# AN ACTIVITY-BASED COST CONTROLLING MODEL FOR IMPROVING THE MANAGEMENT OF CONSTRUCTION PROJECT OVERHEADS

**Nyoman Martha JAYA**

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# AN ACTIVITY-BASED COST CONTROLLING MODEL FOR IMPROVING THE MANAGEMENT OF CONSTRUCTION PROJECT OVERHEADS

**Nyoman Martha JAYA**

School of the Built Environment

University of Salford, Salford, UK

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**Table of Contents**

Table of Contents ....... i
List of Figures ....... xii
List of Tables ....... xiv
List of Abbreviations ....... xvii
Acknowledgements ....... xviii
Dedication ....... xix
Declaration ....... xx
Abstract ....... xxi
CHAPTER 1. Introduction ....... 1
1.1. Research Background ....... 1
1.2. Statement of the Research Problem ....... 4
1.3. Research Questions ....... 10
1.4. Research Aim ....... 10
1.5. Research Objectives ....... 10
1.6. Research Scope and Limitations ....... 11
1.7. Research Methodology ....... 12
1.8. Structure of the Thesis ....... 14
1.9. Summary ....... 16
CHAPTER 2. Literature Synthesis ....... 17
2.1. Introduction ....... 17
2.2. Construction Industry ....... 17
2.2.1. The UK Construction Industry ....... 19
2.2.2. Indonesian Construction Industry ....... 20
2.3. Construction Projects ....... 24
2.3.1. Residential Building ....... 25
2.3.2. Commercial Building ....... 25

2.3.3. Infrastructure and Heavy Engineering ............................................25
2.3.4. Industrial Buildings...................................................................26
2.3.5. Justification on Commercial Building's Focus ....................................26
2.3.6. Importance of Project Overheads ..................................................27
2.4. Project Overheads ...........................................................................29
2.4.1. Definition of Overheads ..............................................................29
2.4.2. Classification of Overheads .........................................................30
2.4.3. Identification of Site-Project Overheads ..........................................32
2.4.3.1. Unit-Level Overheads ............................................................33
2.4.3.2. Batch-Level Overheads...........................................................33
2.4.3.3. Project-Sustaining Overheads ..................................................34
2.4.3.4. Facility-Sustaining Overheads ..................................................34
2.5. Cost Management and Controlling Practices (CMCPs) of Project Overheads: the Potential Challenges ..............................................................35
2.6. Identification of Critical Success Factors (CSFs) for the Management of Project Overheads ........................................................................37
2.7. Preliminary Groups of Critical Success Factors (CSFs) for Cost Management and Controlling Practices (CMCPs)...............................................43
2.7.1. Understanding the Market Conditions (MARCON) ..............................45
2.7.2. Project Development Focus (DEVFOC).............................................47
2.7.3. Requirement of Investment and Technology (INVTEC) .......................49
2.7.4. Mapping Local Availability of Required Resources (LOCRES) ...............50
2.7.5. Managing the Company's Interest and Project Benefit (INTBEN) .........52
2.7.6. Managing the Nature of Project Complexity (PROCOM).......................53
2.7.7. Improving Contractors' Current Roles in Practice (ROPRAC)................54
2.7.8. Requirement for a Robust Method and Tool (METOOL).......................56
2.8. The Most Important CSFs under Four Evaluation Criteria of Construction Projects ..........................................................................................58
2.9. Activity-Based Costing (ABC) System .....................................................59

2.9.1. Underpinning Philosophy of the ABC System ....................................60
2.9.1.1. Concept of the ABC System ......................................................60
2.9.1.2. Definition of the ABC System ....................................................61
2.9.1.3. Philosophy of the ABC System ..................................................65
2.9.1.4. Cost Drivers.........................................................................66
Unit Level ...........................................................................................66
Batch Level .........................................................................................67
Project Sustaining..................................................................................67
Facility Sustaining..................................................................................68
2.9.2. The Traditional Costing versus the ABC System.................................68
2.9.2.1. Cost Allocation Process............................................................68
2.9.2.2. Major Criteria for Different Costing Systems................................69
2.9.3. Application of the ABC System in Construction Projects ......................71
2.9.3.1. Adaptation of the ABC system in Construction Companies ............71
2.9.3.2. Application of the ABC System in Construction Projects ................73
2.10. Summary ..........................................................................................75
CHAPTER 3. Development of the Activity-Based Cost Controlling (ABCC) Model ...76
3.1. Introduction.........................................................................................76
3.2. Conceptual Research Model ..................................................................77
3.3. Structure of the Activity-Based Cost Controlling (ABCC) Model ..................79
3.4. Description of the Activity-Based Cost Controlling (ABCC) Model ...............81
3.5. Project Cost Measurement Model ..........................................................86
3.6. Cost Management and Controlling Practices (CMCPs) ...............................90
3.7. Summary ............................................................................................92
CHAPTER 4. Research Methodology ..................................................................93
4.1. Introduction.........................................................................................93
4.2. Research Philosophy..............................................................................94
4.2.1. Ontology .........................................................................................95

4.2.2. Epistemology ........ 98
4.2.3. Axiology ........ 99
4.2.4. Positioning the Research Stance ........ 100
4.3. Research Strategy ........ 101
4.4. Research Design ........ 104
4.4.1. Literature Review ........ 106
4.4.2. Questionnaire Survey ........ 108
4.4.3. Project Documentation and Direct Observations ........ 109
4.4.4. Semi-structured Interviews ........ 110
4.4.5. Research Findings ........ 110
4.5. Research Methods ........ 111
4.5.1. Quantitative Methods ........ 111
4.5.2. Qualitative Methods ........ 112
4.5.3. Mixed Methods ........ 112
4.6. Research Techniques and Procedures ........ 114
4.6.1. Research Protocol ........ 115
4.6.2. Research Activities ........ 118
4.6.3. Justification of Research Techniques to the Aim and Objectives ........ 120
4.6.3.1. The Aim of the Research ........ 120
4.6.3.2. The First and Second Research Objectives ........ 121
4.6.3.3. The Third Research Objective ........ 121
4.6.3.4. The Fourth Research Objective ........ 123
4.6.3.5. The Fifth Research Objective ........ 123
4.7. Data Collection ........ 124
4.7.1. Probability Sampling ........ 125
4.7.2. Non-probability Sampling ........ 125
4.7.3. Purposive Sampling ........ 126
4.7.4. Justification of Data Collection to the Research Questions ........ 127
4.7.4.1. The First and Second Research Questions ........ 127

4.7.4.2. The Third and Fourth Research Questions ............................... 129
4.7.4.3. The Third and Fifth Research Questions ................................. 129
4.7.5. Determination of Project Case Studies ........................................ 130
4.7.6. Pilot Case Study ........................................................................ 130
4.7.7. Indonesian Construction Projects ............................................... 131
4.7.8. Project Cases ............................................................................. 132
4.8. Data Analysis ................................................................................. 136
4.8.1. Analysis of Questionnaire Data ................................................... 137
4.8.1.1. Data Analysis for Identification of Project Overheads................. 138
4.8.1.2. Data Analysis for Prioritisation of Critical Success Factors (CSFs). 140
4.8.2. Analysis of Case Study Data ....................................................... 146
4.8.2.1. Cost Measurement and Analysis of the Activity-Based Cost Controlling (ABCC) Model ............................................................... 146
4.8.2.2. Cost Management and Controlling Practices (CMCPs) of Project Overheads ............................................................................... 148
4.8.3. Analysis of Interview Data .......................................................... 150
4.8.3.1. Content Analysis Techniques ................................................. 151
4.8.3.2. Cognitive Mapping Techniques ............................................... 152
4.8.4. Validation of Development of the Activity-Based Cost Controlling (ABCC) Model ............................................................... 153
4.8.5. Expert Interview Findings ........................................................... 153
4.8.6. Theme A - the Management of Project Overheads ......................... 157
4.8.7. Theme B - the Activity-Based Costing (ABC) System....................... 160
4.8.8. Theme C - the Cost Management and Controlling Practices (CMCPs) of Project Overheads ............................................................. 161
4.9. Summary ....................................................................................... 163
CHAPTER 5. Findings and Analysis ........................................................... 165
5.1. Introduction ................................................................................... 165
5.2. Analysis of Identification of Project Overheads during the Construction Stage ............................................................................................. 166
5.2.1. Literature Review Findings on Identification of Project Overheads ..... 166

5.2.2. Questionnaire Survey Findings on Identification of Project Overheads 166
5.2.3. Descriptive Statistical Analysis for Identification of Project Overheads 169
5.3. Analysis of Critical Success Factors (CSFs) for Improving the Management of Project Overheads 172
5.3.1. Literature Review Findings of the CSFs 172
5.3.2. Questionnaire Survey Findings of the CSFs 172
5.3.3. Determining Relative Importance of the Evaluation-criteria 174
5.3.3.1. Pair-wise Comparisons of the Evaluation-criteria 175
5.3.3.2. Eigenvector Solution of the Evaluation-criteria 177
5.3.3.3. Consistency of the Evaluation-criteria 179
5.3.4. Determining Relative Importance of the CSF-alternatives 180
5.3.5. The Solution through the AHP Tree 183
5.4. Analysis of the Activity-Based Cost Controlling (ABCC) Model for Improving the Management of Project Overheads 186
5.4.1. Literature Review Findings on the Development of the ABCC Model 187
5.4.2. Case Study Findings for Implementation of the ABCC Model 188
5.4.3. Cost Analysis and Procedures of the ABCC Model 188
5.4.3.1. Identification of Project Overheads and their Cost Accounts 190
5.4.3.2. Categorisation of Project Overhead Cost Pools Related to Activities 191
5.4.3.3. Idealisation of Quantity Drivers of Project Overheads 195
Calculation Example of Ideal Quantity Drivers 195
5.4.3.4. Analysis of Ideal Cost Drivers of Project Overheads 196
Calculation Example of Ideal Cost Drivers 197
5.4.3.5. Allocation of Project Overheads to Activity Cost Objects 197
Calculation Example of Activity Cost Objects 198
5.4.3.6. Determination of Activity Driver Rates of Project Overheads 198
Calculation Example of Activity Driver Rates 199
5.4.4. Summary of the Cost Analysis and Procedures of the ABCC Model 200
5.4.5. Cost Management and Controlling Practices (CMCPs) of Project Overheads 201

5.4.5.1. Activity Cost Schedule ............................................................201
5.4.5.2. Project Case Studies...............................................................205
Calculation Example of Overhead Cost Changes ......................................206
Justification for Calculation Result of Cost Changes..................................206
5.4.5.3. Project Cost Control ...............................................................207
Calculation Example for Present Status of Cost Performance Ratio.............208
Interpretation for the Calculation Result of Value and Schedule Ratio (VSR)208
Interpretation for the Calculation Result of Value and Expenses Ratio (VER)209
5.4.5.4. Future Forecast of Cost Performance Index ...............................209
Calculation Example for Future Forecast of Cost Performance Index ..........210
Interpretation for Calculation Result of Estimate at Completion forecast-EAC$f$ ..........................................................................................212
5.4.5.5. Worst Case Scenario (WCS) of the CMCPs' Tools and Techniques212
Calculation Example for the Worst Case Scenario (WCS)...........................213
Interpretation for Calculation Result of the Worst Case Scenario (WCS).....213
5.5. Validation of the ABCC Model through Content Analysis and Cognitive Mapping ..........................................................................................216
5.5.1. Senior Management Perspectives of the Themes for Validation of the ABCC Model ..........................................................................217
5.5.1.1. Senior Management Perspectives on Management of Project Overheads for Development of the ABCC Model .......................................218
5.5.1.2. Senior Management Perspectives on the ABC System for Development of the ABCC Model .............................................................220
5.5.1.3. Senior Management Perspectives on Development of the ABCC Model to Improve the CMCPs of Project Overheads .................................221
5.5.2. Operational Management Perspectives of the Themes for Validation of the ABCC Model...................................................................223
5.5.2.1. Operational Management Perspectives on Management of Project Overheads for Development of the ABCC Model .......................................224
5.5.2.2. Operational Management Perspectives on the ABC System for Development of the ABCC Model .............................................................226
5.5.2.3. Operational Management Perspectives on Development of the ABCC Model to Improve the CMCPs of Project Overheads ..........................228
5.6. Summary..........................................................................................232

CHAPTER 6. Discussion ........................................................................ 234
6.1. Introduction ........................................................................ 234
6.2. The Management of Construction Project Overheads ........................................................................ 236
6.2.1. Overview of Construction Project Overheads ........................................................................ 236
6.2.2. Identification of Construction Project Overheads ........................................................................ 237
6.2.3. Construction Project Overheads ........................................................................ 238
6.3. The Most Critical Success Factors (CSFs) for Improving the Management of Construction Project Overheads ........................................................................ 241
6.3.1. Overview of Critical Success Factors (CSFs) ........................................................................ 241
6.3.2. Identification of Critical Success Factors (CSFs) ........................................................................ 242
6.3.3. The Most Important CSFs for Improving the Management of Construction Project Overheads ........................................................................ 245
6.3.3.1. Relative Importance of Four Evaluation-criteria ........................................................................ 246
6.3.3.2. Relative Importance of Eight CSF-alternatives under Four Evaluation-criteria ........................................................................ 248
6.3.3.3. Relative Importance Ranking of Eight CSF-alternatives through AHP Solution Tree ........................................................................ 251
6.3.4. Implication of the Most Important CSFs ........................................................................ 252
6.4. The Activity-Based Cost Controlling (ABCC) Model for Improving the Management of Construction Project Overheads ........................................................................ 254
6.4.1. Overview of the ABCC Model ........................................................................ 254
6.4.2. Implementation of the ABCC model ........................................................................ 255
6.5. The Cost Management and Controlling Practices (CMCPs) Tools and Techniques of Construction Project Overheads ........................................................................ 255
6.5.1. Overview of the CMCPs ........................................................................ 256
6.5.2. Implementation of the CMCPs ........................................................................ 256
6.6. Summary ........................................................................ 260
CHAPTER 7. Conclusion and Recommendations ........................................................................ 262
7.1. Introduction ........................................................................ 262
7.1.1. Academic Milieu ........................................................................ 263

7.1.2. Project Practices ........................................................................ 264
7.1.3. Organisational Advantages .............................................................. 265
7.2. The Overview of the Research Aim and Objectives ................................... 266
7.2.1. The First Research Objective; Identification of project overheads ...... 266
7.2.2. The Second Research Objective; Analysis of the Critical Success Factors (CSFs) ........................................................................ 268
7.2.3. The Third Research Objective; Investigation of the Activity-Based Costing (ABC) System .................................................................... 270
7.2.4. The Fourth Research Objective; Development of the ABCC Model and implementation of the CMCPs' Tools and Techniques ....................... 271
7.2.5. The Fifth Research Objective; Validation of the ABCC Model ............. 273
7.3. Conclusions ........................................................................ 274
7.4. Recommendations for Future Research ................................................ 275
7.5. Summary ........................................................................ 276
REFERENCES ........................................................................ 277
APPENDICES ........................................................................ 301
APPENDIX 1: An Example of Project Cost Measures ........................................... 302
Appendix 1: The Ratio of Activity Progress Values (APV) and Actual Project Expenses (APE); an example ........................................................................ 303
APPENDIX 2: Research Instrument ........................................................................ 305
Appendix 2-a: Survey Questionnaire ........................................................................ 306
Appendix 2-b: Interview Guide ........................................................................ 313
APPENDIX 3: Descriptive Statistic Analysis of Project Overheads ......................... 314
Appendix 3-a: Descriptive Statistic Analyses for Identification and Availability of Project Overheads ........................................................................ 315
APPENDIX 4: Analytic Hierarchy Process (AHP) for Critical Success Factors (CSFs) 316
Appendix 4-a: Relative Importance of the Evaluation-criteria .......................... 317
Appendix 4-b: Relative Importance of CSF-alternatives under the Project Type 318

Appendix 4-c: Relative Importance of CSF-alternatives under the Project Phase319
Appendix 4-d: Relative Importance of CSF-alternatives under the Project Monitoring ........................................ 320
Appendix 4-e: Relative Importance of CSF-alternatives under the Project Delivery ........................................ 321
Appendix 4-f: The Solution Matrices through the AHP Tree ........................................ 322
APPENDIX 5: Project Case Studies ........................................ 323
Appendix 5-a: The Case Study Data of Project Overheads for the Resort Project (Basement/ Substructure) ........................................ 324
Appendix 5-b: Cost Measurement and Analysis of the ABCC Model ........................................ 326
Appendix 5-c: Cost Measurement and Analysis of the ABCC Model *(continued)* . 327
Appendix 5-d: The Cost Management and Controlling Practices (CMCPs) of Project Overheads ........................................ 328
Appendix 5-e: The Cost Management and Controlling Practices (CMCPs) of Project Overheads *(continued)* ........................................ 329
Appendix 5-f: The Case Study of the Hospital Project ........................................ 330
Appendix 5-g: The Case Study of the Car-Park Project ........................................ 342
Appendix 5-h: The Case Study of the Villa Project ........................................ 354
Appendix 5-i: The Case Study of the Hotel Project ........................................ 367
APPENDIX 6: Expert Interview Outcomes on Development of the ABCC Model ..... 379
Appendix 6-a: Sample of Expert Interview Transcription ........................................ 380
Appendix 6-b: Senior Management Perspectives for Validation of Development of the ABCC Model ........................................ 383
Appendix 6-c: Operational Management Perspectives for Validation of Development of the ABCC model ........................................ 384
APPENDIX 7: Publication ........................................ 385

Appendix 7: Publications .......................................................................... 386
APPENDIX 8: Administration and Progress ........................................................ 388
Appendix 8-a: Internal Evaluation Confirmation ............................................ 389
Appendix 8-b: The Most Innovative Methodology Award ................................ 390
Appendix 8-c: Documentation of the Research Findings and Results ................ 391

**List of Figures**

Figure 1-1: Overheads Allocation Problem in Construction Projects ........................ 6

Figure 1-2: Cost Accounting Management Problem in Construction Projects ........... 8

Figure 2-1: Key Indicators to the Construction Industry .......................................18

Figure 2-2: The Largest Economy of the Global GDP...........................................20

Figure 2-3: Construction's Economic Indicators in Indonesia .................................23

Figure 2-4: The Cost Allocation Process for the Traditional Costing versus the Activity-Based Costing System........................................................................69

Figure 2-5: Application of the ABC System in Construction Projects .......................73

Figure 3-1: The Conceptual Research Model.......................................................78

Figure 3-2: The Structure of the ABCC Model ......................................................80

Figure 3-3: The Project Phases.........................................................................82

Figure 3-4 : Project Cost Measurement Model ....................................................88

Figure 4-1: The Systematic Research Process 'Onion'...........................................93

Figure 4-2: Philosophical Positioning of the Research...........................................95

Figure 4-3: Basic Type of Designs for Case Studies............................................105

Figure 4-4: Concurrent Activities of the Research ..............................................118

Figure 4-5: Sampling Techniques.....................................................................125

Figure 4-6: Integrated Resort Plan and View ....................................................134

Figure 4-7: Mobilisation and Substructure Activities ..........................................135

Figure 4-8: Range Statistic Analysis for Availability of Project Overheads .............139

Figure 4-9: The Structure of Analytic Hierarchy Process .....................................143

Figure 4-10: Project Cost Measurement and Analysis of the ABCC Model .............147

Figure 4-11: Project Cost Management and Controlling Practices (CMCPs) ...........149

Figure 4-12: Overview to Data Analysis of the Texts .......................................... 151
Figure 4-13: Relationship of the Converging Themes with advantages of the ABCC Model .......................................... 156
Figure 5-1: Weighted Scores of Forty-seven Items of Project Overheads .......................................... 168
Figure 5-2: Range Scores of Forty-seven Items of Project Overheads .......................................... 168
Figure 5-3: Range Statistics Analysis for the Availaility of Project Overheads .......................................... 169
Figure 5-4: The Particular Members of Eight Group CSFs .......................................... 173
Figure 5-5: Four Evaluation-criteria under the Decision Goal .......................................... 174
Figure 5-6: AHP Solution Tree for CSF-alternatives under Evaluation-criteria .......................................... 184
Figure 5-7: The Worst Case Scenario (WCS) in Percentage Budgets for the Cost Performance Indices .......................................... 215
Figure 5-8: Cognitive Map of Senior Management Perspectives for Advantages of the ABCC Model .......................................... 217
Figure 5-9: Cognitive Map of Operational Management Perspectives for Advantages of the ABCC Model .......................................... 224
Figure 6-1: Research Findings and Documentation of the ABCC Model .......................................... 235

**List of Tables**

Table 2-1: Categories and Items of Site-Project Overheads .................................. 34

Table 2-2: Identification of Important CSFs for the Management of Project Overheads ........................................................................................... 40

Table 2-3: Activity Cost Drivers ........................................................................ 67

Table 2-4: Major Differences between the Traditional Costing and the Activity-Based Costing System........................................................................... 70

Table 3-1: RIBA Outline Plan of Work ................................................................ 82

Table 4-1: The Criteria for Different Research Strategies..................................... 102

Table 4-2: Research Protocol ............................................................................ 116

Table 4-3: Project Cases .................................................................................. 133

Table 4-4: The Fundamental Scale of Saaty's Absolute Numbers ......................... 141

Table 4-5: The List of Five Experts ................................................................... 144

Table 4-6: The List of Interviewees ................................................................... 154

Table 4-7: Summary of the Concepts from Senior and Operational Management Levels ............................................................................................................ 158

Table 5-1: The List of Respondents ................................................................... 167

Table 5-2: Matrix Algebra of the Evaluation-criteria ............................................ 177

Table 5-3: Iteration of Squared Matrices of the Evaluation-criteria ....................... 177

Table 5-4: Last Iteration of Squared Matrices of the Evaluation-criteria ................ 178

Table 5-5: Random Inconsistency Index ............................................................ 180

Table 5-6: Matrix Algebra of CSF-alternatives under the Project Type .................. 181

Table 5-7: Iteration of Squared Matrices of CSF-alternatives under the Project Type ............................................................................................................. 181

Table 5-8: Last Iteration of Squared Matrices of CSF-Alternatives under Project Type ........ 182
Table 5-9: Summary of Eigenvectors and Consistency Ratio (CR) ........ 183
Table 5-10: AHP Solution Matrices of CSF-Alternatives under Evaluation-criteria ... 185
Table 5-11: The Ranking Importance of CSF-alternatives ........ 185
Table 5-12: The Priority of Importance of CSF-Alternatives ........ 186
Table 5-13: Actual Cost Data of Project Overheads ........ 190
Table 5-14: Actual Progress Schedules of Substructure Activities ........ 191
Table 5-15: Cost Measurement and Analysis of the ABCC Model ........ 193
Table 5-16: Cost Management and Controlling Practices (CMCPs) ........ 203
Table 5-17: The Worst Case Scenario (WCS) in IDR for the Cost Performance Indices ........ 214
Table 5-18: The Worst Case Scenario (WCS) in Percentage Budgets for the Cost Performance Indices ........ 214
Table 6-1: The 39 Items of Construction Project Overheads ........ 240
Table 6-2: The Eight Groups of Important CSFs with the Focus Area of Construction Project Activities ........ 243
Table 6-3: The Four Evaluation-criteria for the Most Important CSFs of Construction Projects ........ 244
Table 6-4: The Best Eigenvector Solution of Evaluation-criteria for the Decision-goal ........ 246
Table 6-5: Four Matrix Algebras of CSFs under Project Type ........ 248
Table 6-6: Four Matrix Algebras of CSFs under Project Phase ........ 249
Table 6-7: Four Matrix Algebras of CSFs under Project Monitoring ........ 249
Table 6-8: Four Matrix Algebras of CSFs under Project Deliveries ........ 249

Table 6-9: The Best Eigenvector Solution of CSF-alternatives under Evaluation-criteria ........ 250

Table 7-1: List of 47 Items of Project Overheads ........ 267

Table 7-2: List of 39 Construction Project Overheads ........ 268

**List of Abbreviations**

ABC : Activity-Based Costing

ABCC : Activity-Based Cost Controlling

AC : Actual Cost

AD : Activity Duration

AHP : Analytic Hierarchy Process

APE : Actual Project Expenses

APV : Activity Progress Value

BRICs : Brazil, Russia, India, and China

CD : Cost Driver

CMCPs: Cost Management and Controlling Practices

CO : Cost Object

CSFs : Critical Success Factors

DR : Driver Rate

EAC*f* : Estimate at Completion *forecast*

EU : European Union

GDP : Gross Domestic Products

GVA : Gross Value Added

ISO : International Organisation for Standardisation

LPJK-*I* : Lembaga Pengembangan Jasa Konstruksi-*Indonesia* (*Indonesian* Institute for Construction Service Development)

N-11 : Next Eleven Countries

OCS : Overhead Cost Schedule

OECD : Organisation for Economic Cooperation and Development

PPP : Purchasing Power Parity

QD : Quantity Driver

UK : United Kingdom

US : United States

VER : Value/Expenses Ratio

VISTA : Vietnam, Indonesia, South Africa, Turkey, and Argentina

VSR : Value/Schedule Ratio

WCS : Worst Case Scenario

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## Dedication

*I dedicate this piece of research to my dearest Erna, Karis, Sasha, and my brothers and sisters.*

## Declaration

This thesis is submitted under the University of Salford roles and regulations for the award of a PhD degree by research. While the research was in progress, some research findings were published in conference papers, electronic book, poster, and refereed journals prior to this submission (refer to Appendix 7).

The researcher declares that no portion of the work referred to in this thesis has been submitted in support of an application for another degree of qualification of this, or any other university or institution of learning.

Nyoman Martha Jaya

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**Abstract**

The construction industry was considered very important as it contributed a significant part of the Gross Domestic Product (GDP) for the economic development of any country. Construction projects appeared to have high expenditures and complex processes that involved a wide range of participants, stakeholders, investments, and technologies. This continued to increase construction project overheads considerably. Project overheads were common to multiple cost objects, but cannot readily be allocated directly to particular construction activities.

The traditional costing system added project overheads to construction cost on a percentage basis, which often provided inaccurate distributions for most of the activities. The current cost accounting management approach focused too much on satisfying external standard requirements, consequently paying little attention to internal cost management improvements. This research proposed an Activity-Based Cost Controlling (ABCC) model through the identification of overheads in construction projects, the analysis of Critical Success Factors (CSFs), and application of the Activity-Based Costing (ABC) system for improving the Cost Management and Controlling Practices (CMCPs) of construction project overheads. The critical realist philosophical stance with multiple case studies was adopted for this research. Data collection used questionnaire survey, project documentation, observations, and interviews. Data analysis utilised descriptive statistics, Analytic Hierarchy Process (AHP), the ABC system and Earned Value Measurement System (EVMS), content analysis and cognitive mapping.

Forty seven generic overheads were identified, however, eight overheads were eliminated for construction projects. The remaining 39 overheads were the most often present in construction projects and were categorised into Unit, Batch, Project, and Facility levels. 40 CSFs were identified and grouped into eight, out of which three were identified as priority areas (requirement of a robust method and tool - METOOL, understanding the market condition - MARCON, and managing project complexity - PROCOM). The ABCC model was developed using three themes: the construction project overheads, the ABC system, and the CMCPs. The top three priority CSFs were incorporated into the CMCPs' tools and techniques for implementation of the ABCC model. The opinions of experts (senior and operational management levels) were used to validate the ABCC model, which generated 36 concepts that were incorporated into the model during the refinement stage. Therefore, the ABCC model was developed for improving the management of construction project overheads to increase the body of knowledge.

# CHAPTER 1. INTRODUCTION

## 1.1. Research Background

The construction industry generally provides a wide range of opportunities for the development of an economy within the geographic area of any country, both regionally and globally. The global construction industry achieves a financial output of up to £2.95 trillion, and was responsible for 10 per cent of global GDP in the middle of the last decade (General UK Statistics, 2007). According to Hook (2011), recent construction output has been reported at approximately £4.62 trillion representing over 11 per cent of global GDP in the beginning of this decade, and is expected to grow by 67 per cent up to £7.69 trillion by the end of 2020, representing 13.2 per cent of world GDP. Total accumulated expenditures of the construction industry worldwide would be £62.65 trillion during this decade (Hook, 2011). This indicates that the world construction industry continues to grow, despite the current economic downturn.

Construction projects are divided into two categories, civil engineering and building constructions (Kirkham, 2007). This may refer to construction processes, techniques and professionals involved. According to the function of properties, facilities, and utilities of development projects, construction projects are classified into four types, residential, commercial, infrastructure and heavy engineering, and industrial projects, (Hendrickson and Au, 1989; Ostwald, 2001; and Gould and Joyce, 2009). Construction projects may consume lots of time, materials, and other resources (Clough *et al*., 2005), and are very much dependant on other production sectors (Alarcón *et al*., 2009). Sophisticated construction projects and their complex nature often direct the client's selection criteria for the contractor towards the project with the best value principle, instead of being based on project costs (CIOB, 2009). Consequently the construction projects appear to have high expenditures and also complex *activities*.

The term 'activities' is defined in this research as actions involving many resources in order to accomplish jobs, projects or services during the construction stage of construction projects. This includes the various elements of substructure and superstructure activities of construction projects. Vast construction activities usually involve a wide range of project participants (e.g., clients, consultants, main contractors, subcontractors, and suppliers), and stakeholders (e.g., investors, creditors, regulators, public and private agencies, general communities, etc.).

Every project has the possibility to develop particular characteristics, uniqueness, and supply chains (Alarcón *et al.*, 2009). Project complexities, the intricate nature, sophisticated clients, fragmented packages, and diversified activities require an integrated process and coordination with participants and stakeholders that are difficult activities during actual construction operations (CIOB, 2009). A project environment like this should involve organisations and may require higher investment and advanced technologies, together with knowledgeable and experienced human resources. These would inevitably increase the indirect costs of *project overheads* considerably compared to direct materials and labour costs.

In competitive market conditions, construction costs are budgeted in line with market prices. Project price usually includes Value Added Tax (VAT), income tax, and all other construction cost components such as *materials, labour, contingency, profits, and overheads* (Aretoulis *et al.*, 2006; Giammalvo, 2007 and 2009; and Šiškina *et al.*, 2009). Taxes are normally related to government agencies and regulations. Materials and labour are variable costs which the easiest cost components to be budgeted precisely. Contingency cost is the sum of provisional costs that are assumed to be completely utilised to recover project risks. Project profits are mostly planned and added at a fixed amount on a percentage basis. Consequently, project overheads become a single opportunity and very important aspect to be manipulated for obtaining additional project profits. Construction project overheads are defined as allocated costs for sustaining site-projects that cannot be distributed directly to individual activities and should not be included in compound costs (CIOB, 2009).

Project participants such as clients and main contractors often agree to incorporate outsourcing suppliers, specialist subcontractors, and specialist consultancy companies for a complex project to transfer project risks and to share project overheads (Kim and Ballard, 2002 and 2005). Construction projects become more complex related to project overheads due to involvement of many parties with their own particular interests (Ostwald, 2001; and Walker, 2007). Project overheads tend to increase more rapidly compared to the project direct costs with regard to project complexities (Assaf *et al.*, 2001; Kim and Ballard, 2002 and 2005; and Enshassi *et al.*, 2008). Project overheads therefore would appear to be one of the important cost components that require appropriate cost management, controlling methods, tools and techniques in practice, which cannot be satisfied by the traditional costing system (refer to Cockins, 2001; Daly, 2002; Giammalvo, 2007) and current cost management and accounting principles (refer to Horngren *et al.*, 1997 and 2005; and Drury, 2008).

The Activity-Based Costing (ABC) system is a reliable cost accounting methodology for measuring the cost of resources, activities, jobs, and projects as the cost objects (Turney, 1994). The concept and underpinning philosophy of the ABC system is that the jobs, products or services consume activities, and activities incur costs (Cooper and Kaplan, 1988; Innes *et al.*, 1994; Hicks, 1999; Cokins, 2001; Daly, 2002; Kaplan and Anderson, 2007; and Drury, 2008). The underpinning philosophy of the ABC system provides relevant features, such as reliable cost accounting, management methods, multiple cost pools, diverse cost drivers, several cost objects, and transparent cost tracers (Jaya, *et al.*, 2010a). This system also presents important aspects, such as cost, activity, management, and control (Jaya, *et al.*, 2010a and 2010b). The concept, philosophy, features, and aspects of the ABC system could be used to develop an Activity-Based Cost

Controlling (ABCC) model for improving the management of project overheads and cost controlling practice during the construction stage of construction projects.

## 1.2. Statement of the Research Problem

The Royal Institute of British Architects (RIBA) identified five discreet project phases, which include: *(1) preparation, (2) design, (3) pre-construction, (4) construction, and (5) use.* The project preparation phase includes two work stages, they are: *appraisal and design brief*. The project design phase represents three planning stages, which are: *concept, design development, and technical design*. The pre-construction phase includes three procurement processes: *production information, tender documentation, and tender action*. The construction phase incorporates two work activities: *mobilisation and construction to practical completion*. Finally, project use includes *post practical completion* (refer to Philips, 2009; and Cartlidge, 2009).

This research focuses on the project construction phase, and based on the conventional project delivery method and contract price between the client and main contractor. The role of the main contractor was limited to the construction delivery, and concerns project efficiency and effective costs during the construction stage, rather than the other project phases.

The traditional costing system has been well established and is appropriate for estimating direct costs, such as materials and labour (Daly, 2002). Indirect overhead costs are mostly arbitrarily allocated to construction costs on a percentage basis (RICS, 2009; and CIOB, 2009). These percentage overheads are allocated against materials or labour costs which may not have a relevant basis (Kim and Ballard, 2001) and aggregated in a single cost pool which would be more applicable if accumulated to multiple cost objects (Kim and Ballard, 2002 and 2005). The percentage overheads which are allocated on the basis of material costs, machine hours, or direct labour may cause significant cost distortions (Cooper and Kaplan, 1988; Cockins, 2001; and Giammalvo, 2007).

Moreover, pro-rata overhead allocations on a labour cost basis are criticised when contrasted with typical overhead cost behaviours which should be accurately attached on the basis of diverse cost drivers for the real price of specific products (e.g., Giammalvo, 2007). An explanation of this criticism can be illustrated by this example: every single unit of banana, apple, lettuce, and vegetable has different overheads related to storage, shelf life, water requirement, refrigeration, particular handling, and so on. When the green grocer deals with the retailer, they should consider the fair overheads per item-sold, similarly with each activity completed in construction projects' to avoid cost distortions. The pro-rata overheads which are distributed to project activities on the labour cost bases represent unfair overheads for every particular activity completed (Giammalvo, 2007).

Furthermore, the traditional costing system remains an unclear definition of project overheads apropos activities, an arbitrary method of allocating overhead costs, and an inaccurate distribution of project overheads related to every element of construction activities. It would appear that there is *a clear gap in knowledge on overhead cost accounts* when implementing the traditional costing system for the management of project overheads.

Overheads are recognised as indirect costs that have distinct cost behaviours to direct labour costs. They should be considered for allocating activity costs through separate means. According to Cockins (2001), this labour basis causes a significant problem of distortion of either hidden profit with over-costed overheads up to two times (200 per cent), or unknown losses of under-costed overheads up to ten times (1,000 per cent) (refer to Figure 1-1).

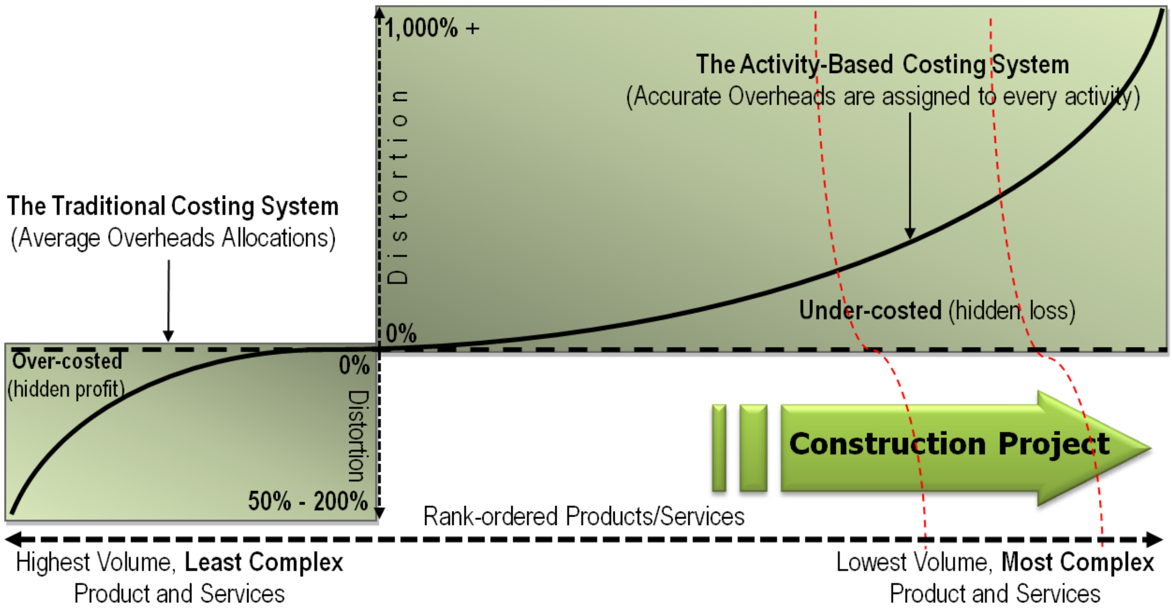


***Figure 1-1: Overheads Allocation Problem in Construction Projects***

***Source: Adapted from Cockins (2001)***

The average allocation of overheads to products or services is illustrated with the dotted horizontal line in Figure 1-1. The curve shows clear evidence of a contemporary ABC system based on the provided volume of the products or services and the complexities of manufacturing production lines. The contemporary ABC system can assign more accurate overheads on the basis of diverse cost drivers to avoid hidden losses of cost distortions (Cockins, 2001), and consequently, this system can generate savings or profits (Daly, 2002; and Giammalvo, 2007).

Construction projects are unique in character and mostly are complex in nature, shown with the sliding arrow to the right side of Figure 1-1. The complex nature of construction operation and pro-rata allocation of project overheads could create costing problems. Construction projects would appear to have a problem of under costing of project overheads, in other words, unknown potential losses (refer to the ABC system on the right side curve of Figure 1-1). This highlights *a problem of* *under costing or potential losses on the traditional costing system* in construction project practices.

The other problem related to construction project overheads is at operational levels (Kerzner, 2009); eliminating some components of project overheads seems to be the easiest way to reduce cost when the project budget is exceeded. On the other hand, project overheads tend to increase significantly (Assaf *et al*., 2001) and become very important cost components to maintain the entire construction activity (CIOB, 2009). Therefore, current project overheads are unclearly defined, inaccurately accounted, and have uncertain relationships to construction activities during the construction stage. These require an appropriate and effective overhead cost accounting management system.

The current cost accounting management system is reliable for recording, documenting, (sometimes) interpreting, communicating, and reporting economic information (Horngren *et al*., 1997; Glynn *et al*., 2003; and Drury, 2008). The goal of the cost accounting management approach is that it is mainly focused on recording and reporting the financial transaction of regular activity progress for monthly payments. This approach is mainly criticised because it focuses too much on providing regular reports to senior management and external parties. This cannot provide a satisfactory improvement for current Cost Management and Controlling Practices (CMCPs) in order to increase project *profits*. The project profits may be increased through *cost savings* which result from effective management and control mechanisms of project overheads during the construction stage. The sum of cost saving added into initial profits is termed as *project benefits* (refer to Figure 1-2).

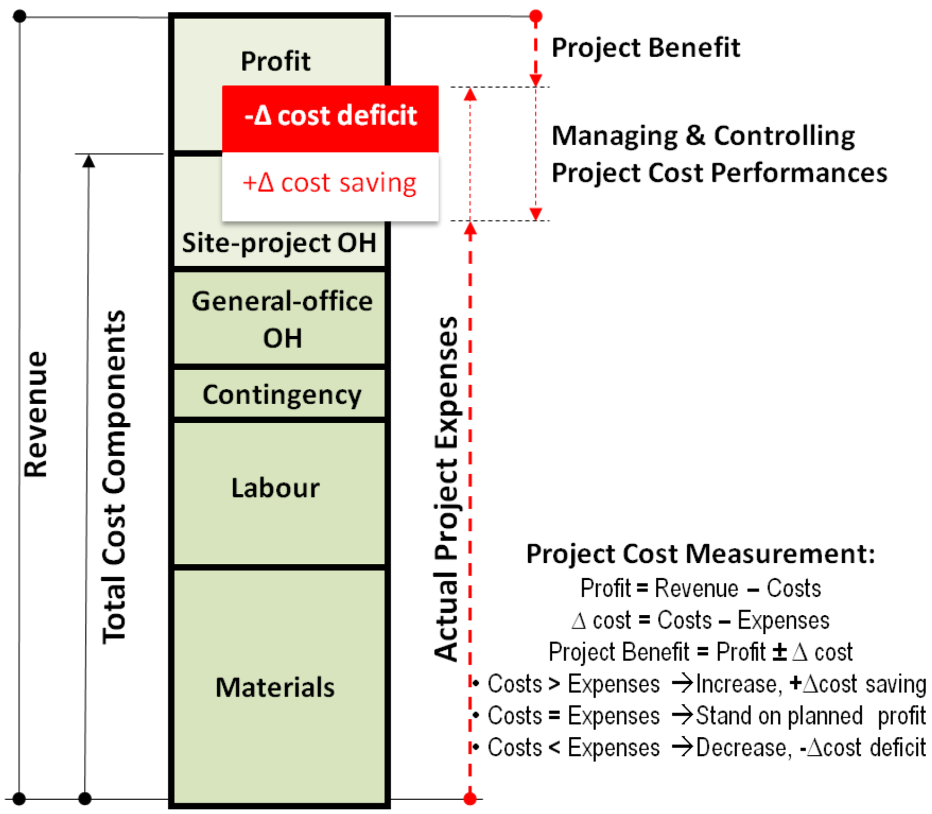


***Figure 1-2: Cost Accounting Management Problem in Construction Projects***

***Source: Adjusted from Jaya et al (2010b)***

Most contractors usually prefer to obtain profits by carefully planning affordable costs below the project revenue (refer to Figure 1-2). Project participants such as general contractors and specialist subcontractors endeavour to increase profits or project benefits by retaining the excess revenue over costs through limiting the smallest possible expenses below the total cost during the construction stage. The creation of increasing project benefits through controlling overhead costs and managing cost performances carefully during construction operations, and enabling appropriate actions to be taken by the project managers (e.g., preventative, or corrective, or immediate actions) are becoming more and more important.

In real-life construction projects, the cost performance and changes, e.g., deficit or savings, will vary subject to successful cost management and controlling practices, such as planning costs, updating day-to-day project progress and expenditures for construction activities, and managing cost changes with regard to planned costs. The ABC system therefore could develop transparent links of resource costs to the insight of cause-and-effect relationships between the cost behaviour knowledge of project overheads with the practical knowledge of construction activities or a particular complexity of construction processes of the jobs in order to establish optimum costs and minimum expenses for generating maximum project benefits (refer to Figure 1-2). This highlights *a problem in the cost accounting management approach* in the construction project practice.

The need for the identification of the cost-cause relationship between project overheads and construction activities for improving the management of project overheads during the construction stage has identified two main problems:

- The shortcoming of the traditional costing system, including unclearly defined, arbitrarily allocated, and mostly inaccurately distributed project overheads to particular construction activities. It requires appropriate cost accounting methods to enable accurate assigning of project overheads to every activity of construction projects.

- The current cost accounting management approach pays little attention to project cost management and controlling practices. It requires appropriate models, tools and techniques to enable effective management and control of cost performances, for improving the management of construction project overheads.

The cost management and controlling practices for the management of project overheads are not explicitly addressed by the traditional costing system and current cost accounting management approaches. Therefore, this research investigates the application of the ABC system in construction projects, and to propose the ABCC model for improving the management of project overheads during the construction stage, through implementing the effective tools and techniques of Cost Management and Controlling Practices (CMCPs) on substructure activities of construction building projects.

## 1.3. Research Questions

1. What overheads are included in construction projects?
2. What CSFs are important for improving the management of project overheads?
3. Why and how could an underpinning philosophy of the ABC system be adapted in construction projects?
4. How could the ABCC model be developed and implemented on substructure activities of construction building projects, for improving the management of project overheads?
5. How could the ABCC model be validated for improving the management of project overheads in construction projects?

## 1.4. Research Aim

The aim of this research was to propose the ABCC model for improving the management of project overheads during the construction stage of construction projects. The specific focus was on implementation of the ABCC model through the CMCPs' tools and techniques on the substructure activities of construction building projects. In order to achieve this aim, a series of objectives are identified.

## 1.5. Research Objectives

1. To identify project overheads during the construction stage of construction projects.

2. To analyse Critical Success Factors (CSFs) for the management of construction project overheads.

3. To investigate an underpinning philosophy of the ABC system in construction projects.

4. To propose the ABCC model and implement the CMCPs' tools and techniques on substructure activities of construction building projects, for improving the management of project overheads.

5. To validate the ABCC model on improving the management of project overheads.

## 1.6. Research Scope and Limitations

This research investigates the application of the ABC system in construction projects. The ABCC model is proposed to improve the management of project overheads during the construction stage of construction building projects.

The specific area of this research focuses on commercial building projects in both public and private sectors, such as office buildings, hospitals, villas, hotels, resorts, and so on. The commercial building project requires higher investment and technologies, effective cost management and tighter controls, because it is more sensitive to financial losses and also provides a greater opportunity for project benefits. Therefore, this research focuses on commercial buildings rather than other types of construction building projects (refer to Section 2.3.5 for a detail discussion).

Construction building projects are generally categorised into two main building components, i.e. superstructures and substructures. The superstructure work may include a wide range of specific activities, such as: frames, floors, walls, doors and windows, roofs, and other facilities and utilities, while the substructure work consists of soil excavations and foundation activities. The implementation of the

ABCC model for this study focuses on substructure activities of construction building projects, due to limitations of the study duration and involvement of a number of activities.

Two types of project overheads: general-office overheads and site-project overheads are identified (refer to Section 2.4.2 for a detailed discussion). However, this research focuses on site-project overheads only, which include: unit level, batch level, project sustaining, and facility sustaining overheads (refer to Section 2.4.3). Site-project overheads related to substructure activities of commercial building projects are therefore examined with regard to the development of the ABCC model and implementation of the CMCPs' tools and techniques.

## 1.7. Research Methodology

The ABCC model was developed based on a literature review and empirical studies. Three domains of research philosophies were assessed (i.e., *ontology, epistemology, and axiology)*. Ontology addressed about the nature of reality, epistemology considered the observable phenomena to the knowledge, and axiology considered the role of values in research (Saunders, *et al*., 2009). This philosophical assessment positioned the research into *a critical realist stance* (refer to Section 4.2.4).

*During the data collection*, *a questionnaire survey* was administered for identification of project overheads and prioritisation of important CSFs for improving the management of project overheads. *Project case studies and direct observations* were documented for the development of the ABCC model and implementation of the CMCPs' tools and techniques on substructure activities of construction building projects. *Expert interviews* were conducted to validate the ABCC model related to three themes: the management of project overheads, application of the ABC system, and implementation of the CMCPs.

With regard to data collection, both primary and secondary data were gathered during *the literature review and field research*. *Most secondary data* was collected during the review of literature and project databases or documents. *Primary data* was mostly collected during the field research of project case studies and direct observations in Indonesia. *Quantitative data* was collected through the questionnaire survey. Project case study databases and direct observation data were documented from actual projects that were accessible to the researcher. *Qualitative data* was collected through expert interviews. These multiple sources of evidence were *triangulated* in order to ensure the validity and reliability of the research.

*During the data analysis*, the construction project overheads and important CSFs were identified based on the literature review. Then, availability of construction project overheads was analysed using *descriptive statistic techniques*, and the most important CSFs through *Analytic Hierarchy Process (AHP)*. The underpinning philosophy of the ABC system and its' relevant features and important aspects were analysed during *the literature review* in order to develop the ABCC model. Project cost documents and observation data were examined using cost measurement systems such as *the ABC accounting system and Earned Value Measurement System (EVMS)* for a refinement and implementation of the ABCC model. The most important CSFs and the ABCC model were incorporated into the CMCPs' tools and techniques for the implementation of the ABCC model within the project case studies, for improving the management of project overheads during the construction stage. The expert interview outcomes used content analysis *and* cognitive mapping to validate the identification of project overheads and application of the ABC system for the development of the ABCC model in order to enable an improvement of the CMCPs in construction projects.

Therefore, the research has considered *multiple sources of evidence* for the data collection and *mixed methods* of analysis to increase the validity and reliability.

## 1.8. Structure of the Thesis

The seven chapters are outlined below to give an overview of all the contents of the thesis.

*Chapter one* introduces the research background and provides a statement of two research problems: the traditional costing system and current cost accounting management approaches. The research aim, objectives, and questions are outlined in this section, as well as research scope and limitations. A brief introduction of the research methodology and the structure of the thesis are provided before summarising this section.

*Chapter two* is devoted to synthesising the literature for organising the value of both references and ideas on the study area: the cost management and controlling practices of construction project overheads. It starts with a review of the construction industry and commercial building projects. Management of construction project overheads is the focus of the study area. Then, it identifies the important CSFs for improving the management of project overheads and investigates an underpinning philosophy of the ABC system in construction projects, in order to develop the ABCC model.

*Chapter three* presents the development of the ABCC model which includes chronological processes such as the conceptual research modelling, the ABCC model development, description of the ABCC model, the project cost measurement model, and cost management and controlling mechanisms in practice – the CMCPs of construction project overheads.

*Chapter four* provides a research methodology which elaborates on three main aspects which are research philosophy, research strategy, and research techniques. Three domains of the research philosophy are considered; ontology, epistemology, and axiology, and these position the research into a critical realist stance. The research strategies, multiple case study designs, and mixed methods are described. Further, the chapter explains the data collection and analysis techniques in detail.

*Chapter five* presents research findings and data analysis. Research findings include literature review findings, questionnaire survey data findings, case study data findings, and expert interview outcomes. Data analysis involves several methods and techniques, such as descriptive statistics, Analytic Hierarchy Process (AHP), the ABC system, Earned Value Measurement System (EVMS), content analysis, and cognitive mapping. Descriptive statistics are used to analyse the identification and availability of project overheads in construction projects. The AHP techniques utilise multi level decision making to determine the highest priority of importance of CSFs. The ABC system and EVMS are implemented for the cost accounting, cost measurement, and cost performance analyses of the ABCC model and the CMCPs' tools and techniques. Content analysis and cognitive mapping are used for assessing expert interview outcomes in order to ensure the validation of the ABCC model.

*Chapter six* of this thesis provides a discussion that integrates the significance of each of the particular elements of the research results which have been incorporated to illuminate their importance against the research aim and objectives. Particular elements of the discussion chapter include the identification of availability of construction project overheads, the highest three priorities of important CSFs, the application of the ABC system in construction projects for the development of the ABCC model, and implementation of the CMCPs' tools and techniques, in order to improve the management of project overheads during the construction stage of construction building projects.

*Chapter seven* is the final part of the thesis that evaluates the study conducted against the research aim and objectives, and presents a contribution to knowledge and practice. This chapter has mostly drawn conclusions from the research findings and analysis and the discussion. This section ends the thesis by highlighting some recommendations for further research.

## 1.9. Summary

This chapter introduces the research by highlighting two main problems on assigning, managing, and controlling project overheads in practice: the traditional costing system and current cost accounting management approaches. The research aim is achieved by investigating five research objectives and a series of questions that focus on substructure activities of construction building projects. It also presents the research scope and limitations. A brief overview of the research methodology is provided and the structure of the thesis is presented before summarising in this section. The next chapter will present the literature synthesis.

# CHAPTER 2. LITERATURE SYNTHESIS

## 2.1. Introduction

This chapter starts with the literature review on the construction industry to give an overview of the research focus on the commercial building projects. Section 2.4 presents the identification of construction project overheads that discusses the importance, definition, classification and categorisation of project overheads in detail, and the important CSFs for improving the management of project overheads are identified in section 2.6. An application of the ABC system in construction projects is investigated, in order to propose the ABCC model and the implementation of the CMCPs' tools and techniques on substructure activities of construction building projects.

## 2.2. Construction Industry

The boundaries of the construction industry are difficult to define, due to the known fact that it involves many people, organisations, agencies, and governments (Ostwald, 2001; Gould, 2005; Clough *et al.,* 2005; Sears *et al.,* 2008). The construction industry provides a wide range of opportunities in their economic development activities. It generally has been inseparably linked with other industries and production sectors (Alarcón *et al.*, 2009), and the development of economy of any country, both globally and regionally.

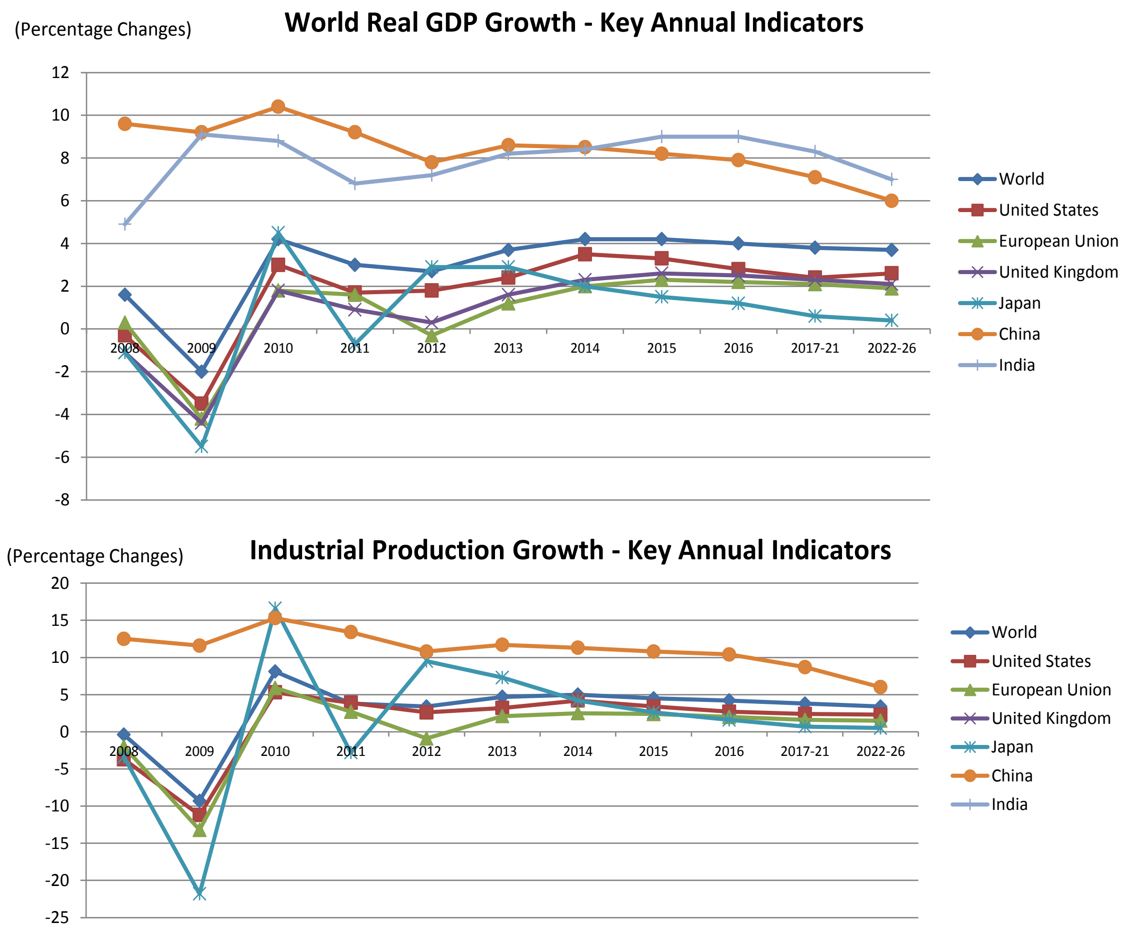


***Figure 2-1: Key Indicators to the Construction Industry***

***Sources: Amiel (2011)***

Figure 2-1 indicates Asian emerging markets, on one hand, expected to develop its growth for both GDP and industrial productions during 2013, e.g., China's GDP grows by 8.6 per cent with 11.7 per cent of industrial production and India by 8.2 per cent respectively. On the other hand, the on-going crisis in the US, the EU, and the UK is likely to continue. Their country's GDP and industrial production growth are expected to come in below the world trends respectively, e.g., the world GDP grows at 3.7 per cent with 4.7 per cent of industrial production growths in 2013 (Amiel, 2011). The world economic downturn and especially in the US, the EU, and the UK would affect the construction industry worldwide.

However, the database of the global construction industry has estimated growths of outputs in this decade up to 2020. In the middle of the previous decade, the construction industry provided estimated outputs of about £2.95 trillion and contributed up to 10 per cent of global GDP (General UK Statistics, 2007). The current output of the construction industry is estimated to be £4.62 trillion representing over 11 per cent of global GDP, and expected to grow by 67 per cent up to £7.69 trillion representing 13.2 per cent in 2020. During this decade to the end of the year 2020, total spending of construction globally has accumulated to £62.65 trillion (Hook, 2011). This output of the global construction industry has been reported regardless of current economic downturn.

