & Construction Agency
OH & PF	- Overhead & profit factor
psi	- Pounds per square inch
RPD	- Resident Project Director
Z – D	- Zacry - Dillingham Joint Venture

List of Tables

¥

7

+

4

Page

Table 5.1	Computation of mean productivity rate and	56
	standard deviation for Contractor D	
Table 5.2	Mean hourly production rates and standard	58
	deviations for contractors	
Table 5.3	Computation of mean productivity rate and	59
	standard deviation for Contractor 01,	
	Canal Category - 01	
Table 5.4	Mean hourly production rates and standard	61
	deviations for canal excavation	
Table 5.5	Contract packages for Zone 04A development	61
Table 5.6	The performances of the contractor who have	63
	bidden for the development works of Zone 04A	
Table 5.7	Bid values of the contractors (A, B, D, E, F, G&H)	66
	for the contract packages (P,Q,R,S&T)	
Table 5.8	Estimated time durations taken by contractors	67
	for the contract packages (P,Q,R,S&T)	
Table 5.9	Relationship between the fill quantity and	68
	the command area for each contract	
Table 5.10	Forecast of the incomplete quantity of	69
	earthwork/corresponding turnout area by the	
	end of the contract period.	
Table 5.11	Monthly payment details of MECA supervision	71
	staff and other charges pertaining to supervision	
Table 5.12	Supervision staff arrangement for balance work	73
Table 5.13	Delay cost	74
Table 5.14	Priority order of the contract packages for	81
	the development of Mahawelitanna Unit	
Table 5.15	Works already awarded to the above contractors	82
	through tendered contracts and the time	
	duration taken to complete the work in hand	

		Page
Table 5.16	Available contractors to be considered for	82
	awarding the package no. Ol	
Table 5.17	Time duration taken by these contractors to	83
	complete the package no. Ol	
Table 5.18	Awarding of the package no. 01	83
Table 5.19	Construction programme for the development	84
	works of Mahawelitanna Unit	
Table 5.20	Works already awarded and their progress	85
Table 5.21	Manual excavation outputs for different	86
	categories of canals	
Table 5.22	Approved MECA rates for excavation works	87
Table 5.23	Maximum depth of cut for each category of	87
	canal	
Table 5.24	Maximum quantity of earthwork that can be	88
	included in each category of excavation	
	package Bectronic Theses & Dissertations	
Table 5.25	Rate of excavation for different categories	89
	of canals	
Table 5.26	Number of labourers to be employed for	89
	different categories of canals	
Table 5.27	Specimen calculation for the mean Hourly	90
	production rate of Contractor C during the	
	actual execution of earthworks	
Table 5.28	Specimen calculation for the mean Hourly	92
	production rate of canal excavation,	
	Category-01, during the actual execution of	
	earthworks	
Table 5.29	Comparison of performance rates derived from	94
	past records with which observed during the	
	actual execution of the work.	
	Observation form for Contractor D	120
	Observation form for Contractor E	121
Table B.3	Observation form for Contractor B	123

4

х

					·			Page
Table	B.4	Observation	form	for	Contractor	С		124
Table	B.5	Observation	form	for	Contractor	A		126
Table	B.6	Observation	form	for	Contractor	01,	Canal	128
		Category-01						
Table	8.7	Observation	form	for	Contractor	02,	Canal	129
		Category-01						
Table	B.8	Observation	form	for	Contractor	03,	Canal	131
		Category-01						
Table	B.9	Observation	form	for	Contractor	04,	Canal	132
		Category-01						
Table	B.10	Observation	form	for	Contractor	05,	Canal	133
		Category-01						
Table	B.11	Observation	form	for	Contractor	01,	Canal	135
		Category-02						
Table	B.12	Observation	form	for	Contractor	02,	Canal	136
		Category-02	. Electroni www.lib.	ic Theses mrt.ac.II	& Dissertations			
Table	B.13	Observation	form	for	Contractor	03,	Canal	137
		Category-02						
Table	B.14	Observation	form	for	Contractor	04,	Canal	139
		Category-02						
Table	B.15	Observation	form	for	Contractor	05,	Canal	140
		Category-02						
Table	B.16	Observation	form	for	Contractor	01,	Canal	142
		Category-03						
Table	B.17	Observation	form	for	Contractor	02,	Canal	143
		Category-03						
Table	B.18	Observation	form	for	Contractor	03,	Canal	144
		Category-03						
Table	B.19	Observation	form	for	Contractor	04,	Canal	146
		Category-03						
Table	B.20	Observation	form	for	Contractor	05,	Canal	147
		Category-03						

xi

Table C.1 Sectoral, Aggregate and Primary Input Conversion Factors : Basic Results

.

Page

150



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

xii

<u>List Of Figures</u>

		Page
Figure 1.1	Organisation Chart - MECA	5
Figure 2.1	Conversion of frequency density diagram to accumulative frequency diagram	16
Figure 2.2	Conversion of frequency density diagram of lowest mark-up to accumulative frequency diagr	20 am
Figure 2.3	Frequency density diagram of mark-up	21
Figure 3.1	Typical canal sections University of Moratuwa, Sri Lanka, Electronic Theses & Dissertations	37
Figure 5.1	A Typical Observation Form	55
Figure A.1	Lay Out Plan – System `B'	116
Figure A.2	Lay Out Plan – System `B´, Left Bank	117
Figure A.3	Lay Out Plan – Mahawelitanna Unit	118
Figure A.4	Lay Out Plan – Mahawelitanna Unit (Detail Of Earthwork & Contract Packages)	119