### 2.2.1. The UK Construction Industry

The UK economy was ranked in the 'global top ten' (Alley, 2004; and World Bank, 2010), and is inextricably linked with the construction industry contributing to GDP. The contribution of the UK's construction industry accounted at 7.3 per cent of GDP in the middle of the 1990s, and increased to 7.4 per cent in 2000, and 8.0 per cent in 2005 (General UK Statistics, 2007). It continued to grow by 8.5 per cent in 2008 and rose to 10 per cent overall when it considered the entire value chains and drivers of GDP growth (Wates and Cridlan, 2009).

The UK is recognised as the second largest construction industry in the EU, after Germany, with contribution at about 8.2 per cent of the nation's Gross Value Added - GVA (General UK Statistics, 2007). According to the ONS-Office for National Statistics (2010), total outputs of the construction industry in the UK increased by 6.6 per cent on the figure for the three previous years with nominal outputs accounting for up to £108.233 billion in 2007. Due to the global economic crisis in 2008 and 2009, the output of the UK construction industry suffered average declines of about 6.2 per cent per year. However, the 3$^{rd}$ quarter of 2010 demonstrated a significant increase at 8.6 per cent compared to the same quarter in 2009. Moreover, the figure in 2010 shows gradual improvements during each quarter (e.g., 6.8 per cent in 2$^{nd}$ quarter, and 4.0 per cent in 3$^{rd}$ quarter). It can be speculated that there will be a rise during the coming quarters, unless the economic crisis continues.

The UK based construction industry involves about three hundred (300) thousand construction companies running construction projects, and employs three (3) million people (representing 8 per cent of UK employment) of which more than 40 per cent are highly skilled labourers (Wates and Cridlan, 2009). Therefore, the UK construction industry will continue to play an important role behind the economic development of regional EU countries. The following section considers the attractiveness of the construction industry in Indonesia.

## 2.2.2. Indonesian Construction Industry

Indonesia is a member of the G20 countries and was ranked 16th economically of world-GDP in 2009, based on Purchasing Power Parity (PPP) calculations (World Bank, 2010). Indonesia, as an emerging market economy, has recovered from the global recession of 2008 and early 2009 (Mussa, 2010).

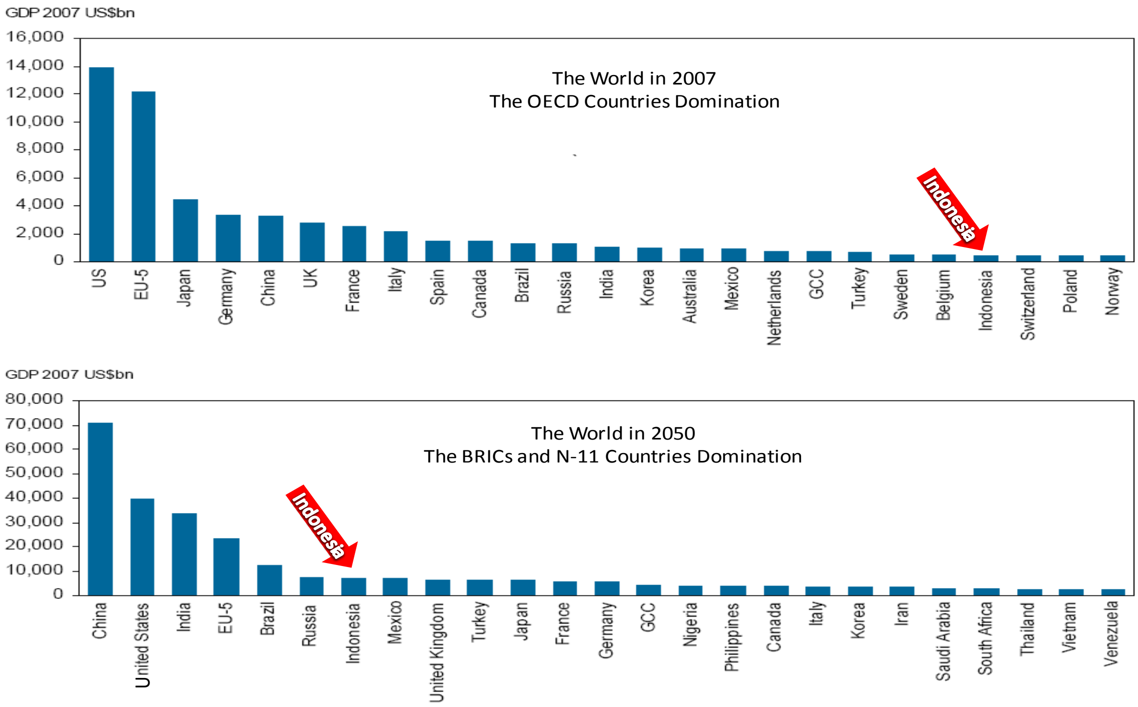


***Figure 2-2: The Largest Economy of the Global GDP***
***Source: Wilson and Dragusanu (2008).***

Figure 4-6 represents the leading ten countries of the Organisation for Economic Cooperation and Development (OECD), namely the US, Japan, Germany, the UK, France, Italy, Spain, Canada, Brazil, and Russia, which dominated the world economy in 2007. They are mostly recognised as developed countries and democratic governments. The BRICs – big four economies (Brazil, Russia, India, China) are recognised as great saving countries. The N.11- Next Eleven countries (Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey, Vietnam, Bangladesh, and Egypt) continue to improve their purchasing power parity.

Three of the BRICs (Brazil, India, and China) and six of N-11 countries (Indonesia, Iran, Mexico, the Philippines, Vietnam, and Egypt) are expected to contribute up to 60 per cent of the world's GDP in 2050 (Wilson and Dragusanu, 2008). It would make Indonesia the 7$^{th}$ strongest economy in the world together with China, the US, India, the EU-5, Brazil, and Russia (refer to Figure 4-6). This global economic figure indicates Indonesia should play an important role behind the development of the worldwide economy.

Moreover, emerging market groups of the VISTA block countries (Vietnam, Indonesia, South Africa, Turkey, and Argentina) would encourage the upward trend of many world investors to Indonesia; where these nations generally have shown political stability, a young growing labour force, and surging levels of consumption, beyond the BRIC countries (Dutram, 2011). This overview show the potential of the VISTA economic society and was investigated in more detail by Thomson (2012) as represented below:

*Vietnam:* Population 86.9 million; GDP (2010) US$106.43bn (£67.5bn); GDP annual growth (2010) 7 per cent; GDP per capita (2010) US$1,224 (£789); Population aged 15 to 64 years (per cent of total) 70 per cent.

*Indonesia:* Population (2010) 239 million; GDP (2010) US$706.5bn (£455.4bn); GDP annual growth (2010) 6 per cent; GDP per capita (2010) US$2,946 (£1,899); Population aged 15 to 64 years (per cent of total) 67 per cent.

*South Africa:* Population (2010) 49.9 million; GDP (2010) US$363.9bn (£234.5bn); GDP annual growth (2010) 3 per cent; GDP per capita (2010) US$7,280 (£4,630); Population aged 15 to 64 years (per cent of total) 65 per cent.

*Thailand:* Population (2010) 69 million; GDP (2010) US$318bn (£205bn); GDP annual growth (2010) 8per cent; GDP per capita (2010) US$4,608 (£2,931); Population aged 15 to 64 years (per cent of total) 71 per cent.

*Argentina:* Population (2010) 69 million; GDP (2010) US$318bn (£205bn); GDP annual growth (2010) 8 per cent; GDP per capita (2010) US$4,608 (£2,931); Population aged 15 to 64 years (per cent of total) 71 per cent.

Indonesia was the fourth largest population in 2013 (about 250 million people) out of any nation in the world after the USA (320 million), and the third after China (1,388 million) and India (1,257 million) in Asian countries (WorldOmeters, 2013). The vast population of Indonesia, has a gross domestic product of more than one trillion US dollar, this means that the average socio-economic development (which is indicated by GDP per capita) was about US$ 4,000 in terms of purchasing power parity. This low level of GDP indicates a positive point as it means low costs for manufacturing firms and construction industry in Indonesia, for all over the world. In addition, Indonesia is close geographically and has economic relationships with the key developed markets such as Australia, Singapore, India, China, the Philippines, South Korea and the rest of the East Asian countries. Investment markets consider Indonesia as an attractive destination that would, in turn, improve the nation’s socio-economic developments.

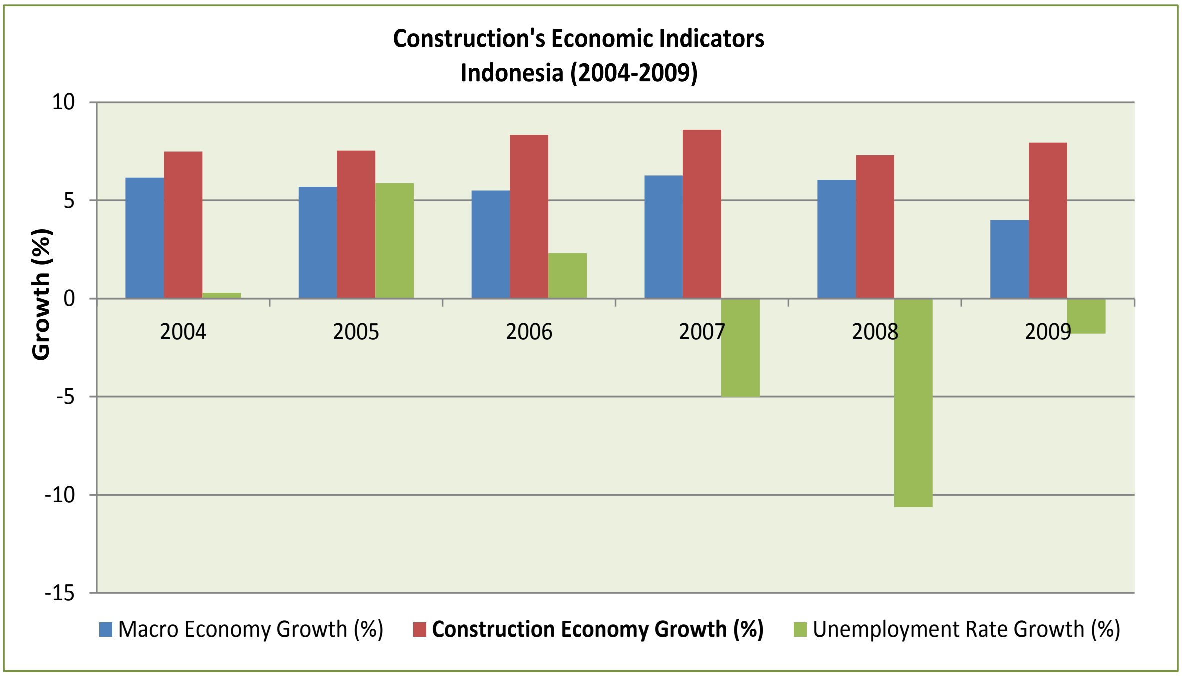


***Figure 2-3: Construction's Economic Indicators in Indonesia***
***Source: Suraji (2010)***

Indonesia maintains the second largest market after China for construction industry in Asia with the contribution at 8.2 per cent of GDP in 2004 (refer to Figure 4-7). The Indonesian construction industry increased significantly up to 8.9 per cent of GDP in 2007, and expects a constant growth of more than 9 per cent in the next few years (Suraji *et al.*, 2010). Figure 4-7 shows that the construction industry grew relatively consistently with development in macro economies between the 2004 and 2009. Indonesia has improved employment rates with a significant increase of up to 10.5 per cent mostly through construction sector in 2008, despite global economic downturns in the same period (e.g., Mussa, 2010). The construction sector in Indonesia would seem to have an opportunity to cross-exchange the construction industry resources by exporting and importing with other countries around the globe.

The total output of the construction building sector in Indonesia (specified categories: government and private buildings) are expected to rise by 38 per cent per year in floor area, from 26 million square meters in 2009 to 36 million square meters in 2010 (Siswanto, 2010). The total monetary value of the construction building sector is estimated to increase 43.7 per cent from £8.46 billion in 2010 to £12.16 billion in 2011 (Dinar, 2010). These figures indicate that construction sector provides a significant contribution to the improving economic development in Indonesia.

These global and regional economic conditions of the construction industry growth can be considered as one of the key reasons for the attractiveness of construction projects, in addition to basic human need for shelter. Project complexities and the intricate nature of constructions typically cause increasing requirements of higher investments and advanced technologies, and lots of time and resources. The following section will discuss the types and complexity of construction projects.

## 2.3. Construction Projects

Construction projects cannot simply be defined from the concept of production that it is assembling materials and products (Gould and Joyce, 2009). The construction process is fundamentally a different kind of production (Ballard and Howell, 1998). However, recognising a recent development of knowledge and technology, it would not be impossible that the process of construction activities may adapt the concept of production, where, the construction process should follow production procedures, such as *'input, process, output, and evaluation'*. Construction projects inevitably require *'resources'* as an input, to support *'activities'* where the process mainly occurs, for acquiring output such as *'jobs, projects,* or *services'*, and this construction cycle needs a proper *'control'* as an evaluation.

Kirkham (2007) refers to the construction process, in which construction projects are categorised into two types: (1) building construction and (2) civil engineering. Hendrickson and Au (1989) introduce four major types of construction projects based on clients' interests and powers on acquiring specific types of constructed facility: (1) residential housing construction, (2) institutional and commercial building construction, (3) infrastructure and heavy construction, and (4) special industrial construction. Ostwald (2001) breaks down construction projects into four types of different processes: (1) residential houses, (2) commercial buildings, (3) heavy engineering and infrastructure, and (4) industrial buildings. Further, Gould (2005); Sears *et al* (2008); and Gould and Joyce (2009) classified construction projects into four project types with similar meanings with what was introduced by Hendrickson and Au (1989) and Ostwald (2001), as: (1) residential projects, (2) building construction projects, (3) heavy construction projects, and (4) industrial projects. These four projects types are briefly discussed below.

### 2.3.1. Residential Building

Residential buildings are affected by government roles on taxes, fiscal policies, and laws, and are developed for the living space of individual people or families; e.g., individual home, multifamily dwellings, condominium, small/ simple apartment, etc.

### 2.3.2. Commercial Building

Commercial buildings tend to be technically complex which require tighter financial controls and a managerial practice during project planning and construction operations; e.g., government buildings, offices, sport stadia, hotels, resorts, large/ complex apartments, hospitals, universities, schools, churches, shopping malls, retail stores, theatres, and warehouses, etc.

### 2.3.3. Infrastructure and Heavy Engineering

Infrastructure and heavy engineering usually serve public needs, tend to be long in construction duration, and mostly publically funded: e.g., airports, roadways, bridges, dams, flood control systems, hydro power stations, canals, tunnels, irrigation systems, storm-water collection, water treatment and distribution, and urban rapid-transit systems, etc.

### 2.3.4. Industrial Buildings

Industrial buildings maintain production activities and are often privately funded (e.g., mills, mine development, petroleum refineries, petrochemical processing plants, automobile plants, nuclear plants, fossil-fuel plants, synthetic-fuel plants, oxygen-fuel plants, and heavy duty manufacturing plants, etc.).

### 2.3.5. Justification on Commercial Building's Focus

Every type of projects has its particular uniqueness and complexities. Different types of projects may have to maintain different purposes and processes. Construction building projects are quite challenging areas to be investigated. Construction projects were highly affected by market conditions and slightly increasing in total demand that cause a substantial investment in construction execution with potential risks or rewards (Hendrickson and Au, 1989). The commercial project is typically demanded by sophisticated construction clients (CIOB, 2009) for commercial purposes which require a financial return on the investment within a specific period of time. The commercial building type of construction projects are recognised as capital-intensive projects and very high risk as well as providing opportunities on the fluctuation of global market conditions. Project participants may have to be aware of construction processes related to investments, and arrange the financial plan and tighter control for executing construction projects (Hendrickson and Au, 1989). Hence, the commercial building projects may be more sensitive to financial losses or benefits compared to other types of construction projects as described before, such as residential, infrastructure and heavy engineering, and industrial projects. Therefore, this research is focused on investigating *the commercial building project* such as office buildings, hospitals, villas, apartments, hotels, and resorts.

Construction projects are generally characterised by consuming a large number of materials and other resources (Clough *et al*., 2005). Project complexity and an intricate nature will result in a higher investment and spending of funds and time. Also, construction projects are critically linked, and are very much dependent on a wide variety of other sectors (Alarcón *et al*., 2009), such as material productions, consultancy and professional services. The increasing sophistication of construction clients and the complexity of their needs have caused their selection criteria for contractors to be based on the best value principles, instead of project costs (CIOB, 2009). Main contractors prefer to incorporate specialist subcontractors for multifaceted projects to share project overheads (Kim and Ballard, 2002 and 2005).

Project complexities, the intricate nature, sophisticated demands, fragmented project packages, and diversified activities cause a construction operation on site to become very difficult to manage, which involves other parties with different organisation interests, and which are also complex businesses in their own right. Project environments like this should involve good experienced organisations, and may require higher investments, advanced technologies, skilled human resources, and knowledgeable personnel. These considerations could affect the increasing importance of project overheads significantly.

### 2.3.6. Importance of Project Overheads

Project complexities are often characterised by differentiation, e.g., different types and locations may use different construction methods and technologies. A shopping mall of commercial projects is typically built in a crowded area of central cities, and this would require more complex construction methods, equipment, and operations compared to a still mill storage of industrial projects in a quieter area. The project’s interdependency to other production and service sectors (Alarcón *et al*., 2009) due to different companies with each of their interests often increases project complexities during construction operations. These project complexities could result in increasing project overheads more rapidly compared to direct costs.

Assaf *et al* (2001) argued that the majority of contractors have had increased project overheads during recent years, based on a survey carried out among practitioners of 61 large building construction companies in Saudi Arabia. Up to 77 per cent of contractors had a significant increase in overheads, while 9.8 per cent remained unchanged, and only 13.2 per cent reported a decrease in overhead costs. Enshassi *et al* (2008) reported the outcome of a survey questionnaire among forty (40) building contractors in Palestine, which showed a much greater change in overheads than what Assaf *et al* (2001) reported. A significant increase in overheads has been claimed by the large number of these contractors. About 93 per cent of contractors in Palestine showed the increasing trend in overhead costs. This implies that project overheads contribute a considerable portion of the construction cost.

Relevant literature such as Ostwald (2001) and Enshassi *et al* (2008) describe that project overheads range between 8 per cent and 15 per cent of total construction costs depending on the project complexity. Project overheads are required to sustain the entire construction activity. Assaf *et al* (2001) suggested that project overheads are easily overlooked and extremely important in construction, and some contractors have been forced out of business (financial losses) due to neglecting project overheads.

In the global competitive market, all project resources are accounted as accurately as possible and budgeted quite tightly. Cost overruns in construction projects must be prevented, and eventually have to be run under budgets to help avoiding any financial losses. The project contract price should recover all components of project costs such as materials, labour, contingency, overheads, and extra profits for the contractor (Aretoulis *et al*., 2006; Giammalvo, 2007 and 2009; and Šiškina *et al*., 2009).

Construction materials and labour are typically costed very close to the price of informed open-markets. Overheads are becoming an important component for being well planned and controlled to sustain project activities. The project overheads would therefore be considered as fundamental costs to be potentially manipulated in a total project price for generating real benefits during the construction stage of construction projects. The succeeding section discusses about project overheads in detail.

## 2.4. Project Overheads

### 2.4.1. Definition of Overheads

The general definition of overheads is very rare and uncommon in scientific literature, but it was initiated about eighty years ago. Bunbury (1931) defined overheads from the accounting viewpoint as *'those expenses of production which cannot readily be allocated directly to particular units of production or particular productive processes'*. This definition indicates that overheads are unclearly related to particular activities of construction projects. It could result in a significant cost misrepresentation if allowing overheads arbitrarily allocated to activities, jobs, and projects on the basis of direct materials or labour costs. This may lead to distorting the activity costing for related overheads during the construction operation, either one activity being budgeted too low or the other too high.

Tatikonda and Tatikonda (1994) defined overhead costs as *'a cost item that is common to two or more cost objectives and cannot be identified specifically with any one of the cost objects in an economically feasible manner'*. This definition focuses on explaining the process of accounting overhead costs to fulfil multiple types of cost objects through multiple rates of diverse cost drivers. Cost drivers will be further discussed in Section 2.9.1.4.

## 2.4.2. Classification of Overheads

Numerous authors and professionals have discussed the differentiation between *general-office* and *site-project overheads* in construction projects in different ways (e.g., Kim and Ballard, 2001; Assaf *et al.,* 2001; Aretoulis *et al.,* 2006; Enshassi *et al.,* 2008; Singh and Taam (2008); Beaulieu and Mikulecky, 2008; and Šiškina *et al.,* 2009).

Kim and Ballard (2001) define office-related costs as general-office overheads which include general selling and administrative costs, while job-related overhead costs may be associated with site-project overheads for the projects being run on site. Whilst, Assaf *et al* (2001) investigated overheads in two categories: building company overheads may be defined as general-office overheads, and construction project overheads refer site-project overheads.

Similarly, Aretoulis *et al* (2006) described overheads from the contractor's point of view with various cost categories included in construction projects for the contract price. The contract price should include direct costs, indirect costs, contingency funds, and profits. The indirect costs consist of general overheads and project overheads. General overheads can be associated with general-office overheads and project overheads related to site-project overheads.

Enshassi *et al* (2008) separate general and administration costs from indirect job costs. The general and administration costs are similar to general-office overheads, while indirect job costs refer to site-project overheads. Various items of overhead costs were not absorbed when calculated remaining costs of running projects. Unabsorbed overhead costs were categorised as general-office overheads, which consist of: office rent, utilities, furnishings, office equipment, executive staff salaries, support and clerical staff salaries, project related staff (e.g., engineers, estimators, schedulers), mortgage costs, outside legal and accounting expenses, depreciation, transportation staff and equipment, professional trade licenses and fees, employee recruitment, relocation, training and education, photocopying, entertainment, contributions, donations, postage, cost of preparing bids, review of submittals, taxes, advertising, insurance premiums, interest costs, data processing/ computer costs, and so on (Singh and Taam, 2008).

Beaulieu and Mikulecky (2008) indicated the complexity of construction processes related to activities and various types of resources. It appears that three types of cost terms related to construction activities are identified as: direct-variable costs (e.g., materials and labour costs); direct-fixed costs (e.g., safety shoes, helmets, hand tools, equipment rental, scaffolding, hiring consults/ experts, supervisions, general planning, resource planning, and cost scheduling, site-office rent, services, consumption costs, etc.); and indirect-fixed costs (e.g., general office and supplies, staff salaries, and general administration costs, etc.).

It is thought that indirect-fixed costs for projects may refer to indirect-project overheads (also known as general-office overheads). While, direct-fixed costs can be identified as direct-project overheads (also known as site-project overheads). Direct-variable costs have been well known as direct materials and labour costs, where these costs can be directly related to individual activities of construction projects. However, both general-office and site-project overheads are recognised as having indirect costs of cause-and-effect relationships with, and they cannot be directly allocated to particular activities of construction projects.

Šiškina *et al* (2009) evaluated the competitiveness of construction company overheads that reflect its management system and utilisation of available assets and facilities. They provide a clarification of general-office overheads which include: head office expenses, building rental, clerical salaries and facilities, proceeding taxes and fees, common use automobiles expenses, head office staff wages, social security, taxes and insurance fees from head office staff wages, and so forth. General-office overhead costs are incurred in office expenses that cannot be directly associated to specific project activities, as the other term of site-project overheads.

Therefore, the general term *'overheads'* in construction projects can be classified into two types as discussed in this section: *general-office overheads* (i.e., allocated costs for maintaining the entire business of the construction company), and *site-project overheads* (i.e., allocated costs for sustaining all activities of individual construction projects).

### 2.4.3. Identification of Site-Project Overheads

This research will only consider the management of construction project overheads, and that identifies the overheads related to site-projects during the construction stage of project phases.

According to the Project Management Body of Knowledge (PMBOK), project monitoring and control includes the process of *initiating, planning, executing, and closing* processes (PMI, 2008). However, the construction stage could involve just three construction processes by excluding the 'initiating' process. Project overhead cost accounts can be stemmed from the project contract price during the 'planning' process, while monitoring and controlling the status of project progress and cost performance can be addressed during the 'executing' process to establish the project completion in the 'closing' process.

The nature of project complexity is technically more concentrated on site-activities rather than on general-office which is more focused on organisational policies and administration matters. The majority of construction activities and costs of individual projects take place during the construction stage. Referring to the research scope and limitations in Section 1.6, this research focuses on site-project overheads, which include: unit-level, batch level, project-sustaining, and facility sustaining overheads.

Site-project overheads are referred to as allocated costs that are not apportioned to particular activities and which should not be included in the composite rates (CIOB, 2009). However, site-project overheads can be identified typically and their hierarchy of occurrences may be associated to related activities which require overheads for supporting the completion of jobs, projects or services. Consequently, site project overheads can be assigned to particular activities on the basis of *activity cost drivers* of the Activity-Based Costing (ABC) system (refer to Section 2.9.1.4). Site-project overheads can be categorised on the basis of their occurrences on particular activities for the project completion, as: unit-level, batch-level, project-sustaining and facility-sustaining costs (Kim and Ballard, 2001 and Beaulieu and Mikulecky, 2008). Therefore, four categories of site-project overheads related to particular activities are defined below.

#### 2.4.3.1. Unit-Level Overheads

Unit-level overheads are defined as activity costs which are assigned for by the unit of occurrence of product basis, where these overhead costs can be traced for every unit of activity output. For example: *project helmets, safety shoes, hand tools*, etc. can be categorised to unit-level overheads because every unit of their actual project expenses may occur during a particular activity, *e.g., construction preparation activity.*

#### 2.4.3.2. Batch-Level Overheads

Batch-level overheads are activity costs that are assigned for by the batch of occurrence of product basis, where overhead costs can be traced for every batch of activities, regardless of the size of the batches. For example, *an excavator* with *an operator* is categorised to batch-level overheads because every batch of their actual project expenses may occur during particular activities, *e.g., preparation and excavation activities.*

#### 2.4.3.3. Project-Sustaining Overheads

Project-sustaining overheads are activity costs that are assigned for by the individual occurrence of the product basis, where overhead costs can be traced for related activities of the project, regardless of the size of units and batches. For example, *site managers, quantity surveyors, drafters,* and so on are categorised to project-sustaining overheads because every hour/week/month rate of their actual project expenses may occur during parallel activities which are included on all substructure activities, such as *preparation, precast concrete pilling, excavation & back filling, pile cap, tie beam & ground slab concreting activities*.

#### 2.4.3.4. Facility-Sustaining Overheads

Facility-sustaining overheads are activity costs that are assigned for by the facility employed for the project basis, where overhead costs can be traced for sustaining a whole project. For example, *site-office and supplies, administration staff and consumption, site-storage, security, telephone, power, water,* and so forth *are* categorised as facility-sustaining overheads due to actual project expenses of these services occurring during whole construction activities.

The site-project overheads are synthesised and summarised based on empirical investigations on the projects and works documented by practitioners and researchers such as Andersen *et al* (1917); Sanders (1924); Bunbury (1931); Wallace (1934); Ostwald (2001); Assaf *et al* (2001); Kim and Ballard (2001, 2002, and 2005); Barnett, *et al* (2006); Oxera (2007); Enshassi *et al* (2008); and Šiškina *et al* (2009). These categories and items of site-project overheads are listed in Table 2-1:

***Table 2-1: Categories and Items of Site-Project Overheads***

| Categories of Site-Project Overheads | Items of Site-Project Overheads | | |
|---|---|---|---|
| **Unit Level Overheads** | • Equipment depreciations | • Direct tool sets | • Safeguards |

| | | | |
|---|---|---|---|
| **Batch Level Overheads** | • General inspections<br>• Mobilisation and setup equipment<br>• Demobilisation materials and equipment<br>• Drawing reviews | • Change orders<br>• Sample of materials<br>• Material tests<br>• Placing purchase orders<br>• Materials deliveries | • Receiving materials<br>• Paying suppliers<br>• Moving materials<br>• Quality inspections<br>• Intermediate project release |
| **Project Sustaining Overheads** | • General planning<br>• Scheduling projects<br>• Planning resources<br>• Planning costs | • Engineering costs<br>• Controlling costs<br>• Project reporting<br>• Soft drawing | • As built drawing |
| **Facility Sustaining Overheads** | • Site-office & project storage<br>• Site-project administration<br>• Site-project supervision<br>• Site-project labour<br>• First aids<br>• Project insurance<br>• Legal expenses<br>• Rental plant and equipment | • Rental land, and base camp for workers<br>• Scaffolding<br>• Hoarding screen<br>• Temporary building<br>• Water supply<br>• Power and lighting<br>• Telephones and communications<br>• Security services | • Cleaning services<br>• Transport and haulage<br>• Managing contract conditions<br>• Project's working conditions<br>• Project sundries |

Every project can utilise different items and different categories of overheads as listed above and maintain costs in particular methods (e.g., overheads are arbitrarily allocated, or accurately assigned) depending on characteristics or complexities of the project. However, overhead costs should be appropriately distributed to support particular construction activities and properly managed and controlled during operations. The following section discusses the potential challenges of cost management and controlling practices – the CMCPs of construction project overheads.

## 2.5. Cost Management and Controlling Practices (CMCPs) of Project Overheads: the Potential Challenges

The management of project overheads may include cost planning, budgeting, and controlling. Overhead cost planning is a process of approximating activity costs related to overheads. Overhead cost budgeting is the process of aggregating planned overheads to support activities during the construction stage. Overhead cost controlling is a process of monitoring, updating, and evaluating the status of project progress and cost performance.

The challenge of cost management and controlling begins with the lack of estimating knowledge of construction processes (Akintoye and Fitzgerald, 2000), and misunderstanding of the cost planning for detailed processes and activities. Project overheads are arbitrarily allocated, inaccurately budgeted, and inappropriately distributed related to every activity, and consequently they are quite difficult to be managed and controlled in regard to the cost plans.

According to Kerzner (2009), when the limited budgets are exceeded, the simple way to reduce costs is to cut the work or activity items. Indirect item costs or project overheads such as management fees and inspections are much easier to reduce than direct items, e.g., volume of materials and labour. Therefore, on one hand, overhead costs are typically cut or reduced in the first overlook, such as: project management supervision, line management supervision, process controls, quality assurance, material tests, equipment, facilities, and so on (Kerzner, 2009). Whilst on the other hand, project overheads often increase significantly compared to direct costs (e.g., Ostwald, 2001; Kim and Ballard, 2002; and 2005; and Enshassi *et al.*, 2008) and are extremely important for sustaining construction activities during operations (Assaf *et al.*, 2001). This contra phenomenon on project overheads (being the easiest way to cut costs, and on the other hand cost trends usually increasing in practice), most probably can cause the planned overheads to become inaccurate and under-costed (refer to Mansuy, 2000; and Cockins, 2001). The traditional costing system allocates overheads inaccurately to construction activities. Current cost accounting and management approach is not applicable for project cost management and controlling practices during the construction stage.

Management cost and controlling systems have two cycles of construction operations: the construction cost planning and operating cycles (Kerzner, 2009).

The construction cost planning stems from a project's contract price, while the operating cycle may include measuring physical activities, recording economic transactions, updating project expenses, and managing cost changes to increase project benefits through effective management of project overheads.

Project overheads are known as allocated costs and are increasingly important for sustaining the entire activity of construction operations. Current construction processes are arbitrarily supported with average overheads to complete projects. Specific factors for successful completion of the projects are not clearly related to the management of project overheads. Successful construction projects may also be influenced by numerous factors. Therefore, it is important to investigate and identify Critical Success Factors (CSFs) to improve cost management and controlling practices of project overheads during the construction stage of construction projects. The subsequent section will explore and identify CSFs which may have a significant effect to improve the management of project overheads during the construction stage of construction projects.

## 2.6. Identification of Critical Success Factors (CSFs) for the Management of Project Overheads

It was recognised that the Critical Factors (CFs) may not necessarily provide a positive impact in construction projects. For instance, Shaikh *et al* (2010) conducted a survey to analyse the CFs that delay the construction of high rise buildings in numerous countries worldwide. This survey analysis found that project delays impact the time factor and consequently result in the most common and important problem on project expenses: cost overruns. In fact, some factors inevitably influence project costs with a negative impact. It was identified that critical problems are listed within four categories: *(1) client problems, (2) contractor problems, (3) general problems,* and (4) *resource problems.* Firstly, the *client problems* include: bid problems, incomplete drawing and specifications, delay in work approval, change orders / change in site conditions / change in scope of works, delays in inspection and testing of works, late payment by the client to the contractor during construction, slow decision making. Secondly, the *contractor problems* consist of: planning and scheduling problems, late payment by contractors to workers during construction, and poor performance of works. Thirdly, the *general problems* include: environmental problems, ground conditions, weather problems, economic downturns, and inflation. Finally, the *resource problems* comprise: materials suppliers, late delivery of materials, suppliers and late delivery of equipment, low quality of materials, shortage of workers, shortage of equipment, failure of equipment, and so on.

However, early awareness and understanding of these problems, and project participants organising preliminary anticipation in order to avoid project losses and provide reasonable savings, can lead to a successful performance of project completion. Construction costs are important components to be accurately accounted for construction plans, correctly allocated for all activities, and properly monitored for updating the status of project progress and cost performance.

Many organisations and construction projects have introduced and applied project cost accounting and performance management initiatives in certain areas. Mansuy (2000) initiated a cost accounting method using activity-based costing principles to improve project bidding. Activity-based costing features have been adapted on corporate culture changes, regarding how individual personnel 'think and act' based on transparent cost 'cause-and-effect' relationships for successful project progress and cost performance (SAP-AG, 2000). These initiatives are applied without proper understanding of CSF consideration in those areas. Some construction companies attempt to address CSFs, however, they are still ineffective in implementing CSFs to the cost management area.

CSFs are defined as *'the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation,* [and] *……, the CSFs are the areas of activities that should receive constant and* *careful attention from management'* (Rockart, 1979, p.85). From the perspective of the CSFs, the key areas of activities are necessary to satisfy managerial goals (Rockart, 1982). A successful cost performance may be the primary goals expected by the management of many organisations. Forster and Rockart (1989) explain that the process of generating CSFs is sharing an explicit understanding and necessary action of the organisation's environment management.

In the context of the cost management and controlling practice, the CSFs can be expected as key areas of facts or activities to be carefully considered for improving the management of project overheads. The key areas of facts and activities are related to project process assessment and cost performance measurement, in which a successful project is a necessity for management goals and a maximum benefit for the organisation. The management success and maximum benefits can be perceived as the goals that the organisation should strive for.

This study investigates important CSFs for the cost management and controlling practices, in order to improve the management of project overheads during the construction stage of construction projects. Therefore, the important CSFs can be investigated, identified, and created in order to achieve successful cost management and controlling practice, especially, for improving the management of project overheads during the construction stage of construction projects in the construction industry.

This section identifies various CSFs related to the construction industry, associated with project cost management and controlling practices. More than forty (40) important CSFs were identified through the literature review, to have a significant effect on the cost management and controlling practices of project overheads (refer to Jaya *et al.*, 2011a). Table 2-2 represents a summary of relevant issues, potential challenges, and important CSFs for improving the management of project overheads during the construction stage of construction projects.

***Table 2-2: Identification of Important CSFs for the Management of Project Overheads***

| Relevant Issues and References | Potential Challenges | Important CSFs |
|---|---|---|
| Construction employment has fallen significantly by 3.3 per cent (all jobs: 1.6 per cent) between June 2007 and June 2009. The output of the UK's construction industry suffered sharp declines at 12.4 per cent due to crises in 2008 and 2009 (ONS-Office for National Statistic, 2009) Company's expectations on employees are: downsizing 59 per cent, survival 33 per cent, and predicted growth 8 per cent (Pitcher, 2009). | Industrial downturn and economic conditions cause a significant effect on the process of construction projects, availability of jobs, and the growth of employment. The project outsourcing may be the best choice for the lower risks during this global crisis. However, understanding the effect of global economic crisis clearly could avoid financial losses and contribute to project benefits. | ▪ Understanding the effect of unstable economy<br>▪ Anticipation to Industrial downturns<br>▪ Rationing project job cuts and redundancy<br>▪ Project outsourcing<br>▪ Global market conditions |
| Global economy is inevitably linked with the UK construction industry which ranked in the 'global top ten' (Alley, 2004). The UK construction output in the 3rd quarter of 2010 has demonstrated a significant increase at 8.6 per cent compared to the same quarter in 2009. Moreover, the figure in 2010 shows gradual improvements during each quarter (e.g., 6.8 per cent in 2nd quarter, and 4.0 per cent in 3rd quarter) (ONS-Office for National Statistic, 2010). The new and specific projects are developed to obtain a quicker economic recovery (Mussa, 2010). | Construction industry and economic conditions in the UK have increased with a steady rise between 1990s and 2005 (General UK Statistics, 2007), represented 10 per cent of GDP in 2008 (Wates and Cridlan, 2009). Moreover, the UK based construction industry involved about 300 thousand construction companies, employed 3 million people (represented 8 per cent of UK employment) which more than 40 per cent are higher skilled labourers (Wates and Cridlan, 2009). This indicates there is an attractive development in construction sector. | ▪ Strategy of crisis recovery through construction sector<br>▪ Development focuses on new and particular construction projects |
| Construction projects in nature appear to have high spending, and complex and intricate projects that require lots of time and various resources which include human, funds, equipment, and materials (Lock, 2004; and Walker, 2007). | Project complexities require higher investments, advanced technologies, and construction methods. These are potential to increase project overheads to be well-planned and managed during the construction stage. | ▪ Requirement of higher investment<br>▪ Requirement of modern technology<br>▪ Requirement of skilled human resources |

| | | |
|---|---|---|
| An intricate operation and a cyclical business of construction projects inevitably consume lots of time and are related to availability of resources (Ostwald, 2001; Sears *et al.*, 2008; Gould and Joyce, 2009), supply chains and other production and service sectors (Alarcón *et al.*, 2009), and experienced specialty subcontractors (Kim and Ballard, 2002 and 2005). | Before starting a project, the project manager should ensure an availability of local potentials such as materials, equipment, builders, and knowing local law and codes (Duglase, 2012). | ▪ Higher quantity and quality of construction materials<br>▪ Local availability of required resources |
| | Construction projects have numerous possibilities of interconnections between other production and service sectors (Alarcón *et al.*, 2009). Construction company is a legal system in running business for acquiring benefits (Skadmanis, 2009). | ▪ Dependency of other production sectors<br>▪ Cyclical business and company's interests and commercial benefit |
| 'The increasing sophistication of construction clients and the complexity of their needs have led most of them to base their selection criteria for contractors on best value principles rather than lowest cost' (CIOB, 2009). Project complexity is associated with one condition where 'the uncertain information of available resources is too costly or time consuming to collect and analyse' Winch, 2009). Constructability involves the issue of buildability of designs (Sears *et al.*, (2008); and Gould and Joyce, 2009), and also logical consequences of construction and integration of the system (McDowell, 2008). Predictability of cost is related to the situation where 'the past is not a reliable guide to the future costs in many situations'. | The project complexity, sophisticated construction clients, diversified construction activities, and fragmented operations are the potential challenges for the cost management and controlling practices, in order to create buildability of project designs, constructability of buildings, and predictable costs. Those are the potential drivers to increase project overheads, and the opportunity to be managed properly in order to improve project benefits. | ▪ Sophistication of client's values<br>▪ Complexity of construction demands<br>▪ Buildability of project designs<br>▪ Predictability of project costs<br>▪ Constructability of project buildings<br>▪ Nature of site-based projects<br>▪ Diversification of typical activities<br>▪ Fragmented project package<br>▪ Reliability of project parties<br>▪ Expertise of the specialist subcontractors<br>▪ Project size and scope<br>▪ Project location<br>▪ Project duration |
| Overheads are unclearly defined related to particular activities, inaccurately accounted on percentage basis, and arbitrarily distributed to project activities. It was reported that 77 per cent of surveyed contractors increased project overheads, which | A significant growth of overheads in construction projects should be properly managed and tightly controlled in practice to improve affordable costs, and contribute savings to project benefits. Project benefits may be maximised through optimising | ▪ Clear vision and definition of project overheads<br>▪ Project participants' perspectives on project overheads<br>▪ Proportional ratios of project overheads |

| | | |
|---|---|---|
| constitute up to 13 per cent in Saudi Arabia (Assaf et al., 2001), 11.1 per cent in Palestine (Enshassi et al., 2008), while in some literatures range between 8 and 15 per cent of project costs. | authorised costs and minimising actual expenses. | |
| Percentage addition of project overheads and profit are based on contractor's building costs and preliminaries (RICS, 2009), and is often a part of the tender settlement process (COIB, 2009). | Distribution of project overheads should be shown on transparent bases for tracing costs through cause-and-effect relationship of the cost with activities in real project operations | ▪ The roles and current practices for project overheads<br>▪ Implication of the role and regulation on real-life projects |
| Traditional bill of quantities (BoQ) with mark-up of project overheads is widely used in the UK and overseas, it may remain to be so due to the lack of practical knowledge of the construction process (Akintoye and Fitzgerald, 2000). The project overheads are perceived that something could be fairly predicted (Sutrisna *et al*., 2004). | Project overheads should be accurately accounted, assigned, and distributed to every activity, which is related to detailed construction process, in order to achieve successful project completions in practice. | ▪ Practical knowledge of construction process<br>▪ Adaptation of the traditional costing system<br>▪ Alternative methods of costing system |
| The lack of individual understanding with contemporary methods, and availability of data histories of activity costs should not damage project cost estimations (Heitger, 2007). | Company personnel may require a specific adjustment on previous methods and activity cost data in order to predict project cost estimations accurately. | ▪ Updating project's activity cost data<br>▪ Specific adjustment on initial methods<br>▪ Monitoring the project status |
| Neural fuzzy network, sustainability and whole life cost models are suggested to have additional investigations to ensure the formula and tools are effective in project practices (Fortune, 2006). | Construction projects require practical and robust methods, tools and techniques, in order to account and distribute project overheads accurately to every activity. | ▪ Requirement of robust and vigorous methods, tools, and techniques |
| Current cost estimating model was initiated based on designs and product features to satisfy cost estimations (Staub-French and Fischer, 2002), but it excludes some important aspects, such as characteristic of sites, availability of required resources, and site-project overheads | The cost controlling model for the management of project overheads would be investigated and developed to improve project benefits during construction operations. | ▪ Requirement of cost management and controlling practice |

Important CSFs have been identified from relevant issues and potential challenges within the construction industry (refer to Table 2.2). These factors may be considered by project managers to be important indicators and an appropriate tool for improving the cost management and controlling practices of project overheads during the construction stage of construction projects.

The CSFs approach has provided some advantageous features, such as: ensuring a competitive performance of the organisation (Rockart, 1979); satisfying operational management goals (Rockart, 1982); and sharing explicit understanding and necessary actions on managing an organisation's environment (Foster and Rockart, 1989). Project managers could provide constant and careful attention and take appropriate action based on the CSFs approach for improving the management of project overheads related to construction activities.

In order to relate various CSFs effectively and to achieve successful project completions, the important CSFs should be grouped into *a limited number of areas* (Rockart, 1979), or *a key area of activities* (Rockart, 1982), which represent more focus and comparable information, issues, challenges, and interrelationships among sets of several CSFs. About forty important CSFs have to be grouped into a limited number of CSFs or the key area of activities. In the process, the important CSFs in Table 2-2 would be examined through the description of similar comparable information or simple relationships between them to determine a group of important CSFs. The following section discusses an initial grouping of important CSFs.

## 2.7. Preliminary Groups of Critical Success Factors (CSFs) for Cost Management and Controlling Practices (CMCPs)

The concept of grouping CSFs may be initiated during initial reviews of the literature through descriptive studies (Yang, *et al.*, 2009) based on the similarity of comparable information and simple relationships among several elements of important CSFs. However, individual CSFs can be considered as the variable of subject matter to design the survey questionnaire during the literature review stage. A survey questionnaire also requires additional consultations to develop consensus with experts in the specified area prior to the field survey. The survey questionnaire can be subsequently administered to collect greater responses for more detailed information related to cost management and controlling practice – CMCPs of project overheads from project professional viewpoints, such as project management teams, professional management staff, and senior management lines.

In this research, the grouping techniques was initiated or implemented during the literature review stage. While the individual CSFs are used to develop questionnaires to collect expert opinions and larger responses of data set from project professionals which can therefore be analysed in order to determine descending orders and the best priorities of importance among these groups of CSFs. The data analysis techniques are discussed in more detail in the research methodology, Section 4.8.1.2.

An identical grouping method was applied by Akintoye (2000) to consider a comparative study for project cost estimating practice of the eighty four (84) construction contractors in the UK for grouping twenty four (24) relevant factors. These factors are grouped into the seven (7) most important factors which are made up from several types of relevant factors. Li *et al* (2005) studied grouping and ranking the importance of eighteen (18) CSFs into five (5) groups of important CSFs for Public - Private Partnerships (PPP) through the Private Finance Initiative (PFI) projects in the UK construction industry. Suganthalakshmi and Mothuvelayuthan (2012) have grouped various CSFs of Enterprise Resource Planning (ERP) systems based on the similarity of information in the literature into four groups of CSFs (i.e., technological, organisational, strategic, and tactical), and mapping them into a matrix to determine communal patterns between them.

This section also includes a discussion on initial findings of grouping the important CSFs based on their similarity of comparable information to describe inherent relationships among them. These groups of CSFs are enumerated and abbreviated (by the researcher) accordingly: (1) Understanding the Market Condition *(MARCON)* could avoid financial losses and in turns maintain project benefits including project overheads; (2) Project Development Focus *(DEVFOC)* considers a development of new commercial projects instead of restoration of artefact buildings to be more attractive projects; (3) Requirement of Investment and Technology *(INVTEC)* represents project's capital intensives that should be given a careful and special attention to increase project savings; (4) Mapping Local Availability of Required Resources *(LOCRES)* could balance surrounding potentials and develop efficient and effective supply chains to reduce operational costs and improve project benefits; (5) Managing a Company's Interest and Project Benefit *(INTBEN)* provides great opportunities to increase intellectual capitals and tangible assets for construction companies in respect of common legal systems for financial profits; (6) Managing Project Complexity and Intricate Nature *(PROCOM)* provides the real potential challenges of project managers to be faced as well as great opportunities to create efficiency and effectiveness for project savings; (7) Improving Contractors' Current Roles in Practices *(ROPRAC)* considers the contractors' responsibility to provide accurate and competitive estimations of project overheads which reflect detailed processes of construction activities; and (8) Requirement for a Robust Method and Tool *(METOOL)* implies that project managers should consider appropriate methods, and effective tools and techniques for improving the Cost Management and Controlling Practices (CMCPs) of project overheads (refer to Jaya *et al.*, 2011a).

### 2.7.1. Understanding the Market Conditions (MARCON)

***Relevant Issues***

Global economic conditions may have causal relationships with the rise and fall of the construction industry. The industrial downturn is affected by an unstable economy (Pitcher, 2009). The construction industry output in the UK suffered a sharp decline during the global recession in 2008 and 2009 (ONS-Office for National Statistics, 2009 and 2010). The UK, the EU, the US, and the world GDPs continue to come below the leading Asian markets such as China and India in this decade (refer to Figure 2-1; and Amiel, 2011). The economic crisis is known as a threat on one hand, while on the other hand provides opportunities to boost crisis recovery rather quickly through construction sectors (Mussa, 2010). The construction sectors will contribute a significant contribution of global GDP in 2020 (Hook, 2011). The market circumstances like this may affect construction markets and developments in general, and particularly to the project managers' role on cost management and controlling practice during the construction stage.

***Potential Challenges***

Construction project participants, and particularly, project managers in charge, must understand clearly how to deal with market prices, how to predict market movements, and be able to adjust project costs flexibly enough to meet current market conditions for avoiding financial losses, which, in turn, should contribute additional benefits to the organisation. The clear understanding, flexible adjustments, and managerial attention on the effect of the market conditions such as: economic fluctuations, industrial production sectors (e.g., affecting the GDP), employment, market price, project outsourcing, et cetera, are the important aspects for successful project completion through effective cost management and controlling practices of project overheads.

***A Group of Important CSFs***

A group of important CSFs in this area is identified accordingly and has similar issues, challenges, comparable information, and close relationships among them. This includes: understanding the effect of an unstable economy, rationing project job cuts and redundancy, project outsourcing, and global market conditions (Pitcher, 2009), and anticipation to the industrial downturn (ONS-Office for National Statistic, 2009). The CSFs of the *understanding the market conditions (MARCON)* may represent the issues and challenges on global economic conditions and its effects that have to be anticipated and manipulated properly for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

### 2.7.2. Project Development Focus (DEVFOC)

***Relevant Issues***

It can be speculated that because of the magnitude of the economic downturn, a steady rise will happen during the next period of time. The construction industry is inevitably linked to the cyclical economic development of any country worldwide (Alley, 2004). A longstanding increase of the UK economy between the 1990s and 2005 is good evidence of development focus on the construction sector, instead of other sectors (General UK statistics, 2007). After the global crisis affected the UK construction industry in 2008 and early 2009, a gradual improvement of the economy and a development of employment were recovered by the end of 2010, and mostly through the construction sector (refer to the ONS – Office for National Statistic, 2010). The development in the construction sector may represent a successful strategy for crisis recovery (Mussa, 2010). The UK National Infrastructure (2011) has invested for the expenditure in infrastructure developments to boost the UK's global competitiveness of economy through the construction sector (Osborn and Sassoon, 2011). Construction projects would appear to be becoming more expensive and more complex related to global construction dynamics that require knowledgeable and experienced human resources, investments and technologies. These could increase unavoidably the importance of project overheads. Construction dynamics may challenge project cost managers for dealing with their roles thoroughly for managing and controlling project overheads in practice effectively.

***Potential Challenges***

The development focus on new projects is suggested as a good policy in the construction sector, rather than restoration of artefact buildings. It is often more attractive to develop new commercial projects (e.g., shopping malls, hotels, and resorts) with public facilities (e.g., hospitals, universities, and car park buildings), and new industrial projects for commercial products (e.g., petroleum, petrochemical, automobile, synthetic-fuel plants, etc.). These sectors may attract economic development activities, e.g., in the UK construction industry, new project developments involve 300,000 construction companies, and 3 million people, more than 40 per cent of which are skilled labourers (Wates and Cridland, 2009).

A new project with various activities requires lots of resources, e.g., human, money, materials, and machines (Lock, 2004; and Walker, 2007), including a significant portion of project overheads (Ostwald, 2001; and Enshassi, *et al*., 2008), and project overheads are extremely important to maintain construction processes (Assaf *et al*., 2001). This is a potential challenge and also an opportunity at the same time, which should be manipulated properly to contribute considerable benefits in project practice during construction operations through effective management and controlling practices of project overheads.

***A Group of Important CSFs***

A group of CSFs in this area of activities consists of the *strategy of crisis recovery through the construction sector* and *the development focus on new projects*. It can be perceived that these areas have similar issues, challenges, comparable information, and close relationships between these factors (refer to Table 2-2). Therefore, important CSFs on the area of the *project development focus*

*(DEVFOC)* may become a good strategy for improving cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

### 2.7.3. Requirement of Investment and Technology (INVTEC)

***Relevant Issues***

The UK National Infrastructure (2011) has planned a contribution approximately at £400 billion investment which is required for the development of infrastructures from 2011 to the end of 2020 to boost economic growth and maintain competitive advantage of the UK construction industry globally (Osborn and Sassoon, 2011). It was predicted that every £1 invested in construction expenditure may have multiplier effects on generating £3 across supply chains of the UK economic activities (Threlfall, 2012). The attractiveness of the construction industry in the UK and worldwide appears to command high spending for construction projects, with often very complex and intricate operations, which are strongly linked to other supply-chains of production and service sectors (Alarcón *et al.*, 2009). Construction projects consume various resources including: human, funds, equipment, and materials (Lock, 2004 and Walker, 2007). Complicated projects and intricate construction processes may result in requiring a higher investment and advanced technology that could increase project overheads. Project overheads should be allocated and distributed accurately to every activity of the construction project during the construction stage.

***Potential Challenges***

Investment and technology are very important aspects in current construction operations. Project cost managers must have enough knowledge in practice about investment principles which was suggested by Simon (2011) that: *'invest in what you know and invest in value'*. In the context of construction projects, investment is about funding costs for generating value-added activities, to obtain project benefits. Therefore, proper management and tighter control of investments are critical in construction projects, as well as the requirement for investment in advanced technologies (e.g., construction materials, equipment, systems, and methods). The higher investments and advanced technologies are commonly found in large scale projects that could increase the requirement of project overheads. Project overheads may represent important components to be managed and controlled properly to attain successful completion of construction projects.

***A Group of Important CSFs***

Important CSFs included in this group are *the requirement of higher investments*, the requirement of *modern technology*, and the requirement of *skilled human resources* (refer to Table 2-2). Therefore, the *requirement of higher investment and technology (INVTEC)* can be the important CSFs for the successful improvement to cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

### 2.7.4. Mapping Local Availability of Required Resources (LOCRES)

***Relevant Issues***

Projects in remote locations require more time and costs in mobilising materials and equipment to site according to the long distance and transportation problems. Typically, sophisticated client demands, complicated projects, fragmented packages, and diversified activities on site-based construction projects inevitably consume a lot of time and resources (Sears *et al.*, 2008; and Gould and Joyce, 2009). Available local resources may include lower quality materials and inappropriate capacity of equipment, unskilled human resources, and less experienced project participants, unpleasant environments, which are not suitable for the project execution. These issues may be considered as potential drivers that could increase project overheads.

### *Potential Challenges*

Typical projects located in remote areas are quite challenging to project manager roles related to the availability of local resources and requirement of project overheads. Some contractors operating in remote locations could fail to accomplish projects because of neglecting the importance and occurrence of project overheads. Assaf *et al* (2001) illustrated a related project in Saudi Arabia, and Enshassi *et al* (2008) described typical projects in the Gaza Strip, Palestine. The project manager had to know local conditions before mapping local potentials and starting project execution (Duglase, 2012), e.g., identifying affordable local subcontractors, local building resource suppliers, a local manufacture for materials, and its qualifications and technical specifications. The availability of local resources and supplies can determine the degree of complexity and the requirement of particular technology, systems, and construction methods. Local resource conditions and availabilities can be a potential effect to the requirement of project overheads. Mapping the availability of appropriate local resources and good supply chains could be expected to reduce operational costs and improve project benefits through effective management and controlling practices of project overheads in the early stages of mobilisation and during construction to practical completion.

### *A Group of Important CSFs*

The quality and quantity of construction materials, local availability of required resources, requirement of skilled human resources, capacity of equipment, supply chains etc. (refer to Table 2-2) could be included in this group of important factors. The area of activities in the *mapping local availability of required resources (LOCRES)* should be considered as a group of CSFs which may have a significant impact on the successful improvement of the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

### 2.7.5. Managing the Company's Interest and Project Benefit (INTBEN)

***Relevant Issues***

A concept of the company is a corporation based under common legal systems for creating a company's commercial interests and financial benefits (Skadmanis, 2009). Construction companies should have the top priority of creating profits for many reasons (Ostwald, 2001), through maintaining excess revenue over optimum costs, and sustaining minimum expenses for maximum project benefits (Jaya *et al.*, 2010c and 2011a). Alarcón *et al* (2009) suggested that in order to complete projects successfully, the project manager should ensure the key-roles and interconnection are built and agreed with project participants prior to the new project beginning. Construction companies have various possibilities to develop project partnerships with a variety of contributors who encourage individual company interests. The company's commercial interests may involve intellectual capital (e.g., experience, expertise, personnel knowledge and skills) and tangible assets (e.g., equipment, transportation, office-building, and other facilities).

***Potential Challenges***

Project benefits may include initial planned profits and additional cost savings of project overheads (refer to figure 1-2). Company's interests for improving intellectual capital may be achieved through formal training and overall project experience (e.g., knowledge by training and skill by experience). Project benefits for increasing tangible assets may be achieved through effective cost management and controlling practices of project overheads. Project benefits may be the top motivator for sustaining the future survival of construction companies. The company's interests and project benefits could be stimulated and accumulated through one of the project features, e.g., effective cost management and controlling practice of project overheads during construction operations.

***A Group of Important CSFs***

The important CSFs in these areas include: the interdependency to other production sectors (Alarcón *et al*., 2009), the company's commercial interest for intellectual capital, tangible assets, financial benefits (Skadmanis, 2009), the cyclical nature of business (Sears *et al*., 2008; and Gould and Joyce, 2009), etc. (refer to Table 2-2). The *managing the company's interest and project benefit factor (INTBEN)* may be incorporated in this group of CSFs to affect the improvement of the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

## 2.7.6. Managing the Nature of Project Complexity (PROCOM)

***Relevant Issues***

Effron and Ort (2010) suggested that, while eliminating complexities, managers have found the ways to increase the value of elements of the goal-setting processes. Managing project complexity is not just about simplifying and reducing the intricate nature of complexity itself, but to innovate the possibility for generating an outstanding balance from the cost of complexities with its' cost savings through developing and implementing the critical success factors, appropriate models, tools, and techniques. The principal problem in this process is that it is optimising authorised costs relating to project complexities, minimising actual expenses according to scheduled activities, and creating maximum project benefits through avoiding cost deficits to generate cost savings (refer to figure 1-2). A project's complexity and the sophistication of construction clients often mean that the best selection criteria are used for determining contractors, instead of basing decisions on lowest costs (CIOB, 2009). Fragmented project packages and diversified construction activities become more difficult processes to satisfy all project parameters such as specified quantity and quality of activities, within limited time durations, and authorised budgets (Sears *et al.*, 2008).

***Potential Challenges***

These complexities of project constraints are the real potential challenge to be faced by project leadership (Maznevski *et al.*, 2007). As well as being opportunities, if the project could be successfully completed, there would be great rewards to be gained. Project managers should understand the project's complexity, it's nature and intricate operation on site to deal with the sophistication of clients' and the complexity of the construction demands (CIOB, 2009), buildability of project designs (Gould and Joyce, 2009), constructability of project delivery methods and techniques (McDowall, 2008), predictability of project costs (Winch, 2009), and reliability of project participants on site at the frequent times and appropriate durations (refer to Table 2-2).

***A Group of Important CSFs***

These important factors become the group of CSFs of *managing the Nature of project complexity (PROCOM)* which should be given appropriate attention and careful consideration, so that the improvement of the cost management and controlling practices - the CMCPs of project overheads can be achieved during the construction stage of construction projects.

### 2.7.7. Improving Contractors' Current Roles in Practice (ROPRAC)

***Relevant Issues***

Overheads are described as indirect expenses for particular productions or processes (Bunbury, 1931), or indirect cost items for cost objects (Tatikonda and Tatikonda, 1994). Project overheads are unclearly defined in regard to particular activities, inaccurately estimated on the percentage cost basis, and arbitrarily allocated to construction activities. Average overheads are distributed to every activity on a direct labour basis (Mansuy, 2000; and Giammalvo, 2007). Contractors' current roles in project practices allocate project overheads and profits of construction building cost on a percentage addition basis (RICS, 2009; and CIOB, 2009). Project overheads cannot be variably accounted in the same way as aggregating material and labour costs. They must refer to different cost behaviours appropriate to each of them such as direct-variable, direct-fixed, and indirect-fixed (Beaulieu and Mikulecky, 2008). Implications of contractor roles in allocating overheads in practice have to reflect a detailed process of particular construction activities for the occurrence of project overheads (e.g., supervision, equipment, operators, power, etc.). These project overheads should be associated with physical building works (e.g., site mobilisation, excavation, precast concrete pile, concrete formwork, reinforced steel bar, concrete pouring, etc.). Project overheads are also influenced by many other factors such as market flux, development focus, resources, investment, technology, project complexity, site characteristics, etc. Therefore, the contractors' role and current practices may need specific adjustment.

***Potential Challenges***

Contractors are responsible for estimating accurate overheads and meeting the competitive criteria of the project tendered, and the successful bidder would have to reflect the real construction process on site. The project overheads have to be managed and controlled appropriately generating additional profits and project benefits. The activity-based costing system could be implemented to estimate project overheads accurately on the basis of diverse cost drivers, and distribute them to all activities in order to control and trace project expenses clearly during the construction stage (Jaya *et al.*, 2010b and 2010c), instead of contractors' current method of cost measurement which is to add compound overheads and profits on the basis of adding a percentage to the construction building cost arbitrarily (RICS, 2009; and CIOB, 2009).

***A Group of Important CSFs***

Several areas of activities are included in this group, such as clear vision and definition of project overheads, participant's perspective on project overheads, proportional ratio of project overheads to construction building cost, implication of the role and current practices and regulations on real life projects (refer to table 2-2). Hence, *the improving contractors' current roles in practices (ROPRAC)* would appear to have a significant effect on the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

## 2.7.8. Requirement for a Robust Method and Tool (METOOL)

***Relevant Issues***

Project cost management and controlling systems concern the monitoring of construction operations including construction process and performance requirements (Kerzner, 2009). Construction processes may include a synchronisation of some factors, e.g., work personnel, function of facilities, and physical activities that can help contractors directly fulfil the requirement of cost performance related to quantity and quality of works, time of completion, and cost of activities (Turney, 1994).

The traditional costing system is a reliable way of estimating direct costs such as material and labour (Daly, 2002) rather than indirect overhead costs. A current cost accounting management approach is reliable for measuring, recording, documenting, and reporting financial transactions of project expenses in order to satisfy senior management and stakeholders (refer to Horngren *et al.*, 1997 and 2005; Glynn *et al.*, 2003; and Drury, 2008). Current cost management and controlling practices focus on monitoring and assessing the quantity of physical progress, and reporting this assignment to the company's accounting department for regular requirements (e.g., proposals for monthly payments or requests for financial supports). The progress report is normally submitted without proper measurement and evaluation on activity progress values versus actual project expenses in respect of project cost schedules, because there are no necessary obligations to project team management on site. These indicate that there is lack of project progress with less reliable methods, and inappropriate tools and techniques in practice. This current approach provides unsatisfactory results for improving the project cost management and controlling practices during construction operations.

***Potential Challenges***

There remain great challenges and opportunities for construction companies who regard creating profits as a top priority (Ostwald, 2001) and commonly base corporate legal systems for generating commercial benefits (Skadmanis, 2009). Project benefits could be gradually improved by planning and expending optimum costs, and using minimum expenses to obtain maximum project benefits (Jaya *et al.*, 2010c and 2011a). Therefore, cost management and controlling methods, tools and techniques could be developed to improve the management of project overheads. This area of activity may create important CSFs to be involved to satisfy project managers and construction companies in order to achieve a successful completion of construction projects.

***A Group of Important CSFs***

Important CSFs are included in this group, such as a practical knowledge of construction process, adaptation of the traditional costing system, an alternative method of costing system, updating activity cost data, specific adjustments on initial cost data, monitoring of project status, and a requirement for robust and vigorous methods, and requirement of cost management and controlling model, tools and techniques in practice (refer to Table 2-2). The *requirement for a robust method and tool (METOOL)* should be incorporated with the other CSFs in providing advantaged features for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

The CSFs should be able to facilitate the project managers in order to take managerial decisions related to the specific focus of project success. Having discussed the group of CSFs, the next section considers the evaluation criteria for project success.

## 2.8. The Most Important CSFs under Four Evaluation Criteria of Construction Projects

The important CSFs should be properly considered in respect of evaluation criteria. The evaluation criteria represent the areas in which the project is considered to be successful.

The evaluation criteria of project success in construction projects were identified during the literature review stage, they are:

1. The commercial buildings by *project type* (refer to Section 2.3; Hendrickson and Au, 1989; Ostwald, 2001; Gould, 2005; Kirkham, 2007; Sears *et al*., 2008; and Gould and Joyce, 2009).

2. The construction stage of the *project phase* (refer to Section 3.4; Smith *et al*., 2006; Philips, 2009; Cartlidge, 2009; and RIBA, 2012).

3. The present status of *project monitoring* (PMI, 2008; Gould and Joyce, 2009; Kerzner, 2009; Jaya *et al*., 2010c and 2011a).

4. The construction method of *project delivery* (Gould, 2005; Sears *et al*., 2008; and Gould and Joyce., 2009).

In terms of the construction *project type,* commercial buildings tend to be more technically complex and require more effective cost management and tighter controls due to its' greater sensitivity to financial losses, and also to provide better opportunities for incurring benefits, compared to other construction project types (refer to Section 2.3.2; and Section 2.3.5).

The construction stage is one of the five discreet *project phases* of construction projects where two major activities are carried out to realise projects, these are site resource mobilisation and construction to practical completions (refer to Cartlidge, 2009; Philips, 2009; and RIBA, 2012).

The status of *project monitoring* for the project progress and the cost performance is focused during the cost planning and operating cycles (refer to Kerzner, 2009). During the construction stage, *project delivery* techniques might involve four construction methods, these are conventional Design – Bid – and Build (DBB), Design – and Build (DB), Construction Management (CM), and Partnering delivery systems (refer to Gould, 2005; Sears *et al.*, 2008; and Gould and Joyce, 2009).

The most important CSFs should receive constant and careful attention, and would be used by the project managers to ensure the improvement of competitive cost performance through the Cost Management and Controlling Practices (CMCPs) of project overheads during the construction stage of construction projects. The Activity-Based Costing (ABC) system provides a cost accounting and management method that may be applicable for measuring, controlling, and managing project overheads related to construction activities. The following sections introduce the concept, definition, underpinning philosophy, cost drivers, advantages of the ABC system, and the application of its' relevant features and important aspects for the management of project overheads in the construction projects.

## 2.9. Activity-Based Costing (ABC) System

The concept of traditional costing was initiated in England in the middle part of the 18$^{th}$ century, when the industrial engineers and cost accountants such as Josiah Wedgwood (in 1754) developed a cost accounting system to minimise the risk of bankruptcy during the time of recession (Giroux, 1999). A fundamental change began at the end of the 20th century, and was initiated by the Consortium for Advanced Management – International (CAM-I) as the beginning of the contemporary ABC concept (refer to Cooper and Kaplan, 1988; Kaplan and Cooper, 1998; Hicks, 1992 and 1999; Kaplan and Anderson, 2007; and Drury, 2008). The development of the ABC system continuously improves the cost accounting methods and weaknesses. Although, the sophisticated ABC system has most notable backers such as the US Marine Corps and a number of commercial applications of business-intelligent software (Nayab and Scheid, 2011), however, Kaplan and Anderson (2007) promulgated a new strategy of proportionate cost accounting techniques that overcomes a shortcoming of the initial ABC system through *'a time-driven ABC'* basis.

## 2.9.1. Underpinning Philosophy of the ABC System

### 2.9.1.1. Concept of the ABC System

The initial concept of the ABC system was suggested through a *'two-stage'* process of production costing in manufacturing. The two-stage processes of the ABC system were introduced by Cooper and Kaplan (1988): in the *first stage*, costs are assigned to cost pools, and in the *second stage*, cost pools are assigned to products. Different authors explain the two-stages of the ABC system in different ways with a similar purpose. Innes *et al* (1994); and Glad and Becker (1997) explain that activities consume resource costs, and products consume activities. Hicks (1992 and 1999) defines costs as being assigned to an organisation's activities, and activity costs are eventually assigned to jobs, products or services. Innes and Mitchell (1998) state that overheads are charged to cost pools, and cost pools are attached to products. Drury (2008) describes that accounted overhead costs are allocated to activity cost pools, and those activity costs are assigned to cost objects. The ABC system can therefore be defined in regard to these two stages of allocating costs in construction projects.

### 2.9.1.2. Definition of the ABC System

The ABC system is defined by Turney (1994a) as '*a* [cost accounting] *methodology that measures resources, activities, and cost objects*'. This definition accommodates three important components of project costing: resource costs, activities, and cost objects. Cost objects require activities, and activities incur costs. The contemporary ABC system exists for multiple measurements, and this should be consistent with the standard requirement for monitoring project *processes* and *performances* (refer to Kerzner, 2009) such as, performance measurements and process assessments. The performance measurements support organisation strategies and operations for economic performances related to resource costs, activities, and cost objects, while the process assessments should make the organisation directly able to fulfil comprehensive ways of work being done for the compromised quality, time, and cost of work performance (Turney, 1994a).

Freedman (2013) defines the ABC system as the overhead cost allocation through a cost accounting method on the basis of activity cost drivers to particular activity pools and cost objects. This definition indicates that specific project overheads can be assigned to construction activities on the basis of cost drivers. Several activities can be grouped into batch, project, or facility levels to trace costs to the group of activities. The project overhead costs can therefore be distributed more accurately into these particular groups of activities (Jaya *et al.*, 2010b).

Construction companies need to ensure their continued existence and constantly improve their capacity through generating project profits. The ultimate goal is to increase project benefits: the ABC system can help companies to do this by improving profitability. The simple profit equation: *Profits = Revenue – Expenses* (Cooper and Kaplan, 1994) is usually applied in construction companies by planning their costs and profits accordingly to increase project benefits, often through cost savings during the construction operation (refer to figure 1-2 and Jaya *et al.*, 2010b and 2010c).

Hardy and Hubbard (1994) provided a definition of differentiation between the traditional costing method and the ABC system in financial reporting. They identified the essential features of the traditional costing systems, which address the overhead costs of both production and service departments by using the predetermined overhead rates. In contrast, the ABC system was defined and understood from the two-stage cost allocation concepts (refer to Section 2.9.1.1) by utilising multiple bases in assigning overhead costs to the production and the product. The ABC system represents a more flexible method of assigning costs through diverse cost drivers into the construction activities and the jobs, projects, and services as the cost objects (Giammalvo, 2007).

The ABC system has been analysed in UK companies by academics and practitioners (e.g., Nicholls, 1994, and Innes and Mitchell, 1995). They define the ABC system from users' experience viewpoint, which reflects that the ABC system is perceived to be a complex management tool, however many authorities considered this system to be simple enough to implement and match the complexity of projects. Seventeen percent of companies responding to a study in 1994 considered adopting the ABC system as their favoured approach (Nicholls, 1994). More than eighty percent of respondents from UK building companies considered adopting the ABC system and about 9.5 percent have implemented the system in the main core of their cost accounting departments (Innes and Mitchell, 1995). Therefore, the successful implementation of the ABC system may have been considered as an important approach in many construction companies in the UK. However, project managers of construction companies should have initiated a pilot case study in the specific area of construction activities before subsequently implementing the system in the wider areas, for example: substructure activities of construction building projects (Jaya *et al.*, 2012).

Manufacturing and service companies, together with construction companies, have experienced a fundamental change in the way they operate businesses in the twenty first century. The traditional costing methods and current accounting management practices do not effectively answer the need for improvement in cost management and controlling practices – the CMCPs of construction project overheads (refer to Section 1.2, and Jaya *et al.*, 2010c). The ABC system nowadays has been adapted in many institutions and companies. It was identified, along with other factors as a major contribution to change in Australian service companies; other factors are: global markets, products, businesses, customer focus, quality, deregulations, and a technological explosion (Lamond, 1994).

Roth and Borthick (1994) define the ABC system as 'the glory of better management decision making' on the basis of knowledge of the real product costs, being able to identify cost drivers, establishing driver-cost relationships and implementing the drivers. Project managers need a cost accounting system and cost information to manage and control project progress and cost performance. The ABC system represents relevant features to project costing and management, they are: reliable cost accounts, cost pools, diverse cost drivers, multiple cost objects, and transparent cost tracers for improving the CMCPs of construction project overheads (Jaya *et al.*, 2010a). Consequently, the ABC management systems enable continuous improvement in many objectives: to eliminate waste, reduce lead-time delivery, increase quality, reduce cost; develop people to improve skills, and increase productivity and moral (Roth and Borthick, 1994).

Construction projects involve many resources to accomplish jobs, projects and services through *activities*. The ABC system addresses the measurement of resources and cost objects including activities. The reason why activities and their execution are important in the construction stage is because they are key to understanding the way waste is eliminated to improve activities. Turney (1994b) provided guidance for improving activities and strengthening many organisational strategic positions, as identified here: *(1) identify nonessential activities, (2)* *analyse significant activities, and (3) compare activities to the best practices*. This provided detailed discussion on measuring non essential activities through involving these two questions: *'why do we do it?'* and then, *'how do we get rid of it?'*

Construction activities have values, to clients and other stakeholders, for example: the *'decoration activity'* of luxury resort buildings has an essential value to the client (or customer in general terms), because it is required to develop business, and is constructed to provide more than just a basic shelter (it has a value-added benefit to the client). Secondly, *'updating activity progress reports and financial statements'* must be prepared to satisfy organisations, senior management and external stakeholders (e.g., government agents, bankers, regulators, etc.), therefore, it has a value-added benefit to organisations and another institutions. The other activities may not be essential or be non value-added activities.

Typically, construction projects have *several common activities* and *vast detailed activities*, for example: site preparation, substructure, superstructure, finishing, and facilities and utilities (refer to the work breakdown structure – WBS in construction projects). In order to analyse significant activities, the key is to focus on satisfying the client and organisational requirements. Moreover, the activities must be selected to analyse their significance in providing the greatest opportunities for activity progress values and cost performance. Turney (1994b) suggested the Pareto principle: *'80 per cent of what you care about is determined by 20 per cent of what you do.'* This principle can be implemented through ranking the cost of activities in a descending order, and select the 20 per cent of activities which cause 80 per cent of the cost. This is the 20 per cent of activities that are most likely to provide better cost performance during construction operations.

Every construction project has uniqueness and complexity, however, many activities can be compared to similar activities within another part of the construction company or in another company alltogether. In order to improve project progress and cost performance, comparing an activity to the best practice available could help the improvement of those activities (Turney, 1994b).

Having discussed the definitions of the ABC systems related to costs and activities, the following section summarises the discussion into the underpinning philosophy of the system in construction projects.

#### 2.9.1.3. Philosophy of the ABC System

An underpinning philosophy of the ABC system is defined by Hicks (1999) as *'the jobs, products, and services an organisation provides,* [that] *require it to perform activities, and those activities cause it to incur costs'*. This definition is used to underline further applications of the ABC system in construction projects, and highlights important features (e.g., *overhead cost accounts, activity cost pools, diverse cost drivers, multiple cost objects, and transparent cost tracers*).

Overhead cost accounts are allocated to activity cost pools on the basis of diverse cost drivers and common to maintain multiple cost objects. The features of the ABC system provide transparent cost tracers of cause-and-effect relationships between costs, activities and cost objects that enable effective improvement of cost management and control mechanisms of construction project overheads.

*Project costs* are mainly caused by *activities* to realise projects, incurred costs can therefore be *managed*, and triggers of the costs should be *controlled*. Project cost is defined as the value of money that has to be paid for accomplishing jobs, projects, or services, while activities are actions that involve many resources to maintain the completion of projects within the time planned. Project *resources* may include human, financial, technology, and natural resources. Management is a process of organisational activities in coordinating resources. While project control is the process of monitoring, updating and evaluating the status of project progress and cost performance. Therefore, project costs, activities, management, and controlling can be considered as important aspects for the management of *project overheads* during the construction stage of construction projects (Jaya *et al.*, 2010a and 2010b).

Project overheads are usually added to building costs on a percentage basis (RICS, 2009; and CIOB, 2009), and traditionally allocated to construction activities on the basis of materials and labour costs (Mansuy, 2000; and Giammalvo, 2007). However, construction project overheads should be properly identified and accurately assigned on the basis of *activity cost drivers* in order to improve the Cost Management and Controlling Practices (CMCPs) during the construction stage (*Jaya et al.*, 2011c and 2012). The following section discusses activity cost drivers in construction projects.

#### 2.9.1.4. Cost Drivers

The ABC System identifies several categories of cost behaviours within the complex nature of processes, such as direct-variable costs (e.g., unit costs), direct-fixed costs (e.g., batch and project sustaining costs), and indirect-fixed costs (e.g., facility sustaining costs) (refer to Beaulieu and Mikulecky, 2008). Various cost drivers have been set to serve manufacturing production systems, while specific adjustment is required to adapt them to the construction process.

The hierarchy of construction activities and their cost drivers are provided in Table 2-3. It highlights the applicability of activity cost drivers in construction projects, namely: unit-level, batch-level, project-sustaining, and facility-sustaining.

**Unit Level**

Unit level is an activity cost driver that assigns costs by the unit of output basis, where costs are traced for every unit of output. Good examples of unit level activities include: site helpers and equipment depreciation (Kim and Ballard, 2001). Table 2-3 provides an example for this category of unit level cost driver: the unit of time (e.g., hour, day, week, month, or year) becomes a cost driver for depreciation. The ABC method in this context employs resource cost drivers in similar ways to allocating direct costs.

***Table 2-3: Activity Cost Drivers***

| Activity hierarchy | Cost driver |
|---|---|
| **Unit-level activities** | |
| Depreciation | time units |
| Site labour | labour hours |
| **Batch-level activities** | |
| Mobilisation | number of mobilisations |
| Quality inspection | number of inspections |
| **Project-sustaining activities** | |
| General plan | number of engineering hrs |
| Resource planning | number of planning hours |
| **Facility-sustaining activities** | |
| Rental office | Square footed or time-scaled |

**Batch Level**

Batch level is an activity cost driver that assigns costs by the batches of output basis, where costs are traced for every batch of output, regardless of the batch size of project outputs. Selected examples for batch level activities include: *procurement batch* (e.g., purchase order placement, material received, suppliers payment), *delivery batch* (e.g., material delivery to site), *process/task batch* (e.g., setup equipment, mobilisation, quality inspection), and *hand-off batch* (e.g., external quality inspection) (Kim and Ballard, 2001). Table 2-3 represents an example for this category of batch level cost driver: the number of inspections may become a cost driver for this particular type of inspection activity.

**Project Sustaining**

Project-sustaining is an activity cost driver that assigns costs by the particular existence of output bases, where costs are traced for every output of the project, regardless of the unit and batch numbers of products. Examples for project sustaining activities include: general planning, resource planning, cost planning, and cost controlling (Kim and Ballard, 2001). Table 2-3 provides an example of the category of project sustaining cost driver: the number of resource plans may become a cost driver for a resource planning activity.

**Facility Sustaining**

Facility-sustaining is an activity cost driver that assigns costs by the facility employed of output bases, where facility costs support the whole project and entire organisation. Examples for facility sustaining activities are: rental offices and general administration costs (Kim and Ballard, 2001). Those activities are not directly related to the construction activities, but Table 2-3 shows the rental office activity can be assigned by facility-sustaining cost drivers which seems to be traceable, e.g., per 'square-footage' (Beaulieu and Mickulecky, 2008). However, construction projects cannot avoid those inevitable costs.

The following section discusses differentiations between the traditional costing and the ABC system according to project overhead costs.

## 2.9.2. The Traditional Costing versus the ABC System

### 2.9.2.1. Cost Allocation Process

Simplistic traditional costing systems can be distinguished from the contemporary ABC system (refer to Figure 2-2). The concept of the traditional costing system uses volume-based allocations (Kim and Ballard, 2001 and 2005) to accumulate indirect costs directly to a single type of cost object with a single rate of unit cost; whereas the ABC system utilises a reliable hierarchy process in assigning indirect costs to activities, and those activity costs are accumulated to multiple types of cost objects with multiple rates of diverse cost drivers. The traditional costing system allocates average overheads arbitrarily (Cockins, 2001; Daly, 2002; and Giammalvo, 2007), on the basis of direct labour (Cooper and Kaplan, 1988; and Mansuy, 2000), to jobs, projects, or services directly (Hicks, 1999). The ABC system can assign accounted overheads to every activity (Mansuy, 2000; and Giammalvo, 2007), and these activity costs can be distributed to jobs, projects, or services on the basis of diverse cost drivers (Cooper and Kaplan, 1988; Innes and Mitchell, 1998; Hicks, 1999; and Drury, 2008).

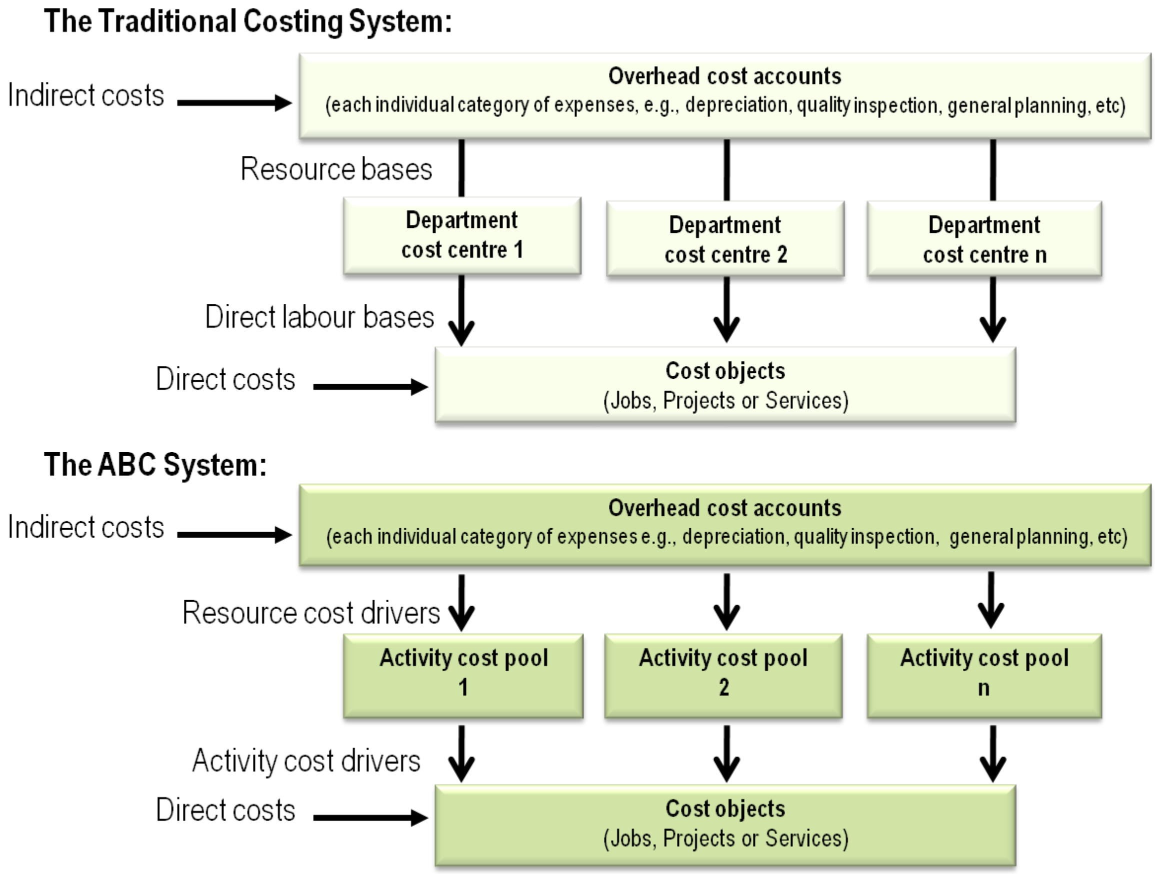


***Figure 2-4: The Cost Allocation Process for the Traditional Costing versus the Activity-Based Costing System***

***Source: Modified from Drury, 2008***

### 2.9.2.2. Major Criteria for Different Costing Systems

There are differences between a simplistic traditional costing system and the contemporary ABC system. Table 2-4 represents some criteria differentiating between both costing systems, based on empirical studies and published literature, such as: Cooper and Kaplan (1988); Innes *et al* (1994); Glad and Becker (1997); Innes and Mitchell (1998); Hicks (1999); Mansuy (2000); Grannof *et al* (2000); Cokins (2001); Daly (2002); Kaplan and Anderson (2007); and Drury (2008).

***Table 2-4: Major Differences between the Traditional Costing and the Activity-Based Costing System***

| Criteria | The Traditional Costing System | The ABC System |
|---|---|---|
| Interpretation of resource consumptions | Resource costs are directly consumed by cost objects | Resource costs are consumed by activities, then those activity costs are consumed by cost objects |
| Orientation of cost accounting | The basis of cost accounting is orientated on departmental structure of the organisations | The basis of cost accounting is orientated on hierarchical activities of the process |
| Utilisation of cost drivers | Cost accounting mostly employs volume-base allocations at single rate of unit level costs, i.e., unit of volume | Cost accounting uses activity hierarchy levels at multiple rates of cost drivers such as unit, batch, product, and facility sustaining |
| Concern on cost objects | It focuses on estimating single type of cost objects by the single rate of unit level cost for measuring the products and services | It focuses on estimating multiple types of cost objects by the multiple rate of cost drivers for sustaining the jobs, products, and services |
| Specific distribution of overheads (advantages / disadvantages) | It allocates prorate overheads and brings a problem of cost distortions, because of its' inability to highlight the visibility of costs to cause-and-effect relationships | It assigns overheads per activity to avoid a problem of cost distortions, because its' ability to highlight the visibility of costs to cause-and-effect relationships |
| Relative monetary value of accounting systems (potential benefits / losses) | It is financially cheaper to implement and maintain because is familiar system to available human resources, but provides simplistic cost accounting, hiding unknown benefit or potential to lose. | It is relatively expensive to implement and maintain, requires qualified human resources, but provides higher cost accounting accuracy, potential to create clear benefits or profits. |

Academics and practitioners such as Cooper and Kaplan (1988); Glad and Becker (1997); Innes and Mitchell (1998); Hicks (1992 and 1999); Kaplan and Anderson

(2007); Drury (2008); and others have initially attempted to improve the simplistic traditional costing system for production lines of manufacturing companies. However, this may have extended features to serve cost accounting management concerns for trading, banking, insurances, healthcare, universities, and other service companies including the construction industry. Kennedy and Affleck-Graves (2001) provide empirical evidence of using the ABC system within the first three years after adoption. The success of companies using the ABC system was approximately 27 per cent higher than the achievement of non-ABC companies economically. The statistical data in the US indicated that more than 50 per cent of companies use the ABC system when planning costs for profit (Daly, 2002). The implication of the ABC application in the competitive market is evident by a significant improvement in the creation of profits (Cockins, 2001), and through pricing and selling products accurately (Daly, 2002; and Giammalvo, 2007).

Having discussed the concept, definition and philosophy of the ABC system, how it differs from the traditional costing systems, and empirical evidence of its adoption in various sectors, the following section elaborates the application of the ABC system in construction projects of the construction industry.

## 2.9.3. Application of the ABC System in Construction Projects

### 2.9.3.1. Adaptation of the ABC system in Construction Companies

The ABC system is not new to the construction industry and other organisations. Innes and Mitchell (1995 and 1997) reported a survey result based on 439 responses of 21 cross sector organisations in the UK’s 1,000 largest companies. The part of their research relates to construction building sectors. A large number of construction building companies (81 per cent) have considered adopting the ABC system, 9.5 per cent have decided dropping the system, and 9.5 per cent have used it for the main core of the system in general accounting department. This indicates that the ABC system has been suitably introduced into construction companies.

Construction companies could use the ABC system to maintain the competitiveness of project bidding (Mansuy, 2000), in line with market prices. Contractors could win the bid but still lose money if the project is priced below market prices, or lose the bid and miss the opportunity to earn profits if the project is priced above competitive markets. Furthermore, the ABC system can become a leading method to the cost management and process controls that encourages managers to manage construction operations effectively, identify cost inefficiencies, and undertake appropriate action (Marchesan and Formoso, 2001).

The corporate culture of construction companies in the project cost management practice would seem to have changed due to the progress of cost accounting systems and management developments. It might be assumed that cost information systems recently focused on financial accounting reports to satisfy senior management and external parties, whereas today, it could be extended to measure internal organisational activities, such as construction processes, the cost performance of projects and anything that requires effective management and controls for project costs and informed decision making. The application of the ABC concept and development of the ABC system in construction projects may give opportunities and powerful drivers for cost management systems at a managerial level with a transparent system and clear cost 'cause-and-effect' relationships, to change their roles on how personnel 'think and act' (SAP-AG, 2000).

The adaptation of the ABC system in accounting departments causes construction companies to adopt two different cost accounting systems. This is because current cost accounting management approaches are established to produce external financial reporting, whereas the ABC accounting system is required to improve internal project costing. Therefore, the following section introduces the application of the ABC system for the cost management and control mechanisms in construction projects.

### 2.9.3.2. Application of the ABC System in Construction Projects

A chronological process of adaptation of the ABC system in a construction project is carried out during the literature review stage and represented through a diagram in Figure 2-3 below:

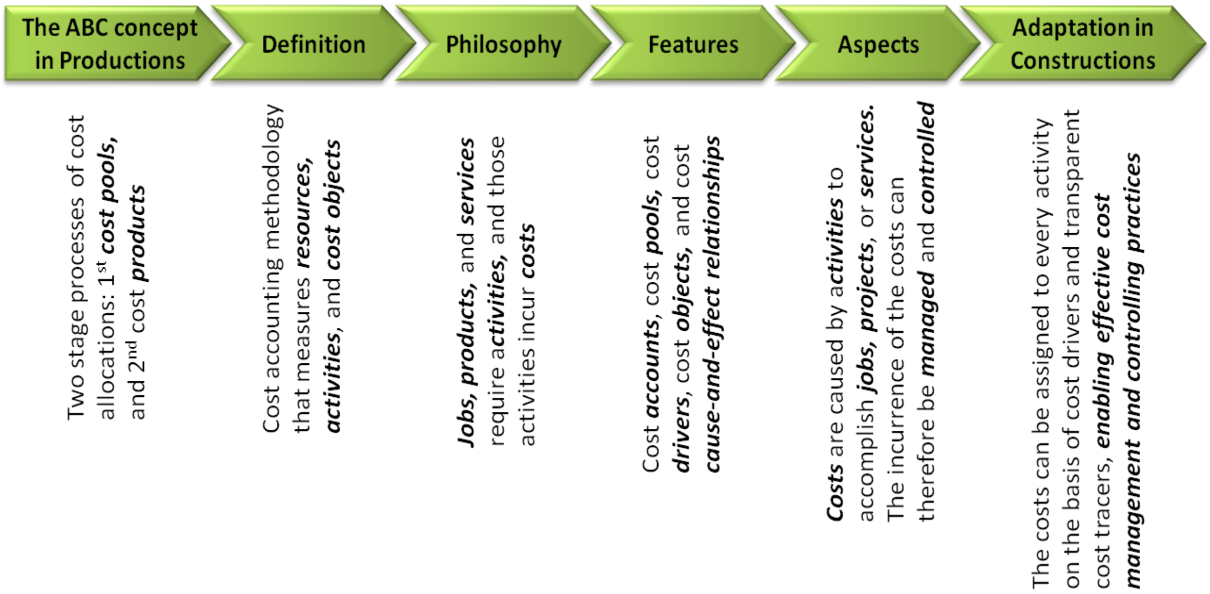


***Figure 2-5: Application of the ABC System in Construction Projects***

***Sources: Literature Review and Principles***

The literature review on this subject (refer to Section 2.9.1) has discovered the ABC ***concept*** (e.g., Cooper and Kaplan, 1988), ***definition*** (e.g., Turney, 1994a), and ***philosophy*** (e.g., Hicks, 1993 and 1999). Relevant ***features*** of the ABC system are identified, such as reliable cost accounting, certain cost hierarchies, diverse cost drivers, multiple cost objects, transparent cost tracers, and effective cost management systems (Jaya *et al*., 2010a); and it is important that ***aspects*** of the ABC system are highlighted, such as accountable project overhead costs, particular construction activities, effective cost management and appropriate cost controlling methods (Jaya *et al*., 2010b), according to a process flow-view of the manufacturing ***'production principle'*** (e.g., Kim and Ballard, 2001). The *construction process* can be assumed as behaving in an identical way to the basic *production principles* of manufacturing (e.g., ***input – process – output***) in regard to the ABC concept, definition, and underpinning philosophy of the ABC system. The ABC system is considered in manufacturing production lines, where manufacturing *jobs, products or services* are identical to the *construction's jobs, projects and services* ***(construction outputs)*** which require *activities* ***(construction processes)***, and those activities consume *resource costs* ***(construction inputs)***.

The construction activity process and manufacturing production lines would appear to have utilised a similar procedure (e.g., inputs – processes – outputs, and evaluations). They involve similar features (e.g., cost accounting, cost hierarchies, cost drivers, cost objects, cost tracers, and cost management and control); and rely on similar aspects (e.g., costs - activities - products/projects, and management and control). These *'activity-based'* systems provide clear process views and transparent cost flows to cause-and-effect relationships between resource costs, activities, and jobs, projects or services. Therefore, construction process views would provide a systematic approach to relate *project costs* with *scheduled activities* transparently to complete a project and to manage and control them effectively (e.g., to implement the competencies, discover inefficiencies, reduce unnecessary costs or non-value-added activities) to improve productivities in order to increase project benefits.

Project costs may include profits, contingency, direct, and indirect costs (Aretoulis *et al*., 2006; Giammalvo, 2007 and 2009; and Šiškina *et al*., 2009). Project profits can be measured as excess revenue against project costs. Contingency is an undefined provisional sum of money for unknown activities (CIOB, 2009). Direct cost includes materials and labour which are directly associated to activities, whereas indirect overheads are not clearly related to particular activities. However, project overheads are perceived as potential costs which should be fairly predicted to maintain project activities (Sutrisna *et al*., 2004). In this way, the role of the ABC system can facilitate accurate distribution of project overheads to every activity (Giammalvo, 2007), and it can reduce unexpected costs (Kim and Ballard, 2001). Therefore, the ABC system would be suitably adapted and applicable in the 'construction process' (refer to Figure 2-3).

The application of the ABC system in construction projects can therefore be investigated in order to design and develop the concept of Activity-Based Cost Controlling (ABCC) model through the literature review and empirical study.

## 2.10. Summary

This chapter provided a detailed discussion and explanation of the literature review and principles used in the research project. The research began with a statement of the research problem, and reflects on synthesising the literature review in the area of cost management and controlling practices – CMCPs of project overheads. The ABCC model is developed using construction project overheads and the ABC system and the important CSFs are identified, they are incorporated into the CMCPs to improve the management of construction project overheads. The research area focuses on commercial building projects to investigate the impact of project complexities in the construction stage of construction projects. This section also highlight the attractiveness of the construction project specifically and the construction industry worldwide.

The following chapter discusses a conceptual design and development process of the ABCC model for improving the management of project overheads during the construction stage of construction projects.

# CHAPTER 3. DEVELOPMENT OF THE ACTIVITY-BASED COST CONTROLLING (ABCC) MODEL

## 3.1. Introduction

There are several ways that the topic in the research area can be presented. This chapter discusses the research framework through developing a chronological process of the research, including: a conceptual research model, structure of the Activity-Based Cost Controlling (ABCC) model, description of the ABCC model, project cost measurement, and implementation of the Cost Management and Controlling Practices (CMCPs) of construction project overheads.

The conceptual research model presents a framework of the research through abstracting the problem situation related to research aim and objectives to enable problem solving. Section 2.4 discussed the identification of project overheads, Section 2.7 presented the groups of Critical Success Factors (CSFs), and Section 2.9 elaborated an application of the Activity-Based Costing (ABC) system to maintain development of the ABCC model to improve the management of project overheads. Description of the ABCC model provides a clarification of relationships between all important aspects discussed in these sections. Project cost measurement section gives an insight of the flow and capacity of every aspect of the ABCC model to measure project costs, activities, and performance. Project cost performance will be measured using the three criteria of cost measurement: cost savings; cost deficits; and cost neither savings nor deficits. The cost performance can be managed through implementation of the CMCPs' tools and techniques for improving the management of project overheads during the construction stage of construction projects.

This chapter discusses the conceptual research model, the structure of the ABCC model, project cost measurement model, and the CMCPs' tools and techniques of construction project overheads.

## 3.2. Conceptual Research Model

A conceptual model is defined as the process of abstracting a model design which presents a problem situation from a real world perspective (Kotiadis and Robinson, 2008). It may be expected to represent the relationships between ideas and objectives that must be maintained and incorporated to enable problem solving. Therefore, the important factors and relevant aspects to include have to be determined.

The eight groups of ***important CSFs*** have been created (refer to Section 2.7). The limited number of important CSFs is recognised as an effective method ensuring a competitive performance of operational management for organisational goals (Rockart, 1979 and 1982) through involving explicit understanding and necessary actions in the particular area (Foster and Rockart, 1989). Project managers should employ the satisfactory CSFs when monitoring the project progress and performance related to cost management and controlling practices of project overheads for the successful project completion.

The underpinning philosophy of ***the ABC system*** provides a clear process view (Kim and Ballard, 2001), where jobs, projects, or services require activities which incur costs (Hicks, 1999; Cockin, 2001; Daly, 2002; Kaplan and Anderson, 2007; and Drury, 2008). The ABC system provides important features, such as reliable *cost accounts and management*, certain *cost hierarchies*, diverse *cost drivers*, multiple *cost objects*, and transparent *cost tracers* (Jaya *et al.*, 2010a). Project costs are caused by activities, the incurrence of the costs can therefore be managed, and the triggers of the costs should be controlled. Project *costs, activities*, *management,* and *controls* are important aspects for the management of project overheads (Jaya *et al.*, 2010b). The ABC philosophy and its features are maintained for, and relevant to, the conceptual development of ***the ABCC model.*** The important aspects and conceptual structures of the ABCC model are described in more detail in Section 3.3.

The groups of important CSFs are examined and the structure of the ABCC model is developed to fulfil the cost management and controlling practice. The important CSFs and the ABCC model could be incorporated to improve ***the management of project overheads*** (Jaya *et al.*, 2010c and 2011a). Therefore, the construction progress and cost performance can be effectively monitored through the *planning cycle* (e.g., scheduling activities, and authorising costs), and *operating cycles* (e.g., measuring activity progress values, documenting financial transactions, updating actual project expenses, managing cost performance and changes) during the construction stage of projects (refer to Figure 3-1).

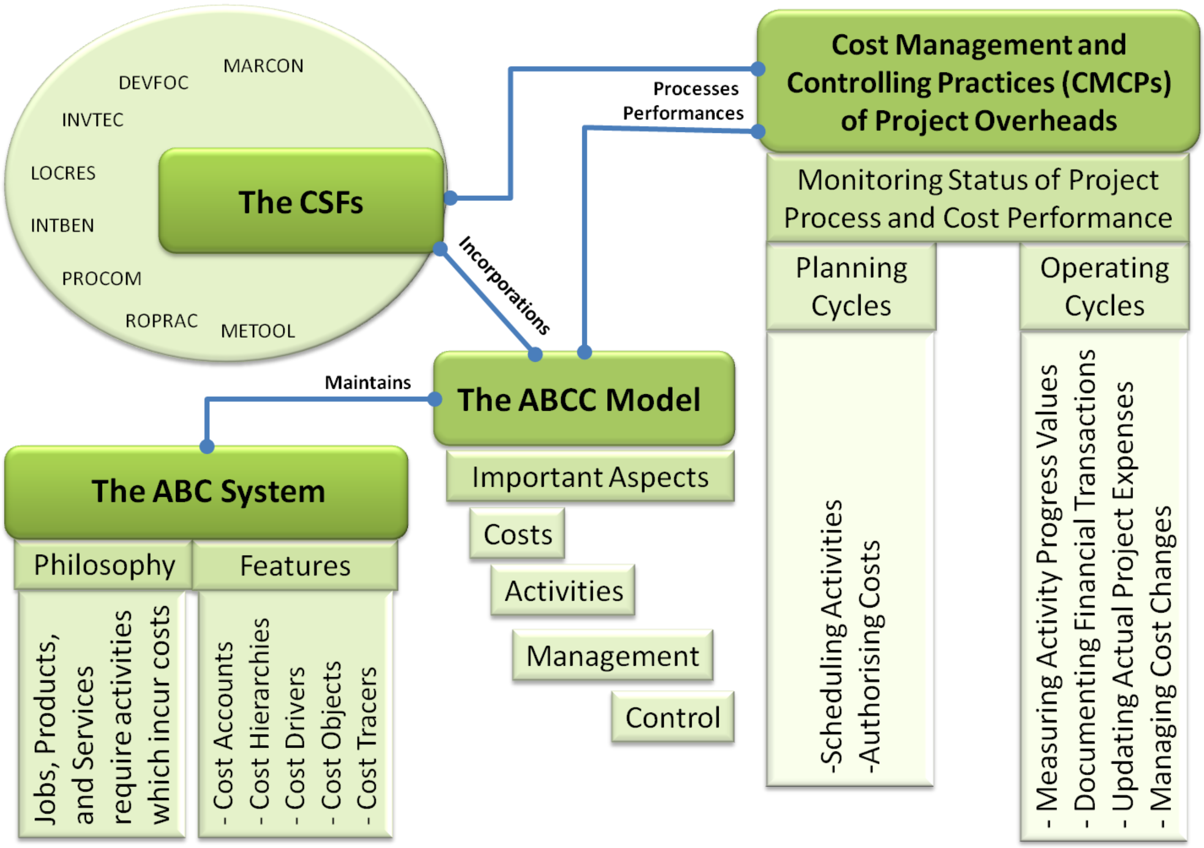


***Figure 3-1: The Conceptual Research Model***

The relationship between important aspects of the ABCC model, e.g., costs, activities, management and controls will be described during the development of the model. Cost control mechanisms could be applied immediately after project expenses are updated to measure and evaluate cost changes in order to take earliest managerial actions appropriately, before it is too late and the expenses become cost overruns. The following section elaborates the process of constructing the ABCC model.

## 3.3. Structure of the Activity-Based Cost Controlling (ABCC) Model

The ABCC model is expected to improve the simplistic traditional costing system and resolve current cost accounting management problems (refer to Section 1.2) through effective cost management and controlling practices of project overheads in order to improve project benefits. Figure 3.2 shows the terms costs and expenses. In this context, only site-project overheads are measured and related to the ABCC model rather than other cost components. ***Costs*** are defined as authorised costs scheduled for performing activities. ***Expenses*** are defined as actual expenditures on activities performed. ***Activity progress values*** are monitored, measured, and reported based on completed works on both typical bases: weekly or monthly periods and on its cumulative accounts. The activity progress **V**alues and actual **E**xpenses **R**atio (***VER***) can be used as an effective cost performance indicator to measure project benefits (refer to Appendix 1 for an example). This model represents the project benefit measurements, where: the higher the project ***VER>1*** the greater ***cost savings*** and contribution for improving the project benefit, and in the opposite way, the lower the project ***VER<1*** the greater ***cost deficits*** which decreases the project benefit. The project ***VER=1*** indicates activity progress value equal to actual project expenses. The procedures of measuring project benefits are shown in the structure of the ABCC model (refer to Figure 3-2).

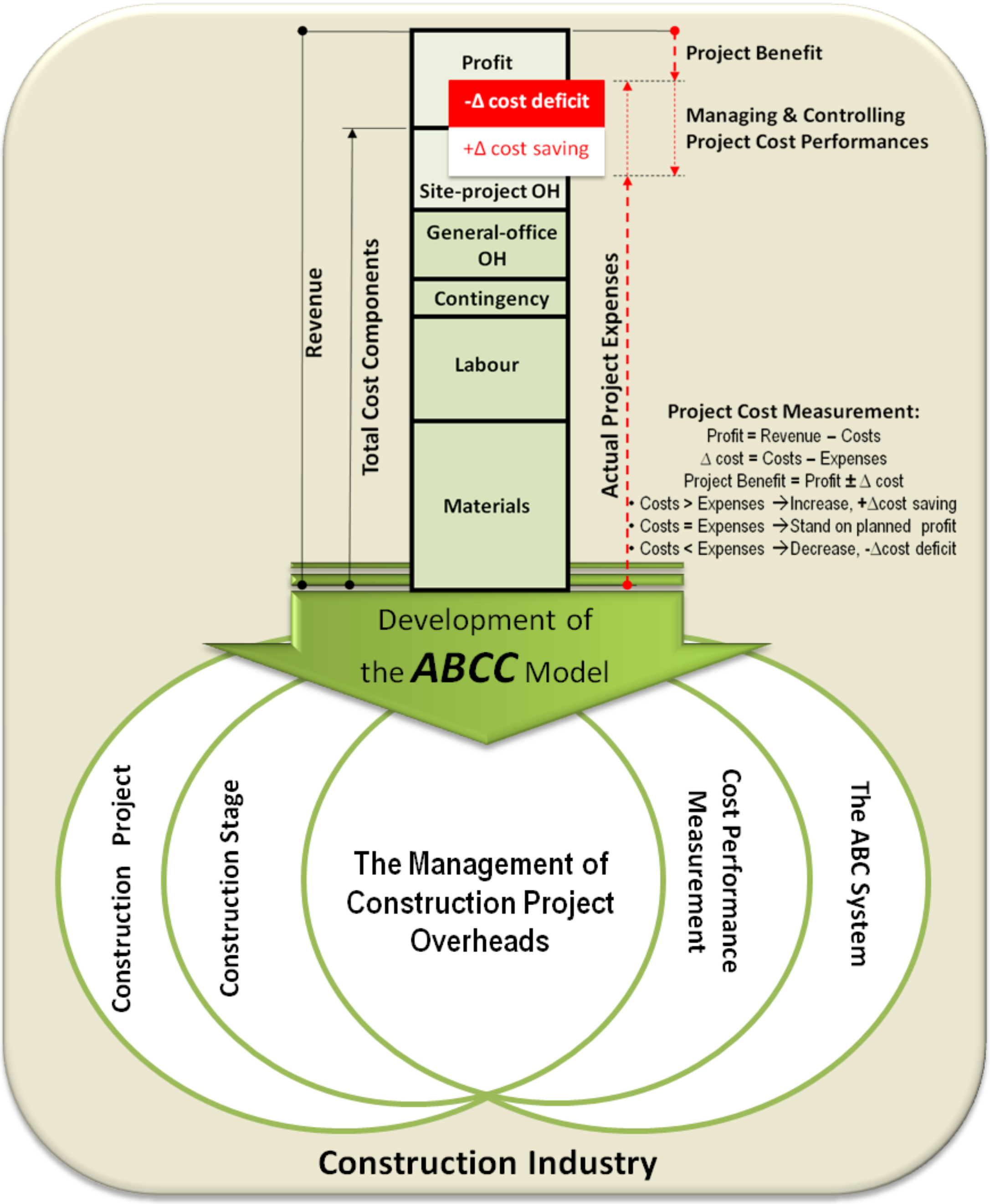


***Figure 3-2: The Structure of the ABCC Model***

***Source: Adapted from Jaya et al., 2010b and 2010c***

The ABCC model represents construction companies' (contractors') perspective, which prioritise profits, for many reasons (Ostwald, 2001). Project ***profit*** can be generate through excess revenue over cost plan ***(profit = revenue – cost)***. Cost changes *(Δcost saving* or *Δcost deficit)* can be measured through activity progress value minus actual project expenses ***(Δcost = activity progress value – actual project expenses).***

***Project benefit*** can therefore be improved gradually based on effective cost management and controlling practice in terms of updating day-to-day actual project expenses relating to activity progress values of every activity performed, and managing cost performance and changes in respect of costs scheduled ***(project benefit = profit ± Δcost saving*** or ***Δcost deficit)***.

The bottom part of the structure of the ABCC model represents particular areas in which this model is related to, and will be described in the following section.

## 3.4. Description of the Activity-Based Cost Controlling (ABCC) Model

The structure of the ABCC model, at the bottom part of Figure 3-2, represents the ***construction industry*** and four types of ***construction projects*** (refer to Section 2.3), such as residential building projects, commercial building projects, infrastructure and heavy engineering projects, and industrial building projects (Hendrickson and Au, 1989; Ostwald, 2001; Gould, 2005; Sears *et al.*, 2008; and Gould and Joyce, 2009). However, according to Kirkham (2007), the construction industry is classified into two types: construction building and civil engineering. The ABCC model represents the contractor’s point of view that is developed and associated in commercial building construction projects during the construction stage as discussed in Section 2.3.5.

The Royal Institute of British Architects (RIBA) identified the ***construction stage*** which is one of the important stages of the discreet project phases. Figure 3-3 represents the five (5) stages of work strategies involving eleven (11) terms of project phases which have been established recently (Philips, 2009 and Cartlidge, 2009).

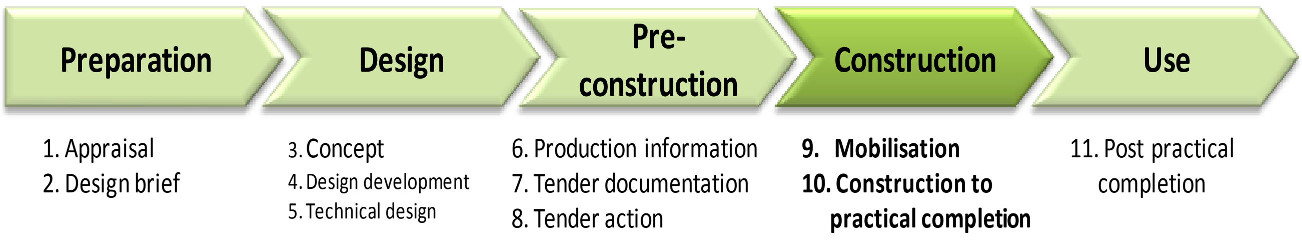


***Figure 3-3: The Project Phases***

***Source: Modified from Philips (2009) and Cartlidge (2009)***

The project phases are outlined in the chronological 'RIBA work stages' as represented in the outline plan of work (refer to Philips, 2009): ***(i)*** *preparation,* i.e., (1) appraisal, (2) design brief, ***(ii)*** *design,* i.e., (3) concept, (4) design development, (5) technical design, ***(iii)*** *pre-construction,* i.e., (6) production information, (7) tender documentation, (8) tender action, ***(iv)*** *construction,* i.e., (9) mobilisation, (10) construction to practical completion, and ***(v)*** *use,* i.e., (11) post practical completion. The process of designing, organising, managing, administering, servicing, and fees for the operational building works are usually based on detailed stages as explained in Table 3.1 below.

***Table 3-1: RIBA Outline Plan of Work***

| Discreet Phases 2009 | Discreet Phases 2013 | Work Stages | Explanation |
|---|---|---|---|
| | **0 Strategic Definition** | | |
| **1 Preparation** | **1 Preparation & Brief** | **1 Appraisal** | ▪ Identification of client's needs and objectives, business case and possible constraints on development.<br>▪ Preparation of feasibility studies and assessment of options to enable the client to decide whether to proceed. |
| | | **2 Design Brief** | ▪ Development of initial statement of requirements into the Design Brief by or on behalf of the client confirming key requirements and constraints.<br>▪ Identification of procurement method, procedures, organisational structure and range of consultants and others to be engaged for the project. |

| | | | | |
|---|---|---|---|---|
| 2 Design | 2 Concept Design | 3 Concept | | ▪ Implementation of Design Brief and preparation of additional data.<br>▪ Preparation of Concept Design including outline proposals for structural and building services systems, outline specifications and preliminary cost plan.<br>▪ Review of procurement route |
| | 3 Developed Design | 4 Design Development | | ▪ Development of concept design to include structural and building services systems, updated outline specifications and cost plan.<br>▪ Completion of Project Brief.<br>▪ Application for detailed planning permission. |
| | | 5 Technical Design | | ▪ Preparation of technical design(s) and specifications, sufficient to co-ordinate components and elements of the project and information for statutory standards and construction safety. |
| 3 Pre-construction | 4 Technical Design | 6 Production Information | 6.1 | ▪ Preparation of production information in sufficient detail to enable a tender or tenders to be obtained.<br>▪ Application for statutory approvals. |
| | | | 6.2 | ▪ Preparation of further information for construction required under the building contract. |
| | | 7 Tender Documentation | | ▪ Preparation and/or collation of tender documentation in sufficient detail to enable a tender or tenders to be obtained for the project. |
| | | 8 Tender Action | | ▪ Identification and evaluation of potential contractors and/or specialists for the project.<br>▪ Obtaining and appraising tenders; submission of recommendations to the client. |
| | 5 Fabrication Design | | | |
| 4 Construction | 6 Construction (Offsite & Onsite) | 9 Mobilisation | | ▪ Letting the building contract, appointing the contractor.<br>▪ Issuing of information to the contractor.<br>▪ Arranging site hand over to the contractor. |
| | | 10 Construction to Practical Completion | | ▪ Administration of the building contract to Practical Completion.<br>▪ Provision to the contractor of further information as and when reasonably required.<br>▪ Review of information provided by contractors and specialists. |
| 5 Use | 7 In Use | 11 Post Practical Completion | 11.1 | ▪ Administration of the building contract after Practical Completion and making final inspections. |
| | | | 11.2 | ▪ Assisting building user during initial occupation period. |
| | | | 11.3 | ▪ Review of project performance in use |

***Source: Modified from Philips (2009) and RIBA (2012)***

Construction stages are based on the construction contract agreement which delivers the completed project in a stipulated period of time. The development of the ABCC model is concerned with the measurement of cost performance during the construction stage, namely project planning and operations on site (refer to Smith *et al.*, 2006). Therefore in Figure 3-3, the construction stage refers to Philips (2009) and Cartlidge (2009), i.e., *mobilisation* and *construction to practical completion*. These two construction activities are the source of acquiring information on developing the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage.

According to PMI (2008) the project ***cost management and controlling*** tools and techniques are introduced, and include: Earn Value Management (EVM), Forecasting, To-Complete Performance Index (TCPI), Performance Reviews, Variance Analysis, and Project Management Software. The *EVM* method is commonly used to monitor three key dimensions for control cost accounts, such as a planned value, earned value, and actual cost. The *Forecasting* is developed for estimating cost of completions as the project progresses. The *TCPI* is the calculated projection of cost performance on the remaining works to achieve the management goals. The *Performance Review* is used for comparing cost performances overtime (e.g., overrunning or under-running budget). The *Variance Analysis* is a cost controlling tool used to assess cost variation versus the original cost bases. *Project Management Software* is often used to display the three dimension trends of the EVM graphically, and to forecast final results of project monitoring (PMI, 2008). These methods are applicable for monitoring project costs related to all construction activities. However, none of them have been exclusively applied to control the project overhead costs. Therefore, it is important to investigate the ABC system for cost management and controlling practice relating to construction project overheads.

***The ABC system*** was initiated to serve higher complexities of manufacturing production systems in assigning overheads accurately to particular jobs, products, and services on the basis of diverse cost drivers (Cooper and Kaplan, 1988; Hicks, 1992 and 1999; Cockins, 2001; Daly, 2002; Kaplan and Anderson, 2007; and Drury, 2008). These activity cost drivers may replace direct labour bases (Mansuy, 2000; and Cockins, 2001). Construction projects tend to have higher complexities, have an intricate nature, are fragmented packages, and have diverse operational activities. This requires robust methods of distributing project overheads accurately to every activity with relevant cost drivers. These activity cost drivers may replace percentage allocations which are described in RICS (2009) and CIOB (2009). The ABC system would be suitably implemented in assigning project overheads accurately to jobs, activities or project packages in construction projects (Jaya, *et al.*, 2010a and 2010b). The unique feature of the ABC system provides cost accounting and management that includes individual cost accounts, certain hierarchy cost pools, diverse cost drivers, multiple cost objects, and transparent cost tracers (Jaya *et al.*, 2010b and 2010c). The ABC system provides appropriate tools and techniques to enable assigning overheads accurately to every activity of construction projects (Giammalvo, 2007). In order to trace costs transparently from one point to the next, the ABC system can visualise costs to cause-and-effect relationships between overheads, activities, and projects. In this way the ABC system can be considered as a robust method to develop a cost controlling model. Therefore, the ABCC model (presented in figure 3-2) has been developed for improving the management of project overheads during the construction stage of construction projects in the construction industry (Jaya *et al.*, 2010c and 2011a).

Construction operations on site may face a higher variability of overhead costs which can affect project benefits substantially. Project overheads must be effectively planned and controlled during construction. The standard requirement of monitoring the status of project processes and performances are increasingly important. A project's planned costs have to be effectively used to support construction activities. Financial transactions (e.g., invoice, and payments) should be properly recorded and regularly reported to update the day-to-day or weekly progress of project expenses. The physical overhead activities must be reported accordingly in order to measure the cost schedules for these activities which have progressed. The value of the activities and comparison with actual project expenses are used to examine cost changes, and indicate cost performance levels. These practices are quite challenging roles for project managers in implementing the ABCC model as a robust tool for managing and controlling project overheads, during the construction stage.

The requirement of monitoring the status of project progress and cost performance to analyse the relationships between cost scheduled, physical-activity progress values, actual expenditures, and project benefits are expected to be resolved with the application of the ABCC model and improve the management of project overheads. The implementation of the ABCC model should consider the concepts and procedures for the cost management and controlling practice, which include:

> *'......... influencing the factors that create [cost] changes ....., ensuring that all change requests are acted [upon] ........, managing the actual change ........., ensuring that cost expenditures do not exceed the authorised funding ........., monitoring cost performance to isolate variances ........., monitoring work performance against fund expenditures ........, preventing unapproved changes ........., informing appropriate stakeholders of all approved changes ........., and acting to bring expected cost overruns within acceptable limits .........'* (PMI, 2008, pp. 179-180).

After discussing the development of the ABCC model, the following section explains project cost measurement through an application of the activity-based costing to improve the Cost Management and Controlling Practices (CMCPs) of project overheads during the construction stage of construction projects.

## 3.5. Project Cost Measurement Model

The measurement of project costs, activities, and performances is the most important aspect of the ABCC model to improve the cost management and controlling practices – the CMCPs of project overheads during cost planning and construction operation. Project managers should have an understanding of which specific resources are required by particular activities in order to perform jobs, projects, and services during the construction stage.

Figure 3-4 shows that project ***information*** and company ***databases*** are the primary areas of the project management initiatives toward cost management, through estimating, budgeting, and controlling. The Project Management Body of Knowledge (PMBOK guide) provides a brief overview of project cost management which includes cost estimates, budgets, and control. Project cost estimation is about the process of approximating monetary values of the resources for completing activities. Project budgeting is about the process of aggregating estimated activities or works for authorising costs. Whereas, cost controlling is about the process of monitoring the status of cost performance and updating project budgets for managing cost changes (PMI, 2008).

Project costs should recover all operational cost components such as materials, labour, contingency, profit, and overheads (refer to Aretoulis *et al.*, 2006; Giammalvo, 2007 and 2009; and Šiškina *et al.*, 2009). The procedure of activity-based project costing requires project costs to be accounted on each particular component by breaking resources separately (e.g., differentiate between ***direct and indirect resources***).

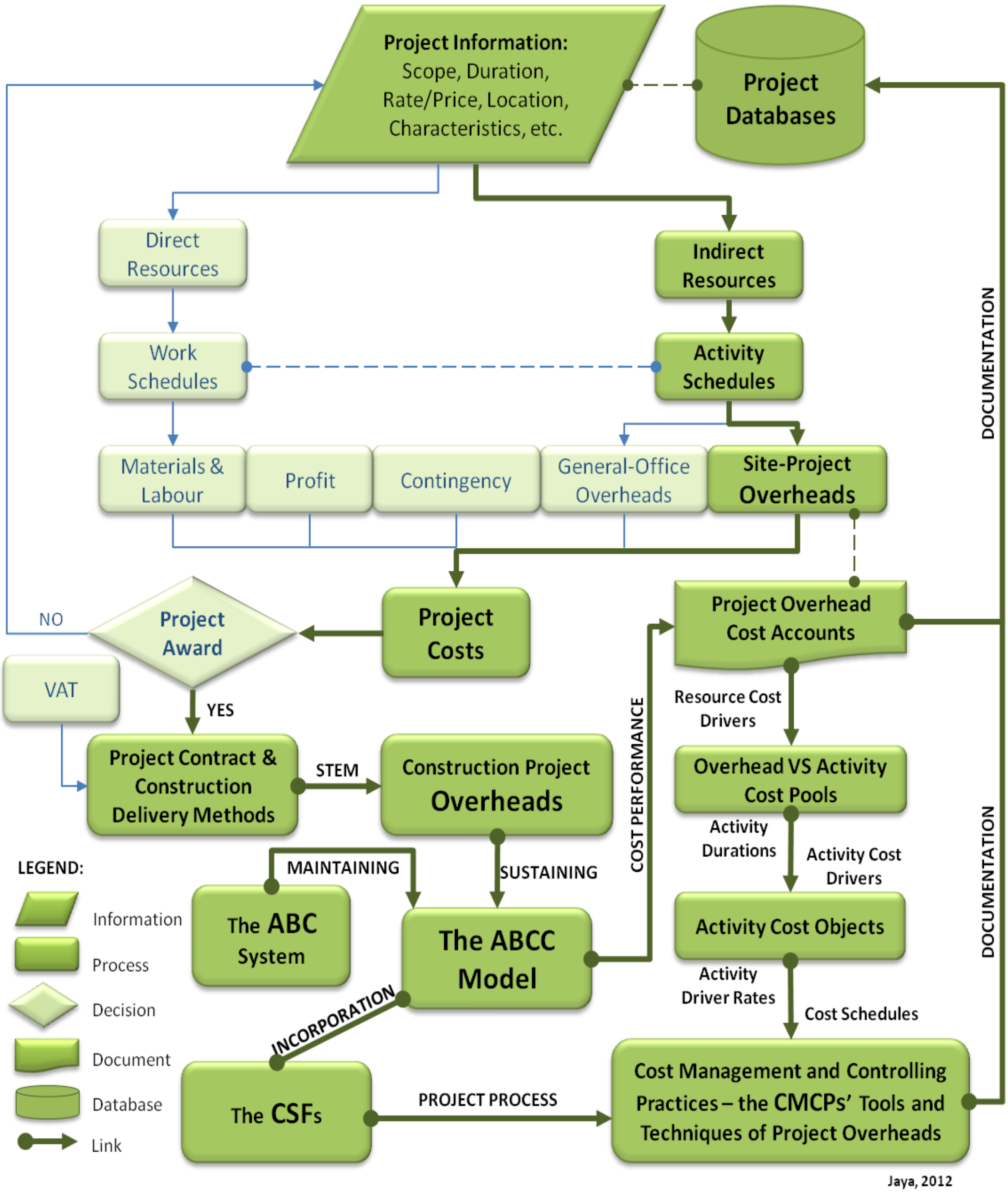


***Figure 3-4 : Project Cost Measurement Model***

***Indirect resource costs*** are normally measured against utilisation of resources needed based on cost drivers for supporting construction activities. Resource cost drivers can be defined as unit rates of measurements to costs of activities which require those resources. Resource rates normally refer to *information provided* and the contraction company's *current databases*. Construction activities are identified through Bill of Quantities, detailed designs of the project plan and schedule for estimating ***project costs*** to represent a competitive bid which includes both affordable and practicable ***project overheads***.

After the project is ***awarded***, the ***project contract*** should be issued and includes Value-Added Taxes (*VAT*) in the *project price*. The construction ***delivery methods*** also have to be the part of agreement to develop construction procedures, schedules and techniques from the contractor view point. Project overheads can particularly stem from the contract price. Then, the project overheads may be *re-accounted* and individually treated in different way to material and labour costs.

***The ABC system*** (refer to Section 2.9) is a reliable cost accounting method for measuring project overheads, activities, and cost objects. Potential features of the ABC system may be utilised for assigning project overheads through reliable cost accounting and management, hierarchy cost pools, diverse activity-cost drivers, multiple cost objects, and transparent cost tracers. Important aspects of the ABC system, such as costs, activities, management, and controls are very important for developing and maintaining ***the ABCC model***. Groups of ***important CSFs*** (refer to Section 2.7) are identified and created in this particular area of activity for project managers' views and perspectives on monitoring the status of day to day project process, physical progress, and actual expenses of project overheads.

***Project overheads*** have specific cost behaviours that indirectly occur on particular ***activities***. They have quite distinct characteristics to materials and labour which are directly attached in the volume of the works. Specific project overheads may be occurred on particular activities with relevant measures of ***diverse cost drivers*** such as unit-level, batch-level, project-sustaining, and facility-sustaining, whereas materials and labour costs are only attached on the unit of volume basis.

The status of project progress and cost performance can be monitored and updated on a regular basis, e.g., daily, weekly, or monthly. Project managers play important roles for the success of these tasks on both planning, budgeting and controlling the authorised costs for construction activities in operation cycles. Therefore, project managers require appropriate methods, tools, and techniques to enable effective monitors of project overheads.

Figure 3-4 also represents the collaboration between the ABC system, the ABCC model, the important CSFs and cost measurement in order to improve the management of project overheads. The ABC system maintains the ABCC model in the process of accounting and measuring the performance of project overheads. The implementation of the ABCC model incorporates the important CSFs in order to improve the Cost Management and Controlling Practices – the ***CMCPs*** of project overheads during the construction stage of construction projects.

## 3.6. Cost Management and Controlling Practices (CMCPs)

Project managers can assess project benefits according to the cost savings or cost deficits, based on the cost measurement criteria (refer to Figure 3-2: the structure of the ABCC model). A spreadsheet in excel format is designed as appropriate tools and techniques of the CMCPs for accounting, scheduling, controlling, and managing project overheads. The CMCPs' tools and techniques facilitate the implementation of the ABCC model through cost performance measurements of detailed overhead cost accounts and clear relationships between Overhead Costs Scheduled *(**OCS**)*, Activity Progress Values *(**APV**)*, and Actual Project Expenses *(**APE**)*.

In order to make well informed decisions and take necessary action with regard to the ABCC model, project managers can follow the three measurement criteria for cost management and controlling practice – the CMCPs of project overheads to increase effectiveness:

- If activity progress values are greater than actual project expenses ***(APV > APE):*** Project ***VER>1***, it means an increased positive cost saving for the project benefits. Therefore, the related activities most probably provide some cost advantages, even though it requires continuous attention to improve. Then, these particular activities can be recommended/ directed for moving forwards.

- If activity progress values are equivalent to actual project expenses ***(APV = APE):*** Project ***VER=1***, it means the initial profit is stagnant (refers to the viewpoint of contractors, but means nothing for the clients). The related activities nevertheless provide less attractiveness and a lack of project managers' creativity for project benefits. Then, these particular activities deserve more careful and constant managerial attention before being recommended.

- If activity progress values are lower than actual project expenses ***(APV < APE):*** Project ***VER<1***, it indicates either cost overrun, or there is a deficit in overhead costs and this substantially decreases the project benefits. Therefore, the related activities may have suffered some cost disadvantages. These particular activities must be given careful and special attention as to whether they require *preventative, corrective,* or *immediate* action depending on each relative level of cost deficit.

The level of project cost deficit or saving forecasted in respect of the total budget estimated at completion can be resolved by implementing a Worst Case Scenario ***(WCS)***. The WCS can be implemented in project practice in order to take managerial decisions through examining the status of cost performance indices during the construction operation. The WCS decision making method considers the lowest favourable savings or the highest unfavourable deficits (refer to Section 5.4.5.5).

## 3.7. Summary

This chapter has presented the process of developing the ABCC model. The relationships between the problem situation, aim, and objectives, are abstracted in the conceptual research model to solve the problem that involves the CSFs, the ABC system, the ABCC model, and the CMCPs of construction project overheads (refer to Figure 3-1). The ABCC model is restructured in Figure 3-2 with the explanation in Section 3.4. The cost measurement model (Figure 3-4) highlights the process of differentiating the direct and indirect resources. When the project is awarded, the construction project overheads stem from the project contract price. Then the role of the ABCC model is to measure the overhead cost accounts through the ABC accounting features (overhead cost accounts are assigned to activity cost pools and cost objects), in order to examine the implementation of the CMCPs' tools and techniques of construction project overheads. The ABCC model and the CMCPs are documented into project databases for future projects.

Having discussed the three related chapters: introduction; literature synthesis; and development of the ABCC model, the following chapter elaborates the research methodology.

# CHAPTER 4. RESEARCH METHODOLOGY

## 4.1. Introduction

The term research is defined by Walliman (2005, p.6) as: *'...... collecting masses of information, delving into theories, and producing new products'*. Information and data are not merely collected and assembled to move facts from one situation to another. The research is *'.....any form of disciplined inquiry that aims to contribute to a body of knowledge or theory'* (Fellows and Liu, 2008, p.4). It is expected that a process of inquiry and investigation should be designed methodologically and systematically to increase knowledge (Collins and Hussey, 2003). Methodological assumptions are focused on the best means of acquiring knowledge about the natural world (Denzin and Lincoln, 2005). However, the process of research should be described clearly to meet the research aim and objectives.

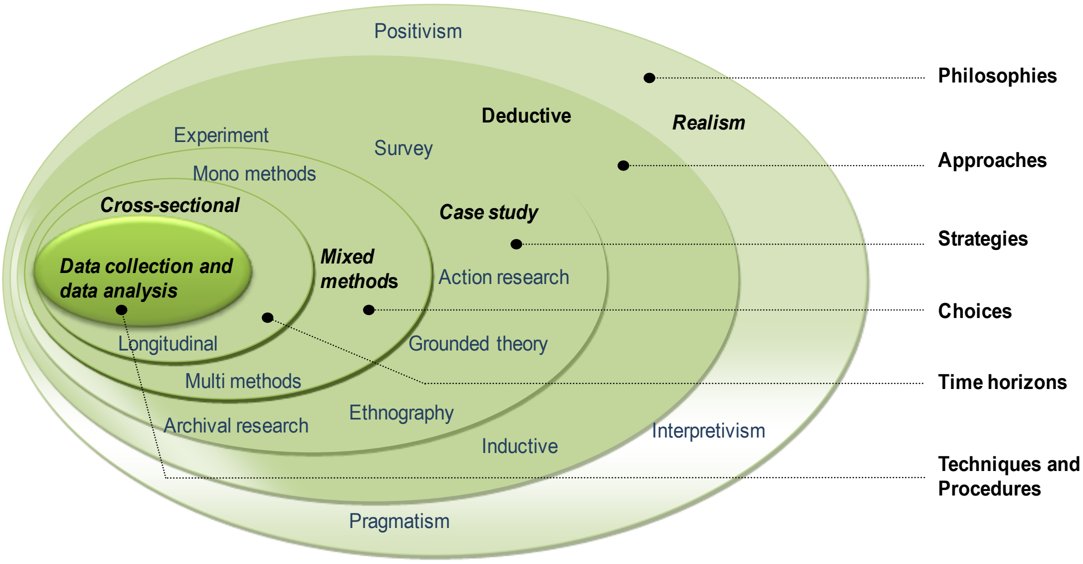


***Figure 4-1: The Systematic Research Process 'Onion'***

***Source: Modified from Saunders et al (2009)***

Saunders *et al* (2007 and 2009) explained the detailed procedures of research methodology using the research process *'onion'* (Figure 4-1). The six layers of the research onion do not clearly position the branches of research philosophy such as ontology, epistemology, and axiology. The philosophical domains of the research onion has mixed implicit branches of different natures in the first layer, such as: *ontology* (e.g., realism), and *epistemology* (e.g., positivism, realism, pragmatism, and interpretivism). The other layers are perceptible as *axiology* which can help researchers understand the role of values and meaning, purpose and the specific domain of the research.

The following sections will discuss the research methodology adopted for this research, and justify primary aspects of the research process, e.g., research philosophy, research strategy, research design, research methods, and research techniques and procedures.

## 4.2. Research Philosophy

The research philosophy contains important assumptions about the researchers' views of the world (Saunders *et al.*, 2009). These assumptions helped the researcher to choose a research strategy and design, to determine research methods, techniques and procedures. There are three major domains in the research philosophy, i.e., *ontology, epistemology,* and *axiology*. These are discussed in next few sections.

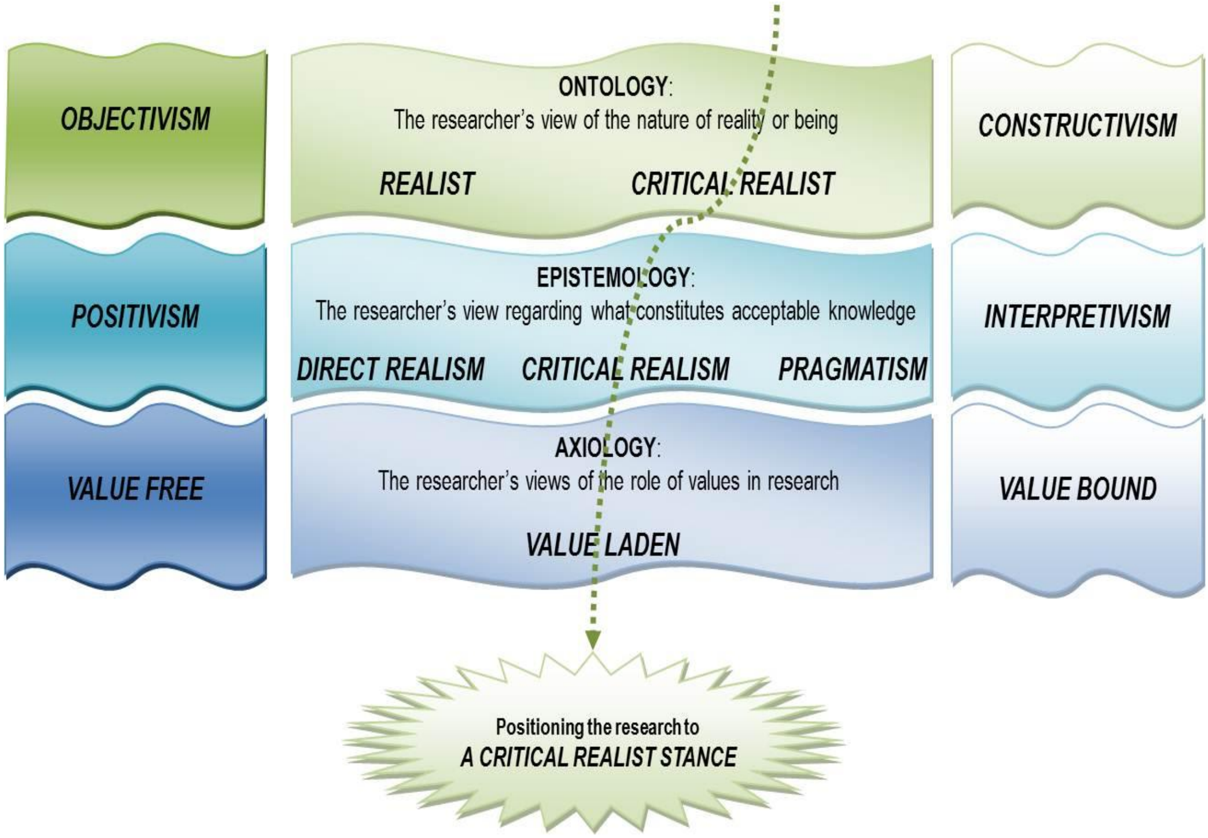


***Figure 4-2: Philosophical Positioning of the Research***
***Source: Synthesised from Saunders et al (2009).***

## 4.2.1. Ontology

Ontology is about the researcher's view of the nature of reality (Saunders *et al.*, 2009). The researcher can inquire and analyse the nature of the world and everything within the universe. There are two extreme views, i.e., objectivism and constructivism (refer to the top level of Figure 4-2). The *objective stance* considers the nature of realities in the world, external to the researcher's own mind. The *constructive stance* argues that reality is socially constructed and reality is only understood by examining the perception of human actors (Collis and Hussey, 2003; and Saunders *et al.,* 2007 and 2009). The research onion presented by Saunders *et al* (2007 and 2009) has not explicitly shown the position of ontological stances. The ontological stance considers 'what knowledge is and assumptions about reality' (Pathirage *et al.*, 2008).

The area of this research is about *Cost Management and Controlling Practice (CMCPs)*, where the Activity-Based Costing (ABC) system is applied to develop the Activity-Based Cost Controlling (ABCC) model for improving the management of project overheads during the construction stage of projects. This model will be implemented and focused on substructure elements of construction activities of commercial building projects.

On one ontological extreme side, ***the traditional costing system and current cost accounting management approaches*** would seem to be considered through *the* ***objectivism assumption***. The traditional costing system utilises the standard Bill of Quantities (BoQ) to estimate project costs with a percentage addition of project overheads on construction building costs (RICS, 2009; and CIOB, 2009). The standard financial statements (e.g., balance sheet, profit and loss statement) are regularly reported, and cost accounting managers must apply the same standard forms of cost accounting and management reporting system, e.g., General Accepted Accounting Principles (GAAP). It is used by several organisations in a similar way. This reality exists independently of human factors, where the standard cost accounting system is normally followed to fulfil the requirements of external standards and regulations on a regular basis (e.g., quarterly, by semester, or yearly). This system is commonly implemented to satisfy senior management and external parties such as investors, creditors, auditors, regulators, and taxation authorities (Horngren *et al.*, 1997; Glynn *et al.*, 2003; and Drury, 2008). The current cost accounting and management standard may still be applicable to financial reporting (Kaplan and Cooper, 1998).

The other ontological extreme is considered for the view that objectivist aspects of the traditional costing and standard cost accounting and management systems are less important. The cost accounting standard system (e.g., the GAAP) may be quite different to ***contemporary cost management strategies*** in which social entities attach their thoughts and beliefs consistently for successful management environments of organisations. Management strategy is very important in business and management that may have *'neither a fixed start nor certain end'* (Nordberg, 2010). It is very difficult to limit the strategy and may only be understood through constructive perception of human creators. The research relating to developing contemporary cost management strategies can be considered through socially constructed reality, i.e., ***the constructivism assumption***.

However, this research consider *cost management and controlling practices* – CMCPs of project overheads during the construction stage which cannot be positioned to both ontological extreme sides, i.e., objectivism or constructivism. This research falls between the two ontological extremes. The research relating to development of the ABCC model and implementation of the CMCPs' tools and techniques for improving ***'the management of project overheads during the construction stage'*** could be considered as an independent reality of the researcher's own mind. This phenomenon exists independently because the researcher is not involved or contributing directly to the failure or success of projects in practice. The researcher's thoughts and knowledge are only used for understanding and interpreting the meaning of project documents and the perception of human actors during the research period. The researcher's view about this phenomenon is clearly considered as the outsider who has no control on the reality. The ways in which social entities, such as management lines and project team managers involve their knowledge, beliefs, skills, expertise, and experiences are considered as *critical aspects* for the best way they think and act to achieve successful project progress and cost performance through cost management and effective control of practices.

Project documents such as drawings, costs, schedules, physical progress, invoices, etc., are documented from the real project reports during the construction stage. These project documents (representing existence of reality) are created based on actual project progress independently of the researcher's involvement (*realist assumption*). The existence of realities is also interpreted by human factors as the respondents of questionnaire survey and participants of interviews focused on explaining the context of the research area (*critical realist*).

Therefore, this research is connected with both categories of continuum of realities, and leans towards ***a critical realist stance*** (refer to Figure 4-2).

### 4.2.2. Epistemology

The second branch of philosophy is epistemology: the researcher's view about an original creation and dissemination of what constitutes acceptable knowledge in a particular area of research (Saunders *et al.*, 2009). It involves examination of relationships between the researcher and that being researched (Collis and Hussey, 2003). Saunders *et al* (2009) categorised epistemological research philosophies into four perspectives: *positivism, realism, pragmatism,* and *interpretivism* (refer to Figure 4-1 and Figure 4-2).

*Positivism* argues that credible data or facts can only be provided by observable phenomena, it focuses on causality and law like generalisations. *Realism* considers two perspectives: *(1) direct realism* considers whether observable phenomena provides insufficient data then represents inaccuracies in sensations, and alternatively, *(2) critical realism* considers that phenomena create sensations which are open to misinterpretation. These two realism perspectives focus on explaining phenomena within contextual areas. *Pragmatism* believes either or both observable phenomena and subjective meanings which can provide acceptable knowledge dependent upon the research questions. This focuses on practical applied research and integrating different perspectives to help interpret the data. *Interpretivism* believes that social phenomena and subjective meanings focus upon the details of a situation, a reality behind these details (Saunders *et al.*, 2009). It seems that there are philosophical overlaps between those areas.

After considering the epistemological philosophy, this research deals with the observable phenomena of *cost management and controlling practices - CMCPs of construction project overheads* which are acceptable to knowledge and create sensations that are biased and interpreted through several research activities, such as identification of project overheads during the construction stage; analysis of important CSFs for management of project overheads; investigation of the underpinning philosophy of the ABC system in construction projects; development of the ABCC model to improve the management of project overheads; and validation of the ABC system to maintain the ABCC model through expert interview outcomes.

The ABCC model is investigated, designed, developed, and implemented on substructure activities of construction building projects. These observable phenomena enable a focus on explaining the specific area of the cost management and controlling practices – the CMCPs for improving the management of project overheads during the construction stage of construction projects. Therefore, the epistemological philosophy indicates that this research can be considered through ***a critical realism stance*** (refer to Figure 4-2).

### 4.2.3. Axiology

The third philosophical stance, axiology, relates to the researcher's view which is concerned with the role of values in the research. That is, whether the researcher's own values play a role in the stages of the research process (Saunders *et al.*, 2007). Axiology considers the role of researcher's values in extreme continuums, such as value free and value bound. *A value free* approach believes that the researcher is independently related to the data and it becomes objective. *A value bound* are considered when the researcher cannot be separated with what is being researched, it will become subjective. *A pragmatist approach* considers both objective and subjective, however a realist assumption may consider *a value laden* approach that the world views, cultural experiences, and upbringing will impact on the research (Saunders *et al.*, 2009).

The researcher generally has their own knowledge and experience, even though these values may not exist explicitly, that would help to determine and recognise the facts, sensation, and interpretations which are generated from the reality (Collis and Hussey, 2003). The relationship between phenomena, the researcher's values, and knowledge are not explicitly defined by Saunders *et al* (2007 and 2009). However, this axiological philosophy could bring this research to consider the role of values and meaning which had been understood by the researcher.

The direction of this research lies between *value free* and *value bound* (refer to Figure 4-2; and Saunders *et al.*, 2009), but the research tilts more towards ***a value laden*** approach as the research would be mostly influenced by professional views, expertise, experience, knowledge, and upbringing.

### 4.2.4. Positioning the Research Stance

This research typically follows a logical research process which starts from reviewing the literature and principles to developing the *'research model'* as the proposition for enabling conclusions to be drawn against research aim and objectives. According to Walliman (2005), a simple argument and general premise should be identified, and then narrowed to a more specific premise, to allow the drawing of conclusions.

An identification of project overheads and application of the ABC system in construction projects are investigated for maintaining a development of the ABCC model. Important CSFs are identified and analysed to improve the management of project overheads. The important CSFs are incorporated into effective tools and techniques of the CMCPs for the implementation of the ABCC model for improving the management of construction project overheads. This approach enables the drawing of logical conclusions from a set of these particular premises.

Research philosophies, i.e., ontology, epistemology, and axiology, may influence the choice for the research strategy and method to be adopted when conducting research. The researcher's views about the nature of reality, acceptable phenomena to knowledge, and the role of values are considered. In order to interpret the role of values in research, different research methods, such as quantitative, qualitative, mixed, and other techniques and procedures are triangulated to justify the results of the research. Therefore, these philosophical domains are positioning the research into ***a critical realist stance*** (refer to research philosophy by Saunders *et al.*, 2009; and Figure 4-2).

Many researchers believe that ontological and epistemological philosophies which underpin logical reasoning fall into two main strategies of the research; they are *deductive* and *inductive* approaches. The deductive research approach usually starts from theories with more general premises to more specific available facts, whereas, the inductive approach moves from more specific observations involving uncertainty to broader generalisations on establishing theories (Burney, 2008). This research works through the deductive approach; it began from general theories on the construction industry and project cost management to developing a specific cost controlling model and implementing effective tools and techniques for improving the management of construction project overheads in practice.

Having discussed the philosophical stance and research approach, the next section determines the research choice through examining several criteria of research strategies.

## 4.3. Research Strategy

The research strategy depends on research objectives and questions. The main research questions being investigated should be considered for the best results, by linking critically to the method of data collection and analysis (Fellows and Liu, 2008). Yin (2009) considers several research strategies, such as the experiment, survey, archival analysis, history, and case study. These research strategies are shown in Table 4-1.

***Table 4-1: The Criteria for Different Research Strategies***

| **Strategy** | **(1) Form of Research Questions** | **(2) Requires Control of Behavioural Events?** | **(3) Focuses on Contemporary Events?** |
|---|---|---|---|
| Experiment | ***How, why?*** | Yes | Yes |
| Survey | Who, what, where, how many / much? | No | Yes |
| Archival analysis | Who, what, where, how many / much? | No | Yes / No |
| History | ***How, why?*** | ***No*** | No |
| ***Case study*** | ***How, why?*** | ***No*** | ***Yes*** |

***Source: Yin (2009)***

A systematic choice of the research strategy is examined in Table 4-1, which highlights the role of the three research criteria: *(1) the form of research questions, (2) the control of behavioural events, and (3) the focus on contemporary events*.

1) *The form of research questions:* the research objectives deal with tracing operational links of evidences and occurrences, that can be mainly achieved by *'how'* and *'why'* type questions. This research uses research questions such as: why can the ABC system be adapted in construction projects? How can the ABCC model be developed for improving the management of project overheads? The philosophy and the features of the ABC system are investigated in order to develop the ABCC model for improving the

management of project overheads during the construction stage of construction projects. There is a potential link between the ABC system and the management of project overheads in construction projects. The ABC system can develop clear costs of cause-and-effect relationships between project overheads, activities, jobs, projects, and services. As such, *experiments, history, and case studies* seem to be the appropriate strategies for this research. Whereas, *who, what, where*, and *how many / how much* may be relevant to favour *survey* methods or the analysis of *archival* data, since the research objectives are related to the incidence or prevalence of phenomena (Yin, 2009). However, *'survey and archival analysis are disqualified'* from the first criteria for the research on the development of the ABCC model to improve the cost management and controlling practices – CMCPs of construction project overheads.

2) *The level of control requirements:* the experiment, history, and case study can be determined through assessing the distinction among them according to the extent of the researcher's ability to control the phenomena. The research of the development of the ABCC model does *'not require'* the researcher to control the phenomena, and the historical method is selected because there is virtually *'no access or control'* over the phenomena (Yin, 2009), while the *experiment* requires the researcher's control of behaviour events. Therefore, the *'experiment strategy cannot be implemented'* for this research in regard to the second criteria. The remaining two research strategies: history and case study; are assessed below using the third criteria.

3) *The focus on contemporary events:* the development of the ABCC model requires recently updated information of project events which are

accessible to the researcher. The *'historical strategy is not appropriate'* for this type of research, since it deal with the 'dead' (Yin, 2009), and focused on past events according to the third criteria.

This research considers a case study definition by Hohmann (2005), as: *'an empirical enquiry that investigates a contemporary phenomenon within its real-life context'.* The ***'case study'*** research strategy is considered to satisfy all three different criteria of research strategy and represent a suitable method to fulfil the research aim and objectives of this research.

## 4.4. Research Design

Disciplined inquiries of academic and professional research will never be exactly or precisely similar between different processes. Different authors define the research process in different ways or by using different focuses. However, the research should be designed methodologically and systematically (Collin and Hussey, 2003), to collect masses of information (Walliman, 2005), about a natural world (Denzin and Lincoln, 2005), for a better process of inquiry and investigation (Fellow and Liu, 2008), in order to fulfil particular research questions and objectives (Saunders *et al*., 2009), that aim to increase a body of knowledge. Yin (2009, pp. 46-59) considered four specific types of research designs for case studies (refer to Figure 4-3) which include: *Type (1)* single-case with holistic designs; *Type (2)* single-case with embedded designs; *Type (3)* multiple-case with holistic designs; and *Type (4)* multiple-case with embedded designs.

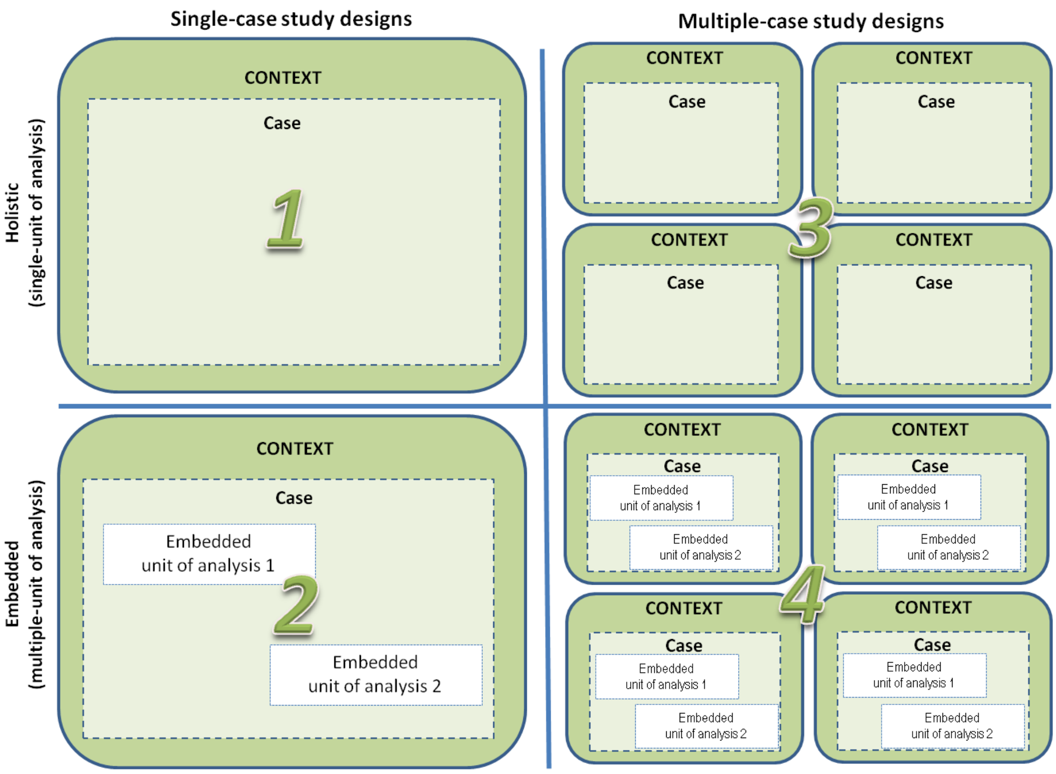


***Figure 4-3: Basic Type of Designs for Case Studies***

***Source: Modified from Yin (2009)***

Single-case study designs (Type 1 and Type 2) are suitable on the basis of five rationales: *(1) a critical case* for testing a well-formulated theory, *(2) an extreme or unique case,* for example, clinical psychology, *(3) a representative or typical case,* for instance, manufacturing firms in the same industry, *(4) a revelatory case* for a phenomenon inaccessible previously to social science inquiry, and (5) a *longitudinal case* for studying how certain conditions change over time. This research will not fall into any of the above conditions; consequently, the single-case study approach was not adopted.

Multiple-case study designs (Type 3 and Type 4) develop a rationale for empirical and comparative studies. They have distinct advantages for more compelling evidence and are regarded as more vigorous and robust than single-case studies. Therefore, this research chooses *a case study design Type 3* (refer to Figure 4-3):

'multiple-case studies with a single unit of analysis' to investigate the cases on research area of the Cost Management and Controlling Practices (CMCPs) of project overheads during the construction stage in construction projects.

Multiple-case study designs enable the research process to gain information from multiple sources of evidence. The case study will explore in depth limited by time and activities. Collecting data can include a program, process, events, activities, and one or more individuals (Creswell, 2009). This case study design also provides the opportunity to carry out the most important research processes for *the research findings*, such as (1) *the literature review,* (2) *survey questionnaire,* (3) *project documentation* and *direct observation case studies,* and (4) *semi-structured interviews.*

### 4.4.1. Literature Review

A literature review enables the synthesis and valuing of current works that is required to make inference judgements and organise ideas related to the research area (Saunders *et al.*, 2009). It is an important process to understand the research problem with ideas in order to fulfil the research aim and objectives. In this research, the literature review identifies project overheads and Critical Success Factors (CSFs), and investigates an underpinning philosophy of the Activity-Based Costing (ABC) system in construction projects in order to develop the activity-Based Cost Controlling (ABCC) model for improving the management of project overheads during the construction stage through implementation of effective tools and techniques of the CMCPs.

Three basic types of research designs are closely related to the literature review: exploratory, constructive, and empirical studies.

*Exploratory research* is conducted for better understanding of the situation. It is not designed to come up with final answers or decisions. The objective of exploratory research is to gather preliminary information that will help to define problems and suggest hypotheses. Exploratory research often relies on secondary research such as reviewing available literature and/or data, or qualitative approaches such as informal discussions with consumers, employees, management or competitors, and more formal approaches through in-depth interviews, focus groups, projective methods, case studies or pilot studies.

*Constructive research* is the most common method in computer science. Nevertheless, constructive research may involve the theory, mathematic equations, models, frameworks, or software. This approach requires validation, but it does not necessarily need to be based on explanatory research, as the other types of research explained above, or for empirical studies which area discussed below.

*Empirical research* is generally based on observations and measurement of the phenomena, the knowledge may be derived from actual experience rather than from current theory or initial belief. Empirical research approaches may be conducted for gaining knowledge through direct and indirect observations or experience, which can be further analysed using quantitative or qualitative methods. Quantitative evidence can be triangulated by qualitative data, or by description of quantitative results in a qualitative form to make it more understandable or make more sense. Researchers using empirical methods often combine two research traditions - qualitative and quantitative methods of data collection and analysis to answer research questions, meet aims and objectives, and solve the problem.

This research was initiated with a statement of the research problem (refer to Section 1.2) and was followed by the research question in Section 1.3 (e.g., How could the ABCC model be developed for improving the management of construction project overheads?) which are implemented in construction projects using the CMCPs' tools and techniques of construction project overheads. Usually, an empirical study is initiated by investigating certain theory to create ideas related to the topic. Therefore, based on this theory, the problem situation was stated, and research questions, aim and objectives, or hypotheses were proposed: *'Development of the ABCC Model for Improving the Management of Construction Project Overheads'.* From this proposed ABCC model (or hypothesis) specific events are predicted about: *'Implementation of the CMCPs' tools and techniques of construction project overheads on substructure activities of construction building projects'.* These predictions can then be examined by implementing suitable analysis techniques (e.g., the ABC system and Earned Value Management System – EVMS). The outcomes of this implementation and examination would/would not then contribute and support the theory on which the hypotheses (the ABCC model) and predictions (the CMCPs) were proposed.

The following sections discuss empirical research conducted through a questionnaire survey, project case study documentation and observations, and expert interviews.

### 4.4.2. Questionnaire Survey

A questionnaire survey may be used to collect quantitative data from individuals or institutions without any controls, sanctions, and structured limitations (Yin, 2009). It is an important procedure to cross match information from construction project professionals in the specified area of research. This research is related to identification and availability of project overheads which most often present in construction projects, and analyse the important CSFs in order to improve the management of construction project overheads.

The pros and cons of the questionnaire survey may be related to availability of respondents, type of questions, and techniques of data analysis. *Respondents* can be contacted through email or post to deal with a wider geographical area or remote locations, and without direct presentations they may answer and return the form to the researcher at a convenient time. However, it was only suitable for a specific type of respondent and simple and relatively short questions must be used to increase response rate (Nedarc, 2006). *The type of questionnaires* can be structured or open-ended questions to give wider opportunity for further information, while due to absence of the researcher and using the structured format would not give the opportunity to clarify the questions, so, it could lead to misinterpreted answers. *Statistical analyses* of quantitative data collected by questionnaires are relatively easy to process with aided computer programs. On the other hand, questionnaires tend to a low usable data set or response rates when respondents provide incorrect answers due to misunderstood questions, and the data analysis can become complex and distorted, leading to misinterpretation of the results (Jones, 2013).

### 4.4.3. Project Documentation and Direct Observations

Project documentation and direct observation of case studies may be used to collect project cost data, schedule and progress and to identify construction activities and occurrences of project overheads during the construction stage. This factual data can be used for the measurement of the ABCC model through implementation of the tools and techniques of the Cost Management and Controlling Practices (CMCPs) that focus on substructure activities of construction building projects.

The strengths of the case studies showed specific characteristics through enabled innovative ideas and provided actual examples of the cases which were generally practical in nature, and encouraged generalisations through replication of operational methods which provide a similar result and acceptable inconsistency across cases (Yin, 2009). Whereas, limitations of the case studies are the target group of the sample distribution and the available access for collecting data and information needs appropriate criteria and established promotion.

According to Krippendroff (2004), the most important type of reliability is *replicable techniques* at different points and perhaps under different circumstances. The cost accounting and measurement procedures of the ABCC model and implementation of the CMCPs' tools and techniques based on the results of the case studies examined on the substructure activities would suggest that it should be replicated in different elements of construction activities and other types of construction projects beyond these project cases.

### 4.4.4. Semi-structured Interviews

The semi-structured interview method considers the requirement of qualitative data and information from the experts through three convergent themes (e.g., the management of construction project overheads, the ABC system, and the CMCPs' tools and techniques). The expert interview outcomes could validate the ABCC model for improving the CMCPs' tools and techniques of construction project overheads.

Advantages of the interview method generally include a higher rate of responses, because the presence of the interviewer can explore answers and gain wider information from the interviewees. The interviewer can explain questions and unfamiliar words to be able to get qualitative data and more accurate information. However, the disadvantages of the interview method for data collection and analysis are that it is very difficult to define and meet the list of certain populations. This method needs trained interviewers, especially when interviewees might feet reluctant to share information related to personal beliefs. This would bring bias to the interview in both verbal and non-verbal values when the data is analysed (Nedarc, 2006).

### 4.4.5. Research Findings

This research design would expect four categories of research findings, such as *literature review findings, questionnaire survey findings, project case study findings, and interview outcomes.* Therefore, the most importance of CSFs and the result of the ABCC model would be incorporated into the CMCPs' tools and techniques for improving the management of construction project overheads. These should enable an effective implementation of the ABCC model.

## 4.5. Research Methods

Although the research process is defined according to disciplined inquiries of academic and business purposes differently, the research method may refer to a research process which is currently offered in published literature, such as through methodological research designs, a systematic research process of inquiry and investigation, and to increase the body of knowledge (Amaratunga, *et al.*, 2002).

Research methods are basically influenced by the philosophical position of the research. This research positions the 'critical realist stance' that represents assumptions about the nature of reality and knowledge, and observable phenomena to be critically interpreted by the social entities that are revealed through the value laden system (refer to the research philosophy, Section 4.2).

*Quantitative* and *qualitative methods* are the two systematic and distinct categories that are generally used in conducting research. In order to increase validity and reliability of the research or to consider consistency of the results, different methods may be combined in order to triangulate the research through *mixed methods or multi methods* (Saunders *et al.*, 2009).

### 4.5.1. Quantitative Methods

A quantitative research method is a numeric description derived from the study of a sample of population to represent trends, attitudes, or opinions of a population (Creswell, 2009). This research provides computational expressions of empirical inquiries and investigations through a process of *direct observations* and *questionnaire survey* (refer to Section 4.6.3.2 for the justification) measurements for collecting and analysing numerical forms of data.

*Direct observations* obtain audio and visual records, *project documents*, and *analysed events* or *activities* related to the research area and focus (refer to Section 4.6.3.4 for the justification). Questionnaire surveys contain open-ended and close questions for obtaining more details and avoiding redundant responses. It can be administered electronically or via printed documents for the respondents to collect quantitative data (Saunders *et al.*, 2009).

### 4.5.2. Qualitative Methods

A qualitative research method contains word expressions of empirical inquiries and investigations through a process of interview assessments for understanding human behaviours and their interpretation of the phenomena. Qualitative data or information can be collected by face-to-face, by telephone, or by other electronic media such as the internet or intranet (Saunders *et al.*, 2009).

However, specific qualitative inquiries may be in the form of structured or semi-structured interviews, and unstructured interviews. This research utilises *semi-structured interview methods* (refer to Section 4.6.3.3 and 4.6.3.5 for the justification) during field research, even though Saunders *et al* (2009) suggested that the appointment and confirmation may be ensured through telephone or internet.

### 4.5.3. Mixed Methods

There are different methods of research which contain both quantitative and qualitative methods, as the research could provide bias. The mixed method (triangulation method) can compensate each single method's weaknesses through the counter balancing strength of another (Amaratunga *et al.*, 2002), and could reinforce each of the different methods by normalising a bias of any single method by serving the bias inherent in the other method (Creswell, 2009). These have implications on positioning the two research approaches in relation to the ontological and epistemological philosophies (refer to Section 4.2.1 and Section

4.2.2). Scientific approaches argue that hypotheses should be formulated and use precise measurement techniques to test. On the other hand, the issue must be considered whether the scientific approach is the right choice to adopt and how this could be included in social research. It would seem to be a possibility and desirability for combining both quantitative and qualitative versions.

Quantitative and qualitative approaches were seen from an ontological and epistemological assumption, where a grounded theory research was not compatible to combine both quantitative and qualitative approaches. According to the nature of these philosophical assumptions, the mixed method approach is not possible for the grounded research. However, most researchers see these two approaches as capable of being triangulated to give the greater strengths of the data collection and data analysis based on a technical assumption (Bryman, 2012).

In fact, research can be more confident when combining different methods and techniques for observing a phenomenon from different angles or dimensions to obtain compelling information. Yin (2009) suggested that case studies may use multiple sources of information and case study databases, and maintain the chain between evidences in order to increase *validity* (construct, internal and external) and *reliability* of the research. Further, it was explained that *construct validity* can be achieved through establishing correct operational procedures to address and utilise appropriate instruments for data collection. *Internal validity* considers causal relationships between facts and certain conditions in order to establish other conditions through the implementation of correct analytic strategies for data analysis, while, *external validity* considers appropriate sampling strategies and unit of analysis to establish a generalisation of research findings. *Reliability* considers that the replication of operational methods of the research which provide similar results and acceptable inconsistencies across cases through a clear research methodology. However, Creswell (2009) provides a basic assumption of the mixed method inquiry that its' diversified types of data collection techniques and procedures could serve a better understanding of the research problem.

This research begins with reviewing the related literature to identify project overheads and Critical Success Factors (CSFs) in construction projects, then, a questionnaire survey is developed in consultation with experts to generalise results, in respect of the project's evaluation criteria. During the literature review phase, this research also investigates an underpinning philosophy of the Activity-Based Costing (ABC) system in construction projects to develop the ABCC model for improving the management of project overheads.

The second phase continues with the field research. Three main research processes are carried out during this period, such as: (1) questionnaire survey, (2) project documentation and direct observation of case studies, and (3) semi-structured interviews with the experts. The next section discusses the research techniques and procedures.

## 4.6. Research Techniques and Procedures

This section refers to Figure 4-1 in order to elaborate upon the last inner layer of the *'research process onion'* by Saunders *et al* (2009). It includes two important research processes of *'data collection and data analysis'.* Every research study normally investigates different line of inquiry and requires different characteristics of data and information (Fellow and Liu, 2008). Even though the researcher may be experienced, data collection can be complex and difficult. If data collection is not done well, the entire research process can become inconsistent. This may be avoided by skills in the specific field of research including protecting ethical consent and anonymous human subjects. In order to conduct field research, Yin (2009) suggested that previous research experiences should not allow the researcher to take completing case studies for guaranteed. Therefore, it is quite important to prepare *a research protocol* (refer to Table 4-2) and schedule of *research activities* (refer to Figure 4-4) systematically, prior to conducting the field research.

### 4.6.1. Research Protocol

This research started by reviewing the related literature and principles. It identifies two main research problems in the area of Cost Management and Controlling Practices (CMCPs) of construction project overheads, as elaborated in Section 1.2: the shortcomings of traditional costing system and the need for improved cost management and controlling practices. The research aim and objectives represent the list of research activities to be carried out (refer to Section 1.3 and Section 1.4). Research questions (Section 1.5) provide an indication of how to achieve the research aim and objectives in order to solve the problem.

A conceptual research model discussed in Section 3.2 and Figure 3-1, abstract the research problem which should be resolved through incorporating the Critical Success Factors (CSFs) and the Activity-Based Cost Controlling (ABCC) model into the CMCPs of construction project overheads. An underpinning philosophy of the Activity-Based Costing (ABC) system (refer to Hicks, 1999), the relevant features (Jaya *et al.*, 2010a), and important aspects (Jaya *et al.*, 2010b) underpin the development of the ABCC Model for monitoring the status of project progress and cost performance. The important CSFs are identified to improve the management of construction project overheads. The implementation of the CMCPs' tools and techniques are examined on the substructure activities of construction building projects during the construction stage of commercial projects.

The case study strategy has been chosen for this research (refers to Section 4.2 and Table 4-1) based on the research design criteria by Yin (2009). Multiple case studies are designed and their specific rationales and advantages are discussed in Section 4.4 and Figure 4-3. This research adapts mixed methods to collect data through multiple sources of evidence, and would analyses the data using several analytical techniques, such as descriptive statistics, Analytic Hierarchy Process (AHP), the ABC accounting system, Earned Value Measurement System (EVMS), content analysis and cognitive mapping.

The literature review results are used as the basis for developing the questionnaire survey (refer to Appendix 2-a), interview guides (refer to Appendix 2-b), and the research protocol (refer to Table 4-2), in order to collect data from respondents and participants during the field research period and project case study stage.

***Table 4-2: Research Protocol***

<table>
<tr><td colspan="5">Area: An Application of the Activity-Based Costing (ABC) system for the Cost Management and Controlling Practices (CMCPs) of construction project overheads.</td></tr>
<tr><td colspan="5">Aim: A proposal of the Activity-Based Cost Controlling (ABCC) model for improving the management of construction project overheads.</td></tr>
<tr><td colspan="5">Focus: The most important CSFs incorporate into the CMCPs' tools and techniques for implementation of the ABCC model on substructure activities of construction building projects.</td></tr>
<tr><th>Research Objectives</th><th>Research Question</th><th>Research Methods</th><th>Literature Synthesis and Data Collection</th><th>Analysis Techniques</th></tr>
<tr><td>1. Identification of project overheads during the construction stage of construction projects</td><td>1. What overheads are identified and included in construction projects?</td><td>▪ Literature review<br>▪ Questionnaire survey</td><td>▪ Identification and available overheads in construction building projects (refer to section 2.4)<br>▪ Questionnaire responses in five Likert scales of project overheads (refer to appendix 2-a)</td><td>▪ Description and explanations<br>▪ Descriptive statistic analysis techniques</td></tr>
<tr><td>2. Analysis of Critical Success Factors (CSFs) for improving the management of project overheads</td><td>2. What CSFs are important for improving the management of project overheads?</td><td>▪ Literature review<br>▪ Questionnaire survey</td><td>▪ Relevant issues, challenges, and factors for management of project overheads (refer to section 2.6; table 2-2; and section 2.7)<br>▪ Questionnaire responses in five Likert scales of the important CSFs (refer to appendix 2-a)</td><td>▪ Description and explanations<br>▪ Prioritisation of CSFs through Analytical Hierarchy Process (AHP)</td></tr>
</table>

| | | |
|---|---|---|
| **5.** Validation of the ABCC model on improving the management of project overheads. | **4.** Development of the ABCC model and implementation of the CMCPs tools and techniques on substructure activities of construction building projects. | **3.** Investigation of an underpinning philosophy of the ABC system in construction projects |
| **5.** How could the ABCC model be validated for improving the management of project overheads? | **4.** How could the ABCC model be developed and implemented for improving the management of construction building projects? | **3.** Why and how could an underpinning philosophy of the ABC system be adapted in construction projects? |
| ▪ Literature reviews<br>▪ Semi-structured interview of experts | ▪ Literature review<br>▪ Case studies: Project documentations and direct observations | ▪ Literature review<br>▪ Semi-structured interview of experts |
| ▪ Application of the ABC system in construction project (refer to section 2.3.9.2).<br>▪ Description of expert interview outcomes (refer to Appendices 2-b; 6-a; 6-b; and 6-c) | ▪ Relevant feature and important aspects of the ABC system, cost measurement, and cost management and control procedures (refer to chapter 3)<br>▪ Project documents, schedule, progress, financial records, reports, etc. (refer to appendix 3-a) | ▪ The ABC concept, definition, philosophy, features, important aspects (refer to section 2.9)<br>▪ Adaptation and application of the ABC system in construction projects (section 2.3.9.1 and section 2.3.9.2) |
| ▪ Description and explanations<br>▪ Content analysis and cognitive mapping | ▪ Description and explanations<br>▪ Cost component analysis: the ABC accounting system, and Earned Value Measurement System (EVMS) | ▪ Description and explanations<br>▪ Content analysis and cognitive mapping |

## 4.6.2. Research Activities

The research protocol above is used as an operational guide to collect both primary and secondary data, and quantitative and qualitative data. Entire activities of this research are scheduled on a chronological structure of the concurrent activities as shown in Figure 4-4.

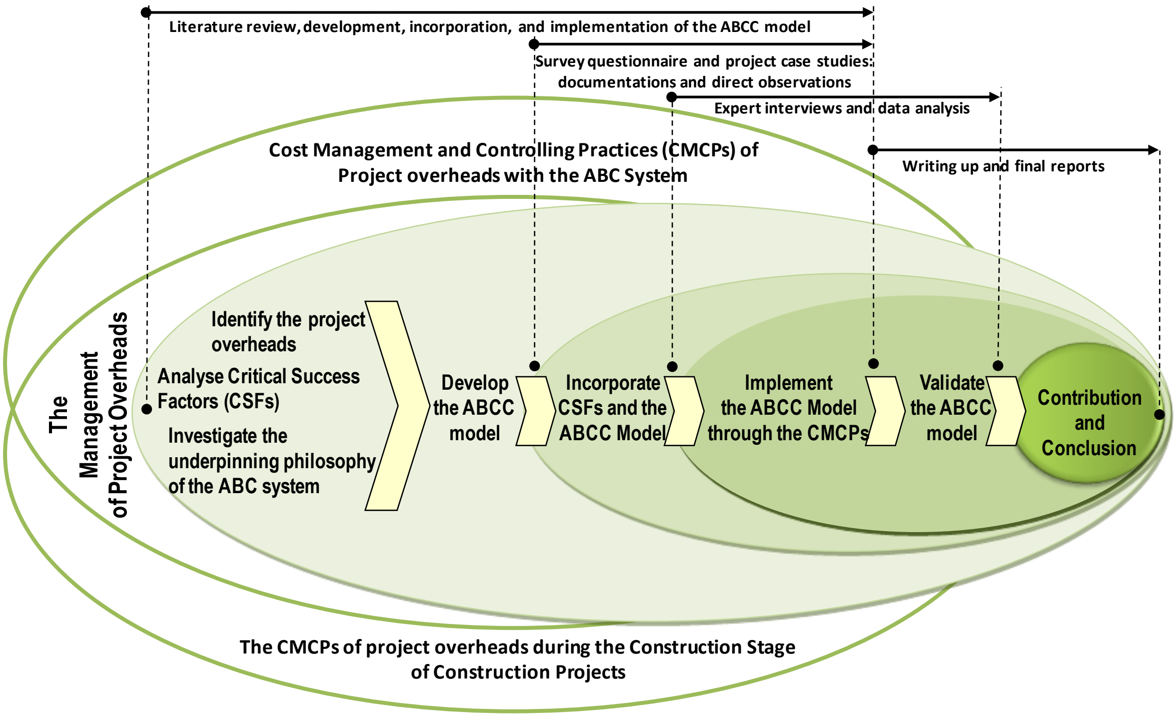


***Figure 4-4: Concurrent Activities of the Research***

The research protocol, techniques and procedures are considered to reflect the research objectives (Section 1.4) and research questions (Section 1.5) as described below:

- Project overheads are identified during the literature review and justified through the questionnaire survey and expert interview for the management of construction project overheads.

- Important CSFs are identified through the literature review and questionnaire survey, and incorporated into the CMCPs' tools and techniques for improving the management of construction project overheads.

- The underpinning philosophy of the ABC system in construction projects is investigated through the literature reviews and expert interview for the development and validation of the ABCC model.
- The ABCC model is developed through the literature review, project case study documentation and direct observations, implemented on substructure activities of construction building projects through the CMCPs' tools and techniques for improving the management of construction project overheads.
- Application of the ABC system in construction projects, development of the ABCC model, and implementation of the CMCPs' tools and techniques for improving the management of construction project overheads are validated through expert interview outcomes.

The literature review period provides preference judgements and ideas for organising a research protocol (refer to Table 4-2), and research techniques and procedures (refer to Figure 4-4). Project case studies and survey questionnaires have been conducted in construction projects in Indonesia (refer to Section 4.7.7), and additional data gathered through expert interviews to validate the application of the ABC system in construction projects and development of the ABCC model enabling a contribution to the body of knowledge and project practices. Therefore, the research techniques and procedures consider *concurrent activities* being carried out during the four research stages (refer to Figure 4-4), and these are:

- Literature review, development, incorporation, refinement, and implementation of the ABCC model
- Project Case studies and questionnaires survey

- Expert interviews and data analysis
- Write up and final reports

These research activities are associated with the research area in order to enable the research aim and objectives to be fulfilled and are justified in the following section.

## 4.6.3. Justification of Research Techniques to the Aim and Objectives

### 4.6.3.1. The Aim of the Research

This research aims to adapt an application of the ABC system in order to develop the ABCC model for improving the management of project overheads during the construction stage of construction projects (refer to Section 1.3). The important CSFs are incorporated into the CMCPs in order to implement the ABCC model which focuses on substructure activities of construction building projects. The CMCPs' tools and techniques are examined in order to demonstrate the implementation of the ABCC model on concrete pile foundations of factual construction projects.

The underpinning philosophy of the ABC system is investigated in construction projects to discover the ABC features and it important aspects for maintaining the development of the ABCC model. The ABCC model and the important CSFs are incorporated into the effective tools and techniques of the CMCPs for monitoring the status of project progress and cost performance in order to improve the management of project overheads during the construction stage of construction projects. The aim of the research can be achieved through fulfilling a series of research objectives.

#### 4.6.3.2. The First and Second Research Objectives

*Project overheads* and *important CSFs* (refer to Section 1.4) are identified and investigated during *the literature reviews*. The availability of project overheads and prioritisation of important CSFs are examined through empirical studies in real life projects through a *questionnaire survey* which is administered among professionals at different levels within the construction projects, such as senior management positions, office management staff, and project management teams. Professional positions related to construction projects include: the senior management positions (e.g., directors, operational managers, accounting department managers, project sponsors, management representatives, etc.); the office management staff (e.g., project managers, procurement, cost control, central logistics, etc.); and the project management teams (e.g., site managers, surveyors, engineers, site-area managers, quantity surveyors, site logistics, draftsmen, supervisors, etc.).

The questionnaire survey was administered during field research in Indonesia. Quantitative data was collected through scoring verbal values of Likert scales which ranged from the lowest 1 (not important) to highest 5 (highly important), to address identification and availability of project overheads in construction projects, and to measure the weight of CSF-alternative variables in respect of evaluation criteria for determining ranking orders of priority of importance among the eight groups of important CSFs.

#### 4.6.3.3. The Third Research Objective

An underpinning philosophy of *the ABC system* (refer to Section 1.4) is investigated during the *literature reviews* to develop the ABCC model for improving the management of project overheads (refer to Chapter 3). The application of the ABC system in construction projects is justified through empirical studies and *expert interviews* in order to validate the development and implementation of the ABCC model. According to Oxford dictionary, an expert is defined as *'a person who is very knowledgeable about and skilful in a particular area'.* As stated in RICS (2011), the general criteria for inclusion is that independent experts should have a minimum of ten (10) years of post experience in the primary profession. General criteria of the expert in construction projects may refer to practitioners who have extensive working experience, are currently and directly involved in the management levels of construction projects, and have detailed knowledge and skill in a particular area (Chan *et al.*, 2001). In order to address this objective, the experts being interviewed are similar to professionals described in Section 4.6.3.2, but with more experience in overall jobs or related areas, and higher positions in project management lines.

If necessary, the interviews can be carried out by telephone or through electronic media. In some circumstances, especially when interviewees were geographically distributed, and where the experts or professionals had very tight schedules, the interviews conducted via *'internet or intranet'* by *'synchronous or asynchronous'* (real time or offline) of electronic media had significant advantages. In addition, using internet or email reduced associated audio-recording problems; since computers use automatic recording software (refer to qualitative interviews suggested by Saunders *et al.*, 2009: pp.348-351).

Moreover, for this interview which has an initial arrangement and agreement by both parties (interviewer and interviewees) can express two-ways communication through convenient conversations, (rather than formal-structured question and answer), without rushing or interrupting questions for *'correct words* and *meanings'.* The natural communication is a good thing to do when inquiring original information, unique opinions, and creative ideas (Drever, 2006). Qualitative data for fulfilling the third research objective was collected through *semi-structured* and *face-to-face* interviews to address the adaptation and application of the ABC system in construction projects in order to develop the ABCC model.

#### 4.6.3.4. The Fourth Research Objective

*The ABCC model* is developed based on the concepts, definition, philosophy, relevant features, and important aspects of *the ABC system* in construction projects. The ABCC model would be implemented through the CMCPs' tools and techniques (refer to Section 3.6). Case studies and direct observations would ensure the project documents being examined would provide a reflection and implication to this research objective, then, the results could be clearly interpreted by the researcher.

*Project documentations and direct observations* have been conducted and completed through project case studies. Quantitative and qualitative information was gathered for elaborating on the ABCC model and implementing the CMCPs' tools and techniques in order to examine the management of project overheads on substructure activities of construction building projects during the construction stage.

The development of *the ABCC model* and implementation of *the CMCPs' tools and techniques* are focussed in order to examine substructure elements of construction activities of building projects through project case studies. However, their robust methods, tools and techniques could be replicated for other elements of construction building projects, such as superstructure, architecture, landscape, and other components of facilities and utilities.

#### 4.6.3.5. The Fifth Research Objective

The application of *the ABC system* and development of *the ABCC model* would be validated through conducting *expert interviews*. The selection of experts may refer to the management levels explained in Section 4.6.3.2 and 4.6.3.3 that have greater experience than ten years, and where project professionals are in a more senior position in the related area of construction projects. The expert interviews may follow the semi-structured and face-to-face interview techniques as described in Section 4.6.3.3.

The expert interview outcomes are used to validate the development and implementation of the ABCC model in construction projects related to this research objective. Therefore, the robust method of the ABCC model incorporates the most important CSFs and the CMCPs' tools and techniques would make a contribution to knowledge and practice, in terms of the academic milieu and project practices, and provide organisational advantages. Data collection and analysis techniques are discussed in the following sections.

## 4.7. Data Collection

The detailed description of research philosophies for positioning the research on the critical realist stance is discussed in research methodology sections (e.g., Section 4.2.1 to Section 4.2.4). The case study strategy and research designs have been chosen based on the criteria identified by Yin (2009). The research methods in Section 4.5 discussed two main categories of research process and tradition such as quantitative and qualitative researches. A mixed research method is used in order to ensure the data triangulation is collected as it has a certain validity and reliability. However, this section also describes specific types of data to be collected. Appropriate sampling techniques should be communicated during the proposal of research techniques and procedures in order to collect both quantitative and qualitative data. Rigorous sampling techniques on selected samples should also be discussed in order to establish validity and reliability of the data. Saunders *et al* (2007 and 2009) described that data collection often involves two categories of sampling techniques which are identified as ***probability*** (or representative) and ***non-probability*** (or judgemental) sampling techniques (refer to Figure 4-5).

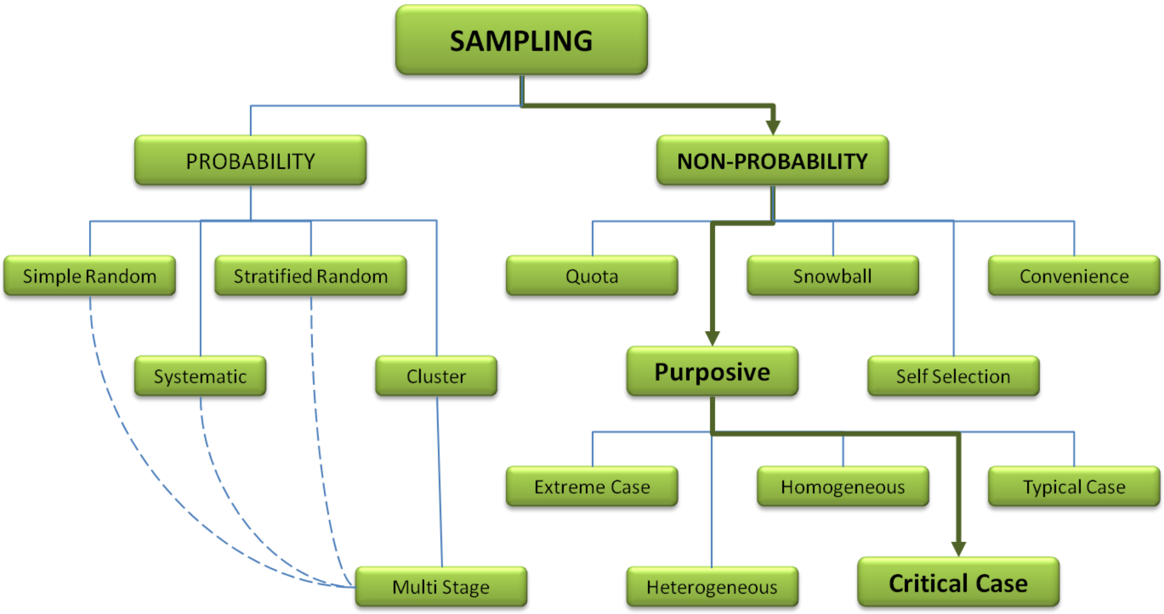


***Figure 4-5: Sampling Techniques***

***Source: Adopted from Saunders et al (2009)***

## 4.7.1. Probability Sampling

*Probability sampling* represents a list of samples within sample frames, and every unit of samples has an equal probability of being selected, then its influence can be generalised to a related larger population. Probability sampling may include simple random, stratified, cluster, systematic, and multi-stage sampling techniques that are mostly associated with larger sample populations. ***A systematic*** sampling technique is excluded among the other probability sampling techniques, and it does not always require an actual list of sample frames. However, due to the nature of observable phenomena and an inability to specify a sampling frame due to limited information of resources, it may be more appropriate to use one or several numbers of non-probability sampling techniques (Saunders *et al.*, 2009).

## 4.7.2. Non-probability Sampling

*Non-probability sampling* is the alternative way of sampling techniques to select samples by *subjective judgement*, where the total population is not known

(Saunders *et al.*, 2009). This alternative sampling technique may involve a quota, ***purposive***, self-selection, snowballing, and convenient sampling. The type of data being collected is very much dependent upon a selection of appropriate sampling techniques. Many researchers usually use and are quite confident collecting quantitative data through the quota and purposive sampling techniques, and may collect qualitative data through snowballing, convenient, and self-judgemental sampling techniques. While, in some cases researchers would perceive that a non-probability sampling technique could be used for both ***quantitative and qualitative*** data collections in order to triangulate and improve a validity and reliability of the research within a ***mixed method*** approach through ***purposive sampling*** techniques (refer to Figure 4-5).

### 4.7.3. Purposive Sampling

*Purposive sampling* is an appropriate technique that enables the collection of data through selecting individuals on their experience in relation to the central phenomenon (Creswell, 2009). The purposive or judgemental sampling for selecting individual cases may best enable researchers to answer research questions and address research objectives (Saunders *et al.*, 2009), because the samples and cases can be directly related to the research area.

This research has selected project practitioners who are typically experienced in construction project practices. These practitioners are mostly qualified in particular areas and certified as technical and management professionals or experts based on specific requirements, such as graduated university education, technical certificate qualifications, and current jobs or positions on project management lines. These professionals are regularly involved in construction projects which are qualified with certified ISO-9000: 2000 or 2008. This registered standard certificate represents internationally recognised organisations and projects, and has achieved standardised quality projects and financial management practices. All of the professionals' positions and achievements are closely related to cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

Therefore, non-probability purposive sampling techniques can be used to collect questionnaire survey data from project professionals and interview data from experts based on the specific criteria. The following section considers data collection with regard to the fulfilment of the research questions.

### 4.7.4. Justification of Data Collection to the Research Questions

Process inquiries and investigations for empirical data are carried out through questionnaire surveys, case study documentation and direct observations, and expert interviews. Senior managers, office management professionals, and project management teams are involved in this questionnaire survey, as the respondents. Project documentation and direct observations are carried out during field research. The interviewees are selected from experts based on the criteria that have greater experience and hold higher management positions in relation to the research area of cost management and controlling practices – the CMCPs of construction project overheads.

The questionnaire survey is administered during the data collection phase based on *'purposive sampling techniques'* due to *'unavailability of a specific sample frame'* of respondents (refer to Saunders *et al.*, 2009). Qualified construction professionals, as the basis of jobs of respondents, are included in this survey.

#### 4.7.4.1. The First and Second Research Questions

Primary data is collected through questionnaires in regard to the *first and second research questions*. Although the first research question (identification of project overheads) was mostly answered through the literature review (refer to Section

2.4.3), the availability of categories and items of project overheads which actually occur in real projects had to be identified accordingly.

The second research question is about identification and analysis of important CSFs for improving the management of project overheads. Various important CSFs related to this research question have been identified in construction projects through the literature review (refer to Table 2.2). These important CSFs are used to develop questionnaires in consultation with experts. Empirical data was collected from project management professionals of construction projects in Indonesia. One hundred and ninety eight (198 sets) printed questionnaires, with a covering letter, were handed directly to prospective respondents on site, and the rest (52 sets) were delivered to respondents through their general offices. The questionnaire survey was completed by 107 respondents (out of 250 questionnaires administered). The response rate of 42.8 per cent is considered enough to address this research question. Fellow and Liu (2008) suggest that a minimum of 100 questionnaire responses of usable data sets can be considered as sufficient data to be analysed.

Most respondents who completed their responses during the field research were in the project management teams (e.g., site area managers, supervisors, quantity surveyors, site logistics, etc.); and office management professionals (e.g., project managers, procurement, cost control, accounting department, man-power, central logistics, etc.); and senior managers (e.g., president director, operational directors, management representatives, etc.). A breakdown of responses relating to these management levels is given in Table 5-1. Some other respondents returned their responses to the researcher’s representative collector in Indonesia and these were sent by post to the researcher, based in Manchester, in the United Kingdom.

#### 4.7.4.2. The Third and Fourth Research Questions

The *third and fourth research questions* (refer to Section 1-5) were completed with project documents and direct observation data after reviewing the literature and principles of the ABC system for initiating and further developing the ABCC model for improving the management of construction project overheads. There are two main tasks when examining these project documents and direct observations: firstly, a capability to read, think, and assess measured data closely rather than merely exploring and drawing any information about the recent events; secondly, the ability to present a clear argument, describing and explaining about the data through a thorough interpretation (Thomas, 2011). Relevant data is collected during field research, such as: which project overheads occur during the construction stage, detailed lists of substructure activities, project resource prices, project schedules, progress reports, project drawings, photo documents, etc.

#### 4.7.4.3. The Third and Fifth Research Questions

Seven experts in the area of project management, especially in regard to the three themes (the management of construction project overheads, the ABC system, and the cost management and controlling practices – the CMCPs), were asked their opinions related to these research questions. These experts include the senior technical advisor, president director, engineering/operational director, management representative, finance/accounting manager, cost manager, and project cost control manager. These expert interviews were conducted to gather information and opinions about the adaptation and application of the ABC system in construction projects, and to validate the development of the ABCC model for improving the management of project overheads during the construction stage.

The following section discusses data collected from project documentation and direct observational case studies.

### 4.7.5. Determination of Project Case Studies

Case studies are commonly based on a source of evidence such as written documents, archival records, interviews, direct observations, participant observation, and physical artefacts (Yin, 2009). Numerous sources of data may be used to fulfil both requirements of quantitative and qualitative measurements which should enable the researcher to gather answers for the research questions and meet the research aim and objectives (Saunders *et al.*, 2009). Written documents and direct observation data are collected for this research. Multiple sources of evidence are triangulated and used to deal with establishing construct validity, and by maintaining a chain of evidence, this increases the reliability of the information (Yin, 2009). Primary and secondary data for this study was collected from selected construction projects in Indonesia. Following section provides a brief description of pilot case study and background to the Indonesian construction industry, and determines the criteria of project selection for construction building project cases.

### 4.7.6. Pilot Case Study

A mini version or preliminary study conducted prior to full-scale research project is usually called a *'pilot study'*. The pilot study is not common in qualitative research, however, this is more appropriate for quantitative studies. The advantage of conducting a pilot study is that it might give advance warning about how to follow research protocols, where to avoid potential pitfalls, or whether the proposed design is not practical or too complicated, and research instruments are inappropriate to collect data (Teijlingen and Hundley, 2001). It would allow a necessary adjustment to improve upon case study designs for survey instruments or the interview guide prior to delivering the questionnaire and conducting interviews during field research stages.

This research was initiated by developing a questionnaire survey and interview guide based on variables identified during the literature review stage. The researcher facilitated a consultation with project experts and made necessary changes to ensure the research instruments were appropriate before being delivered to survey respondents and interview participants.

### 4.7.7. Indonesian Construction Projects

Construction projects require lots of resources including human, funds, equipment, and materials (Lock, 2004; and Walker, 2007), which are supplied from other production sectors (Alarcón *et al.*, 2009). Construction projects appear to have high spending, have a complex intricate nature and have fragmented and diversified activities that usually involve three parties of qualified participants, namely clients, consultants, and contractors.

The National Institute for Construction Services Development of Indonesia *(Lembaga Pengembangan Jasa Konstruksi National – LPJKN, 2006)* has registered 1024 qualified contractors (accessed on 15th March 2011). These contractors have been certified as organisations from the International Organisation for Standardisation (ISO-9000: 2000 and 2008). Their construction projects are managed by quality management systems which are recognised as an international standard for financial service information and management practices. These projects have been selected to be the subject of the case studies. Project case studies are determined by non-probability sample criteria (refer to Section 4.7.2) and purposive sampling techniques (refer to Section 4.7.3). These types of purposive sampling techniques with critical cases (refer to Figure 4-5) investigate the importance of project cases related to the research area. Critical cases are normally used for case studies with small samples, and enable the researcher to select cases through judgmental criteria that would fulfil research questions and objectives (Saunders *et al.*, 2009).

Since this research is conducted based on a multiple case study design (refer to Section 4.4), construction building projects from qualified construction companies are selected. The project criteria was developed before starting the field studies and discussed with the experts to match the criteria with the availability of project cases. The criteria of selection are provided below:

- *Project qualifications*: construction building projects with certified ISO-9000: 2000 or 2008.
- *Project type*: commercial building projects.
- *Project locations*: construction project areas with the most attractive development in Indonesia.
- *Project scope*: construction activities including concrete-pile foundation elements of substructure activities.
- *Project delivery schedules*: being constructed or completed in 2010/ 2011, by the time data is collected.
- *Project data collections*: project data should be accessible to the researcher.

Therefore, these criteria were used when selecting case studies for this research.

### 4.7.8. Project Cases

Five specific construction projects that satisfied the criteria were selected and empirical data was gathered during field research in Indonesia. Project names are abbreviated for ethical purposes (e.g., hospital, car-park, villa, hotel, resort, etc.). The project data related costs and other criteria are provided in Table 4-3.

***Table 4-3: Project Cases***

| **Criteria** | **Project Cost Data** | | | | |
|---|---|---|---|---|---|
| Project cases | **HOSPITAL** | **CARPARK** | **VILLA** | **HOTEL** | **RESORT** |
| Project Location | City Centre Area, S-D-Bali1-Ind | City Centre Area, P-D-Bali2-Ind | Tourism Area, K-B-Bali3-Ind | Tourism Area, P-B-Bali4-Ind | Echo Beach Area, C-B-Bali5-Ind |
| Client Category | Public | Public | Private | Private | Private |
| Project Type | Public Service/ commercial Building Project | Public Services/ Commercial Building Project | Private Services/ Commercial Building Project | Private Services/ Commercial Building Project | Private Services/ Commercial Building Project |
| Construction Duration | Oct 2010 – Dec 2010 (2.5 moths/ 10 weeks,73days) | Jul 2010 – Dec 2010 (6 months/ 24 weeks) | Dec 2010 – Dec 2011 (12 months/ 48 weeks) | Jan 2011 – Nov 2011 (10 months/ 40 weeks) | Dec 2010 – Oct 2011 (10 moths/ 42 weeks) |
| Foundation | Bore-Pile Concrete, D30cm, L5.5m | Bore-Pile Concrete, D30cm, L6m | Bore-Pile Concrete, D30cm, L6m | Bore-Pile Concrete, D30cm, L6m | Precast-Concrete Pile, D25x25cm,L6m |
| Scope of Work | Structure and Architecture | Structure and Architecture | Structure and Architecture | Structure and Architecture | Superstructure work |
| Labour *(IDR)* | 148,083,335.50 | 476,944,406.20 | 776,915,077.75 | 674,669,592.61 | 1,691,767,707.61 |
| Materials *(IDR)* | 657,718,244.37 | 2,219,071,864.55 | 3,666,326,443.10 | 3,357,277,458.32 | 11,844,539,760.86 |
| Subcontractor (IDR) | 1,078,083,450.40 | 1,280,563,537.74 | 2,861,372,438.31 | 4,984,534,982.27 | 278,698,959.90 |
| Direct Cost (DC), *(IDR)* | 1,883,885,030.27 | 3,976,579,808.49 | 7,304,613,959.16 | 9,016,482,033.20 | 13,815,006,428.37 |
| Site-Project OHs (IDR), (%): Const. Support *(IDR), (%DC)* | 97,019,748.39<br>5.150% | 109,504,490.00<br>2.754% | 182,615,720.34<br>2.500% | 406,205,200.00<br>4.505% | 2,241,147,863.34<br>16.223% |
| Site-Project OHs (IDR), (%): Preliminaries *(IDR), (%DC)* | 75,355,144.38<br>4.000% | 285,596,471.41<br>7.182% | 365,231,440.68<br>5.000% | 550,389,564.58<br>6.104% | 1,783,829,757.86<br>12.912% |
| Const. Cost (CC), (IDR) | 2,056,259,923.04 | 4,371,680,769.90 | 7,852,461,120.18 | 9,973,076,797.78 | 17,839,984,049.58 |
| General-Office OHs *(IDR), (%RC)* | 112,013,544.00<br>4.785% | 293,035,150.00<br>5.541% | 526,828,500.00<br>4.919% | 937,500,000.00<br>7.500% | 2,181,240,000.00<br>7.500% |
| Profit *(IDR), (%RC)* | void | void | void | void | void |
| Revenue *(IDR)* | 2,270,702,981.82 | 5,129,457,441.34 | 10,388,435,454.55 | 12,125,000,000.00 | 24,153,000,000.00 |
| Income Tax *(IDR), (%PC)* | 70,227,927.27<br>3.000% | 158,640,590.46<br>3.000% | 321,291,818.18<br>3.000% | 375,000,000.00<br>3.000% | 747,000,000.00<br>3.000% |
| Value Added Tax – VAT *(IDR), (%PC)* | 234,093,090.91<br>10.000% | 528,801,968.20<br>10.000% | 1,070,972,727.27<br>10.000% | 1,250,000,000.00<br>10.000% | 2,490,000,000.00<br>10.000% |
| Project Cost (PC), *(IDR)* | 2,340,930,909.09 | 5,288,098,031.80 | 10,709,727,272.73 | 12,500,000,000.00 | 24,900,000,000.00 |
| Project Price(PP), *(IDR)* | 2,575,024,000.00 | 5,816,900,000.00 | 11,780,700,000.00 | 13,750,000,000.00 | 27,390,000,000.00 |

***Source: Documented from the Contractor.***

One of these five projects is a complex of multi-storey apartments and arcade buildings, namely the resort project. This resort has many facilities, such as a beach restaurant, medical centre, lagoon pool, swimming pool, beach club, kids activity club, spa, gym, art and gallery, fashion boutiques, etc. It is an integrated resort project located at the very edge of Echo Beach, at C-B-Bali5-Indonesia (refer to the fifth project case Table 4-3). The contractor is developing six main buildings which include five prototype apartments and one shopping arcade in a single project area (refer to Figure 4-6).

***Figure 4-6: Integrated Resort Plan and View***
***Source: Owner's Website***

All of these five apartment buildings have similar substructure elements with typical concrete pile-and-cap foundation. The focus of the project documentation and direct observation case studies are carried out to examine the implementation of the ABCC model through the CMCPs' tools and techniques. The reason for choosing this project as the focus of the case study is that it meets all case study criteria and complex activities being progressed during the field research.

Substructure activities of all five apartment building projects (termed the basement-structure project) are contracted in a separate project package, and substructure construction activities scheduled in a different part of the superstructure building work package. The substructure activities were completed in five months starting from July to November 2010 (refer to Figure 4-7).

***Figure 4-7: Mobilisation and Substructure Activities***
***Source: Documented from the Contractors***

Another four construction building projects were also documented and observed. All of these four projects have relatively similar concrete-pile foundations and substructure elements of construction activities, regardless of the different types of construction delivery methods and project complexities. Their individual units are constructed in different sizes and locations: (1) the hospital building at S-D-Bali1-Ind; (2) the car-park building at P-D-Bali2-Ind; (3) the villa building at K-B-Bali3-Ind; and (4) the hotel building at P-B-Bali4-Ind. More information about these projects is provided in Table 4-3.

Due to the complexity and magnitude of the research projects, research will use this project to illustrate and explain the development of the ABCC model in findings and analysis chapter. Therefore, all the illustrative examples presented in Chapter 5 are from the resort project.

Secondary data, direct observations, and project documents have been collected through data documentation that includes: project identifications, project plans, schedules, cost accounts, progress reports, drawings, photo documents, and so on (e.g., provided in Table 4-3; illustrated on Figure 4-7; and the actual cost data summarised in Appendix 3-a).

The research protocol and concurrent activities of research techniques and procedures led the field research for the data collection, and data analysis techniques are discussed in the following section.

## 4.8. Data Analysis

Techniques for analysing data are normally used to provide information about variables, and usually relationships between those variables within cases (Fellow and Liu, 2008). A full explanation of the cases will develop critical responses to *'why* and *how'* types of research questions, such as: *'why the ABC system could be adapted in construction projects?'*, and *'how the ABCC model could be developed to improve the management of project overheads, and implemented on substructure activities of construction building projects?'*

The data analysis requires an appropriate analytical strategy and computer-assisted tools to manage, manipulate, and analyse data and study evidence. General analytic strategies such as relying on literature reviews with developing propositions or hypotheses can be more attractive with the use of both ***quantitative*** and ***qualitative*** data analysis techniques (Yin, 2009).

*Quantitative data analysis* may follow data analysis procedures as suggested by Saunders *et al* (2009) and outlined below:

> "..... preparing [data collection results and computer with relevant software], inputting [data] into a computer, and checking [missing data or errors] ....., choosing the most appropriate tables and diagrams to explore and presenting [frequencies of different events] ....., choosing the most appropriate statistics [or other analysis techniques] to describe [e.g., the

> meaning, mean values, deviations, or other calculations] ....., to examine [variables] relationships and trends" (Saunders *et al.*, 2009, p. 416).

Computer-assisted tools with available software such as Microsoft Excel software and a Statistical Package for Social Sciences (SPSS) could make it much easier to perform data management and analysis, including checking missing data and data matrices for errors, and to examine validity, reliability and consistency of the research. *A statistical data analysis technique* and *an Analytic Hierarchy Process (AHP)* can be used to analyse *survey questionnaire data*. Scatter diagrams, line charts, and tables are suitable to show relationships and trends of the variables. Beside these statistical and mathematical hierarchy process techniques, *an arithmetic analysis method* provides appropriate tools and techniques, e.g., the Activity-Based Costing (ABC) system and Earned Value Measurement System (EVMS). These methods, tools, and techniques could be used to calculate and examine other numerical data sets, such as the cost data collected from *project documentation and direct observation case studies*.

*Qualitative data analysis* also provides an opportunity to analyse data by other computer programmes, such as Non-numerical Unstructured Data Indexing Searching and Theorising (NUD*IST) software which was initiated over three decades ago by Tom and Lyn Richards in 1981 (QSR International, 2012). The original founders also formed Qualitative Solutions and Research (QSR) International, nowadays known as NVivo. It can be used to organise the content of *qualitative interview data*, display data findings, and analyse the data using techniques such as *content analysis or cognitive mapping.*

### 4.8.1. Analysis of Questionnaire Data

Quantitative data has been collected through a questionnaire survey of experts and project professionals in Indonesia. The survey questionnaire is organised to accommodate three main sections: (1) the identification of respondents, (2) the questionnaire related to availability of forty seven project overheads, and (3) the questionnaire associated to forty CSFs in respect of four evaluation criteria of construction projects (refer to Appendix 2-a). The experts and project professionals included: senior management, office management staff, and project management teams. They are employed in construction projects in Indonesia, and their expertise and experience are closely related to the research area of Cost Management and Controlling Practices (CMCPs) of construction project overheads. Two research objectives considered through the analysis of questionnaire survey data and examined in this section: (1) *identification of project overheads* and (2) *analysis of Critical Success Factors (CSFs)*.

#### 4.8.1.1. Data Analysis for Identification of Project Overheads

The identification of the availability of project overheads can be analysed using techniques such as weighted scores of descriptive statistic techniques to identify and justify an availability of project overheads during the construction stage of projects. Every project may use different types, categories, and items of project overheads in real operations. The literature review has identified two types of project overheads, which are general-office and site-project overheads. This research only focuses on investigating site-project overheads which have been identified relating to forty-seven (47) items of project overhead terms (refer to Section 2.4.3; Table 2-1; and Appendix 2-a). The occurrences of project overheads related to construction activities should be examined and analysed for their availability in real projects in order to consider effective management and controlling practices – the CMCPs of project overheads during the construction stage.

The availability of project overheads during the construction stage of construction projects can be analysed using techniques such as descriptive statistics, through examining the central tendency of observed data scores. The central tendency of descriptive statistics include: mode, median, mean, variance, standard deviation, and range analysis. Descriptive statistics as a technique of analysis have their advantages and weaknesses depending on objectives of analysis, and always have to refer to the data set. *Mode* statistics consider the score of project overheads that *'most frequently'* occurs during the construction stage. The most frequent score occurrences would not provide a unique or significant measure of evaluating weighted scores of a continuous data set, due to there being more than one mode appearing within a data set. *Median* statistics consider the range-ordered score of *'a middle'* number for an uneven data set or *'an average'* between scores of the two middle numbers for an even data set. *Mean* statistics represent the score of *'the sum of all over the number of data set'*. The difference between median and mean is that a median statistic is not really affected by weighted scores of a data set, whereas a mean statistic is directly affected. *Variance* statistics normally deal with *'square'* of variation numbers which are quite difficult to imagine in relation to an original data set and objectives of analysis. *Standard deviation* takes the square-root of the variance to provide precise statistical measures and a clear insight in relation to the mean statistic of the data set. The relation between the mean statistic point and other statistical measure points of a data set can be determined by using *the range statistic analysis* (refer to Figure 4-8).

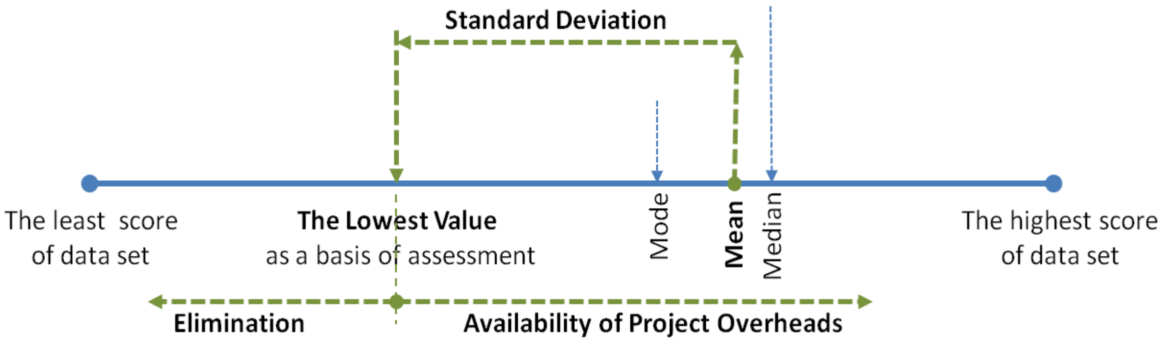


***Figure 4-8: Range Statistic Analysis for Availability of Project Overheads***

The SPSS software provides programmes to facilitate this descriptive statistical analysis. This research would consider the mean statistic as a centre point of assessment (rather than mode and median), with the standard deviation which provides for analysis of *'a range'* of the mean value point into *'a lower value'* as a basis of assessment (mean statistic value minus standard deviation). This statistical measure would be used to assess *'the degree of agreement'* of the respondents *for 'the availability of project overheads'* during the construction stage of construction projects.

#### 4.8.1.2. Data Analysis for Prioritisation of Critical Success Factors (CSFs)

The analysis of important CSFs can be categorised as quantitative data analysis. Statistical *'factor analysis'* techniques can be used for analysing larger response sets of quantitative data and only usable responses of sufficient data sets can be analysed (refer to Fellow and Liu, 2008). However, *Analytic Hierarchy Process (AHP)* would be appropriate for multilevel decision making or determining the priority of alternatives through mathematical analysis techniques that requires a relatively small response from *the questionnaire survey data*. This method was initiated by Thomas L. Saaty in the early 1970s. Saaty (2008) defined the AHP as a theory of complex decision making through measuring pair-wise comparisons that relied on individual judgements to determine priority scales of the alternatives. Expert judgements may be personally decided, and that could be subjective and inconsistent. However, AHP has a mathematical logic analysis to determine options from a list of choices or alternatives through weighting or ratio-scaling its' factors in respect of several parameters.

The AHP technique is used to organise and analyse complex decision problems and to deal with both the rational and intuitive selection of the best alternatives through several elements of criteria (Saaty and Vargas, 2012). Verbal expressions for making pair-wise comparisons would correspond to the absolute number 1 to 9 (Saaty, 2008). The fundamental values of Saaty's nine scales are explained in Table 4-4 below:

***Table 4-4: The Fundamental Scale of Saaty's Absolute Numbers***

| Intensity of Importance | Definition | Explanation |
|---|---|---|
| **1** | Equal Importance | Two activities equally contribute to the objective |
| **2** | Weak or slight | Equally more contribution |
| **3** | Moderate Importance | Experience and judgement slightly favour one activity over another |
| **4** | Moderate plus | Moderately more |
| **5** | Strong importance | Experience and judgement strongly favour one activity over another |
| **6** | Strong plus | Strongly more |
| **7** | Very strong or demonstrated importance | An activity is favoured very strongly over another; it is dominance demonstrated in practice |
| **8** | Very, very strong | Very strongly more |
| **9** | Extreme importance | The evidence favouring one activity over another is of the highest possible order of affirmation |
| **Reciprocals of above** | If activity ***i*** has one of the above nonzero numbers assign to it when compare to activity ***j***, then ***j*** has the reciprocal value when compared with ***i*** | A reasonable assumption |
| **1.1 to 1.9** | If the activities are very close | May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not too noticeable, yet they can still indicate the relative importance of the activities. |

***Source: Derived from Saaty (2008)***

Saaty and Vargas (2012) also explain the validity of the comparison made in many situations for estimating the verbal values, even though the relative importance of two activities are thought as very close, for example, the detailed values between 1.1 and 1.2, ....., 1.8 and 1.9; 2.1 and 2.2, ....., 2.8 and 2.9; 3.1 and 3.2, ....., 3.8

and 3.9; and so on. The comparisons can be made by estimating the specific verbal numbers directly, such as the more specific verbal values of 1.1, 1.2, 1.3, ....., and 1.9 between verbal numbers of 1 and 2 (refer to Table 4-4). These specific verbal values may continue to be represented by its' relative differences. They can be explained in order to make justifications in any of these specific scales: if 1.1 is a smallest piece of *'equally important'*, then 1.3 may represent *'moderately more'*, 1.5 *'strongly more'*, 1.7 *'very strongly more'*, and 1.9 indicated that it is *'extremely more'* (Saaty and Vargas, 2012).

In order to establish AHP techniques, the problem or objectives should be decomposed into the level of hierarchy of criteria and alternatives (Saaty, 1977; and Haas and Meixner, 2005). This research utilises AHP for synthesising the relations inherent between CSF-alternatives with respect to each of their evaluation-criteria in the adjacent level to determine the most important CSFs as a decision-goal (refer to Figure 4-9).

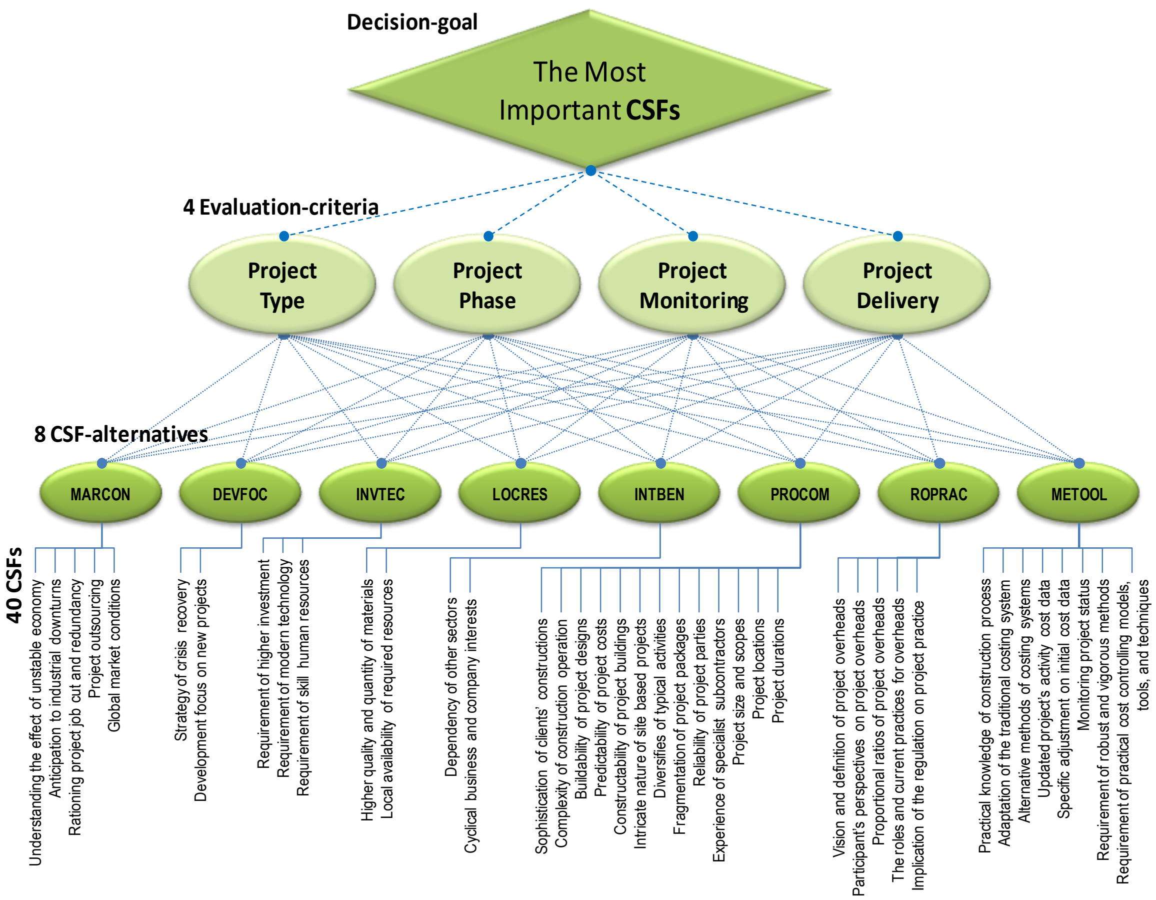


***Figure 4-9: The Structure of Analytic Hierarchy Process***

Three levels of AHP are developed to analyse the priority of importance of the CSF-alternatives. There are three parameters structured in this AHP technique:

- The top level of hierarchy is a Decision-goal which represents the second research objective to be achieved through the AHP technique (e.g., the most important CSFs).
- The middle level involves four elements of evaluation-criteria (refer to Section 2.8): (1) project focus: commercial building type, (2) project phase: construction stage, (3) project monitoring: updating the project progress and cost performance, and (4) project delivery methods.

- The lower level specifies the analysis of CSF-alternatives in respect of each element of evaluation-criteria in the above level. Section 2.7.1 to Section 2.7.8 discusses a detailed description of these eight groups of important CSFs which include: (1) MARCON, (2) DEVFOC, (3) INVTEC, (4) LOCRES, (5) INTBEN, (6) PROCOM, (7) ROPRAC, and (8) METOOL.

This AHP process starts with analysing the evaluation-criteria by comparing every pair-wise of its element. These comparisons are based on an initial consensus of five experts to develop a questionnaire survey amongst them, and continued with their personal judgements to score these questions. The experts answered the questions about the degree of importance of forty variable CSFs related to four evaluation-criteria of construction projects, such as: Project Type, Project Phase, Project Monitoring, and Project Delivery (refer to questionnaire form Appendix 2-a).

Identification of the expert is abbreviated for ethical purposes. These five experts have met the criteria explained in Section 4.6.3.3, such as they are knowledgeable and skilful practitioners with more than ten years overall job experience and working directly in the particular area of construction projects. They have graduated with university degrees, and are currently employed in construction companies with the certified ISO-9000: year 2000 or 2008. The list of those experts is provided in Table 4-5.

***Table 4-5: The List of Five Experts***

| No. | Name | Current Job Title | *Overall Experience | *Recent Job Experience |
|---|---|---|---|---|
| 1 | Mr. AS | President Director | 22 | 1 |
| 2 | Mr. BK | Operational Director | 21 | 10 |
| 3 | Mrs. CM | Finance Manager | 20 | 3 |
| 4 | Mr. DS | Project Manager | 20 | 12 |
| 5 | Mr. ER | Chief Engineering | 18 | 8 |

(*): the number of years

The questionnaire is assessed by the experts in five Likert scales: the smallest unit (1) indicates *'not important'*, (2) *'merely* important', (3) *'moderate'*, (4) *'mostly important'*, and the highest (5) indicates *'highly important'*. It was recognised that a Likert scale is not the exact or precise measurement with regard to particular elements of the evaluation-criteria for validating their comparisons as explained in Table 4-4, but it represents a relative importance of verbal values of personal judgements attached to every factor of CSF-alternatives in respect of every element of evaluation-criteria.

Relative verbal values of every related factor are represented by the scores which were accumulated in every element of the evaluation-criteria. Although it has been assessed and scored by the experts in the specified areas, there may still be inconsistencies, due to their different levels of expertise or experience. This can be managed by improving the consistency, or validity and reliability of the research using redundant data or information (Saaty, 2008).

The questionnaire survey was also distributed to 250 professionals in the area of cost management and controlling practices, which received 107 responses. The response rate of 42.8 per cent is considered as acceptable enough for data analysis.

This data analysis considers the weights of related factors which include forty variables attached in eight groups of CSF-alternatives under four elements of evaluation-criteria. These would enable the measurement of an inconsistency of pair-wise comparison matrices within elements of evaluation-criteria and factors of CSF-alternatives without destroying their particular roles. However, AHP techniques tolerate the inconsistency up to 10 per cent (Saaty, 1977). As a consequence, the element of criteria or the factor of alternatives compared would be limited to small numbers, up to nine units (Saaty, 2008; and Saaty and Vargas, 2012).

Having explained the analysis of questionnaire data, following section elaborates the analysis of case study data.

## 4.8.2. Analysis of Case Study Data

The main purpose of this analysis is to determine realistic rates of project overhead costs exclusively separated from the cost of materials and labour which are attached on project bid costs and contract prices. The Activity-Based Cost (ABC) accounting system maintains project cost measurement and analysis methods of the Activity-Based Cost Controlling (ABCC) model based on costs which are disaggregated from the awarded contract prices (refer to Section 3.5 and Figure 3-4). The ABCC model can therefore be implemented through effective tools and techniques of the Cost Management and Controlling Practices (CMCPs) of project overheads.

### 4.8.2.1. Cost Measurement and Analysis of the Activity-Based Cost Controlling (ABCC) Model

Project cost data collected during project documentation and direct observation as part of case studies was measured and accounted for to represent the development and implementation of the ABCC model. Project overhead cost data are used to fulfil and examine the ABCC model and the CMCPs' tools and techniques. The spread sheet in excel format is used to calculate transparent costs of cause-and-effect relationships for the occurrences of project overheads associated to substructure activities of construction building projects. The procedures of project cost measurement and analysis of the ABCC model are explained through the flow chart in Figure 4-10.

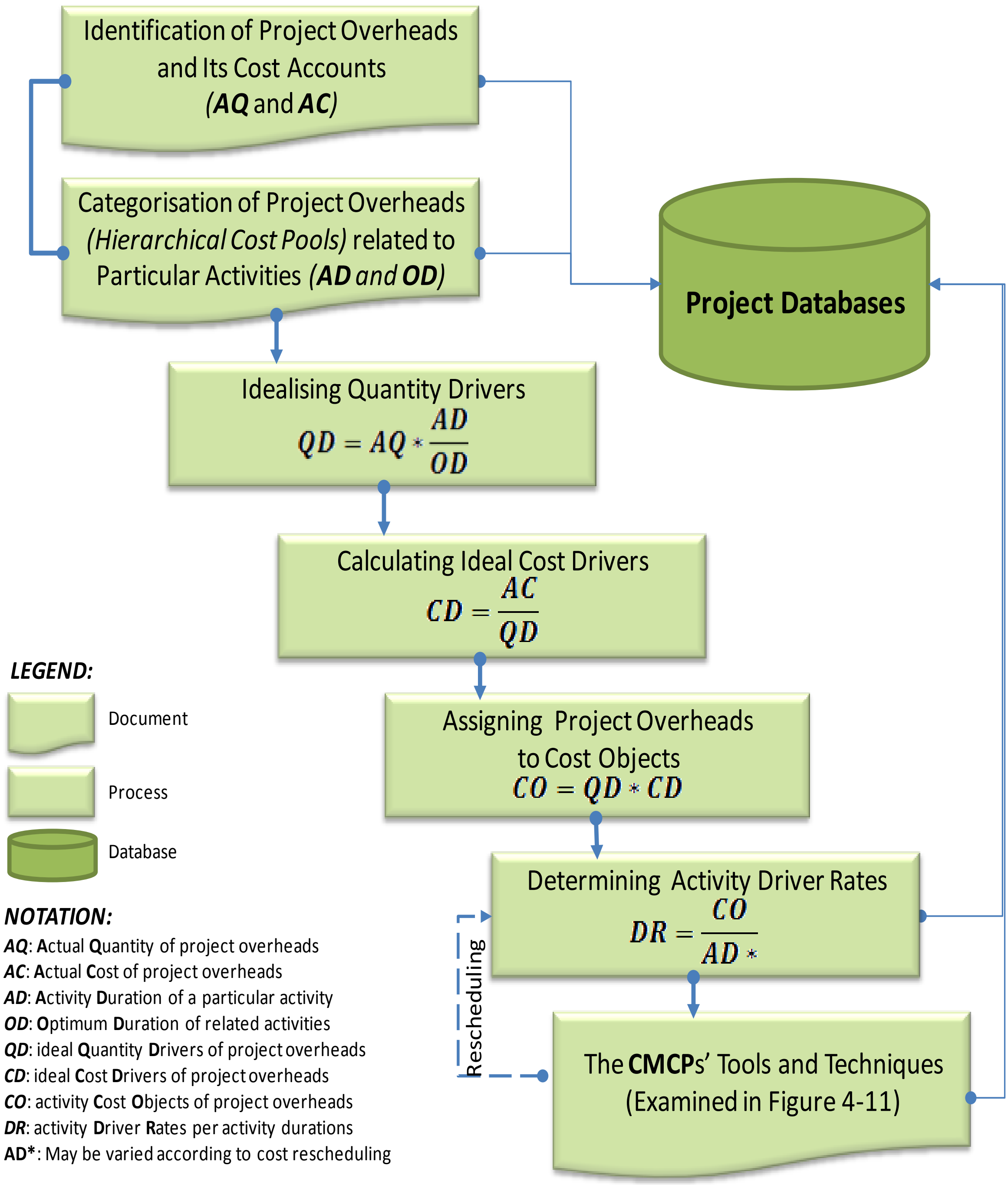


***Figure 4-10: Project Cost Measurement and Analysis of the ABCC Model***

According to Freedman (2013) states that the ABC system is a cost accounting method of assigning overheads on the basis of the ideal cost pools to each pool of particular activities. The rate of each item of project overheads can be measured based on the total invoice divided by its occurrences for particular activities (e.g., overhead rates equal to the total invoice records divided by the number of occurrences). The purpose of this examination is to determine the cost driver rate of each occurrence of certain overhead items per activity duration. The higher the number of the particular item of overhead occurrences, the greater cost might be incurred. Therefore, project overhead costs would be distributed proportionately to every related activity on the basis of specific durations of bar-chart schedules.

#### 4.8.2.2. Cost Management and Controlling Practices (CMCPs) of Project Overheads

The distribution of project overheads and its cost driver rates per activity are scheduled in order to examine the development of the ABCC model through implementation of tools and techniques of the Cost Management and Controlling Practices (CMCPs) of project overheads. The effective cost management and control mechanism and analysis procedures of the CMCPs for improving the management of project overheads are shown in Figure 4-11.

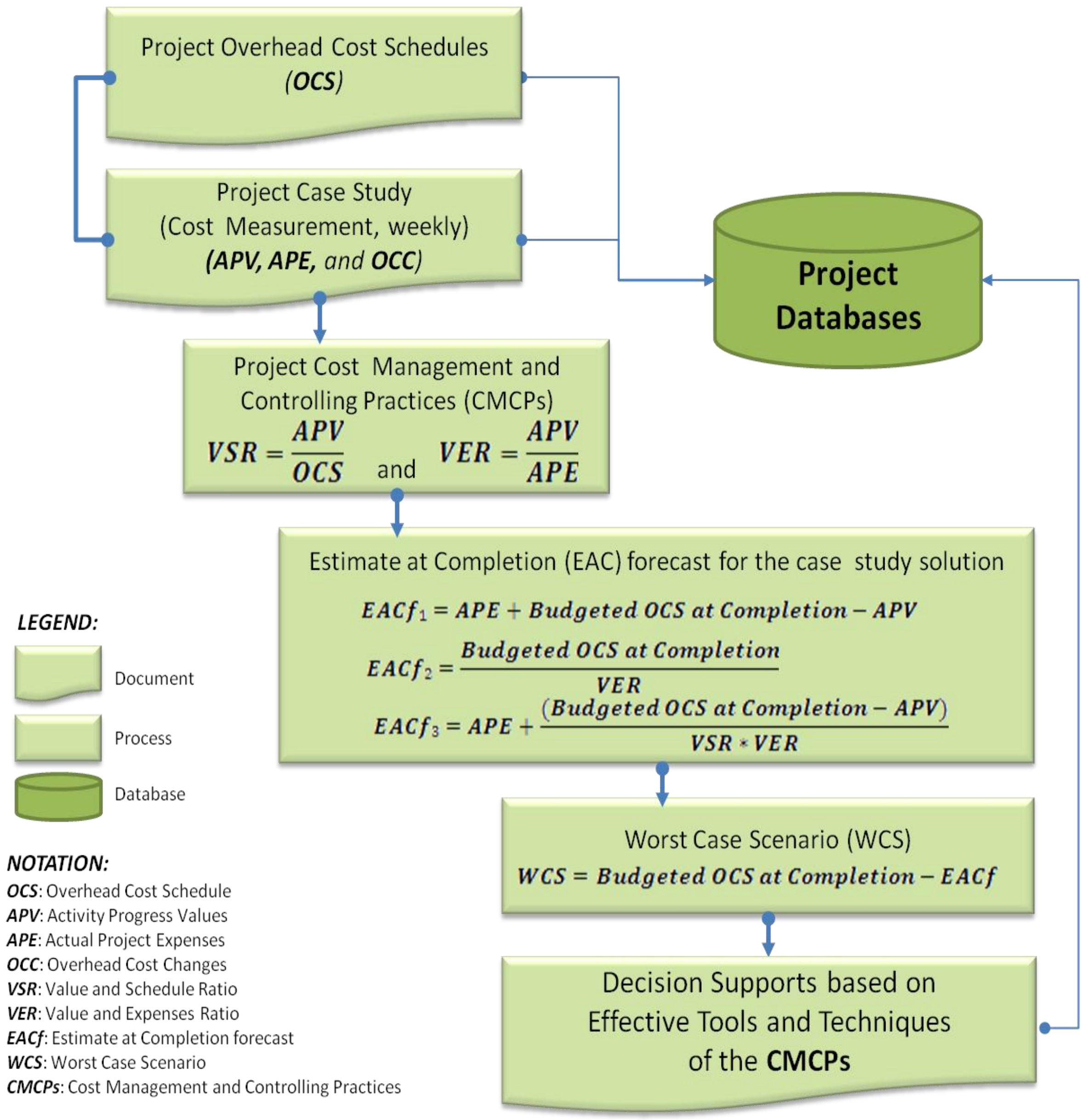


***Figure 4-11: Project Cost Management and Controlling Practices (CMCPs)***

The cost measurement methods for analysing the realistic rates can be documented as the data bases of project cost accounts for estimating future projects with better accuracy. Effective tools and techniques of Cost management and Controlling Practices (CMCPs) of project overheads would also be implemented for improving the management of project overheads.

The principle of cost accounting methodology of the ABC system could therefore be shown that it maintains the development of the ABCC model, and is implemented when examining substructure activities of construction building projects by using the appropriate tools and techniques of the CMCPs for improving the management of project overheads during the construction stage of construction projects.

### 4.8.3. Analysis of Interview Data

In addition, expert interviews were conducted in order to explain the application of the ABC system in construction projects, and validate the development of the ABCC model for the management of project overheads. Qualitative data analysis using sophisticated software of QSR packages provides data management facilities for coding, text retrieving, and theory testing and building (Crowley *et al.*, 2002). The QSR International has popularised the NUD*IST software (NVivo) which may be used to collect, manage, and *display findings of content data of interviews* to represent the meaning of words or texts and the way their messages are delivered by the experts.

Content analysis is *'a scientific tool'* that is defined as *'a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use'* (Krippendorff, 2004, p.18). This indicates that content analysis enables the researcher to systematically identify the texts from textual information such as identifying keywords and meaning in the context of research areas. The scientific tool of content analysis could give clear insights into the research problem and provide information to understand of what practical action may be required (e.g., manual or computer programmes) through identifying and analysing the texts. Pathirage (2007) suggests that there are two different techniques of 'free-flowing texts' analysis, such as *textual analysis* and *mapping techniques*. The explanation of data analysis of the texts is explained in Figure 4-12.

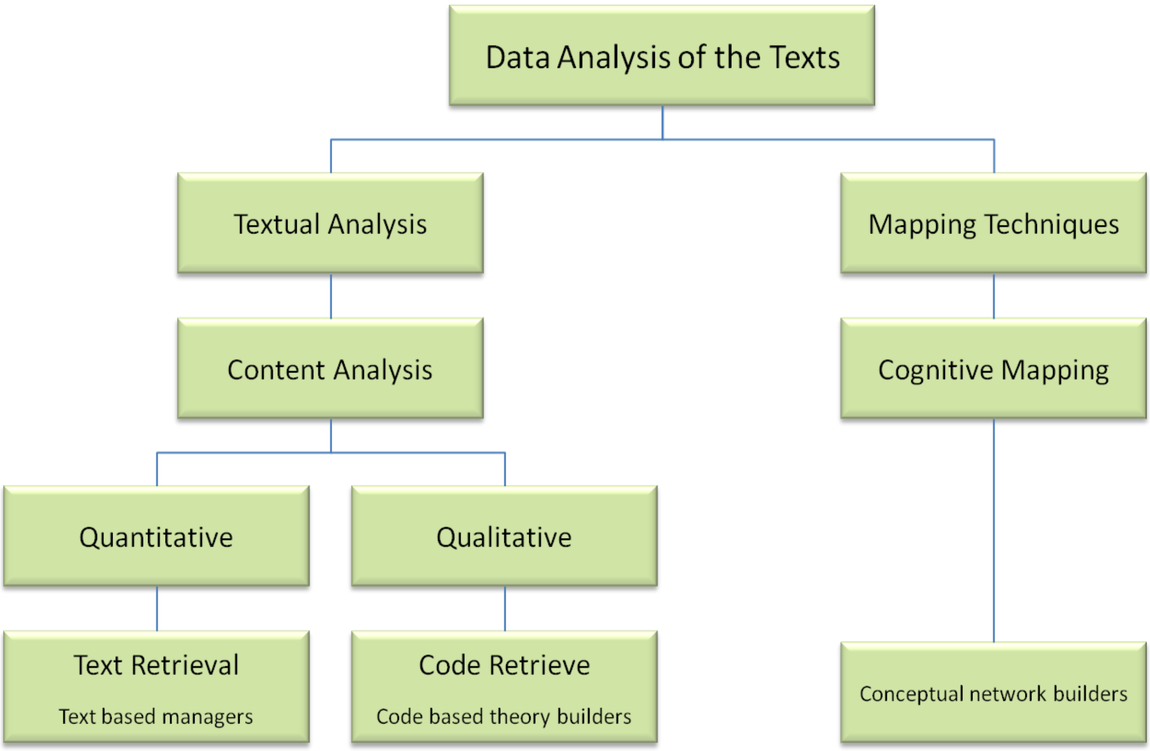


***Figure 4-12: Overview to Data Analysis of the Texts***

***Source: Derived from Pathirage (2007)***

The content analysis techniques in this research may represent an analysis of the texts to identify concepts and develop codes, while, cognitive mapping can be used to investigate inherent relationships among concepts. Content analysis technique in combination with cognitive mapping could be the appropriate technique for interview data analysis.

#### 4.8.3.1. Content Analysis Techniques

The appropriate technique for analysing qualitative data under the textual analysis was widely recognised as the content analysis. Qualitative content analysis provides features to identify themes, concepts, and meaning within the texts of the contexts. Common themes and their contradictions often produce patterns of data which may be used for further interpretations to the research (Easterby-Smith *et al*, 2002). The content analysis can develop codes from the data. Codes may be developed through categorising data into themes, issues, topics, concepts, and propositions (Burns, 2000). Qualitative research coding represents an important step of content analysis, such as labelling, organising, and code retrieval. From the codes, the researcher can make personal judgements about the meanings of continuous pieces of texts for the whole textual analysis (Ryan and Bernard, 2003).

The textual analysis can be used for both research approaches such as theory testing and theory building (Crowley *et al.*, 2002). Remenyi *et al* (2003) considered the best placed for the researcher to refer the research questions and tentative theoretical frameworks. This qualitative textual analysis does not exclusively reliance on grounded theory, and qualitative content analysis is used for analysing data collected from expert interviews based on developed research questions (refer to Section 1.5) and conceptual research model (Section 3.2), through operational research protocols (Section 4.6.1) and concurrent research activities (Section 4.6.2).

Shortcoming of the content analysis is considered as poor data display, whereas a cognitive mapping represents analysis techniques for better visual presentation.

#### 4.8.3.2. Cognitive Mapping Techniques

A cognitive mapping is a powerful technique to represent and analyse qualitative data. A large amount of qualitative data presentations can be analysed using the feature of maps. The map of cognitive structures can be formed on a 'means and ends' loop graph and the cognitive mapping techniques could facilitate several tasks, such as restructuring complex data and developing the analysis strategy (Eden *et al.*, 1992). A layout of the graphical representation would be much more easies to communicate the pattern. The content may provide meaning to concepts and the arrows indicating the direction or implication embedded in the argument (Eden and Ackermann, 2004). Generally, cognitive maps relate causal implication in less precise, and a concept at the tail of arrow implies the concept at the arrow head (Eden *et al.*, 1992). In other words, the concept without out-arrow indicates that it has no implication and refers to head-node, whereas, the concept without in-arrow may indicate that it has implication to other concepts and can be named tail-node. The concepts with both in-arrow and out arrow may represent transfer-node or converge-node.

The interview analysis represents three main themes as the parent nodes derived from literature review findings, such as*: the management of project overheads; the ABC system; and the cost management and controlling practices – the CMCPs*. The child nodes and concepts are synthesised from interview findings. Therefore, the identification of project overheads and the application of the ABC system in construction projects could be investigated using the content analysis and cognitive mapping, in order to validate the development of the ABCC model for improving the CMCPs of project overheads during the construction stage of construction projects.

### 4.8.4. Validation of Development of the Activity-Based Cost Controlling (ABCC) Model

Validation in this context is establishing a cognitive process of development of the ABCC model through identification of availability of project overheads and application of the Activity-Based Costing (ABC) system for improving Cost Management and Controlling Practices (CMCPs) of project overheads during the construction stage. Project overheads are defined as the allocation costs for sustaining all activities of a specific project. The ABC system is the cost accounting method that is concerned with measuring the cost of resources, activities, and cost objects; while the CMCPs are the tools and techniques utilised for managing and controlling project overheads effectively. The development of the ABCC model is validated through expert interview outcomes.

### 4.8.5. Expert Interview Findings

Expert interview participants were selected based on a specific criteria (refer to Section 4.6.3.3 and Section 4.6.3.5), and non-probability sampling technique (refer to Section 4.7.3). The criteria of expertise in construction projects and purposive sampling technique are used to determine the participants in order to collect interview data and their opinions.

The Oxford dictionary defines an expert as *'a person who is very knowledgeable about, and skilful in, a particular area'*. Chan, *et al* (2001) provide general criteria of the expert which may refer to 'practitioners' who have extensive working experience, are currently or directly involved in the management of construction projects, and have detailed knowledge and skill in a specified area.

Selection criteria of the interviewees was considered with several conditions: such as having graduated with university degrees, being qualified professionals in specified areas, and having extensive experience in particular jobs or positions in construction projects. Seven experts from construction projects were selected for these interviews. Table 4-6 presents the list of interviewees. Their identifications are abbreviated due to anonymity, for ethical purposes.

***Table 4-6: The List of Interviewees***

| No. | Name | Mgt. Level | Education | Profession | Current Job Title | Job Experience | |
|---|---|---|---|---|---|---|---|
| | | | | | | Overall | Resent |
| 1 | Mr. Gi1 | Senior Management | PhD in Project and Program Management | Consultant & Contractor | Senior Technical Advisors | 45 | 17 |
| 2 | Mr. Su2 | | Bachelor in Civil Engineering | Contractor | President Director | 22 | 1 |
| 3 | Mr. Ka3 | | Bachelor in Civil Engineering | Contractor | Operational Director | 21 | 10 |
| 4 | Mr. Ju4 | | Bachelor in Architecture | Consultant | Management Representative | 21 | 2 |
| 5 | Mrs. Ma5 | Operational Management | Bachelor in Economics | Contractor | Finance Manager | 20 | 3 |
| 6 | Mr. Su6 | | Bachelor in Civil Engineering | Contractor | Cost Engineer | 17 | 6 |
| 7 | Mrs. Uf7 | | Bachelor in Management and Information System | Contractor | Project Cost Control Manager | 16 | 3 |

The first expert (Mr. Gi1) graduated with a PhD degree in Project and Program Management. He is involved in both construction consultancy and contractor companies with a total experience of forty-five years in construction projects, and has held position of a 'senior technical advisor' for about seventeen years. His expertise meets the criteria explained above. Mr. Su2 is the second expert that participated in the interview. He graduated with a university degree in civil engineering and worked in the contractor company for more than two decades before being awarded a higher position as the president director of senior management lines, several years ago.

The other five participants graduated with a university degree in each variety of their study areas, such as Civil Engineering, Architecture, Economics, and Management Information System. They are employed in construction consultancies or contractors of different companies and are involved in construction projects having between sixteen years' experience (Mrs. Uf7) to twenty-one years (Mr. Ka3 and Mr. Ju4).

Their current job positions also varied, from a 'project cost control manager' to 'operational director' with work experience in this role ranging from two years (Mr. Ju4) to ten years (Mr. Ka3) accordingly (data documented in the year 2011). The management levels of all participants can be categorised into two major positions (refer to Table 4-6), such as senior management (Mr. Gi1; Mr. Su2; Mr. Ka3; and Mr. Ju4), and operational management (Mrs. Ma5; Mr. Su6; and Mrs. Uf7).

Their management positions, education, professions, and job experiences mean that they have satisfied the criteria for the expert interviews in the specified area (refer to Section 4.6.3.3).

Semi-structured interviews were conducted during field research in Indonesia (refer to Section 4.7.4). Face to face, semi-structured interviews were carried out using the interview devices and interview instruments, such as recorders, participant information sheet, participant consent form, and interview guidelines (refer to Appendix 2-b). A recorder device was utilised with the permission from interviewees, and interview guidelines were provided and discussed prior to the interviews in order to scope the research area and not to limit opinions and information. This technique for interviews is believed to be a better interview conduct in order to articulate interview outcomes (refer to Saunders *et al.*, 2009).

Therefore, expert interview outcomes should be able to validate the availability of project overheads and application of the ABC system in construction projects in order to develop the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage.

The process of validation considers *the advantages of the ABCC model* related to three convergence themes which emerged during the literature review stage, such as: *(Theme A) the management of project overheads, (Theme B) - the ABC system,* and *(Theme C) - the CMCPs of project overheads* (refer to Figure 4-13).

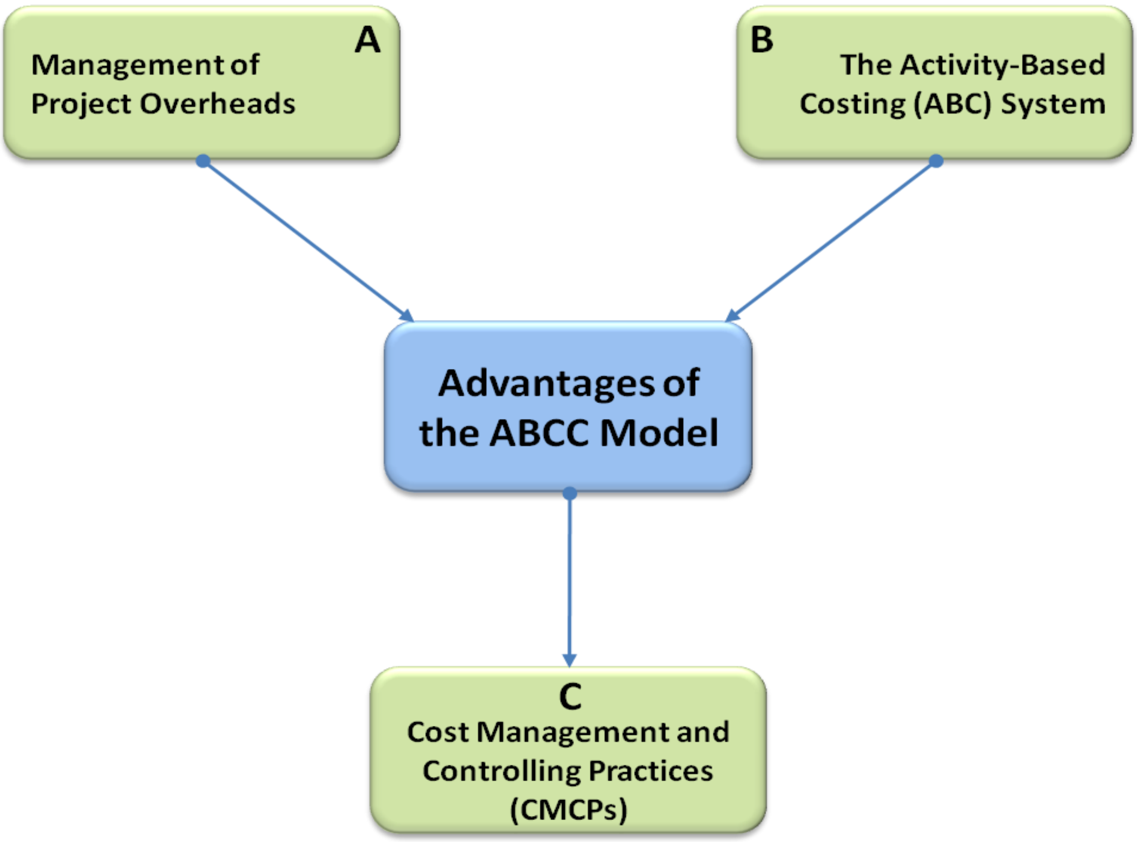


***Figure 4-13: Relationship of the Converging Themes with advantages of the ABCC Model***

### 4.8.6. Theme A - the Management of Project Overheads

Project overheads provide an important support to construction activities that should be appropriately considered during the construction operation. Project overheads are normally included in construction costs and they should exist in the construction process. Enshassi *et al* (2008) reported that construction projects contain a significant portion of project overheads between 8 per cent and 15 per cent, of construction costs. Construction companies may create project benefits through estimating project overheads properly and allocating them to every activity accurately (Ostwald, 2001; Daly, 2002; Kim and Ballard, 2002; and Giammalvo, 2007). However, many construction companies suffer financial losses due to neglecting the importance of project overheads, and it was argued that project overheads are extremely important to maintain construction activities (Assaf *et al.*, 2003).

Project overheads are arbitrarily allocated on a percentage basis of construction building cost (RICS, 2009), and they should not be approximated in a compound cost (CIOB, 2009). Project overheads are distributed to construction activities on the basis of labour costs (Mansuy, 2000). This could cause cost distortions (Cooper and Kaplan, 1988), either being over-costed or under-costed up to ten times (refer to the examination on average overhead allocations by Cockins, 2001).

Furthermore, project overheads are classified into two types (refer to Section 2.4.2): general-office overheads and site-project overheads (e.g., Kim and Ballard, 2001; Assaf *et al.*, 2001; Aretoulist *et al.*, 2006; Enshassi *et al.*, 2008; and Šiškina *et al.*, 2009). The literature review represents research findings that focus on site-project overheads. The site-project overheads are categorised into four hierarchies, these are unit-level, batch-level, project-sustaining, and facility-sustaining overheads (refer to Section 2.4.3). Therefore, the identification of availability of project overheads to support construction activities is quite challenging in order to develop the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

Face to face interviews were conducted during the field research in Indonesia. Seven experts were identified into two management levels (refer to Table 4-6): senior management level (four experts), and operational management level (three experts). They provided opinions related to the management of project overheads. Their opinions are coded into several concepts; they are, from senior management levels: availability of overhead items, incurrence overheads in the general and site office, and about 14 - 33 per cent overheads of project costs, etc. The operational management level discussed inevitable costs of running a construction business, office related and project related costs, costs incurred on operating the construction company and executing a specific project, etc. The list of convergent concepts related to this theme is provided in Table 4-7.

***Table 4-7: Summary of the Concepts from Senior and Operational Management Levels***

| Themes | Questions | Interview Summary (concepts) from Senior Management |
|---|---|---|
| Management of Project Overheads | Q1: Are you familiar with project overheads? | Available overhead terms |
| | Q2: What types of project overheads do you know? | Incurrence overheads on both the general-office and site-projects |
| | Q3: Are you aware of general-office and site-project overheads? | Common practice of overheads in construction projects |
| | Q4: How do you allocate general-office and site-project overhead in your projects? | Percentage overhead basis of project costs |
| | Q5: What is the likelihood percentage of project overheads to total construction cost? | About 14 per cent to 33 per cent overheads of project costs |
| | Q6: Can you predict the percentage proportion (out of 100 per cent) between general-office and site-project overheads? | Proportional overheads in both categories (general-office and site-project) |
| | Q7: Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than allocate them arbitrarily on direct labour basis? | Overhead cost drivers on activity-to-activity basis |

| | | |
|---|---|---|
| **The Activity-Based Costing (ABC) System** | Q8: Are you familiar with cost controlling techniques? | Rigorous and practical costing |
| | Q9: Which cost controlling tools and techniques do you use? | Combination of several costing systems |
| | Q10: Are you familiar with the ABC system? | Reliable cost accounting systems |
| | Q11: Is the ABC system important to be applied in construction projects? | Essential methods to anticipate world *'hard money'* |
| | Q12: What are the advantages of the ABC system? | Very accurate identification on weaknesses and *'core competencies'* |
| | Q13: What are the limitations of the ABC system? | A counterproductive tracer on activity cost of small items |
| **Cost Management and Controlling Practices** | Q14: Can the ABC-control system be implemented in construction projects? | An excellent sample to cost management and controlling databases |
| | Q15: In which project stage does the ABC-Controlling model appropriate? | Point out the problem quickly through *'management by exception'* |
| | Q16: Can you explain the advantages and disadvantages of the ABCC model? | Robust and practical tools and techniques, for particular construction activities |
| | Q17: Can you compare the ABCC model to other tools (e.g., EVM, TCPI, Variance analysis, forecasting, etc.)? | *'Complementary and synergistic'* to other tools and techniques |
| | Q18: Can you explain of any contributions from the ABCC model at organisation level, management level, and project level? | Whilst, *'it may not have been called'* the ABCC model |
| **Note** | Q1 to Q18 (= question numbers 1 to 18) | |

| Themes | Questions | Interview Summary (concepts) from Operational Management |
|---|---|---|
| **Management of Project Overheads** | Q1: Are you familiar with project overheads? | Inevitable costs of running construction business |
| | Q2: What types of project overheads do you know? | Office related and project related costs |
| | Q3: Are you aware of general-office and site-project overheads? | Costs incurred on operating the construction company and executing a specific project |
| | Q4: How do you allocate general-office and site-project overhead in your projects? | Percentage overhead calculations to project costs |
| | Q5: What is the likelihood percentage of project overheads to total construction cost? | About 15 per cent to 35 per cent overheads of project costs |
| | Q6: Can you predict the percentage proportion (out of 100 per cent) between general-office and site-project overheads? | Up to 10 per cent general-office and 25 per cent site-project overheads of project costs |
| | Q7: Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than allocate them arbitrarily on direct labour basis? | Activity cost databases and updated market prices based |

| | | |
|---|---|---|
| **The Activity-Based Costing (ABC) System** | Q8: Are you familiar with cost controlling techniques? | Project cost proposal, cost efficiency and effectiveness controls |
| | Q9: Which cost controlling tools and techniques do you use? | Comparison between several costing alternatives for the cost variances |
| | Q10: Are you familiar with the ABC system? | Concern measuring resource costs reflecting construction process and outputs |
| | Q11: Is the ABC system important to be applied in construction projects? | Specific unit costs rather than just total costs |
| | Q12: What are the advantages of the ABC system? | Detailed activity costs on *'WBS lowest level'* |
| | Q13: What are the limitations of the ABC system? | Scientific approaches and complex implementations |
| **Cost Management and Controlling Practices** | Q14: Can the ABC-control system be implemented in construction projects? | Construction process and performance improvements |
| | Q15: In which project stage does the ABC-Controlling model appropriate? | Construction budgeting and operating cost controls |
| | Q16: Can you explain the advantages and disadvantages of the ABCC model? | Internal cost monitoring and management uses but incompatible with external reporting |
| | Q17: Can you compare the ABCC model to other tools (e.g., EVM, TCPI, Variance analysis, forecasting, etc.)? | Harmony with cost performance management systems |
| | Q18: Can you explain of any contributions from the ABCC model at organisation level, management level, and project level? | Companies' policy, research & development, and personal changes on *'think and act'* |
| **Note** | Q1 to Q18 (= question numbers 1 to 18) | |

### 4.8.7. Theme B - the Activity-Based Costing (ABC) System

As stated by Freedman (2013), the ABC system is the overhead cost allocation through a cost accounting method on the basis of cost pools to each pool of activities and cost objects. The cost accounting method of the ABC system provides *'two-stage'* concepts of cost allocations of project overheads (refer to Section 2.9.1). Project overheads are firstly allocated to cost pools and secondly distributed to cost objects. The ABC system represents relevant features, such as reliable cost accounts, hierarchical cost pools, diverse cost drivers, multiple cost objects, and transparent cost tracers (Jaya, *et al*., 2010a). Important aspects of the ABC system in the 'production principle' can also be considered in the 'construction process', such as resource costs (inputs); construction activities (process); jobs, projects or services (outputs); and cost management and control mechanisms as the evaluation criteria (Jaya *et al*., 2010b); for improving the management of project overheads (Jaya *et al*., 2010c and 2011a). Therefore, the

ABC system would be a reliable and applicable method in construction projects (refer to Section 2.9.3.2), in order to provide the basis for the development of the ABCC model (refer to Jaya *et al.*, 2011b and 2012) for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

Expert interview outcomes are provided in Table 4-7, they are categorised into two management levels, which provided various concepts: from senior management (e.g., rigorous and practical costing, combination of several costing systems, reliable cost accounting systems, etc.); and from operational management (e.g., project cost proposal, cost efficiency and effectiveness controls, comparison between several costing alternatives for the cost variances, concern measuring resource costs reflecting construction process and outputs, etc.).

### 4.8.8. Theme C - the Cost Management and Controlling Practices (CMCPs) of Project Overheads

The CMCPs provide effective tools and techniques for improving the management of project overheads during the construction stage of construction projects (refer to Section 3.6). The CMCPs' tools and techniques can measure cost performances based on three conditions of cost parameters, those are Overhead Cost Schedules (OCS), Activity Progress Value (APV), and Actual Project Expenses (APE). From these three cost parameters, one can derive two present ratios of cost performance indices, they are: the ratio between APV and OCS called Value/Schedule Ratio (VSR), and the ratio of APV over AVE named Value/Expenses Ratio (VER).

The present ratio of VSR provides information about cost performances related to budgeted rates of cost schedules. If VSR is greater than one (VSR>1), it means that progress of construction activities most likely exceeded expectation compared to both the time and budgeted cost schedules. While, if VSR is equal to one (VSR=1), it represents that activity progress was exactly the same as the budgeted cost schedules. It does not provide an attractive project cost management. Whereas, if VSR is less than one (VSR<1), it shows that activity progress is behind the time and budgeted cost schedules.

The project cost ratio of VER provides a present status of cost performances related to actual project expenses (refer to Section 3.6). If a present cost performance index which represents the VER is greater than one (VER>1), it indicates that the activity progress value was higher than the actual project expenses, in that the project would be slightly favourable with potential cost savings. If the present cost performance index shows the VER as equal to one (VER=1), it indicates that the project may not be attractive or effective in term of control of cost performance. Whereas, the present cost performance index which provides the VER is less than one (VER<1), it indicates that the project could be in the unfavourable status due to cost deficit. The project managers will have to take informed decisions appropriately, as to whether they are preventative, corrective, or immediate actions, depending on the level of cost deficits.

Referring to these two cost performance indicators (VSR and VER), there are possibilities in some points of duration of cost measurement that the VSR, on one hand, represents *a favourable VSR* with greater than one *(VSR>1)* which means that the activity progress run ahead of the time schedule, and activity progress values - APV exceeded the overhead cost schedule - OCS. But on the other hand, the VER may represent a counterproductive cost performance to actual project expenses – APE is greater than APV *(VER<1)* which means *an unfavourable deficit* of project cost performance. Whereas, at other times, VSR may be less than one *(VSR<1):* activity progress lags behind the time schedule and showing *an unfavourable cost performance to OCS*, however, VER can be greater than one *(VER>1): a favourable cost performance to APE*. Moreover, the present condition of cost performance only represents the status of construction activities which have been done and completed in the recent past, that are nothing to do with the remaining activities to be performed.

If both the *VSR>1* and *VER>1,* it is absolutely favourable; whereas if both the *VSR<1* and *VER<1,* absolutely unfavourable.

This contradiction or complication of present cost performance measurements remain weaknesses in terms of decision making. The present status of technical activity progress values – APV and actual project expenses – APE in the completed activities would not provide a significant effect to the remaining activities, unless project managers think of finding the best way for their influences on the monitoring project status and managing cost changes, for better cost performance in the future through the implementation of the CMCPs.

The effective tools and techniques of the CMCPs incorporate Earned Value Measurement System (EVMS) and Forecasting models to estimate future status of cost performance indices through the Estimate at Completion forecast ($EACf$) which considers three different present conditions of cost performance indices (refer to Figure 4-11).

## 4.9. Summary

This chapter discussed the research methodology using the research process onion by Saunders *et al* (2009). Three domains of the research philosophy (ontology, epistemology, and axiology) position this research into a critical realist stance. Three criteria of research strategies by Yin (2009) such as the form of research questions, control of behavioural events, and focus on contemporary events are examined for designing the research process through multiple case studies. Mixed methods were conducted for triangulating the data collection and analysis to increase the validity and reliability of the research. Therefore, this research involves a number of data analysis techniques, they are:

- Descriptive statistical techniques for analysing questionnaire survey data to fulfil the identification of the availability of project overheads during the construction stage;
- Analytic Hierarchy Process (AHP) techniques for analysing survey questionnaire data to determine the priority of importance of Critical Success Factors (CSFs) for improving the management of project overheads;
- The Activity-Based Costing (ABC) system and Earned Value Measurement System (EVMS) for analysing case study data to examine the development and implementation of the ABCC model through effective tools and techniques of the Cost Management and Controlling Practices (CMCPs) of project overheads;
- Content analysis and cognitive mapping for analysing the expert interview data to validate the application of the ABC system in construction projects and the development of the ABCC model for improving the management of project overheads during the construction stage.

The next chapter presents research findings and analysis.

# CHAPTER 5. FINDINGS AND ANALYSIS

## 5.1. Introduction

Research normally involves two important activities: a literature review and field research. A literature review is the requirement to make judgements related to both valuing and organising the references for creating ideas and findings (Saunders, *et al.*, 2007 and 2009). Field research is the essential procedures to collect data and create findings (Yin, 2009). It would be possible to derive research findings from both data sources, such as literature and field research. This section discusses two categories of research findings, they are literature review and field research findings. This chapter also discusses research analysis. Accordingly, it is structured into four broad sections of research findings and analysis: (1) identification of construction project overheads, (2) prioritisation of Critical Success Factors, (3) measurement of the Activity-Based Cost Controlling (ABCC) model and implementation of the CMCPs' tools and techniques, and (4) validation of the ABCC model.

*Firstly*, construction project overheads are identified through the literature review findings. Section 5.2.3 analyses forty seven items of project overheads, which are categorised into four hierarchies (unit, batch, project and facility levels). *Secondly*, identification of forty important CSFs through the literature review, which are grouped into eight CSFs are elaborated upon. The three most important CSFs are identified, they are: the requirement of a robust method and tool (METOOL), understanding the market condition (MARCON), and managing the nature of project complexity (PROCOM). *Thirdly*, an overview of relevant features of the ABC system is provided in order to analyse the cost measurement of the ABCC model through the 'two stage' process of overhead cost allocations, and explanation of the implementation of the CMCPs' tools and techniques in detail for the case study on substructure activities of construction building projects. *Finally*, validation of the ABCC model using the three convergent themes (the management of project overheads, the ABC systems, and the CMCPs) are analysed through combining content analysis techniques and cognitive mapping, in Section 5.5.

## 5.2. Analysis of Identification of Project Overheads during the Construction Stage

### 5.2.1. Literature Review Findings on Identification of Project Overheads

About eight decades ago, Bunbury (1931) defined overheads from a cost accounting viewpoint, and sixty three years later Tatikonda and Tatikonda (1994) explained overheads as allocated cost items that are common to multiple cost objectives, but cannot be attributed to specific cost objects efficiently. Two types of overheads, with four categories, and forty seven (47) items of project overheads, have been identified by academic researchers and project practitioners (refer to Section 2.4.3 and Table 2-1). These 47 terms of project overheads were discussed with experts (refer to Table 4-5) whilst developing a questionnaire survey (refer to Appendix 2-a) in order to explore the availability of project overheads in practice, during the construction stage of construction projects.

### 5.2.2. Questionnaire Survey Findings on Identification of Project Overheads

One hundred and seven (107) responses were received from project professionals who were involved at three management levels: senior management, office management staff, and project management teams. The names of the respondents are excluded for ethical purposes. A more detail explanation of respondents is provided in Table 5-1.

***Table 5-1: The List of Respondents***

| Management Levels | Current Jobs/ Positions | Number of Respondents | |
|---|---|---|---|
| Senior Management | Management Director | 1 | 1% |
| | Operational Manager | 2 | 2% |
| | Accounting Department Manager | 2 | 2% |
| | Management Representative | 1 | 1% |
| Office Management Staff | Project Manager | 4 | 4% |
| | Procurement Manager | 9 | 8% |
| | Marketing/ Resource Development | 4 | 4% |
| | Cost Control Manager | 2 | 2% |
| | Central Logistic Manager | 6 | 6% |
| | Quality Control/ Safety Manager | 5 | 5% |
| Project Management Teams | Site Manager | 23 | 21% |
| | Engineering Manager | 8 | 7% |
| | Quantity Surveyor | 11 | 10% |
| | Site-Office and Logistic | 4 | 4% |
| | Architect/ Drawing | 2 | 2% |
| | Supervisor | 23 | 21% |
| **Total Responses** | | **107** | 100% |

Project professionals were asked to complete the questionnaire with five Likert values (ranked between 1: strongly disagree, and 5: strongly agree) regarding the availability of project overheads during the construction stage. The weighted scores of the project overheads are calculated in spread sheets based on one hundred and seven (107) response rates related to forty seven (47) items of project overheads. Every item of project overhead was weighted by the score sum of 107 values of responses. The weighted scores of the project overheads are shown in the following diagram (Figure 5-1).

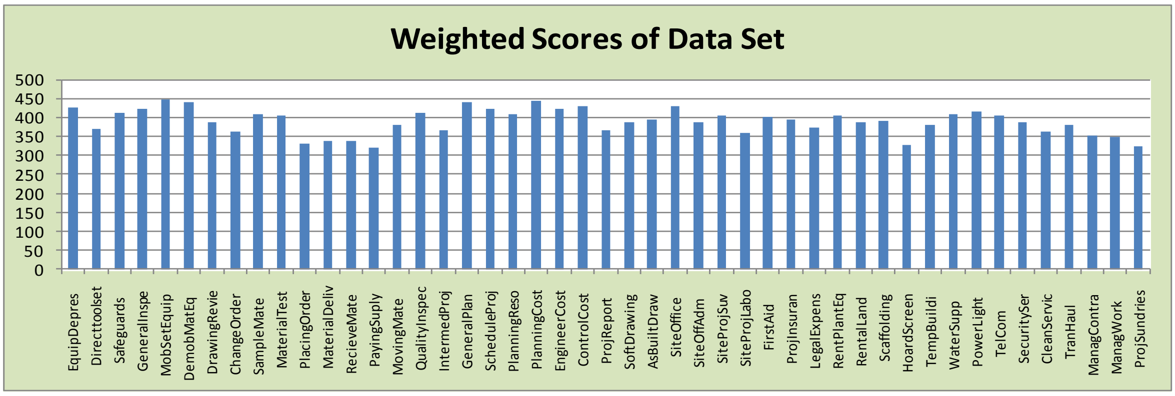


***Figure 5-1: Weighted Scores of Forty-seven Items of Project Overheads***

Every item of project overhead has an individual weight. It represents the degree of availability of project overheads provided by the respondents. In order to compare their relative positions, the weighted scores of the project overheads can be arranged from the least score of 'Paying Suppliers' (score = 322) to the highest score of 'Mobilisation and Setup Equipment' (score = 446). The weighted scores of other project overheads within this range are also provided in Figure 5-2.

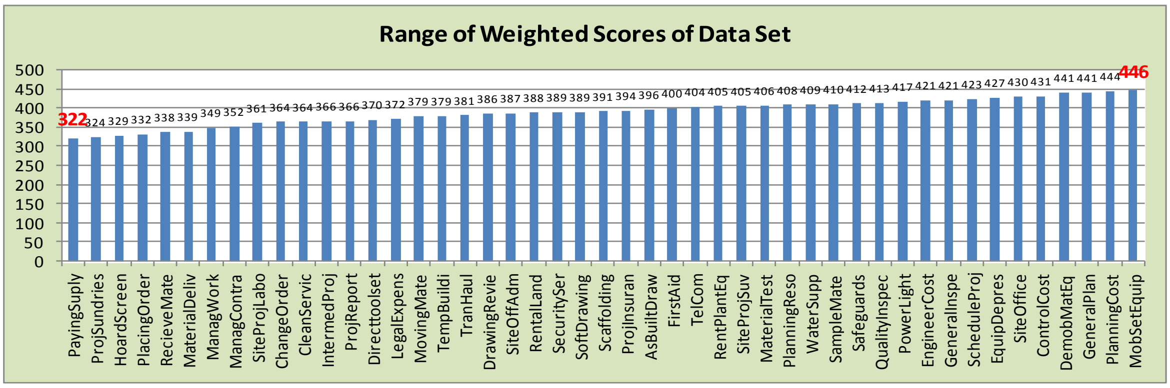


***Figure 5-2: Range Scores of Forty-seven Items of Project Overheads***

The top five scores of project overheads are represented by mobilisation and setup equipment with a total score of 446, Planning costs (444), general planning (441), demobilisation material and equipment (441), and controlling costs (431). Whereas, the bottom five fall into paying suppliers (322), project sundries (324), hoarding screens (329), placing orders (332) and receiving materials (338).

## 5.2.3. Descriptive Statistical Analysis for Identification of Project Overheads

Descriptive statistics can be used as a basis of analysing a central tendency of a series data set. Central tendency statistics include mode, median, mean, variance, and standard deviation. These most basic forms of statistical analysis may use the range of weighted scores of the data set to calculate a basis of assessment for examining the availability of project overheads during the construction stage. The Statistical Package for Social Sciences (SPSS) would help to analyse the central tendency statistics very quickly (refer to Appendix 3-a), however based on the range of weighted scores of the data set in Figure 5-2, this section also provides statistical analyses using the statistics equations, and the results are represented in Figure 5-3 below.

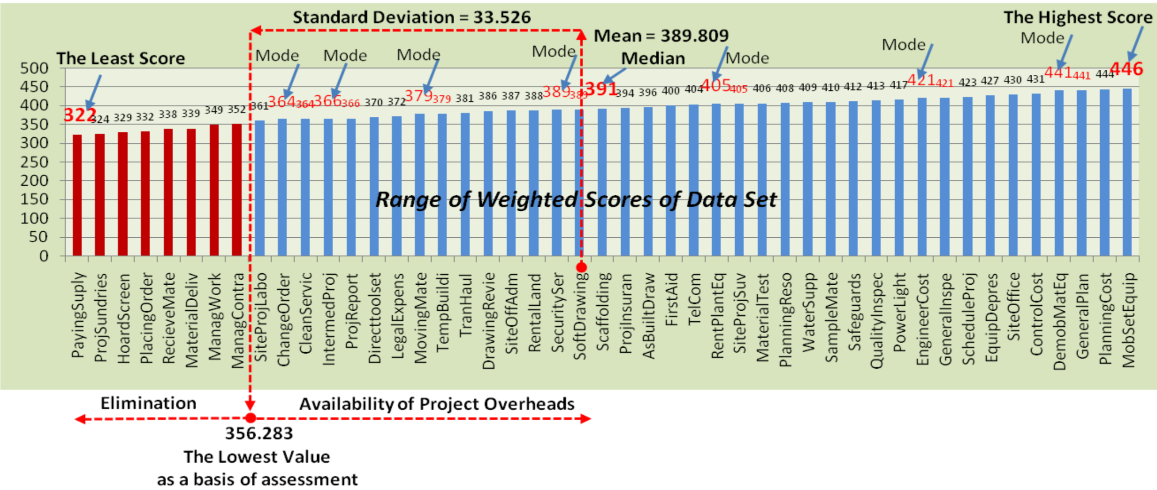


***Figure 5-3: Range Statistics Analysis for the Availaility of Project Overheads***

*A modal statistic* is determined by the most frequent scores which occur within a range of data, and this statistical analysis was represented in seven different modes of project overheads, such as: the lowest score *(364)* occurs twice, the highest mode also occurs twice with the score *441,* and the other five modal statistics are shown in Figure 5-3. *A Median statistic* is represented by the range-ordered score of the middle number of the data set, in this case, to the weighted score of *391*.

The *mean statistic* can be calculated by using the Equation 5-1 below.

$$\boldsymbol{Mean} = \frac{\sum \boldsymbol{x}}{\boldsymbol{n}}$$ *Equation 5-1*

Where,

$\sum x$ : The sum of weighted scores of the data set

$n$ : The number in the data set

The sum value of the data set *(18,321)* and the numbers in the data set *(47)* are calculated and the resulting mean statistic is *389.809*. This is a similar value to the mean statistic calculated using SPSS programmes (refer to Appendix 3-a).

The variance statistic can be analysed through Equation 5-2:

$$\boldsymbol{Variance} = \frac{\sum(\boldsymbol{x} - \bar{\boldsymbol{x}})^2}{\boldsymbol{n}}$$ *Equation 5-2*

Where, $(x - \bar{x})$ is the deviation of each weighted score in the data set from the mean statistic.

A manual calculation of variance statistics should have provided the same value. It was calculated using the SPSS programme at *1,124*.

The Standard Deviation $(SD)$ can therefore be calculated by the square-root of the variance, shown through Equation 5-3 below.

$$\boldsymbol{SD} = \sqrt{\frac{\sum(\boldsymbol{x} - \bar{\boldsymbol{x}})^2}{(\boldsymbol{n} - \boldsymbol{1})}}$$ *Equation 5-3*

Resulting in:

$\boldsymbol{SD} = \sqrt{1{,}124} = 33.526$

Range statistics analysis provide the facility to range-order the distribution of the data set between the minimum and maximum values of weighted scores, and examine the relationship between every point value of all elements of central tendency statistics. The lowest point value of assessment basis for the availability of project overheads would be determined by subtracting the mean value with the standard deviation, as: $389.809 - 33.526 = 356.283$. The project overheads that are positioned at lower values than this point value of assessment basis would be eliminated, because they are considered to be unreliable overheads in construction project practice. There are eight items of project overheads that fall into this category: Paying Suppliers with the score of 322, Project Sundries (324), Hoarding Screens (329), Placing Orders (332), Receiving Materials (338), Material Deliveries (339), Managing Work Schedules (349), and Managing Contract Conditions (352) (refer to Figure 5-3).

These project overheads are disqualified, because they are not related to supporting activities during the construction stage. They may be more appropriate to supporting general office expenditure. For example: paying suppliers, hoarding screens and placing orders are normally included in the marketing department, while managing schedules and contract conditions cannot be categorised into site-project overheads, due to the fact that project management teams have more technical activities than administrative activities.

Having discussed the descriptive statistics analysis for determining the availability of project overheads, the following section presents findings on the survey questionnaire for fulfilling the second research objective; the analysis of Critical Success Factors (CSFs) for improving the management of construction project overheads.

## 5.3. Analysis of Critical Success Factors (CSFs) for Improving the Management of Project Overheads

### 5.3.1. Literature Review Findings of the CSFs

Critical Success Factors (CSFs) for the management of project overheads have not yet been closely studied (Jaya *et al.*, 2010c). Therefore, it is important to investigate the CSFs for the improvement of the Cost Management and Controlling Practices (CMCPs) of project overheads during the construction stage of construction projects. Forty important CSFs were identified from the literature review, based on the relevant issues and potential challenges to improve the CMCPs of project overheads in construction projects.

Initial grouping concepts are used to accommodate the forty CSFs in eight groups of similar challenges: MARCON, DEVFOC, INVTEC, LOCRES, INTBEN, PROCOM, ROPRAC, and METOOL (refer to Jaya *et al.*, 2011b; and Section 2.7.1 to Section 2.7.8). The concept of a grouping technique follows the availability of similar information and relationships inherent amongst relevant issues and potential challenges of CSFs.

### 5.3.2. Questionnaire Survey Findings of the CSFs

Forty identified CSFs were used to develop the questionnaire survey. The researcher facilitated face-to-face meeting with five experts in order to develop the questionnaire and to gain consensus among them. Project identifications, job position, and the experiences of experts are explained in Table 4-5 in chapter 4. Based on this consensus, the experts then provided their individual opinions by filling in the questionnaire. The questions are scored in five Likert scales and collect verbal values of the experts' opinions (refer to Appendix 2-a). The scores of the experts' opinions were weighted to every element of four evaluation-criteria, e.g. Project Type, Project Phase, Project Monitoring, Project Delivery.

As explained in Section 5.2.2, the survey questionnaire received one hundred and seven (107) responses from project professionals (refer to Table 5-1). Forty variable CSFs were grouped into their inherent relationship groups of CSFs in respect of evaluation-criteria of a construction project. Particular members of variable CSFs related to each of eight groups of CSFs are shown at the bottom part of Figure 5-4.

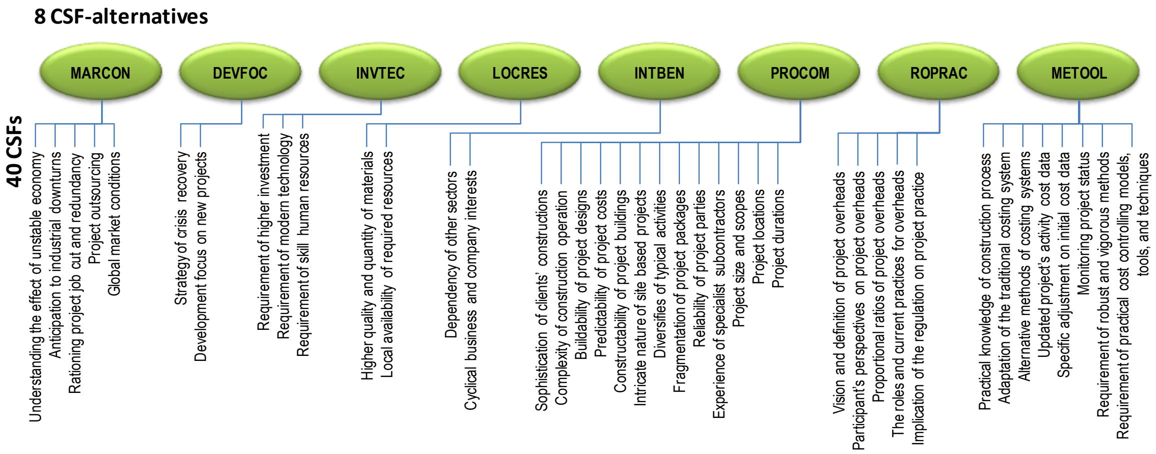


***Figure 5-4: The Particular Members of Eight Group CSFs***

The scores of the variable CSFs are averaged within their particular members, and then weighted across 107 response scores into their group of CSFs (refer to data table sets which are available in the researcher's data files). These averaged scores and weighting methods are implemented into the eight groups of CSFs in respect of four elements of evaluation-criteria of construction projects. The weighted average scores of eight groups of CSFs under four evaluation-criteria are provided on the top parts of Appendix 4-b to Appendix 4-e.

The weighted scores of the elements of the evaluation-criteria and weighted average scores of CSF-alternatives are deconstructed using the features of Microsoft Excel software. Therefore, the relative importance of four evaluation-criteria (refer to Section 5.3.3) and the ranking importance of eight CSF-alternatives (refer to Section 5.3.4) are analysed through Analytic Hierarchy Process (AHP) techniques as provided in Appendix 4-a; and Appendix 4-b to Appendix 4-e).

### 5.3.3. Determining Relative Importance of the Evaluation-criteria

The five experts provided their personal judgements using five Likert scales through scoring forty variable CSFs. Cumulative scores of every element of four Evaluation-criteria are use to develop pair-wise comparisons between them. A relative importance of each element of evaluation-criteria over another is analysed in respect of the Decision-goal as shown on the middle and top level of Figure 5-5.

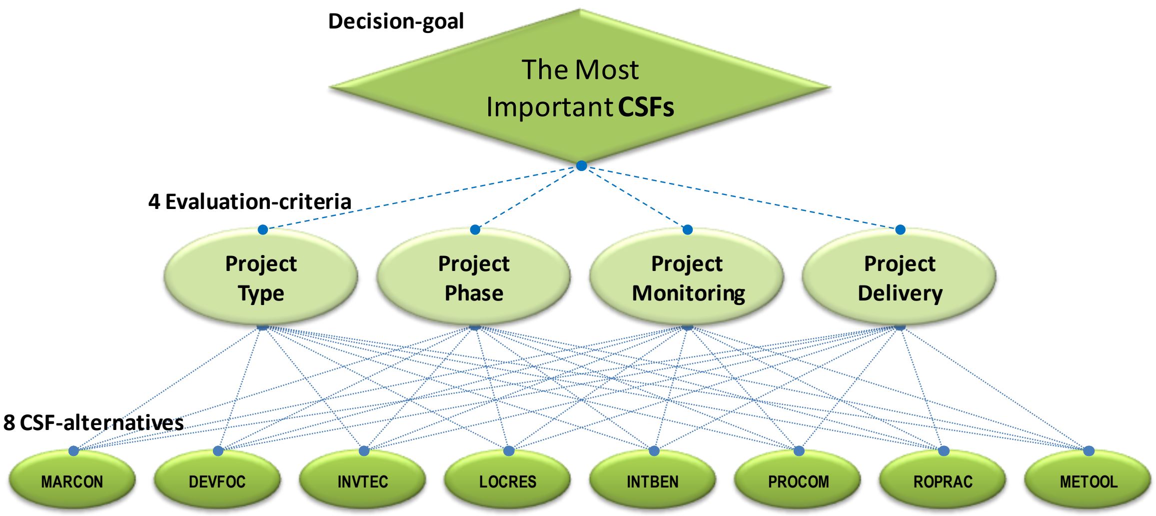


***Figure 5-5: Four Evaluation-criteria under the Decision Goal***

It can be expressed by examining pair-wise comparisons through creating the matrix algebra, and squaring the matrix with multiple iterations until the normalised eigenvector does not change too much compared to the preceding iteration. Prescribed measures are placed in four digit decimals of change values between consecutive iterated matrices (e.g., Haas and Meixner, 2005; and

Hamdeh, 2010). However, greater decimals would provide more precise calculations for better results.

#### 5.3.3.1. Pair-wise Comparisons of the Evaluation-criteria

The dimension of pair-wise comparisons is calculated by a given Equation 5-4. The eigenvalue method is calculated through Equation 5-5 and its' reciprocal values are used to form the matrix $(A)$ for comparing each element of Evaluation-criteria, e.g., Project Type, Project Phase, Project Monitoring, and Project Delivery (refer to Appendix 4-a). Following the matrix formula in Equation 5-6, it is deconstructed as the matrix algebra in Table 5-2.

Number of pair-wise Comparisons $(NoC)$:

$$\boldsymbol{NoC} = \frac{\boldsymbol{n} \times (\boldsymbol{n}-\boldsymbol{1})}{\boldsymbol{2}}$$ *Equation 5-4*

Eigenvalue Method:

$$(\boldsymbol{A} - \boldsymbol{\lambda max\ n}) \times \boldsymbol{W} = \boldsymbol{0}$$ *Equation 5-5*

Matrix Algebra:

$$\boldsymbol{A} = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{wn} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{wn} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{wn}{w_1} & \frac{wn}{w_2} & \cdots & \frac{wn}{wn} \end{pmatrix}$$ *Equation 5-6*

Where,

$NoC$ Number of pair-wise comparisons of matrix $(A)$

| | |
|---|---|
| $n$ | Dimension of matrix $(A)$ |
| $A$ | Pair-wise comparison matrix $(A)$ |
| $\lambda max$ | Principal eigenvalue of matrix $(A)$ |
| $W$ | Relative weights (eigenvectors) of matrix $(A)$ |
| $w_1, w_2, \ldots$, and $wn$ | The weights of element 1, 2, ....., and $n$ |

The $NoC$ and eigenvalue are calculated using Equation 5-4 and Equation 5-5 to deconstruct the matrix algebra $(A)$ through Equation 5-6 as examined in the calculation examples below:

$$NoC = \frac{n \times (n-1)}{2} = \frac{4 \times (4-1)}{2} = 6$$

And,

$$\frac{w_1}{w_2} = \frac{725}{778} = 0.931877$$

Where,

| | |
|---|---|
| $NoC = 6$ | The 6 sets of pair-wise comparisons are located on the top-right side of diagonal matrix $(A)$ and its reciprocals placed on the bottom-left side. |
| $w_1 = 725$ | The weight of element number 1 (Project Type) |
| $w_2 = 778$ | The weight of element number 2 (Project Phase) |
| $0.931877$ | The eigenvalue of Project Type relative to Project Phase, included in the matrix algebra |

The eigenvalues (e.g., 0.931877, 0.834292, 1.186579, etc.) and their reciprocals (e.g., 1.073103, 1.198621, 0.842759, etc.) of each element relative to other elements are represented in Table 5-2.

***Table 5-2: Matrix Algebra of the Evaluation-criteria***

| Criteria | Types | Phases | Monitors | Deliveries |
|---|---|---|---|---|
| **Types** | **1** | 0.931877 | 0.834292 | 1.186579 |
| **Phases** | 1.073103 | **1** | 0.895282 | 1.273322 |
| **Monitors** | 1.198621 | 1.116967 | **1** | 1.422259 |
| **Deliveries** | 0.842759 | 0.785347 | 0.703107 | **1** |
| **Column Sum** | **4.114483** | **3.834190** | **3.432681** | **4.882160** |

### 5.3.3.2. Eigenvector Solution of the Evaluation-criteria

The process of the AHP technique must be iterated properly in order to achieve the best result on the eigenvector solution. The following matrices in Table 5-3 and Table 5-4 have been squared, and normalised eigenvectors are calculated by dividing each row sum by the total column sum.

***Table 5-3: Iteration of Squared Matrices of the Evaluation-criteria***

| Criteria | Types | Phases | Monitors | Deliveries | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|
| Types | **4** | 3.727506 | 3.337169 | 4.746318 | 15.810993 | 0.243044 |
| Phases | 4.292414 | **4** | 3.581128 | 5.093290 | 16.966831 | 0.260811 |
| Monitors | 4.794483 | 4.467866 | **4** | 5.689034 | 18.951383 | 0.291317 |
| Deliveries | 3.371034 | 3.141388 | 2.812428 | **4** | 13.324851 | 0.204827 |
| **Column Sum** | **16.457931** | **15.336761** | **13.730725** | **19.528642** | **65.054059** | **1** |

The normalised eigenvector summation for all elements of Evaluation-criteria (Project Type, Project Phase, Project Monitoring, and Project Delivery) should always be an absolute value of *'one'*, in the other words, it can be assumed that

*100 per cent* of this absolute value belongs to four elements of evaluation-criteria. However, specific values of each element of evaluation-criteria are shown in Table 5-3 and Table 5-4.

***Table 5-4: Last Iteration of Squared Matrices of the Evaluation-criteria***

| Criteria | Types | Phases | Monitors | Deliveries | Row Sum | Eigenvector | Changes | Ranking Importance of Criteria |
|---|---|---|---|---|---|---|---|---|
| Types | **64** | 59.640103 | 53.394707 | 75.941080 | 252.975890 | 0.243044 | 0.00 | The ***3rd*** important criterion |
| Phases | 68.678621 | **64** | 57.298044 | 81.492635 | 271.469299 | 0.260811 | 0.00 | The ***2nd*** important criterion |
| Monitors | 76.711724 | 71.485861 | **64** | 91.024550 | 303.222135 | 0.291317 | 0.00 | The ***1st*** important criterion |
| Deliveries | 53.936552 | 50.262211 | 44.998849 | **64** | 213.197612 | 0.204827 | 0.00 | The ***4th*** important criterion |
| **Column Sum** | **263.326897** | **245.388175** | **219.691600** | **312.458265** | **1,040.864936** | **1** | 0.00 | |

There is no difference between each normalised eigenvector values in the previous iteration matrix and the last iteration matrix as shown in Table 5-3 and Table 5-4. This means that the last iteration matrix has provided the best result for the eigenvector solution.

The *best eigenvector solution* in Table 5-4 represents the relative importance of elements of the evaluation-criteria and they are ranked as:

- Project status monitoring (29.13 per cent) is the most important of the Evaluation-criteria.
- Project construction phase (26.08 per cent) is the second most important.
- Project commercial building type (24.30 per cent) is the third most important.
- Project delivery method (20.48 per cent) is the fourth or least important.

Project status monitoring gives a relative influence of 29.13 per cent. It is a greater value than the assumption that an average weight of four elements of evaluation-criteria is $\frac{100\%}{4} = 25\ per\ cent$. Project construction phase represents a relative influence of 26.08 per cent, is also greater than 25 per cent. These two elements of evaluation-criteria provide the most of their influences to the eight CSF-alternatives. Project commercial building type with a relative influence of 24.30 per cent and project delivery methods with 20.48 per cent provide less effectiveness than the average weight. However, all four elements of evaluation-criteria and the eight CSF-alternatives would be considered to have important interdependency in order to determine the highest priority of importance of CSFs.

#### 5.3.3.3. Consistency of the Evaluation-criteria

The level of inconsistency must be checked to ensure that the result on the relative importance of evaluation-criteria is derived from acceptable consistent matrices. If the result is considered to be robust enough and makes sense, it should be obtained from consistent or near consistent matrices (Ishizaka and Labib, 2009). The principal eigenvalue is necessary for examining the level of inconsistency of the matrix (Saaty, 2008). Therefore, Saaty (1977) has calculated the Consistency Index $(CI)$ and Consistency Ratio $(CR)$ using given Equation 5-7 and Equation 5-8 below:

$$\boldsymbol{CI} = \frac{\boldsymbol{\lambda max - n}}{\boldsymbol{n-1}}$$ *Equation 5-7*

And,

$$\boldsymbol{CR} = \frac{\boldsymbol{CI}}{\boldsymbol{RI}}$$ *Equation 5-8*

Where,

| | |
|---|---|
| $CR < 10\%$ | Consistency Ratio less than 10 per cent indicates an acceptable inconsistency of the matrices, or inacceptable if the consistency ratio is greater than 10 per cent |
| $RI$ | Random Index is an average consistency index of randomly generated reciprocal matrices |

The average random index was the randomly generated reciprocals through analysing the sample size of 500 matrices (Ishizaka and Labib, 2009). The random inconsistency index is provided in Table 5-5.

***Table 5-5: Random Inconsistency Index***

| ***n*** | 1 | 2 | 3 | **4** | 5 | 6 | 7 | **8** | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***RI*** | 0.00 | 0.00 | 0.58 | **0.90** | 1.12 | 1.24 | 1.32 | **1.41** | 1.45 | 1.49 | 1.49 |

***Source: Adopted from Saaty (1977).***

The consistency ratio has been calculated following the procedures of Equation 5-7 and Equation 5-8, with given that $n = 4\,units$, and $RI = 0.90$, resulting in $CR{\sim}0.00 < 10\,per\ cent$ (refer to Appendix 4-a). This indicates that the matrices are near perfectly consistent, therefore the outcomes are considered valid.

### 5.3.4. Determining Relative Importance of the CSF-alternatives

Following a similar AHP procedure to that of Section 5.3.3, the relative importance of the CSF-alternatives is analysed in respect of the four elements of the evaluation-criteria: Project Type, Project Phase, Project Monitoring, and Project Delivery. For the calculation example, the relative importance of CSF-alternatives under the Project Type (the first element of the evaluation-criteria) can be expressed by examining pair-wise comparisons through matrix algebra in Table 5-6. Then, the matrix algebra is squared, and deconstructed in different sequent matrices, in order to iterate these squared matrices as provided in Table 5-7 and Table 5-8.

***Table 5-6: Matrix Algebra of CSF-alternatives under the Project Type***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.213592 | 1.30813953 | 1.322751 | 1.470588 | 1.12069 | 1.227094 | 0.953895 | 9.61675 |
| **DEVFOC** | 0.824 | 1 | 1.07790698 | 1.089947 | 1.211765 | 0.923448 | 1.011126 | 0.78601 | 7.924202 |
| **INVTEC** | 0.764444 | 0.927724 | 1 | 1.01117 | 1.124183 | 0.856705 | 0.938045 | 0.7292 | 7.351471 |
| **LOCRES** | 0.756 | 0.917476 | 0.98895349 | 1 | 1.111765 | 0.847241 | 0.927683 | 0.721145 | 7.270263 |
| **INTBEN** | 0.68 | 0.825243 | 0.88953488 | 0.899471 | 1 | 0.762069 | 0.834424 | 0.648649 | 6.53939 |
| **PROCOM** | 0.892308 | 1.082898 | 1.16726297 | 1.180301 | 1.312217 | 1 | 1.094946 | 0.851168 | 8.5811 |
| **ROPRAC** | 0.814933 | 0.988997 | 1.06604651 | 1.077954 | 1.198431 | 0.913287 | 1 | 0.777361 | 7.83701 |
| **METOOL** | 1.048333 | 1.272249 | 1.37136628 | 1.386684 | 1.541667 | 1.174856 | 1.286404 | 1 | 10.08156 |
| Column Sum | 6.780019 | 8.228178 | 8.86921064 | 8.968279 | 9.970616 | 7.598297 | 8.319722 | 6.467427 | 65.20175 |

Eigenvectors can be normalised by iterating the squared matrices. Normalised eigenvectors may be obtained from the matrices that are calculated in Table 5-7 and Table 5-8. These matrices are measured in six digit decimals.

***Table 5-7: Iteration of Squared Matrices of CSF-alternatives under the Project Type***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 8 | 9.708738 | 10.4651163 | 10.58201 | 11.76471 | 8.965517 | 9.816754 | 7.631161 | 76.934 | 0.14797563 |
| **DEVFOC** | 5.768 | 8 | 8.62325581 | 8.719577 | 9.694118 | 7.387586 | 8.089005 | 6.288076 | 62.56962 | 0.120347 |
| **INVTEC** | 6.115556 | 7.421791 | 8 | 8.089359 | 8.993464 | 6.85364 | 6.508201 | 5.833598 | 57.81561 | 0.111203 |
| **LOCRES** | 6.048 | 7.339806 | 7.91162791 | 8 | 8.894118 | 6.777931 | 7.421466 | 5.769157 | 58.16211 | 0.11186958 |
| **INTBEN** | 5.44 | 6.601942 | 7.11627907 | 7.195767 | 8 | 6.096552 | 6.675393 | 5.189189 | 52.31512 | 0.10062343 |
| **PROCOM** | 7.138462 | 8.663181 | 9.33810376 | 10.49996 | 10.49774 | 8 | 7.76858 | 6.809343 | 68.71537 | 0.13216782 |
| **ROPRAC** | 6.519467 | 7.911974 | 8.52837209 | 8.623633 | 9.587451 | 7.306299 | 8 | 6.268455 | 62.74565 | 0.12068561 |
| **METOOL** | 8.386667 | 10.17799 | 10.9709302 | 11.09347 | 12.33333 | 9.398851 | 10.29123 | 8 | 80.65248 | 0.15512778 |
| Column Sum | 53.41615 | 65.82543 | 70.9536852 | 72.80378 | 79.76493 | 60.78638 | 64.57063 | 51.78898 | 519.91 | 1 |

The normalised eigenvector results in Table 5-6 and Table 5-7 have shown insignificant changes. The last two consecutive normalised eigenvectors have achieved the changes almost close to zero. The highest change is represented by PROCOM (=0.0005297). Therefore, an attempt to iterate one more squared matrix would not have changed the ranking of normalised eigenvectors. These eigenvectors can be called *the best eigenvector solution* (refer to Table 5-8).

***Table 5-8: Last Iteration of Squared Matrices of CSF-Alternatives under Project Type***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Ror Sum | Eigenvector | Changes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 504 | 621.3592 | 669.767442 | 686.7302 | 752.9412 | 573.7931 | 608.9626 | 488.8809 | 4906.43 | 0.1481122 | -0.0001366 |
| **DEVFOC** | 408.704 | 504 | 543.265116 | 557.1461 | 610.7294 | 465.4179 | 493.6962 | 396.5498 | 3979.51 | 0.1201308 | 0.0002163 |
| **INVTEC** | 378.7856 | 467.113 | 503.5044 | 516.3765 | 566.031 | 431.3547 | 457.5488 | 367.4779 | 3688.19 | 0.1113367 | -0.0001336 |
| **LOCRES** | 381.024 | 469.7476 | 506.344186 | 519.168 | 569.2235 | 433.7876 | 460.3757 | 369.5939 | 3709.26 | 0.1119728 | -0.0001032 |
| **INTBEN** | 342.72 | 422.5243 | 455.44186 | 466.9765 | 512 | 390.1793 | 414.0946 | 332.439 | 3336.38 | 0.1007163 | -0.0000929 |
| **PROCOM** | 449.6584 | 554.3652 | 597.554099 | 612.6891 | 671.7602 | 511.9276 | 526.6293 | 436.1214 | 4360.71 | 0.1316381 | 0.0005297 |
| **ROPRAC** | 411.1421 | 506.8708 | 546.359623 | 560.1892 | 614.2082 | 468.069 | 496.774 | 398.8019 | 4002.41 | 0.1208222 | -0.0001366 |
| **METOOL** | 528.36 | 651.3916 | 702.139535 | 719.9221 | 789.3333 | 601.5264 | 638.3958 | 512.5101 | 5143.58 | 0.1552709 | -0.0001432 |
| Column Sum | 3404 | 4197.372 | 4524.37622 | 4639.198 | 5086.227 | 3876.056 | 4096.477 | 3302.375 | 33126.47 | 1 | 0.0000000 |

The consistency ratio for pair-wise comparison matrices of CSF-alternatives under Project Type has been checked following procedures as presented in Equations 5-7 and 5-8, given total factors of CSF-alternatives $n = 8\, units$, with the random inconsistency index $RI = 1.41$ (refer to Table 5-5). The result shows that $CR = 0.019 < 10\, per\ cent$ (refer to Appendix 4-b). This indicates that the matrices examined are nearly consistent.

The relative importance of CSF-alternatives under the other three evaluation-criteria (Project Phase, Project Monitoring, and Project Delivery) have been analysed through the same procedures as applied for CSF-alternatives under the Project Type as before (refer to Appendix 4-c; Appendix 4-d; and Appendix 4-e).

Similar procedures are implemented to check the consistency ratios of CSF-alternatives under the other three evaluation-criteria (Project Phase, Project Monitoring, and Project Delivery). The results and consistency ratio for each of their pair-wise comparison matrices are provided in Table 5-9.

***Table 5-9: Summary of Eigenvectors and Consistency Ratio (CR)***

| ALTERNATIVE | Type | Phase | Monitoring | Delivery |
|---|---|---|---|---|
| | RANKING | | | |
| MARCON | 0.148112189 | 0.147208722 | 0.145532894 | 0.149111634 |
| DEVFOC | 0.120130759 | 0.120809419 | 0.121197368 | 0.120710711 |
| INVTEC | 0.111336686 | 0.109605596 | 0.11438665 | 0.108990986 |
| LOCRES | 0.111972815 | 0.111920442 | 0.112676949 | 0.108440793 |
| INTBEN | 0.100716288 | 0.103449812 | 0.107288051 | 0.099792141 |
| PROCOM | 0.131638076 | 0.130399126 | 0.129120952 | 0.129147904 |
| ROPRAC | 0.120822242 | 0.121657447 | 0.120214404 | 0.121421841 |
| METOOL | 0.155270945 | 0.154949436 | 0.149582732 | 0.162383989 |
| Column Sum | 1 | 1 | 1 | 1 |
| **CR < 10%** | **0.0185** | **0.0210** | **0.0139** | **0.0221** |

The best eigenvector solution of evaluation-criteria resulted in Table 5-4 and all of the best eigenvector solutions of CSF-alternatives derived from Table 5-9, are restructured to develop an AHP solution tree. This is discussed in the next section.

## 5.3.5. The Solution through the AHP Tree

Relative weights of importance of the best eigenvector solutions are attached in each related element of evaluation-criteria and each related factor of CSF-alternatives as illustrated in Figure 5-6. It would appear in the AHP solution tree that every factor of CSF-alternatives is related to the relative importance of each individual element of evaluation-criteria (refer to Figure 5-6 and Appendix 4-f). Therefore, in order to select the highest priority of importance among the eight

CSF-alternatives, their individual weights should be deconstructed to the AHP solution matrices in Table 5-10.

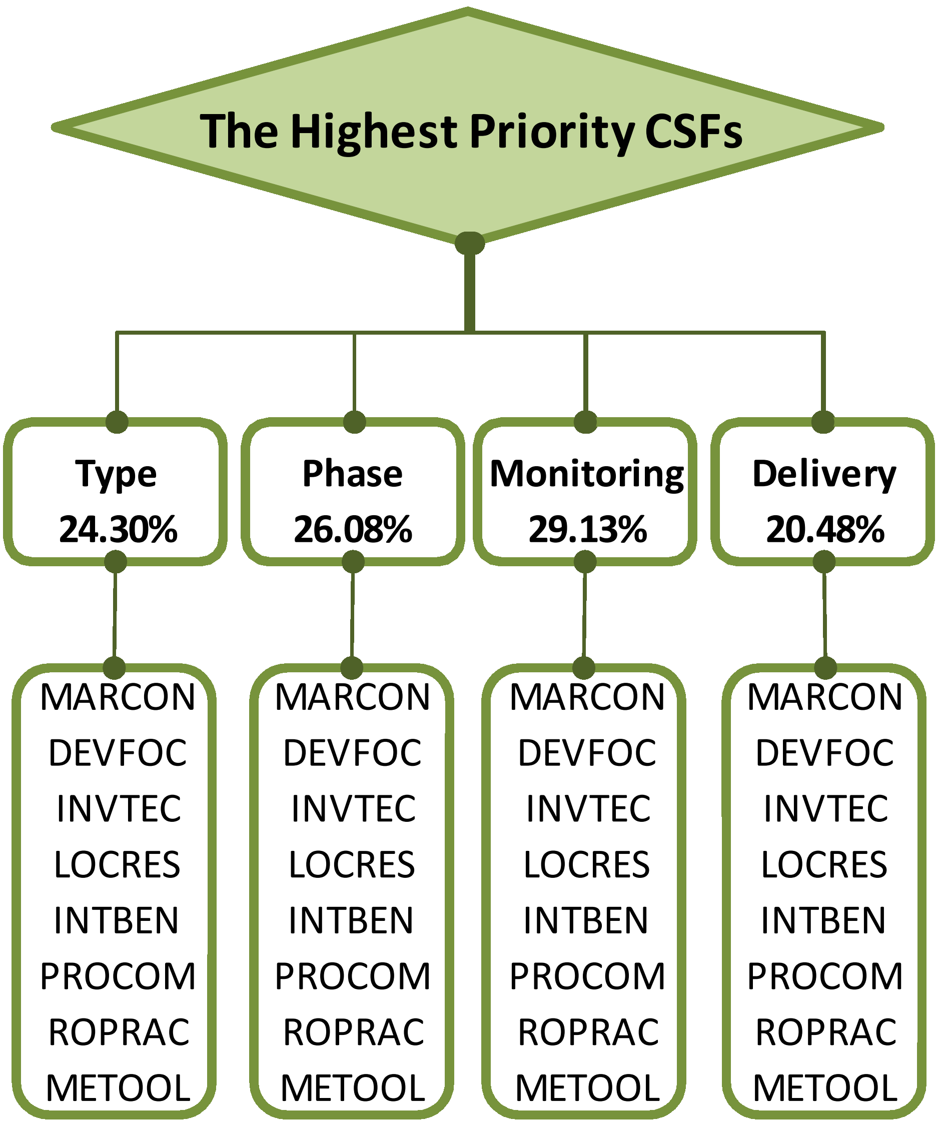


***Figure 5-6: AHP Solution Tree for CSF-alternatives under Evaluation-criteria***

There are two adjacent matrices structured in Table 5-10. Diagonal matrices on the left-side are relative weights of importance of CSF-alternatives and column matrices on the right-side are relative weights of importance of evaluation-criteria. The diagonal matrices would be multiplied by the column matrices.

***Table 5-10: AHP Solution Matrices of CSF-Alternatives under Evaluation-criteria***

| ALTERNATIVE | Type | Phase | Monitoring | Delivery |
|---|---|---|---|---|
| | RANKING | | | |
| MARCON | 0.148112189 | 0.147208722 | 0.145532894 | 0.149111634 |
| DEVFOC | 0.120130759 | 0.120809419 | 0.121197368 | 0.120710711 |
| INVTEC | 0.111336686 | 0.109605596 | 0.11438665 | 0.108990986 |
| LOCRES | 0.111972815 | 0.111920442 | 0.112676949 | 0.108440793 |
| INTBEN | 0.100716288 | 0.103449812 | 0.107288051 | 0.099792141 |
| PROCOM | 0.131638076 | 0.130399126 | 0.129120952 | 0.129147904 |
| ROPRAC | 0.120822242 | 0.121657447 | 0.120214404 | 0.121421841 |
| METOOL | 0.155270945 | 0.154949436 | 0.149582732 | 0.162383989 |
| Column Sum | 1 | 1 | 1 | 1 |

X

| RANKING | CRITERIA |
|---|---|
| 0.243043916 | Type |
| 0.260811264 | Phase |
| 0.291317466 | Monitoring |
| 0.204827355 | Delivery |
| 100% | |

Every row of the left-side matrices are multiplied by related column matrices on the right-side. The results of these multiplication matrices would provide the ranking importance of CSF-alternatives in vertical matrices as shown in Table 5-11.

***Table 5-11: The Ranking Importance of CSF-alternatives***

| | | |
|---|---|---|
| MARCON | 0.147329875 | 2nd |
| DEVFOC | 0.120737273 | 5th |
| INVTEC | 0.111293243 | 7th |
| LOCRES | 0.111440827 | 6th |
| INTBEN | 0.103154401 | 8th |
| PROCOM | 0.130071606 | 3rd |
| ROPRAC | 0.120985813 | 4th |
| METOOL | 0.154986962 | 1st |
| **CSFs** | **1** | **Ranking** |

The ranking importance of CSF-alternatives in Table 5-11 is descended in Table 5-12 to show the order and identify the highest priority of their importance.

***Table 5-12: The Priority of Importance of CSF-Alternatives***

| CSFs | 1 | Order | Differences |
|---|---|---|---|
| METOOL | 0.154986962 | 1st | |
| MARCON | 0.147329875 | 2nd | 0.007657087 |
| PROCOM | 0.130071606 | 3rd | 0.017258268 |
| ROPRAC | 0.120985813 | 4th | 0.009085793 |
| DEVFOC | 0.120737273 | 5th | 0.000248540 |
| LOCRES | 0.111440827 | 6th | 0.009296446 |
| INVTEC | 0.111293243 | 7th | 0.000147584 |
| INTBEN | 0.103154401 | 8th | 0.008138842 |

The highest priority of importance of CSF-alternatives selected should be greater than the assumption of its' average weights. The average weight of the eight CSF-alternatives is calculated through the total percentage weight divided by the number of alternatives, as $\frac{100\%}{8}$ = 12.50 per cent. Therefore, based on this assumption, the best three priorities of importance (of CSF-alternatives) are identified as having greater weights than 12.50 per cent, and they are: METOOL=15.50 per cent, MARCON=14.73 per cent, and PROCOM=13.01 per cent (refer to Table 5-12).

## 5.4. Analysis of the Activity-Based Cost Controlling (ABCC) Model for Improving the Management of Project Overheads

This section discusses the research findings and analysis techniques and summaries of the ABCC model to improve the cost management and controlling practices – the CMCPs of project overheads during the construction stage. The *'two-stage'* processes of the ABC system are implemented for analysing actual project costs through the case studies. Project cost measurement and analysis of the ABCC model would refer to data analysis procedures as provided in Figure 4-12.

### 5.4.1. Literature Review Findings on the Development of the ABCC Model

Industrial engineers initiated the concept of traditional accounting artefacts in England in the middle part of the 18th century. Three centuries ago, Josiah Wedgwood developed accounting system, in the year 1754, to minimise the risk of bankruptcy during the time of recession (Giroux, 1999). However, a fundamental development in the cost accounting system began at the end of the 20th century when the Consortium for Advanced Management – International (CAM-I) established a contemporary concept of the Activity-Based Costing (ABC) system for manufacturing productions (e.g., Cooper and Kaplan, 1988; Kaplan and Cooper, 1998; Hicks, 1992 and 1999; Kaplan and Anderson, 2007; and Drury, 2008). There are *'two-stages'* of the cost accounting process of the ABC system: in the first stage, costs are assigned to cost pools; and in the second stage, cost pools are assigned to cost objects (Kaplan and Cooper, 1998). Other authors explain the two-stages of the ABC system in different ways yet for a similar purpose (refer to Section 2.9.1.1).

The concept and definition of the ABC system (e.g., Cooper and Kaplan, 1988; and Turney, 1994a) provides relevant features to adapt this system in construction projects, such as reliable cost accounting, hierarchical cost pools, diverse cost drivers, multiple cost objects, and transparent cost tracers (Jaya *et al.*, 2010a). The underpinning philosophy of the ABC system (e.g., Hicks, 1992 and 1999) highlights important aspects for the management and control of project overheads, such as the transparent cost cause-and-effect relationships between overheads costs, construction activities, and jobs, projects or services (Jaya *et al.*, 2010b), in order to develop the Activity-Based Cost Controlling (ABCC) model for improving the Cost Management and Controlling Practices (CMCPs) of project overheads (refer to Jaya *et al.*, 2010b and 2010c).

## 5.4.2. Case Study Findings for Implementation of the ABCC Model

Construction building projects were selected in Indonesia and met the criteria as described in Section 4.7.7. Five qualified construction projects are empirically studied and directly observed to collect data. These commercial building projects represent both public and private buildings, such as a public hospital and car park, private villa, hotel, and integrated resorts. The detail of the projects is explained in Section 4.7.8, and specifically illustrated in Table 4-3 and Figure 4-9 (in Chapter 4).

The integrated resort project is the most complex structural and architectural activity among these five projects. It integrates five buildings of multiple-storey apartments and one arcade building, and includes other surrounding facilities, utilities, and services such as beach view restaurants, a medical centre, lagoon and swimming pools, beach club, children's club, spa, gym, cultural show, art gallery, fashion boutiques, and so on (refer to Section 4.7.8 and Figure 4-8). Due to the scale of the resort project, it has been used to explain and illustrate the development of ABCC model.

Secondary data, direct observations, and project documents have been collected through data documentations that include: project identifications, construction plans, schedules, cost accounts, progress reports, drawings, photo documents, and so on (e.g., cost data is provided in Table 4-3; substructure activities are illustrated on Figure 4-9; the actual schedule of substructure activities is represented in Table 5-12; and the actual overhead cost data is summarised in Appendix 5-a).

## 5.4.3. Cost Analysis and Procedures of the ABCC Model

A procedure of cost analysis is unable to be generally set out in a recipe fashion for every style and design of construction projects (Ostwald, 2001). However, cost analysis may deal with two important aspects of cost management during the construction stage, such as *cost planning* and *cost controlling*. Construction costs are planned to enable project managers to look forward before expenditure on the costs for related activities. Cost controls enable project managers to look back retrospectively over the construction expenditures for estimating the costs of completion forecasts.

Construction cost plans may stem from item costs of the awarded contract price. Cost control is required for updating the status of cost performances in order to forecast cost *savings* or *deficits* at construction completion.

The ABCC model would perform of cost analysis during the construction stage. In order to develop tools and techniques of the CMCPs, the ABCC model follows *'two-stage'* cost accounting procedures of the ABC system: the first stage, allocating overhead cost accounts to cost pools (steps 1 and 2); and the second stage, assigning overhead cost pools to cost objects (steps 3, 4, and 5); in order to discover cost driver rates of project overheads related to substructure activities of construction projects (step 6). The two-stages of the ABC system are applied for the cost analysis process of the ABCC model which includes six steps:

1. Identifying project overheads and their cost accounts.
2. Categorising overhead cost pools related to particular activities.
3. Idealising quantity drivers of project overheads.
4. Calculating ideal cost drivers of project overheads.
5. Assigning project overheads to cost objects.
6. Determining activity driver rates of project overheads per activity duration.

### 5.4.3.1. Identification of Project Overheads and their Cost Accounts

Project overheads are separated into two types, they are general-office overheads and site-project overheads. General-office overheads are allocated to maintain the company's survival, while site-project overheads are allocated to sustain whole activities of particular construction projects. Cost data is collected through case study documentation and direct observations on substructure activities of the multiple-storey apartments of commercial building projects. Substructure activity schedules and durations are collected from progress reports.

Project overheads are initially added on as a percentage of building costs to support construction activities. Actual cost expenditures are regularly recorded and conventionally reported as represented in Table 5-13 and Appendix 5-a.

***Table 5-13: Actual Cost Data of Project Overheads***

Data of Project Overheads for Basement / Substructure

| Description | Actual Quantity | UOM | Actual Costs | |
|---|---|---|---|---|
| 1st | 2nd | 3rd | 4th | |
| Upah Pekerjaan Galian dg alat *(Excavator+Opr)* | 1875.12 | m3 | 46,878,000.00 | |
| Upah Pekerjaan Pasang Bowplank *(Measurements)* | 260 | m | 780,000.00 | |
| Upah Pekerjaan Urugan Pasir dipadatkan *(Compactor+Opr)* | 389.07 | m3 | 3,501,630.00 | |
| Upah Pekerjaan Urugan tanah dipadatkan *(Compactor+Opr)* | 384.71 | m3 | 4,231,810.00 | |
| Sub. Pekerjaan Anti rayap tanah *(Anti termit soil treatment)* | 4220.33 | m2 | 35,872,805.00 | |
| Sub. Pekerjaan Pondasi Tiang Pancang *(drilling PC pile)* | 3714 | m | 1,140,158,584.68 | |
| Sub. Pekerjaan *Waterproofing* integral sistem cementaid | 765 | m2 | 221,616,675.00 | |
| *Site manager* | | | 24,300,000.00 | |
| Tunjangan jabatan SM | 5 | bln | 7,390,000.00 | |
| Tunjangan transport SM | 5 | bln | 1,050,000.00 | |
| Uang makan SM | 150 | hr | 1,800,000.00 | |
| Uang lembur SM | 160 | jam | 560,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji SM | 5 | bln | 13,000,000.00 | |
| Pelaksana sipil 1 Orang *(Civil Engineer)* | | | 10,530,000.00 | |
| Tunjangan jabatan pelaksana sipil | 5 | bln | 3,500,000.00 | |
| Uang makan pelaksana sipil | 150 | hr | 1,800,000.00 | |
| Uang lembur pelaksana | 160 | jam | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji pelaksana sipil | 5 | bln | 4,250,000.00 | |
| *Drawing* | | | 12,170,000.00 | |
| Tunjangan jabatan drawing | 5 | bln | 5,420,000.00 | |
| Uang makan drawing | 150 | hr | 1,800,000.00 | |
| Uang lembur drawing | 150 | jam | 450,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji drawing | 5 | bln | 4,000,000.00 | |
| *QS* | | | 15,150,000.00 | |
| Tunjangan jabatan QS | 5 | bln | 5,420,000.00 | |
| Tunjangan transport QS | 5 | hr | 1,050,000.00 | |
| Uang makan QS | 150 | jam | 1,200,000.00 | |
| Uang lembur QS | 160 | bln | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji QS | 5 | bln | 6,500,000.00 | |
| *Logistik* | | | 11,030,000.00 | |
| Tunjangan jabatan | 5 | bln | 4,000,000.00 | |
| Tunjangan transport Logistik | 5 | bln | 500,000.00 | |
| Uang makan | 150 | bln | 1,800,000.00 | |
| Uang lembur | 160 | jam | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji | 5 | bln | 3,750,000.00 | |
| Pemondokan staf *(Staff house rent)* | 5 | bln | 3,750,000.00 | |
| *(Office Supplies)* | | | | 25,995,500.00 |
| Banten sehari hari | 5 | bln | 450,000.00 | 14,378,000.00 |
| Banten mulai kerja | 1 | ls | 2,500,000.00 | |
| Komputer komplit | 2 | bh | 9,000,000.00 | |
| printer | 1 | bh | 1,500,000.00 | |
| Meja kantor | 2 | bh | 500,000.00 | |
| Kursi kantor | 2 | bh | 100,000.00 | |
| Kursi plastik | 8 | bh | 240,000.00 | |
| Kertas A3 | 1 | rim | 55,000.00 | |
| Keras A4 | 1 | rim | 33,000.00 | |
| Cetak foto *(Photo print)* | 100 | lbr | 150,000.00 | |
| Tinta printer | 2 | bln | 960,000.00 | 1,282,500.00 |
| Pelubang kertas | 1 | bh | 7,500.00 | |
| Bulpoin | 2 | ls | 100,000.00 | |
| Pensil | 2 | ls | 100,000.00 | |
| Spidol | 2 | ls | 40,000.00 | |
| Stabilo warna | 2 | ls | 70,000.00 | |
| Tip ex | 1 | ls | 5,000.00 | |
| Helm proyek *(Project helmet)* | 50 | bh | 750,000.00 | |
| Sepatu konsultan *(Safety shoes)* | 1 | psg | 300,000.00 | |
| sepatu staf *(Sfety shoes)* | 5 | psg | 1,500,000.00 | |
| Tabung pemadam kebakaran *(Fire safety kit)* | 1 | bh | 600,000.00 | |

Data of Project Overheads for Basement / Substructure *(continue)*

| Description | Actual Quantity | UOM | Actual Costs | |
|---|---|---|---|---|
| 1st | 2nd | 3rd | 4th | |
| P3k *(First aids)* | 1 | ls | 50,000.00 | |
| lakban | 10 | roll | 500,000.00 | 10,135,000.00 |
| pengaris | 1 | ls | 25,000.00 | |
| Fotocopy | 500 | lbr | 300,000.00 | |
| Maff teka besar | 10 | bh | 110,000.00 | |
| Air aqua | 25 | gln | 275,000.00 | |
| Kopi | 5 | bln | 400,000.00 | |
| Gula | 5 | bln | 250,000.00 | |
| Konsumsi tenaga lembur | 1500 | bks | 7,500,000.00 | |
| Konsumsi lembur staf | 60 | bln | 600,000.00 | |
| Pemanas air konsultan dan staf | 1 | bh | 175,000.00 | |
| Sewa kendaraan stand by *(Car rent)* | 30 | hr | 4,500,000.00 | |
| Sewa kendaraan antar jemput tenaga *(Car rent)* | 30 | hr | 600,000.00 | |
| Bensin stamper | 2 | bln | 200,000.00 | 200,000.00 |
| Fee konsultan *(Specialty consultant)* | 5 | ls | 15,000,000.00 | |
| *Telepon* | 5 | bln | 10,000,000.00 | |
| KANTOR DIREKSIKET *(Site office)* | | | 8,870,642.86 | |
| Plywood 6 mm | 20 | lbr | 1,200,000.00 | |
| AC | 1 | unit | 3,000,000.00 | |
| Paku 3 cm | 1 | kg | 16,000.00 | |
| Paku 5 cm | 2 | kg | 21,785.71 | |
| Paku 7 cm | 2 | kg | 21,428.57 | |
| Paku 10 cm | 2 | kg | 21,428.57 | |
| Upah pembuatan direksiket | 102 | m2 | 4,590,000.00 | |
| GUDANG BAHAN *(Storage)* | | | 6,144,900.00 | |
| Balok 6/12 albesia | 1.64 | m3 | 1,894,200.00 | |
| Usuk 4/6 albesia | 0.78 | m3 | 859,950.00 | |
| Plywood 6 mm | 15 | lbr | 900,000.00 | |
| Plywood 8 mm | 4 | lbr | 380,000.00 | |
| Asbes gelombang | 32 | lbr | 560,000.00 | |
| Paku asbes | 2 | kg | 36,000.00 | |
| Paku 3 cm | 5 | kg | 80,000.00 | |
| Paku 5 cm | 5 | kg | 54,464.29 | |
| Paku 7 cm | 10 | kg | 107,142.86 | |
| Paku 10 cm | 10 | kg | 107,142.86 | |
| Engsel pintu | 1 | set | 30,000.00 | |
| Gembok | 1 | set | 21,000.00 | |
| Grendel kunci pintu | 1 | set | 15,000.00 | |
| Upah pembuatan gudang bahan | 20 | m2 | 1,100,000.00 | |
| KAMAR MANDI *(Toilet)* | | | 462,500.00 | |
| Bak mandi | 1 | bh | 80,000.00 | |
| Kran air | 3 | bh | 45,000.00 | |
| Gayung plastik | 3 | bh | 90,000.00 | |
| Ub.buat kamar mandi | 4.5 | m2 | 247,500.00 | |
| Sewa tanah utk Direksiket *(Land rent)* | 1 | are | 10,500,000.00 | |
| Sewa tanah utk jalan proyek *(Land rent)* | 3 | are | 31,500,000.00 | |
| Sumbangan *(Donation)* | 1 | ls | 5,000,000.00 | |
| Listrik+air *(Power+water)* | 5 | bln | 7,500,000.00 | |
| Alat komonikasi ht *(Handy talky)* | 2 | bh | 1,500,000.00 | |
| Kipem tenaga *(ID cards)* | 325 | org | 16,250,000.00 | |
| Harian gudang dan pembantu *(Cleaner)* | 5 | bln | 4,500,000.00 | |
| *(Scafolding & formwork)* | | | 83,431,250.00 | |
| Scafolding | 3312.25 | m2 | 82,806,250.00 | |
| Scafolding | 25 | m2 | 625,000.00 | |
| *(Concrete Pump)* | | | 37,035,150.00 | |
| Sewa concrete pump per m3 | 20.4 | m3 | 377,400.00 | |
| Sewa concrete pump per m3 | 16.09 | m3 | 297,665.00 | |
| Sewa concrete pump per m3 | 4.9 | m3 | 90,650.00 | |
| Sewa concrete pump per m3 | 330.31 | m3 | 6,110,735.00 | |
| Sewa concrete pump per m3 | 64.78 | m3 | 1,198,430.00 | |
| Sewa concrete pump per m3 | 713.99 | m3 | 13,208,815.00 | |
| Sewa concrete pump per m3 | 715.22 | m3 | 13,231,570.00 | |
| Sewa concrete pump per m3 | 136.21 | m3 | 2,519,885.00 | |

The first column represents a list of project overheads available for substructure activities of construction building projects. The second column shows the actual quantities of project overheads, while the third column is their unit of measurement. Actual costs of project expenses are provided in the fourth column.

Actual expenses of project overheads related to actual progress of substructure activities are recorded and regularly reported during the construction stage. The bar-chart schedule of actual progress for substructure activities is provided in Table 5-14. This schedule shows overlapping bar-charts on completing all parallel activities within a definitive duration of 20 weeks from July to November 2010.

***Table 5-14: Actual Progress Schedules of Substructure Activities***

| IDN | ACTIVITIES | DURATION | Jul-10 | | | | Aug-10 | | | | Sep-10 | | | | Oct-10 | | | | Nov-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| A.1 | Preparation | 4 | | | | | | | | | | | | | | | | | | | | |
| A.2 | Precast Concrete Pile | 18 | | | | | | | | | | | | | | | | | | | | |
| A.3 | Excavation & Backfill | 18 | | | | | | | | | | | | | | | | | | | | |
| A.4 | Pile Cap | 9 | | | | | | | | | | | | | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 16 | | | | | | | | | | | | | | | | | | | | |
| | Sub total | 65 | | | | | | | | | | | | | | | | | | | | |

***Source: Project Case Study***

### 5.4.3.2. Categorisation of Project Overhead Cost Pools Related to Activities

Site-project overheads are divided into four categories that are attached in cost pools: unit-level, batch-level, project-sustaining, and facility-sustaining overheads. Unit-level overheads support a single activity with unit quantity and cost driver rates for the unit of activity outputs, while batch-level overheads support parallel activities with batch quantities and cost driver rates for the batches of activity outputs, regardless of the number of units. Project-sustaining overheads support several activities with package quantity and cost driver rates for the project package outputs, regardless of the unit and batches. Facility-sustaining overheads support whole activities with facilities employed and cost driver rates for the whole project outputs.

Project overhead items positioned on the top row of Table 5-15, and the substructure activities listed on the left-side column of the table. This would demonstrate the transparent cost cause-and-effect relationships between the specific items of project overheads and the particular components of substructure activities. Specific items of project overheads mean that a single overhead may be assigned to *only one* related particular activity on the basis of unit-level activities, or assigned to *more than one* related/ parallel/ overlapping activity through batch-level, project-sustaining, or facility-sustaining activities.

## *Table 5-15: Cost Measurement and Analysis of the ABCC Model*

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of tables).
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Duration (AD) / Optimum Duration (OD). | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | Site manager | Civil engineer | Drawing Review | QS |
| | | | m2 | m' | m2 | month | unit | pair | unit | m2 | m2 | m2 | m2 | unit | unit | m3 | m3 | m' | m2 | m3 | month | month | month | month |
| | | | 4220.33 | 260.00 | 765.00 | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 1,875.12 | 773.78 | 3714.00 | 3,337.25 | 2,001.90 | 5.00 | 5.00 | 5.00 | 5.00 |
| A | SUBSTRUCTURE | WEEK | 4 | 4 | 16 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 20 | 20 | 19 | 17 | 17 | 20 | 20 | 20 | 20 |
| A.1 | Preparation | 4 | 4220.33 | 260.00 | | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 375.02 | 154.76 | 58.64 | | | 1.00 | 1.00 | 1.00 | 1.00 |
| A.2 | Precast Concrete Pile | 18 | | | | | | | | | | | | | | | | 3,518.53 | | | 4.50 | 4.50 | 4.50 | 4.50 |
| A.3 | Excavation & Back Fill | 18 | | | | | | | | | | | | | | 1,687.61 | 696.40 | | | | 4.50 | 4.50 | 4.50 | 4.50 |
| A.4 | Pile Cap | 9 | | | | | | | | | | | | | | | | | 1,766.78 | 1,059.83 | 2.25 | 2.25 | 2.25 | 2.25 |
| A.5 | Tie Beam & Ground Slab | 16 | | | 765.00 | | | | | | | | | | | | | | 3,140.94 | 1,884.14 | 4.00 | 4.00 | 4.00 | 4.00 |
| | SubTotal | 65 | 4220.33 | 260.00 | 765.00 | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 2062.63 | 851.16 | 3577.17 | 4907.72 | 2943.97 | 16.25 | 16.25 | 16.25 | 16.25 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.2 | Precast Concrete Pile | 18 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.3 | Excavation & Back Fill | 18 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.4 | Pile Cap | 9 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.5 | Tie Beam & Ground Slab | 16 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| | SubTotal | | | | | | | | | | | | | | | | | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 35,872,805.00 | 780,000.00 | - | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 8,523,272.73 | 1,406,080.00 | 18,691,124.34 | - | - | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.2 | Precast Concrete Pile | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,121,467,460.34 | - | - | 6,729,230.77 | 2,916,000.00 | 3,370,153.85 | 4,195,384.62 |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | 38,354,727.27 | 6,327,360.00 | - | - | - | 6,729,230.77 | 2,916,000.00 | 3,370,153.85 | 4,195,384.62 |
| A.4 | Pile Cap | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 30,035,250.00 | 13,332,654.00 | 3,364,615.38 | 1,458,000.00 | 1,685,076.92 | 2,097,692.31 |
| A.5 | Tie Beam & Ground Slab | 16 | - | - | 221,616,675.00 | - | - | - | - | - | - | - | - | - | - | - | - | - | 53,396,000.00 | 23,702,496.00 | 5,981,538.46 | 2,592,000.00 | 2,995,692.31 | 3,729,230.77 |
| | SubTotal | 65 | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 8,968,201.25 | 195,000.00 | - | 937,500.00 | 187,500.00 | 450,000.00 | 150,000.00 | 2,217,660.71 | 1,536,225.00 | 115,625.00 | 10,500,000.00 | 375,000.00 | 4,062,500.00 | 2,130,818.18 | 351,520.00 | 4,672,781.08 | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.2 | Precast Concrete Pile | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 62,303,747.80 | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2,130,818.18 | 351,520.00 | - | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.4 | Pile Cap | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,337,250.00 | 1,481,406.00 | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.5 | Tie Beam & Ground Slab | 16 | - | - | 13,851,042.19 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,337,250.00 | 1,481,406.00 | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| | SubTotal | | | | | | | | | | | | | | | | | | | | | | | |

## *Table 5-15: Cost Measurement and Analysis of the ABCC Model (Continued)*

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side c
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

Table A: ***Quantity Drivers*** of Project Overheads related to Activities *(continue)*

| Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Duration (AD) / Optimum Duration (OD). | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
| month | month | | average | l-sum | sheet | unit-month | month | l-sum | month | month | |
| 5.00 | 5.00 | | 5.00 | 1.00 | 100.00 | 2.00 | 5.00 | 1.00 | 5.00 | 5.00 | |
| 20 | 20 | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |
| 1.00 | 1.00 | | 1.00 | 0.20 | 20.00 | 0.40 | 1.00 | 0.20 | 1.00 | 1.00 | |
| 4.50 | 4.50 | | 4.50 | 0.90 | 90.00 | 1.80 | 4.50 | 0.90 | 4.50 | 4.50 | |
| 4.50 | 4.50 | | 4.50 | 0.90 | 90.00 | 1.80 | 4.50 | 0.90 | 4.50 | 4.50 | |
| 2.25 | 2.25 | | 2.25 | 0.45 | 45.00 | 0.90 | 2.25 | 0.45 | 2.25 | 2.25 | |
| 4.00 | 4.00 | | 4.00 | 0.80 | 80.00 | 1.60 | 4.00 | 0.80 | 4.00 | 4.00 | |
| 16.25 | 16.25 | | 16.25 | 3.25 | 325.00 | 6.50 | 16.25 | 3.25 | 16.25 | 16.25 | |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities *(continue)*

| Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | |
| | | | | | | | | | | | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| | | | | | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(continue)*

| Assigning Overheads to Cost Objects (CO) = QD*CD | | | | | | | | | | | | Total Overheads Per Activity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | | |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | | |
| | | | | | | | | | | | | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 3,076.92 | 9,230.77 | 313,846.15 | 615,384.62 | 307,692.31 | 461,538.46 | 276,923.08 | | 156,415,201.85 |
| 3,054,461.54 | 4,153,846.15 | | 7,198,753.85 | 13,846.15 | 41,538.46 | 1,412,307.69 | 2,769,230.77 | 1,384,615.38 | 2,076,923.08 | 1,246,153.85 | | 1,162,029,906.49 |
| 3,054,461.54 | 4,153,846.15 | | 7,198,753.85 | 13,846.15 | 41,538.46 | 1,412,307.69 | 2,769,230.77 | 1,384,615.38 | 2,076,923.08 | 1,246,153.85 | | 85,244,533.43 |
| 1,527,230.77 | 2,076,923.08 | | 3,599,376.92 | 6,923.08 | 20,769.23 | 706,153.85 | 1,384,615.38 | 692,307.69 | 1,038,461.54 | 623,076.92 | | 63,649,127.08 |
| 2,715,076.92 | 3,692,307.69 | | 6,398,892.31 | 12,307.69 | 36,923.08 | 1,255,384.62 | 2,461,538.46 | 1,230,769.23 | 1,846,153.85 | 1,107,692.31 | | 334,770,678.69 |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | | 1,802,109,447.54 |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week*** *(continue)*

| Determining the Driver Rates (DR) = CO/AD | | | | | | | | | | | | Total Overheads Per Activity Per Week |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | | |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | | |
| | | | | | | | | | | | | |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | 39,103,800.46 |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | 64,557,217.03 |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | 4,735,807.41 |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | 7,072,125.23 |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | 20,923,167.42 |
| | | | | | | | | | | | | |

#### 5.4.3.3. Idealisation of Quantity Drivers of Project Overheads

*Quantity Drivers* $(QD)$ are the number of occurrences of overheads on their unit of measures that can make changes to cost objects. The cost object in this context is activities to which the project overheads are occurred and assigned for. In regard to actual progress schedules of substructure activities (refer to Table 5-14), *ideal Quantity Drivers* $(QD)$ of project overheads for supporting particular activities would be proportional to the *Actual Quantity* $(AQ)$ of project overheads to the ratio of a particular *Activity Duration* $(AD)$ over the *Optimum Duration* $(OD)$. Therefore, ideal quantity drivers can be calculated through following the Equation 5-9 below.

$$\boldsymbol{QD} = \boldsymbol{AQ} * \frac{\boldsymbol{AD}}{\boldsymbol{OD}} \qquad \textit{Equation 5-9}$$

Where:

$QD$ Ideal quantity drivers of project overheads related to particular activities

$AQ$ Actual quantity of project overheads

$AD$ Activity duration of a particular activity scheduled

$OD$ Optimum durations of related/ parallel/ overlapping activities scheduled

**Calculation Example of Ideal Quantity Drivers**

Table 5-13 shows the project overhead data; the actual quantity of soil excavated by machine (excavator) with the operator is $1{,}875.12$ cubic meters $(m^3)$. Ideal quantity drivers of the project overheads *(Excavator + Operator)* are related to two overlapping activities with each of their durations, such as *Preparation* with four week durations and *Excavation & Backfill* with eighteen weeks (refer to Table 5-15-A).

Excavator + Operator overheads occur on the Preparation activity that starts *two* weeks before they continue to support Excavation & Backfill activities for another *eighteen* weeks ahead until these activities finished at the end of week *twenty* (refer to actual progress schedules of substructure activities in Table 5-14). This means that in the actual project, Excavator + Operator overheads support both activities sequentially (Preparation and Excavation & Backfill activities) for twenty weeks on the basis of *batch-level*. This is called an optimum duration of related/ parallel/ overlapping activities with $\boldsymbol{OD}$ notation. Therefore, ideal quantity drivers of the Excavator + Operator overhead for supporting Preparation and Excavation & Backfill activities can be calculated by following Equation 5-9, as:

- The Excavator + Operator overheads related to Preparation activity, the ideal quantity driver is $QD = 1{,}875.12 * \frac{4}{20} = 375.02\ m^3$.
- The Excavator + Operator overheads related to Excavation & Backfill activities, the ideal quantity driver is $QD = 1{,}875.12 * \frac{18}{20} = 1{,}687.61\ m^3$.

Table 5-15-A revealed that the total of ideal quantity drivers of Excavator + Operator overheads related to both Preparation and Excavation & Backfill activities is $QD = 375.02m^3 + 1687.61m^3 = 2062.63\ m^3$.

### 5.4.3.4. Analysis of Ideal Cost Drivers of Project Overheads

*Cost Drivers* $(CD)$ are defined as the rate of every occurrence of overheads on their financial values per unit of measures that can make changes to the cost objects. Table 5-14 provides the actual progress schedules of substructure activities, and Table 5-15-B represents the project overheads that would support related activities on the basis of *ideal Cost Drivers* $(CD)$ which can be calculated by the ratio between *Actual overhead Costs* $(AC)$ and its *ideal Quantity Drivers* $(QD)$. Actual costs of project overheads are measured in Indonesian Rupiahs $(IDR)$. Therefore, the ideal cost driver can be calculated through the Equation 5-10 below.

$$\boldsymbol{CD} = \frac{\boldsymbol{AC}}{\boldsymbol{QD}} \qquad \textit{Equation 5-10}$$

Where:

$CD$ Ideal cost drivers of project overheads

$AC$ Actual cost of project overheads

**Calculation Example of Ideal Cost Drivers**

Table 5-13 represents cost data of substructure activities. Excavation + Operator costs have consumed $IDR\ 46{,}878{,}000.00$ of actual overhead costs to support both Preparation and Excavation & Backfill activities (refer to Table 5-15-B). Ideal quantity drivers of Excavator + Operator overheads for both Preparation and Excavation & Backfill activities have been calculated in calculation example of Section 5.4.3.3 before. Ideal cost drivers of this specific overhead can be calculated by dividing the actual cost of overheads with the ideal quantity drivers following the Equation 5-10. Table 5-15-A and B provide the calculation of ideal cost driver of Excavator + Operator overheads, as: $CD = \frac{IDR\ 46{,}878{,}000.00}{2062.63\ m^3} = IDR\ 22{,}727.27\ per\ m^3$ related to both activities mentioned before.

#### 5.4.3.5. Allocation of Project Overheads to Activity Cost Objects

Cost Objects $(CO)$ are defined as activities to which the cost of overheads assigned for in order to support those particular activities. Table 5-15-C provides project overheads which are responsible for supporting their related activities. Therefore, the activity cost objects have dependability for project overheads to accumulate costs as being calculated through substituting ideal quantity drivers of project overheads and its cost drivers accordingly into Equation 5-11 below.

$$\boldsymbol{CO} = \boldsymbol{QD} * \boldsymbol{CD} \qquad \textit{Equation 5-11}$$

Where:

$CO$ Activity cost object of project overheads

**Calculation Example of Activity Cost Objects**

It has been calculated the ideal quantity drivers and cost drivers of project overheads related to the batch-level activity as shown in Table 5-15-A and Table 5-15-B. This section provides an example of calculating Excavator + Operator overheads assigned to both activities (Preparation and Excavation & Backfill) using Equation 5-11, as:

- Preparation activity has incurred project overhead costs as $CO = 375.02\ m^3 * \frac{IDR\ 22{,}727.27}{m^3} = IDR\ 8{,}523{,}272.73$.
- Excavation & Backfill activities have incurred project overheads as $CO = 1{,}687.61\ m^3 * \frac{IDR\ 22{,}727.27}{m^3} = IDR\ 38{,}354{,}727.27$.

These two substructure activities have consumed total costs of $IDR\ 46{,}878{,}000.00$ on the basis of batch-level activity cost drivers (refer to Table 5-15-C). It would appear from these accounting procedures that the ABC system provides advantages in not just cost accounting, but in accounting for overhead costs which have specific cost hierarchies and behaviours compared to materials and labour costs. In the calculation examples above, Excavator + Operator overheads have been examined, they are clearly related to every particular activity (e.g., Preparation and Excavation & Backfill activities), accurately calculated using Microsoft Excel programmes, and transparently distributed on the basis of activity cost drivers. The following section analyses activity driver rates of project overheads.

#### 5.4.3.6. Determination of Activity Driver Rates of Project Overheads

Every activity must be responsible for overheads assigned to it, and more than this, it is expected that the project overheads have to be spent properly to support activities with the activity duration. Table 5-15-D shows the process of calculating the activity driver rates of project overheads attached on every activity. Therefore, Equation 5-12 is used to determine how much overheads are budgeted or scheduled to particular activities for satisfying their specific times of durations.

$$\boldsymbol{DR} = \frac{\boldsymbol{CO}}{\boldsymbol{AD*}} \qquad \textit{Equation 5-12}$$

Where:

$DR$ Activity driver rates of project overheads per activity duration.

$AD(*)$ Scheduled activity durations $[(*)$ could be varied according to a new creation on project schedule].

**Calculation Example of Activity Driver Rates**

Table 5-15-D provides a calculation example for determining activity driver rates of overheads per activity per week. As calculated in calculation example of Section 5.4.3.5 above, Preparation activity is responsible for $IDR\ 8{,}523{,}272.73$ of Excavator + Operator overheads, while, Excavation & Backfill activities are responsible for $IDR\ 38{,}354{,}727.27$. The duration of Preparation activity is scheduled for four weeks, and Excavation & Backfill activities are arranged in eighteen weeks. The durations of both activities are taken to be analysed in this calculation example. Their durations are similar to the actual activity progress schedules discussed before in Section 5.4.3.1 and shown in Table 5-14. The results of activity driver rates of Excavator + Operator overheads for supporting Preparation and Excavation & Backfill activities are represented below following Equation 5-12 (refer to Table 5-15-D):

- Preparation activity is budgeted for overhead cost driver rates $DR = \frac{IDR\ 8{,}523{,}272.73}{4\ weeks} = IDR\ 2{,}130{,}818.18\ per\ week$.
- Excavation & Backfill activities are budgeted for overhead cost driver rates $DR = \frac{IDR\ 38{,}354{,}727.27}{18\ weeks} = IDR\ 2{,}130{,}818.18\ per\ week$.

The same driver rate of $IDR\ 2{,}130{,}818.18\ per\ week$ is resulted for these two different activities (Preparation and Excavation & Backfill activities), indicating that Excavator + Operator overheads occur consistently in a constant rate per unit of duration to every activity. In other words, there would not be different rates incurred by the single set of overheads. In this case example, Excavator + Operator overheads provide the single rate per week to charge each of both activities (Preparation activity and Excavation & Backfill activities).

### 5.4.4. Summary of the Cost Analysis and Procedures of the ABCC Model

Table 5-13 represents case study data and illustrates the list of actual project overheads and their cost accounts which include actual quantities and unit of measurement. Table 5-15-A, B, C, and D provide cost analysis and procedures of the ABCC model. Table 5-13 enumerates project overheads related to substructure activities, and Table 5-15 demonstrate the procedures of cost analysis using the two-stage processes of the ABC system; firstly, project overheads accounted in cost pools (Table 5-15-A), and secondly, on the basis of diverse cost drivers (Table 5-15-B), the cost pools are then assigned to cost objects (Table 5-15-C). The cost objects are rescheduled per activity duration (in Table 5-15-D) in order to examine the tools and techniques of cost management and controlling practices of construction project overheads.

The activity driver rates calculated in Table 5-15-D represent specific details of project overhead costs which are responsible for supporting related particular activities per week. These activities include five components of substructure activities as a case study, they are: *(1) Preparation, (2) Precast Concrete Pile, (3) Excavation & Backfill, (4) Pile Cap, and (5) Tie Beam & Ground Slab*. The last column of Table 5-15-D (continued) revealed that every particular activity has been predicted to consume accumulated amounts of overhead costs per week, along their total activity durations. For instance, Preparation activity consumes

$IDR\ 39{,}103{,}800.46\ per\ week$; Precast Concrete Pile activity $IDR\ 64{,}557{,}217.03$; Excavation & Backfill $IDR\ 4{,}735{,}807.41$; Pile Cap $IDR\ 7{,}072{,}125.23$; and Tie Beam & Ground Slab $IDR\ 20{,}923{,}167.42$.

These cost rates per unit of activity duration are rescheduled (refer to Table 5-15-D) in order to examine the tools and techniques of Cost Management and Controlling Practices (CMCPs) of construction project overheads on substructure activities of construction building projects.

## 5.4.5. Cost Management and Controlling Practices (CMCPs) of Project Overheads

The cost management and controlling practices – the CMCPs of project overheads may follow analysis procedures as provided in Figure 4-13, and include three important aspects in construction activities, they are: *activity costing, activity scheduling*, and *activity monitoring*. Activity costing is a systematic process for aggregating costs that has followed the method of cost measurement and analysis procedures of the ABCC model described in Section 5.4.3. Activity scheduling is a process of approximating activity rates per unit of duration and determining a requirement of total time durations for completing particular activities (refer to Section 5.4.3.6). Activity monitoring focuses on managing and controlling a technical process and physical progress for updating the status of the project and cost performance regularly in respect of activity cost schedules.

### 5.4.5.1. Activity Cost Schedule

Cost schedules usually use bar charts to predict project expenditures. Bar chart schedules would express the specific details of overhead costs, and do not necessarily represent constant values of activity costs per unit of duration bar. However, in this case study, the bar chart schedules of substructure activities are attached with the sum values of several items of overhead costs in constant values of activity driver rates per week (refer to the last column of Table 5-15-D and the activity cost schedule in Table 5-16) to demonstrate how the CMCPs' tools and techniques could work on managing, controlling, and forecasting costs for estimating project *'savings* or *deficit'* at completion.

Table 5-16 shows project Overhead Cost Schedules (OCS) which is planned in five months (twenty weeks) for supporting substructure activities between July and November 2010. Total activity rates of OCS are $IDR\ 1{,}802{,}109{,}447.54$ arranged along twenty weeks for supporting all elements of substructure activities. Particular elements of substructure activities consume (for example): $IDR\ 39{,}103{,}800.46$ for supporting Preparation activity during the first week, $IDR\ 103{,}661{,}017.49$ for supporting two activities such as Preparation and Precast Concrete Pile activities in the second week, and a total of $IDR\ 108{,}369{,}824.90$ is scheduled to support three activities such as Preparation, Precast Concrete Pile, and Excavation & Backfill activities in the third week, and so on until the last (twentieth) week (refer to Table 5-16) below.

# *Table 5-16: Cost Management and Controlling Practices (CMCPs)*

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| IDN | ACTIVITIES | DURATION (week) | Assigned OHs (Per Activity) | Jul-10 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 |
| A | **SUBSTRUCTURE** | | | | | | | |
| A.1 | **Preparation** | **4** | 156,415,201.85 | **39,103,800.46** | **39,103,800.46** | **39,103,800.46** | **39,103,800.46** | |
| A.2 | **Precast Concrete Pile** | **18** | 1,162,029,906.49 | | **64,557,217.03** | **64,557,217.03** | **64,557,217.03** | **64,557,217.03** |
| A.3 | **Excavation & Back fill** | **18** | 85,244,533.43 | | | **4,735,807.41** | **4,735,807.41** | **4,735,807.41** |
| A.4 | **Pile Cap** | **9** | 63,649,127.08 | | | | **7,072,125.23** | |
| A.5 | **Tie Beam & Ground Slab** | **16** | 334,770,678.69 | | | | | **20,923,167.42** |
| | SubTotal | 65 | 1,802,109,447.54 | 39,103,800.46 | 103,661,017.49 | 108,396,824.90 | 115,468,950.13 | 90,216,191.86 |
| **Cost Schedule** | | | | | | | | |
| | Overhead Cost Scheduled ***(OCS)*** | | | 39,103,800.46 | 103,661,017.49 | 108,396,824.90 | 115,468,950.13 | 90,216,191.86 |
| | Cumulative ***OCS*** | | | 39,103,800.46 | 142,764,817.95 | 251,161,642.85 | 366,630,592.98 | 456,846,784.84 |
| | Remaining ***OCS*** for Completion | | | 1,827,032,156.16 | 1,723,371,138.67 | 1,614,974,313.77 | 1,499,505,363.64 | 1,409,289,171.78 |
| **Case Study** | | | | | | | | |
| | Activity Progress Values ***(APV)*** | | | **40,000,000.00** | **90,000,000.00** | **115,000,000.00** | **120,000,000.00** | **120,000,000.00** |
| | Cumulative ***APV*** | | | 40,000,000.00 | 130,000,000.00 | 245,000,000.00 | 365,000,000.00 | 485,000,000.00 |
| | Actual Project Expenses ***(APE)*** | | | **45,000,000.00** | **90,000,000.00** | **100,000,000.00** | **110,000,000.00** | **140,000,000.00** |
| | Cumulative ***APE*** | | | 45,000,000.00 | 135,000,000.00 | 235,000,000.00 | 345,000,000.00 | 485,000,000.00 |
| | Overhead Cost Changes ***(OCC) = APV-APE*** | | | - 5,000,000.00 | - | 15,000,000.00 | 10,000,000.00 | - 20,000,000.00 |
| | Cumulative ***OCC*** | | | - 5,000,000.00 | - 5,000,000.00 | 10,000,000.00 | 20,000,000.00 | - |
| **Cost Control** | | | | | | | | |
| | Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | 1.02 | 0.91 | 0.98 | 1.00 | 1.06 |
| | Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **0.89** | **0.96** | **1.04** | **1.06** | **1.00** |
| | **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS):*** | | | | | | | |
| | Estimate at Completion Forecast.1 ***(EAC ƒ₁)* = APE + Budgeted OCS at Completion - APV*** | | | 1,807,109,447.54 | 1,807,109,447.54 | 1,792,109,447.54 | 1,782,109,447.54 | 1,802,109,447.54 |
| | Estimate at Completion Forecast.2 ***(EAC ƒ₂)** = Budgeted OCS at Completion / VER*** | | | 2,027,373,128.48 | 1,871,421,349.37 | 1,728,553,959.89 | 1,703,363,724.39 | 1,802,109,447.54 |
| | Estimate at Completion Forecast.3 ***(EAC ƒ₃)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 1,982,958,081.42 | 2,041,922,137.14 | 1,766,116,188.79 | 1,709,432,048.66 | 1,725,654,054.42 |
| | *(Budgeted OCS at Completion - APV)* | | | 1,762,109,447.54 | 1,672,109,447.54 | 1,557,109,447.54 | 1,437,109,447.54 | 1,317,109,447.54 |
| | *(VER*VSR)* | | | 0.91 | 0.88 | 1.02 | 1.05 | 1.06 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **WCS₁** *(IDR)* | - 5,000,000.00 | - 5,000,000.00 | ***10,000,000.00*** | ***20,000,000.00*** | - ***0.00*** |
| | Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **WCS₂** *(IDR)* | - ***225,263,680.95*** | - 69,311,901.83 | 73,555,487.65 | 98,745,723.15 | - ***0.00*** |
| | Project ***'saving or deficit'*** at Completion (Scenario-3): | | **WCS₃** *(IDR)* | - 180,848,633.88 | - ***239,812,689.60*** | 35,993,258.75 | 92,677,398.88 | 76,455,393.11 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **WCS₁** *(%Budget)* | -0.28% | -0.28% | ***0.55%*** | ***1.11%*** | ***0.00%*** |
| | Project ***'saving or deficit'*** at Completion (Scenario-2): | | **WCS₂** *(%Budget)* | ***-12.50%*** | -3.85% | 4.08% | 5.48% | ***0.00%*** |
| | Project ***'saving ordefict'*** at Completion (Scenario-3): | | **WCS₃** *(%Budget)* | -10.04% | ***-13.31%*** | 2.00% | 5.14% | 4.24% |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EAC ƒ₁ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***EAC ƒ₂ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***EAC ƒ₃ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

## *Table 5-16: Cost Management and Controlling Practices – the CMCPs (continued)*

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads *(continue)*

| Aug-10 | | | Sep-10 | | | | Oct-10 | | | | Nov-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | |
| 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 |
| 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 |
| 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 |
| 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 32,731,100.06 |
| | | | | | | | | | | | | | | |
| 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 32,731,100.06 |
| 554,135,101.93 | 644,351,293.79 | 741,639,610.88 | 831,855,802.74 | 929,144,119.83 | 1,019,360,311.69 | 1,116,648,628.77 | 1,206,864,820.63 | 1,304,153,137.72 | 1,394,369,329.58 | 1,491,657,646.67 | 1,581,873,838.53 | 1,679,162,155.62 | 1,769,378,347.48 | 1,802,109,447.54 |
| 1,312,000,854.69 | 1,221,784,662.83 | 1,124,496,345.74 | 1,034,280,153.88 | 936,991,836.79 | 846,775,644.93 | 749,487,327.85 | 659,271,135.99 | 561,982,818.90 | 471,766,627.04 | 374,478,309.95 | 284,262,118.09 | 186,973,801.00 | 96,757,609.14 | 64,026,509.08 |
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| | | | | | | | | | | | | | | |
| **6th** | **7th** | **8th** | **9th** | **10th** | **11th** | **12th** | **13th** | **14th** | **15th** | **16th** | **17th** | **18th** | **19th** | **20th** |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **6th** | **7th** | **8th** | **9th** | **10th** | **11th** | **12th** | **13th** | **14th** | **15th** | **16th** | **17th** | **18th** | **19th** | **20th** |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EAC $f_1$ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***EAC $f_2$ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***EAC $f_3$ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

Subsequently, the cumulative OCS can be shown in the adjacent row as $IDR\ 39{,}103{,}800.46$ in the first week, $IDR\ 142{,}764{,}817.95$ in the second week, $IDR\ 251{,}161{,}642.85$ in the third week, and so forth. The remaining OCS for supporting all substructure activities at completion is provided just below the cumulative OCS row to give an idea of how much remaining costs are scheduled in related weeks.

More detailed figures for overhead cost schedules are given in Table 5-16 in order to demonstrate the CMCPs through the project case study example in the following section.

#### 5.4.5.2. Project Case Studies

Quantity surveyors and site managers, on behalf of the contractor, have a responsibility for recording, measuring, and reporting Activity Progress Values (APV), while on the other hand, Actual Project Expenses (APE) related to these activities have to be done and reported by cost control managers on a regular basis (e.g., daily, weekly, or monthly). The quantity surveyors, site managers, and cost control managers should take a position on the front line of project operations, with those responsible for these tasks. The selected case study illustrates an example that both APV and APE are recorded, measured, and reported on a weekly basis.

Table 5-16 provides the series of APV of substructure activities as the case studies recorded along five weeks, as: the first week, $APV_1 = IDR\ 40{,}000{,}000.00$; the second, $APV_2 = IDR\ 90{,}000{,}000.00$; the third, $APV_3 = IDR\ 115{,}000{,}000.00$; the fourth, $APV_4 = IDR\ 120{,}000{,}000.00$; and the fifth week, $APV_5 = IDR\ 120{,}000{,}000.00$. Subsequently, the cumulative APV is calculated in an adjacent row. The APE is also accounted along the similar weeks as APV, and it is accumulated every week, as: the first week, $APE_1 = IDR\ 45{,}000{,}000.00$; the second, $APE_2 = IDR\ 135{,}000{,}000.00$; the third, $APE_3 = IDR\ 235{,}000{,}000.00$;

the fourth, $APE_4 = IDR\ 345{,}000{,}000.00$; and the fifth week, $APE_5 = IDR\ 485{,}000{,}000.00$.

Project cost data of both APV and APE can be analysed to give a primary indication of the status of the project progress and cost performance of cost variations. In this case, it is termed as project Overhead Cost Changes (OCC) and analysed using Equation 5-13.

$$\boldsymbol{OCC = APV - APE} \quad \textit{Equation 5-13}$$

Where:

| | |
|---|---|
| $OCC$ | Overhead cost changes or project cost variations |
| $APV$ | Activity progress value |
| $APE$ | Actual project expenses |

**Calculation Example of Overhead Cost Changes**

The physical status of project overhead cost changes can be calculated and updated through Table 5-16 following Equation 5-13, as: Overhead cost changes are calculated in the first week, $OCC_1 = APV_1 - APE_1 = IDR\ 40{,}000{,}000.00 - IDR\ 45{,}000{,}000.00 = -IDR\ 5{,}000{,}000.00$; the second week, $OCC_2 = -IDR\ 5{,}000{,}000.00$; the third week, $OCC_3 = +IDR\ 10{,}000{,}000.00$; the fourth week, $OCC_4 = +IDR\ 20{,}000{,}000.00$; and the fifth week, $OCC_5 = IDR\ 0.00$.

**Justification for Calculation Result of Cost Changes**

A positive sign (**+**) indicates that the project is performing a cumulative saving during the particular weeks, whereas a negative mark (**-**) indicates the project is experiencing a cost overrun or deficit condition. IDR 0.00 indicates the project neither saving nor being in deficit.

If the variation of the overhead cost schedules and their cost changes in financial values usually accounted in less common dominations for informed decisions, then, it would be a better presentation in percentage values. However, project managers should be able to update the cost changes or variances in terms of both monetary and percentage values for analysing, managing, and controlling project overhead costs in order to take appropriate managerial action during the construction stage of construction projects (e.g., preventative, corrective, or immediate actions).

#### 5.4.5.3. Project Cost Control

Cost control arrangements should be maintained throughout activities of the construction project. The quantity surveyors and site managers should record, measure, and report APV regularly to the project manager in regard to cost schedules – OCS described before. While, cost control managers have responsibility for APE that includes the recording, measurement, and reporting, these are derived from the cost accounting department. These two tasks, i.e. APV and APE updates are the main concern of the project managers for the cost performance regarding an implementation of the tools and techniques of cost management and controlling practices – CMCPs of project overheads during the construction stage.

There are two cost performance ratios that can be measured to provide *the present status of cost performance*, they are: firstly, the cost performance ratio between APV and OCS represents the progress values of activities being accomplished by considering given cost schedules, while the second ratio between APV and APE considers present accounts of actual project expenses. These two ratios of present cost performances can be calculated through Equation 5-14 and Equation 5-15 below.

$$\boldsymbol{VSR} = \frac{\boldsymbol{APV}}{\boldsymbol{OCS}}$$ *Equation 5-14*

And,

$$\boldsymbol{VER} = \frac{\boldsymbol{APV}}{\boldsymbol{APE}} \qquad \textit{Equation 5-15}$$

Where:

$VSR$ Present ratios of activity progress values and (overhead) cost schedules

$VER$ Present ratios of activity progress values and actual project expenses

**Calculation Example for Present Status of Cost Performance Ratio**

Table 5-16 also provides calculations to consider two different conditions, such as the ratios of activity progress value – APV to both OCS and APE. These two different calculations are represented below:

1. Cost schedule performance ratios between APV and OCS along five weeks are calculated using Equation 5-14, as: in the first week, $VSR_1 = \frac{IDR\ 40{,}000{,}000.00}{IDR\ 39{,}103{,}800.46} = 1.02$; the second week, $VSR_2 = \frac{IDR\ 130{,}000{,}000.00}{IDR\ 142{,}764{,}817.95} = 0.91$; the third week, $VSR_3 = \frac{IDR\ 245{,}000{,}000.00}{IDR\ 251{,}161{,}642.85} = 0.98$; the fourth week, $VSR_4 = \frac{IDR\ 365{,}000{,}000.00}{IDR\ 366{,}630{,}592.98} = 1.00$; and the fifth week, $VSR_5 = \frac{IDR\ 485{,}000{,}000.00}{IDR\ 456{,}846{,}784.84} = 1.06$.

**Interpretation for the Calculation Result of Value and Schedule Ratio (VSR)**

*VSR>1.00*, means favourable activity progress which is accomplished at a faster rate than what was scheduled. *VSR<1.00*, means that an unfavourable activity progress which is accomplished at a slower rate than what was scheduled. *VSR=1.00*, means that unattractive activity progress which is accomplished at perfectly similar rate with what was scheduled.

2. Actual expenses performance ratios between APV and APE along five weeks are calculated using Equation 5-15, as: in the first week, $VER_1 =$

$\frac{IDR\ 40{,}000{,}000.00}{IDR\ 45{,}000{,}000.00} = 0.89$; the second week, $VER_2 = \frac{IDR\ 130{,}000{,}000.00}{IDR\ 135{,}000{,}000.00} = 0.96$; the third week, $VER_3 = \frac{IDR\ 245{,}000{,}000.00}{IDR\ 235{,}000{,}000.00} = 1.04$; the fourth week, $VER_4 = \frac{IDR\ 365{,}000{,}000.00}{IDR\ 345{,}000{,}000.00} = 1.06$; and the fifth week, $VER_5 = \frac{IDR\ 485{,}000{,}000.00}{IDR\ 485{,}000{,}000.00} = 1.00$.

**Interpretation for the Calculation Result of Value and Expenses Ratio (VER)**

*VER>1.00*, is a favourable activity progress where the activities are accomplished at greater earned values of activity progress than their actual expenses. *VER<1.00*, is an unfavourable activity progress, where the activities are accomplished at greater actual expenses than their earned values of activity progress. *VER=1.00,* is not attractive activity progress, where the activities are accomplished at perfectly similar values between earned values of activity progress and actual project expenses.

#### 5.4.5.4. Future Forecast of Cost Performance Index

Project Managers can use the present ratio information as cost performance indicators for a primary presentation of the *present status* of the projects. These performance indicators may be used for monitoring, coordinating, motivating, and preventative and corrective action as appropriate. However, in order to take higher, critical, and radical actions immediately, project managers should consider the effect of the present cost performance indicators for *future forecasts* at construction completion in respect of the budgeted cost schedules. Earned Value Management (EVM) concepts provide an estimation of cost performance indices at project completion (refer to PMI, 2008 and Kerzner, 2009).

The calculation of future forecasts for cost performance indices at activity completion may consider three conditions of present status of cost performances. The first is that, remaining activities would be accomplished with present budgets of cost schedules (OCS). Second, remaining activities would be accomplished at the same cost performance index as the present VER. And the third is that remaining activities would be accomplished by considering present conditions of both VSR and VER. The Estimate at Completion forecasts (EAC$f$) could therefore be calculated in three categories of cost performance indices as defined before. Equation 5-16; Equation 5-17; and Equation 5-18 are related to EAC$f$, as shown below.

$$\boldsymbol{EACf_1 = APE + Budgeted\ OCS\ at\ Completion - APV}$$ *Equation 5-16*

$$\boldsymbol{EACf_2 = \frac{Budgeted\ OCS\ at\ Completion}{VER}}$$ *Equation 5-17*

$$\boldsymbol{EACf_3 = APE + \frac{(Budgeted\ OCS\ at\ Completion - APV)}{VSR * VER}}$$ *Equation 5-18*

Where:

| | |
|---|---|
| $EACf_1$ | Estimate at completion *forecast*$_1$, if remaining activities can be completed at budgeted cost schedules (OCS) |
| $EACf_2$ | Estimate at completion *forecast*$_2$, if remaining activities can be completed at the same cost performance as present VER |
| $EACf_3$ | Estimate at completion *forecast*$_3$, if remaining activities can be completed by considering both present VSR and VER |
| $Budgeted\ OCS\ at\ Completion$ | Total budget rates at activity completion include cost changes (revision) if available. |

**Calculation Example for Future Forecast of Cost Performance Index**

The ratios of VSR and VER may have provided information of present status of cost performance indicators in respect of cost schedules and actual expenses for completed activities in the past. However, project managers should use future forecasts of cost estimates to manage and control remaining activities. This case study considers the present status of cost performances for forecasting future Estimate at Completion (EAC *forecast*) (PMI, 2008), through the Earned Value Measurement System (EVMS) (Kerzner, 2009) in order to determine the future status of project progress and cost performance.

Three EAC forecasts are formulated and examined in Table 5-16 following Equation 5-16 which considers present budget rates of OCS; Equation 5-17 considers the ratio of present actual expenses of VER; and Equation 5-18 considers both present cost schedule performance index of VSR and present expenses ratio of VER. The calculation example of the EAC forecasts is examined in a five series week and provided here:

- Estimate at Completion *forecast*$_1$ in the first week, $EACf_{11} = IDR\ 45{,}000{,}000.00 + IDR\ 1{,}802{,}109{,}447.54 - IDR\ 40{,}000{,}000.00 = IDR\ 1{,}807{,}109{,}447.54$; the second week, $EACf_{12} = IDR\ 1{,}807{,}109{,}447.54$; the third week, $EACf_{13} = IDR\ 1{,}792{,}109{,}447.54$; the fourth week, $EACf_{14} = IDR\ 1{,}782{,}109{,}447.54$; and the fifth week, $EACf_{15} = IDR\ 1{,}802{,}109{,}447.54$.

- Estimate at Completion *forecast*$_2$ in the first week, $EACf_{21} = \frac{IDR\ 1{,}827{,}032{,}156.16}{0.89} = IDR\ 2{,}027{,}373{,}128.48$; the second week, $EACf_{22} = IDR\ 1{,}871{,}421{,}349.37$; the third week, $EACf_{23} = IDR\ 1{,}728{,}553{,}959.89$; the fourth week, $EACf_{24} = IDR\ 1{,}703{,}363{,}724.39$; and the fifth week, $EACf_{25} = IDR\ 1{,}802{,}109{,}447.54$.

- Estimate at Completion *forecast*$_3$ in the first week, $EACf_{31} = \text{IDR } 45{,}000{,}000.00 + \frac{(\text{IDR } 1{,}802{,}109{,}447.54 - \text{IDR } 40{,}000{,}000.00)}{1.02 * 0.89} = \text{IDR } 1{,}982{,}958{,}081.42$; the second week, $EACf_{32} = \text{IDR } 2{,}041{,}922{,}137.14$; the third week, $EACf_{33} = \text{IDR } 1{,}766{,}116{,}188.79$; the fourth week, $EACf_{34} = \text{IDR } 1{,}709{,}432{,}048.66$; and the fifth week, $EACf_{35} = \text{IDR } 1{,}725{,}654{,}054.42$.

**Interpretation for Calculation Result of Estimate at Completion forecast-EAC$f$**

The EAC forecasts calculated above identify monetary value indices in three deferent results for the same object of measurement (in related weeks), and their monetary values stand alone without respect to the budgets (see Table 5-16). However, it does not give a cross cut of information or make full sense, and does not yet provide an effective management and a proper control measure for cost performances in order to realise project *'savings or deficit'*. This should be considered as *the most important remaining issue* which needs to be resolved. The ABCC model and the CMCPs' tools and techniques have been designed, developed, and implemented for this remaining issue through *the Worst Case Scenario* (WCS). It is investigated in the following section.

### 5.4.5.5. Worst Case Scenario (WCS) of the CMCPs' Tools and Techniques

Worst Case Scenario - WCS considers both the favourable and unfavourable project status that might happen in terms of the cost performance at future forecasts. The WCS involves cost performance at *the lowest cost saving or highest cost deficit*. The cost savings or deficit can be calculated by Equation 5-19, provided below.

$$\boldsymbol{WCS = Budgeted\ OCS\ at\ Completion - EACf} \qquad \textit{Equation 5-19}$$

Where:

$WCS$ The worst case scenario considers three cost performance indices, such as $EACf_1$; $EACf_2$; and $EACf_3$

**Calculation Example for the Worst Case Scenario (WCS)**

The bottom part of Table 5-16 provides a calculation example for implementing the WCS by following Equation 5-19, and the calculation example is represented below:

- The Worst Case Scenario-1 in the first week, $WCS_{11} = IDR\ 1{,}802{,}109{,}447.54 - IDR\ 1{,}807{,}109{,}447.54 = -IDR\ 5{,}000{,}000.00$; the second week, $WCS_{12} = -IDR\ 5{,}000{,}000.00$; the third week, $WCS_{13} = +IDR\ 10{,}000{,}000.00$; the fourth week, $WCS_{14} = +IDR\ 20{,}000{,}000.00$; and the fifth week, $WCS_{15} = -IDR\ 0.00$.

- The Worst Case Scenario-2 in the first week, $WCS_{11} = IDR\ 1{,}802{,}109{,}447.54 - IDR\ 2{,}027{,}373{,}128.48 = -IDR\ 225{,}263{,}680.95$ ; the second week, $WCS_{12} = -IDR\ 69{,}311{,}901.83$; the third week, $WCS_{13} = +IDR\ 73{,}555{,}487.65$; the fourth week, $WCS_{14} = +IDR\ 98{,}745{,}723.15$; and the fifth week, $WCS_{15} = -IDR\ 0.00$.

- The Worst Case Scenario-3 in the first week, $WCS_{11} = IDR\ 1{,}802{,}109{,}447.54 - IDR\ 1{,}982{,}958{,}081.42 = -IDR\ 180{,}848{,}633.88$; the second week, $WCS_{12} = -IDR\ 239{,}812{,}689.60$; the third week, $WCS_{13} = +IDR\ 35{,}993{,}258.75$; the fourth week, $WCS_{14} = +IDR\ 92{,}677{,}398.88$; and the fifth week, $WCS_{15} = IDR\ 76{,}455{,}393.11$.

**Interpretation for Calculation Result of the Worst Case Scenario (WCS)**

The positive (+) IDR indicates a cost saving, but it does not necessarily determine an absolute favourable project. The negative (-) IDR indicates a cost deficit, and it indicates that the project seems to be unfavourable in the future. The level of favourable or unfavourable cost performances in terms of financial values are provided in Table 5-17.

***Table 5-17: The Worst Case Scenario (WCS) in IDR for the Cost Performance Indices***

| Week | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| **$WCS_1$** *(IDR)* | - 5,000,000.00 | - 5,000,000.00 | ***+ 10,000,000.00*** | ***+ 20,000,000.00*** | ***- 0.00*** |
| **$WCS_2$** *(IDR)* | ***- 225,263,680.95*** | - 69,311,901.83 | + 73,555,487.65 | + 98,745,723.15 | ***- 0.00*** |
| **$WCS_3$** *(IDR)* | - 180,848,633.88 | ***- 239,812,689.60*** | + 35,993,258.75 | + 92,677,398.88 | + 76,455,393.11 |

The cost performance index in financial values (in Table 5-17) does not inform a level of significant reflection to the present budget rates clearly. Therefore, Table 5-18 presents more clear figures/ insights on percentage budgets to elucidate the degree of their important effects on project savings or deficits.

***Table 5-18: The Worst Case Scenario (WCS) in Percentage Budgets for the Cost Performance Indices***

| Week | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| **$WCS_1$** *(%Budget)* | -0.28% | -0.28% | ***+0.55%*** | ***+1.11%*** | ***-0.00%*** |
| **$WCS_2$** *(%Budget)* | ***-12.50%*** | -3.85% | +4.08% | +5.48% | ***-0.00%*** |
| **$WCS_3$** *(%Budget)* | -10.04% | ***-13.31%*** | +2.00% | +5.14% | +4.24% |

The principle of the WCS is the calculation result of cost performance indices which represents *'the lowest favourable saving or highest unfavourable deficit'* forecasted at completion in respect of budgeted costs. Figure 5-7 provides insight percentages of cost performance indices estimated at project completion based on the WCS as listed below:

- The first week represents the highest unfavourable deficit at $-12.50\ per\ cent$ of budgeted overhead cost schedules (percentage budgets of $WCS_2$).

- The second week represents an unfavourable deficit at $-13.31\ per\ cent$ of budgeted overhead cost schedule (percentage budgets of $WCS_3$).
- The third, fourth, and fifth weeks show favourable savings at $+0.55\ per\ cent$; $+1.11\ per\ cent$; and $0.00\ per\ cent$ of budgeted overheads respectively (percentage budgets of $WCS_1;\ WCS_1; and\ WCS_1 or_2$).

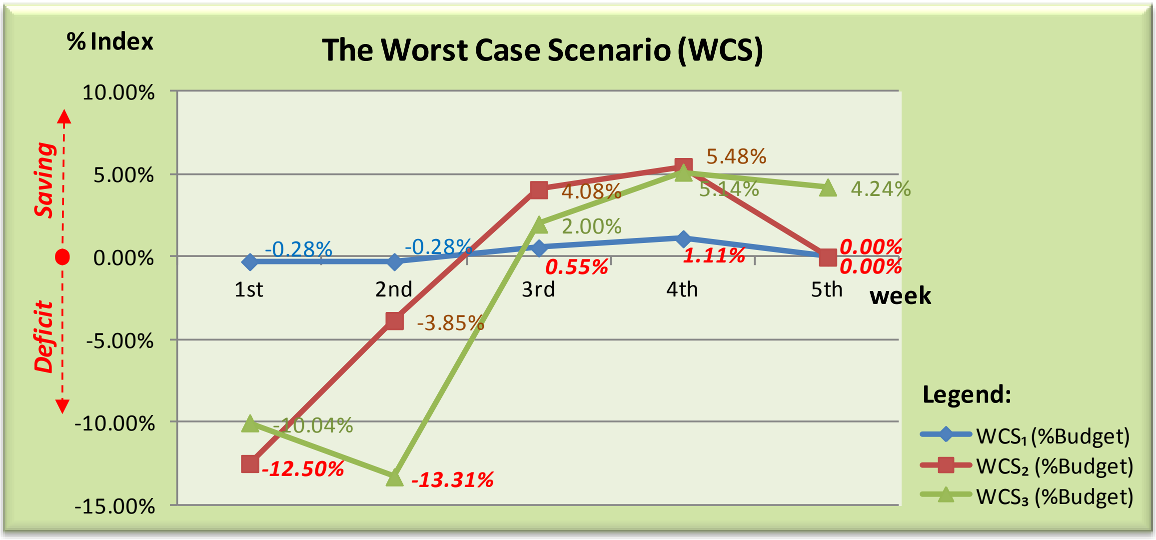


***Figure 5-7: The Worst Case Scenario (WCS) in Percentage Budgets for the Cost Performance Indices***

Therefore, the ABCC model and the CMCPs' tools and techniques have highlighted their importance and advantages for improving the management of project overheads during the construction stage. More detail explanation of the ABCC model and the CMCPs' tools and techniques are provided in the discussion section, Chapter 6.

The validations of project overheads, application of the ABC system and the development of the ABCC model, for improving the cost management and controlling practices – the CMCPs of construction project overheads are examined in the following section.

## 5.5. Validation of the ABCC Model through Content Analysis and Cognitive Mapping

The procedure of qualitative content analysis was started during the process of interview transcription until emerging concepts were identified in order to validate the advantages of development of the ABCC model. Transcription samples of expert interviews are provided in Appendix 6-a. It explains three components of interview results, such as: firstly, time and location of interviews; secondly, personal identifications of interviewee's data; and thirdly, three themes of interview questions. This interview involves eighteen semi-structured questions included in the three themes, they are: *(A) the management of project overheads, (B) the ABC system, and (C) the cost management and controlling practices – the CMCPs of project overheads* (refer to Figure 4-13).

The outcomes of content analysis of expert interviews from the senior management are provided in Appendix 6-b; and expert interview outcomes from the operational management position are presented in Appendix 6-c. These two appendices enumerate thirty-six (36) concepts which describe thematic analysis of interview data. Qualitative content analysis of the concepts is basically used to validate the advantages of development of the ABCC model. It still does not highlighted inherent relationships among the emerging concepts and converging themes; however, limitation on presentation of the content analysis would be counterbalanced by visual graphs of cognitive mapping as presented in Figure 5-8 and Figure 5-9 which are discussed in the following section.

## 5.5.1. Senior Management Perspectives of the Themes for Validation of the ABCC Model

The senior management experts discussed the advantages of the ABCC model based on their personal experiences. The senior management opinions and information are synthesised into eighteen emerging concepts that reflect the development process of the ABCC model. These emerging concepts are converged in three categories of themes (refer to Figure 4-13 and Figure 5-8), such as: the management of project overheads (Theme A1), the ABC system (Theme B1), and the CMCPs of project overheads (Theme C1).

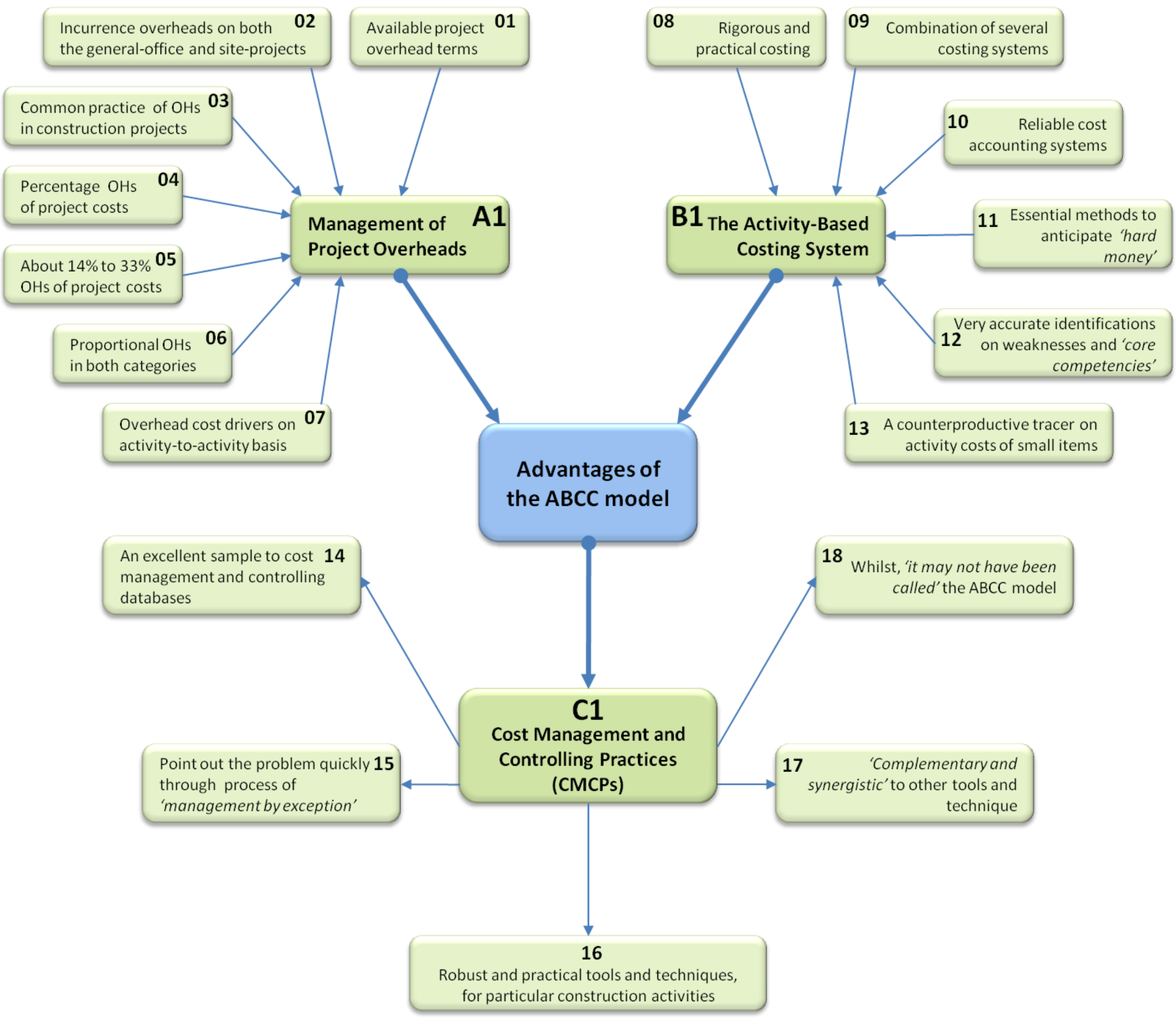


***Figure 5-8: Cognitive Map of Senior Management Perspectives for Advantages of the ABCC Model***

#### 5.5.1.1. Senior Management Perspectives on Management of Project Overheads for Development of the ABCC Model

Regarding the management of project overheads (refer to the Theme A1 in Figure 5-8), the senior management interviewees had knowledge of the principle differences between *direct* and *indirect costs* in construction projects. Direct costs are accounting costs that can be directly related and attached to project costs or construction activities which clearly identified by accounting standards and principles for auditing trials. Common terms in this type of activity costs are materials and labour costs (e.g., on substructure activities: steel reinforcement, fresh pouring concretes, precast reinforced-concrete piles, and so on, which include man hours of labourers). Whereas, indirect costs are overhead costs that cannot be readily compounded to project costs and directly attached to construction activities. Project overheads are not clearly or directly identified by accounting standards and principles for being real on auditing purposes (e.g., project overheads occur on soil excavating, backfilled soil compacting, poured fresh-concrete treating, managing work environment, supervising, etc.).

Project overheads are also *the common term* in construction projects (Concept 01) as mostly explained by the senior management. The occurrence of project overheads was considered on particular construction activities and chargeable to the specific project, for example, managing project Safety, Health, and Environment (SHE), and so on.

The senior management interviewees also emphasised the supporting services provided by general offices, such as accounting, sales and marketing, insurance, etc., which are not clearly attributed to any specific project. This indicates that there are existing overheads in both *the onsite project* and *general office expenditures* (Concept 02), and they are *a common practice in construction projects* (Concept 03). This research only considers the management of site-project overheads.

A typical company policy on construction projects is that, if the construction company wins the bid and is awarded a project contract, it normally shares overheads on *percentage accounts of project costs* (Concept 04), to support general-office spending and site-project expenses. When project overheads are allocated on a percentage basis to total construction costs, this provision provides an unclear definition of project overheads related to construction activities, consequently, the project overheads are inaccurately distributed to every particular construction activity onsite project.

About *14 per cent to 33 per cent of overheads* are added on project costs (Concept 05), and it still remains 'a negotiation problem' of *uncertain proportional overheads between general-office and site-projects* (Concept 06). Although these conditions can be internally compromised or authorised within both the construction company itself and particular project onsite, the remaining problem may provide substantial effects to the survival of the construction company and construction operation on site due to having inaccurate overhead estimations from the beginning.

However, the majority of senior management interviewees provide the same opinion concerning the opportunity of project overhead allocations on the basis of *activity cost drivers*, specifically on the *'activity by activity'* basis (Concept 07). Therefore, the ABC system can assign project overheads for more accurate and clearer costs of cause-and-effect relationships to every construction activity on the basis of diverse cost drivers (e.g., refer to Mansuy, 2000; Cockins, 2001; and Giammalvo, 2007), in order to propose the ABCC model for improving the management of project overheads during the construction stage of construction projects.

#### 5.5.1.2. Senior Management Perspectives on the ABC System for Development of the ABCC Model

The ABC system is mostly understood by the senior management and *some adapted and applied* in construction projects (refer to Concept 08, under theme B1, in Figure 5-8). In practice, the ABC system may be *combined with conventional costing systems* (Bill of Quantities - BoQ), RS-Means Cost Databases using CSI's Master-format for the construction specification of building contracts (refer to Mr. Gi1's script), and cost measurement tools (Earned Value Management – EVM) as they are synthesised in Concept 09.

The senior management interviewees did not explain which project stages or costing departments these systems are incorporated. However, the ABC system is expected to be *a reliable cost accounting system* (Concept 10), and it was considered for adoption and application of the ABC system in the construction building sector since the research of the UK's largest 1,000 cross sector companies reported in the last two decades (refer to Innes and Mitchell, 1995).

Furthermore, construction projects which are awarded by and constructed through a *'unit [cost] in place'* or a *'fixed price'* especially during the current world of *'hard money'*, the contemporary ABC system can anticipate these conditions through its' *essential cost accounting methods* (Concept 11). The ABC system (computer aided) can represent the detailed and very accurate cost information outputs quickly to *identify the weaknesses* of non value added activities and their *'core competences'* about the cost of particular activities (Concept 12). Project managers may use this information to have an 'early warning' and consideration for informed decision making in order to take appropriate action according to the cost performance at a specific point of the project.

Concept 13 also reminds project managers to be aware about *tracking a non-intensive cost of fasteners, small and unimportant activities* (e.g., ordering nails, sending mail, watering, etc.) which remain inefficient or become *'counterproductive'*. However, the ABC system has proved its competencies on applying costing features, such as *diverse cost drivers* (refer to Concept 07), *reliable cost accounts* (refer to Concept 08 and Concept 10), *transparent cost tracers* (refer to Concept 12), etc. The cost driver is defined as a triggering cost on the specific unit rate of measurements that can make changes to the cost objects. Reliable cost accounts mean that the ABC system provides very accurate accounting methods and facilities; while, transparent cost tracers enable tracking cost flows for better management and control costs in practice.

Therefore, the application of the ABC system in construction projects can maintain the development of the ABCC model for improving cost management and controlling practices – CMCPs of project overheads during the construction stage of construction projects.

#### 5.5.1.3. Senior Management Perspectives on Development of the ABCC Model to Improve the CMCPs of Project Overheads

Advantages of the ABCC model discovered in the cognitive map of senior management perspectives are the centre point of this expert interview analysis (refer to Figure 5-9). Implications of the expert opinions represented by emerging concepts are articulated through both the converging Themes A1 (the management of project overheads) and Theme B1 (the ABC system) to represent major advantages of the ABCC model. In this way, the ABCC model could express its advantages to improve the management of project overheads through the converging Theme C1 (the CMCPs of project overheads).

Senior management perspectives provide invaluable information about availability of project overheads on construction sites, such as overhead cost categories, its proportions to project costs, and their methods of calculating overheads. Their perspectives also illuminate the usefulness of the ABC system for assigning project overheads accurately to every particular activity of construction projects.

Even though all interviewees (from senior management) explained that they are quite familiar and feel comfortable using the ABC system for the main tasks of the cost accounting department, they are not indicating the use of the ABC system for *'internal'* cost management and controlling practices in construction projects, due to the accounting department being concerned mostly for producing regular reports to satisfy *'external'* standard requirements, such as investors, creditors, regulators, auditors, government agencies and taxation authorities. Therefore, the ABCC model is developed to improve the internal cost management and controlling practices - CMCPs of project overheads.

Cost measurement procedures which are generated by the ABCC model could contribute *excellent sample databases* (Concept 14). The ABCC model can calculate activity cost driver rates accurately on the basis of *ideal quantity drivers* and *ideal cost drivers* (refer to Section 5.4.3.3 and Section 5.4.3.4). The CMCPs' tools and techniques can point out the problem quickly (refer to Section 5.4.5.5) and resolve the problem by developing appropriate scenarios through *'management by exception'* (Concept 15) which was explained by one of the senior management interviewees:

> *'.........the real value comes in controlling the execution project, if, combined with Earned Value Management [EVM], [the] ABCC [model] can provide near real time status reporting to both on site and home office as to whether the project is in trouble or not, but more importantly, if it is in trouble, [the] ABCC [model] can quickly point out the problems which need management attention, Management by Exception'* (source: interview transcript).

The ABCC model provides a *robust and practical tool and technique for particular construction activities* (Concept 16). The combination between the ABCC model and EVM represents *'complementary and synergistic'* tools and techniques (Concept 17). Moreover, the other statement from senior management indicates that the ABCC model is *an original creation* developed in order to improve the management of project overheads through the implementation of the CMCPs' tools and techniques, as in the statement provided here:

> '*..............it may not have been called this name' [the ABCC model]* (Concept 18).

Therefore, the analysis of expert opinions from senior management perspectives can be considered as *the outcomes of validation process* for the application of the ABC system in construction projects to develop the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

Having discussed the advantages of the ABCC model development from senior management opinions, the following section elaborates the perspectives of operational management levels.

### 5.5.2. Operational Management Perspectives of the Themes for Validation of the ABCC Model

As well as the personal opinions provided by the senior management, Table 4-6 also represents the list of interviewees from operational management, which provided their perspectives on the application of the ABC system in construction projects to develop the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage. The operational management opinions are synthesised into emerging concepts which converged into the three themes, in terms of their implications on the advantages of the ABCC model development and these are represented in Figure 5-9. The three converged themes are elaborated in the following sections that include: Theme A2 - the management of project overheads; Theme B2 - the ABC system; and Theme C2 - the CMCPs of project overheads.

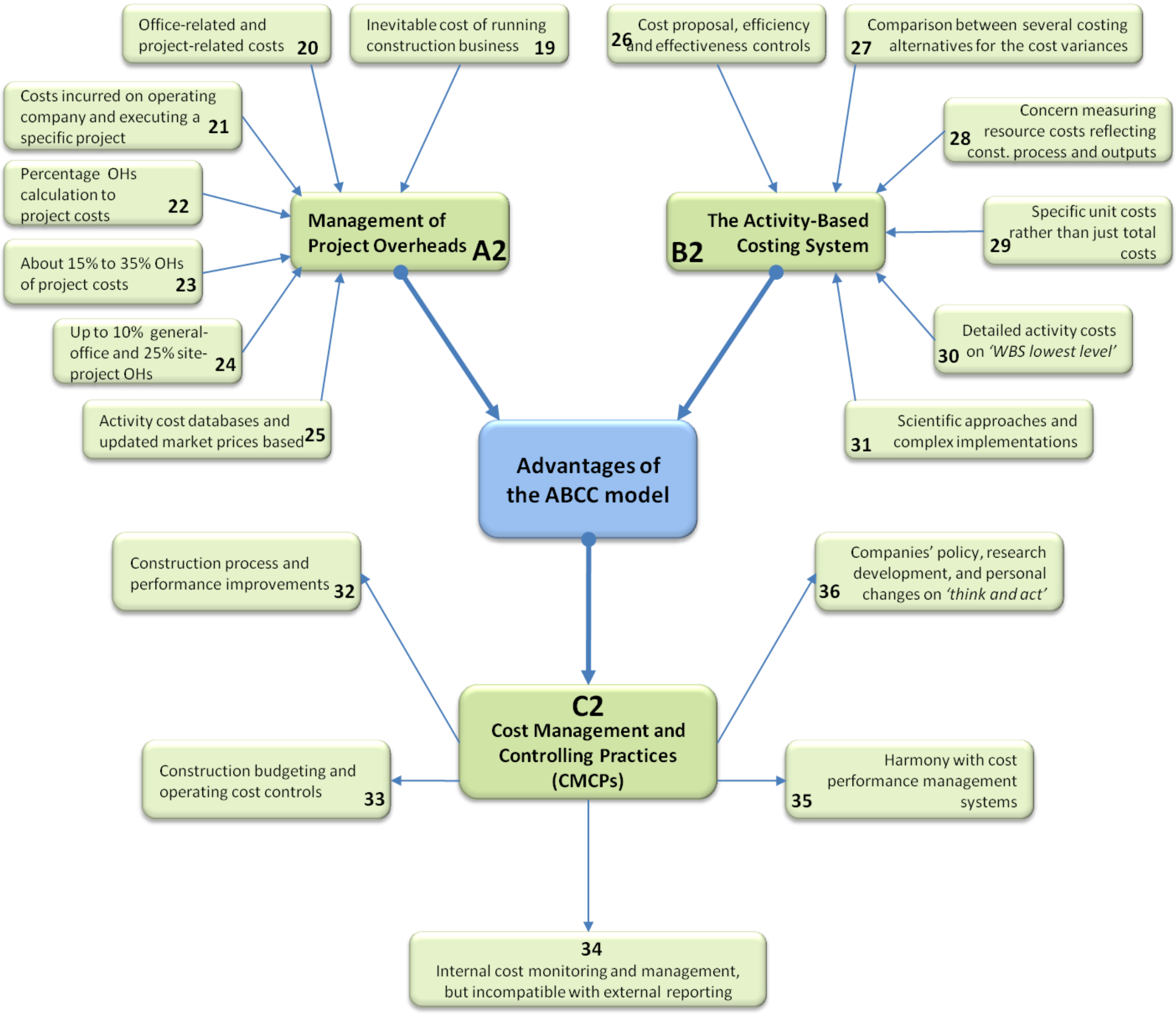


***Figure 5-9: Cognitive Map of Operational Management Perspectives for Advantages of the ABCC Model***

### 5.5.2.1. Operational Management Perspectives on Management of Project Overheads for Development of the ABCC Model

Similar to the senior management, the operational managers were well informed about the differentiation between direct costs (materials and labour costs) and indirect costs (project overheads) in construction projects prior to the interviews being conducted. They are quite familiar with these two cost behaviours in construction projects. Project's supporting costs are considered in terms of overheads which should be allocated and are unavoidable costs in construction projects for running the construction business (refer to Concept 19, under Theme A2, in Figure 5-9).

The operational managers explained the types of overheads as the *'office-related and site-related costs'* (Concept 20). Ordinary expenditures of general office and site project expenses are identified, such as office maintenance and supplies, secretarial helpers, hiring professional cost accounting and quality control personnel, management and supervision salaries, project managers' typical spending and travel costs for attending meetings, donations, insurances, bonds, financial interests, and so on. Technical support for site projects were also identified, such as rents, equipment, land, site office and storage, parking spaces, housing for workers, subcontractors, site-preparation, preliminaries, etc. This broad array of overhead costs is incurred in maintaining both *the survival of construction companies* and *execution of specific projects* (Concept 21).

Expert interviewees from operational management describe that overheads are *mostly allocated on a percentage basis to project costs* (Concept 22) for ordinary spending of the general office and to maintain site project expenses, which are often allocated based on the costing experience of similar projects in the past. At least *15 per cent of project costs* are allocated to maintain both the general office and site project overheads. It is slightly higher than overheads reported in the literature (e.g., Enshassi, *et al.*, 2008 revealed that overheads ranged between 8 per cent and 15 per cent). In some circumstances, overheads are *a negotiable charge up to 35 per cent* (Concept 23) depending on specific characteristics of the particular project which should be considered properly, such as underground soil, site location, project complexity, construction methods, market condition, capital/investment, technology usage, etc. Normally, proportional overheads are budgeted at *10 per cent of project costs for ordinary spending in the general office* and *25 per cent for site project expenses* (refer to Concept 24).

Allocating the proportional percentage overheads to project costs is considered to be a flawed approach and a common mistake in construction projects (Robert, 2012). The proportion of project overheads should be predetermined by calculating predicted expenditures of both the general office and site project before actual construction activities begin on the basis of the *company's activity cost data* which is supported by up-to-date information from *recent market prices* (Concept 25). It is important to calculate separately the general office and site project overheads based on each of their actual expenses. As referred to in Section 1.6, the research scope and limitations of this study are explained as being only focused on the availability of site project overheads (refer to Section 2.4.3; and Section 5.2). Next section discusses the process of validation on the development of the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads during the construction stage of construction projects.

#### 5.5.2.2. Operational Management Perspectives on the ABC System for Development of the ABCC Model

Theme B2 in Figure 5-9 represents that the ABC system reflects the important aspects in construction practice which include resource costs, construction activities, management and control. The cost is caused by activities and these activity costs are incurred by the requirement of the jobs, projects and services. The concept of the two-stage process flows, of the costs from resources to activities and from activities to cost objects, reflects the requirement of improvement to the cost management and controlling practices – the CMCPs of project overheads effectively (Jaya *et al.*, 2010a and 2010b).

The CMCPs of project overheads are explained by the operational management as that the ABC management and control features can be implemented for producing *the most efficient cost proposals and controlling costs* effectively during the construction operation (refer to Concept 26). The construction cost proposal is normally authorised during the construction to completion stage prior to continuing the placing of resource orders and site construction activities.

The operational management perspectives reveal that the cost proposal is examined by *comparing several costing alternatives for incurring the cost variance* (Concept 27) which consider some factors, such as availability of costing methods, the company's current activity databases, information of most recent resource costs, etc. The planned cost variance data (e.g. the cost output using different methods of cost analysis) may be used to help decision makers in order to determine the cost arrangement for accomplishing construction activities, either offsite or onsite.

The ABC system is also considered for measuring resource costs that produce reasonable costs reflecting *the complexity of construction activities for better outputs* of the cost performance (Concept 28), whilst the cost of complexities are expected to provide returns by managing those complexities properly in practice. A reasonable cost should recover basic requirements including complexities, direct cost (materials and labour), indirect expenses (project overheads), and project risk expenditures for unknown activities (e.g., unstable market prices, unforeseen ground conditions, and other technical failures).

Concept 29 illustrates the advantages of the ABC system where its' usefulness can measure *a specific unit cost* of occurrence of a project overhead *rather than just a total cost* in order to support activities. The specific unit cost may represent an ideal cost driver that could measure the occurrences of specific items of project overheads accurately, related to particular activities. Furthermore, the ABC system provides its' capacities on discovering both the strengths and weaknesses of *detailed activity costs* up to *the lowest level of Work Breakdown Structures (WBS)* (concept 30). These would enable the project managers to make well informed decisions in order to take appropriate action with regard to the management of project overheads during the construction stage.

The ABC system is *a more scientific method* rather than a practical approach, and it uses *complex implementations* (Concept 31). Instead of using existing employees who are familiar with the traditional costing system, the ABC system has rather expensive methods which should employ experienced personnel in a project and people who have knowledge of maintaining the system. However, the system can be adapted in practice using existing computer devices with an internet facility and common software or programs such as Microsoft Excel or Access that enables accurate cost accounts through diverse cost drivers in order to avoid cost distortions and losses, and in turn it could provide a cost saving and improve project benefits including project overheads. Therefore, the application of the ABC system in construction projects can be used to develop the ABCC model in order to improve the cost management and controlling practices – the CMCPs of project overheads during the construction stage.

#### 5.5.2.3. Operational Management Perspectives on Development of the ABCC Model to Improve the CMCPs of Project Overheads

Figure 5-9 represents emerging concepts of the operational management perspectives. Concepts 19 to 25 are merged to form Theme A2 (the management of project overheads) and Concepts 26 to 31 are merged into Theme B2 (the ABC system). These two converging Themes (A2 and B2) are brought together into the focus point of advantages of the ABCC model for improving the CMCPs of project overheads (converging theme C2) which implies substantial Concepts 32 to 36, during the construction stage of construction projects.

Theme A2 is formed from emerging concepts from operational management opinions, such as the availability of project overheads in construction projects (Concepts 19 to 21) that are arbitrarily allocated to construction activities on a percentage basis to project costs (Concept 22 to Concept 24). However, to some extent (e.g. especially in more complex and larger size projects), project overheads should refer to the current market prices to update previous activity cost databases (Concept 25).

Theme B2 is formed from emerging concepts that relate to the application of the ABC system (Concept 26 to Concept 29), and the advantages and limitations of the ABC system in construction projects (Concept 30 and Concept 31). The implication of these concepts is thoroughly considered in *validating* the development of the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads (Theme C2) during the construction stage of construction projects.

The advantages of the ABCC model in construction projects reflect *the complexity of construction process* and *an improvement of cost performance* (Concept 32). The complexity of construction projects may include an intricate nature, fragmented projects, diversified activities, and so on. Managing the cost of complexity properly should result in some excessive costs, which provide considerable returns to improve the cost performance through development of the ABCC model and implementation of the CMCPs' tools and techniques of project overheads.

The CMCPs of project overheads during the construction stage may consider two major processes of cost management, these are *construction cost budgeting* and *operational cost controls* (Concept 33). Construction cost budgeting is the process of aggregating an individual cost of activities to establish authorised costs that normally take place prior to the construction operation, while construction cost control is the process of monitoring the status of cost performance and managing cost changes to update authorised costs that are generally carried out during the construction stage. These two typical cost management processes (cost budgeting and controlling) provide a substantial relationship of cost measurements enabling the development of the ABCC model for improving the management of project overheads and examine the implementation of the CMCPs' tools and techniques.

A majority of operational management opinions highlight that the ABCC model may be appropriate for *monitoring and managing an internal status of cost* *performance*, but it is *not compatible with external reporting* (Concept 34). The ABCC model has a capability to monitor the status of project processes and cost performance. Project processes can be monitored by the recording and reporting, day by day, of the technical progress of construction activities to update budgeted activities. Then, the activity progress values – APV may be evaluated, managed, and controlled through comparing with both the overhead cost schedules – OCS and actual project expenses – APE in order to improve project cost performance. These three cost parameters of construction activities (APV, OCS, and APE) are recognised as internal monitoring functions of the ABCC model for the improvement of the management of construction project overheads through implementation of the CMCPs' tools and techniques.

The ABCC model, tools and techniques are not suitable formats for preparing standard reports to fulfil the Generally Accepted Accounting Principles (GAAP). The ABCC formats are *not compatible with external reporting* (Concept 34) of regular financial statements for satisfying a standard requirement of external parties, such as investors, creditors, auditors, regulations, government agencies, taxations, and so on. Therefore, by adopting the ABCC model, construction project managers should rely on operating two different formats of cost accounting management approaches. However, the development of the ABCC model is specifically focused for improving the CMCPs' tools and techniques of project overheads in particular activities of construction projects.

Implementation of the ABCC model in construction project may be in *harmony with other cost performance management systems* (Concept 35), such as Earned Value Management (EVM), To Completed Performance Index (TCPM), Variance Analysis (VA), Forecasting, etc. They are 'complementary and synergistic' to each other (refer to concept 17). The ABCC model is a cost controlling method using the ABC system and EVMS. While in practice, the CMCPs also adapt the concepts of variance analysis and forecasting in order to determine future estimates at completion *forecast* – EAC*f* of cost performance indices based on three different present conditions of cost performance status (i.e., VSR, VER, and their combinations). The forecasting technique results in three different values of EAC*ƒ* to be compared with budgeted costs at completion (refer to Section 5.4.5.4). Consequently, it would provide three different range values of cost performance at every time-point measurement, whether it is a higher or lower cost saving, deficits, or balances. In order to have clear cost information for a decision based on ambiguous cost measures, this specified problem requires *'management by exception'* (refer to Concept 15), through an implementation of Worst Case Scenario (WCS) of the CMCPs' tools and techniques (refer to Section 5.4.5.5).

However, the main contribution of the ABCC model can be categorised into three dimensions, such as *company policy, research development, and individual personnel changes* in terms of the way they 'think and act' (Concept 36) in monitoring and managing project overheads. Construction companies may change their *organisational policies* whilst assigning project overheads accurately based on activity cost drivers (refer to Concept 07) rather than arbitrarily allocate them on a percentage basis (refer to Concept 04 and Concept 22) to avoid cost distortion of either over or under costing. Academics and practitioners could extend their research and development in the areas of cost management and controlling practices – the CMCPs of project overheads in both *academic milieu* and *project practice*. In addition, individual personnel on *construction activity levels* should improve their competencies in the ways they 'think and act' consistently, for the very detail of work breakdown structures – 'WBS lowest level' (refer to Concept 30), on optimising companies' facilities, utilities, and available technologies aided through implementation of the ABCC model and effective tools and techniques of the CMCPs.

Therefore, this research has followed *a methodological process of developing the ABCC model* (refer to Section 3.2 and Section 3.3), in order to improve the CMCPs' tools and techniques of project overheads (refer to Section 3.5; Section 3.6;

Figure 4-10 and Figure 4-11), through the application of the ABC system and Earned Value Measurement System (EVMS) (refer to Section 5.4 and Section 5.5).

## 5.6. Summary

Chapter 5: Findings and Analysis, provides primary findings from both the literature review and field research. This chapter discusses four main sections of research analysis, these are:

- Analysis of identification and availability of project overheads during the construction stage
- Analysis of Critical Success Factors (CSFs) for improving the management of project overheads.
- Analysis of Activity-Based Cost Controlling (ABCC) model for improving the management of project overheads through the implementation of effective tools and techniques of the CMCPs.
- Validation of development of the ABCC model for improving the management of project overheads.

The analysis of project overheads identifies forty-seven (47) items of site-project overheads during the literature review, which have categorise into four hierarchies, such as: unit level, batch level, project sustaining, and facility sustaining overheads. Descriptive statistical analysis examines and determines that thirty-nine (39) project overheads occur most, whilst supporting construction activities of onsite projects (refer to Figure 5-3).

Forty important CSFs were identified and divided into eight groups of CSF-alternatives through literature review, in respect of four Evaluation-criteria of construction projects. The Analytic Hierarchy Process (AHP) revealed that the top three priorities of importance of CSFs are: the requirement of a robust method and tool (METOOL), understanding the market condition (MARCON), and managing project complexity and intricate nature (PROCOM).

The case study data of project overheads was identified and measured in Appendix 5-a, in order to analyse the implementation of the ABCC model on substructure activities of construction building projects (refer to Table 5-15). The ABCC model is examined through the application of the ABC system to determine ideal Quantity Drivers (QD), ideal Cost Drivers (CD), activity Cost Objects (CO), and activity Driver Rate (DR). The implementation of cost management and controlling practices – the CMCPs' tools and techniques adopts the concepts of the earned value measurement system - EVMS for improving the management of project overheads. The worst case scenario – WCS was used for effective management and controls of the project cost performance (cost savings, deficits, or balances) for decision making and in order to take appropriate action (preventative, corrective, or immediate).

Seven expert interviewees represented two management levels: senior and operational management levels. The expert opinions were placed into three converging themes: the management of project overheads, the application of the ABC system, and the CMCPs of project overheads. The advantages of the ABCC model reflect the occurrences of the project overheads and application of the ABC system in construction projects for improving the cost management and controlling practices – the CMCPs of project overheads. Therefore, the development of the ABCC model has been methodologically validated and articulated through expert interview outcomes.

# CHAPTER 6. DISCUSSION

## 6.1. Introduction

This chapter discusses the research findings and analysis of results against the research aim and objectives. The aim of this research is to propose the Activity-Based Cost Controlling (ABCC) model for improving the management of construction project overheads. It was achieved through investigating a series of objectives, which are: the identification of construction project overheads, the analysis of Critical Success Factors (CSFs), the application of the Activity-Based Costing (ABC) system, the development of the ABCC model and implementation through the Cost Management and Controlling Practices (CMCPs) of construction project overheads, and validation of the ABCC model.

Descriptive statistics were used to identify the availability of construction project overheads. The Analytic Hierarchy Process (AHP) was implemented to analyse the most important CSFs for the management of construction project overheads. The literature review investigated the application of the ABC system in construction projects to maintain the development of the ABCC model. Project case study documentation and direct observations incorporated Earned Value Measurement System (EVMS) to facilitate the implementation of the ABCC model through effective tools and techniques of the Cost Management and Controlling Practices (CMCPs). Qualitative Content analysis and cognitive mapping were used to validate and justify the development of the ABCC model and implementation of the CMCPs of construction project overheads. The research findings and results are represented and discussed in more details in Figure 6-1.

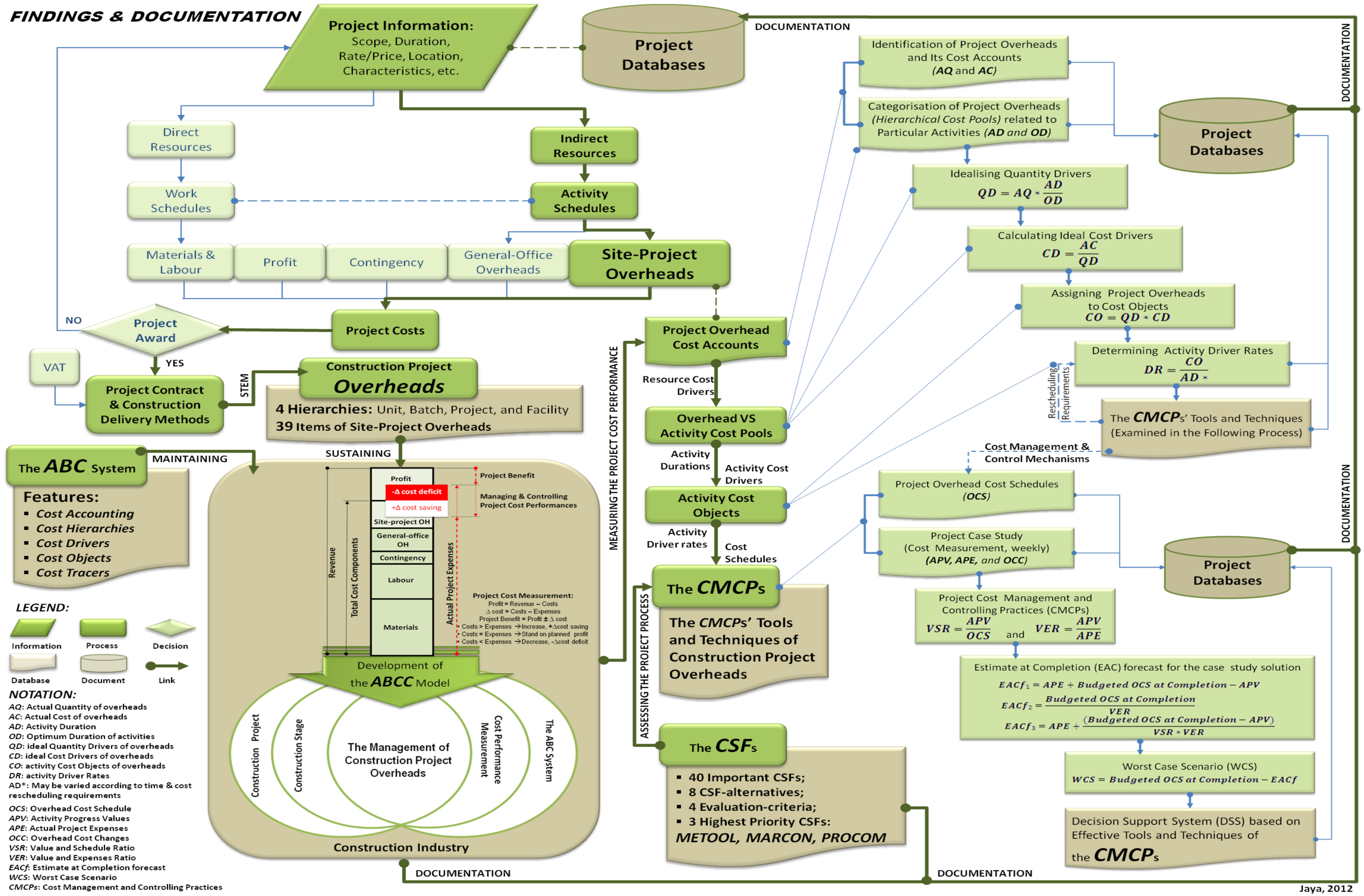


***Figure 6-1: Research Findings and Documentation of the ABCC Model***

Figure 6-1 shows and the research findings and analysis which include the availability of construction project overheads and the application of the ABC system in construction projects for the development of the ABCC model. It has also documented the most important CSFs in the particular areas of construction projects. The ABCC model and the most important CSFs are incorporated into the effective tools and techniques of the CMCPs in order to improve the management of construction project overheads.

The implementation of the ABCC model was examined during the case studies relating to substructure activities of construction building projects through three discreet stages of project cost management (cost budgeting, cost scheduling, and cost controlling). The top three priorities of important CSFs should be considered by the project managers in order to find the best ways to bring the project process directly into satisfactory levels for successful cost performance. The CMCPs' tools and techniques focus on monitoring and managing the present status of project cost performance to be able to improve project benefits.

Therefore, the following section incorporates the four main components of the research findings and results, they are: the management of construction project overheads; the most important CSFs for the management of construction project overheads; the ABCC model for improving the management of construction project overheads; and the CMCPs' tools and techniques of construction project overheads.

## 6.2. The Management of Construction Project Overheads

### 6.2.1. Overview of Construction Project Overheads

Management of project overheads refers to the cost management definition as explained in the Project Management Body of Knowledge (PMBOK® Guide), where the cost management of construction project overheads primarily concerned with consideration of the *'stakeholder requirements'* for the cost of resources to complete project activities (PMI, 2008). However, the management of construction project overheads should also consider the importance of *'managerial decisions'* and the subsequent effects of actual project expenses, to maintain and support the process and performance of construction activities during the construction stage.

The construction stage (e.g., mobilisation and construction to practical completion) represents one of the five project phases according to the Royal Institute of British Architects - RIBA (refer to Cartlige, 2009 and Philips, 2009 in section 3.4). Project overheads have specific characteristics. Bunbury (1931) considered overheads as the costs that cannot readily be allocated directly to a particular product or process of production. Tatikonda and Tatikonda (1994) consider that overheads are the resource costs which are common in supporting one or more cost objects, but cannot specifically be associated to particular activities. However, project overheads in constructions are classified into two types: general-office overheads and site-project overheads (refer to section 2.4.2). General-office overheads maintain general expenditure for the survival of the construction company, while site-project overheads are allocated to support all activities of the particular construction project.

Therefore, the cost management and controlling practices – the CMCPs of project overheads should consider the stakeholder requirements, project manager decision-making, and the characteristic of project overheads. The two following sections focus the discussion on identification of the frequency of occurrence of site-project overheads during the construction stage.

## 6.2.2. Identification of Construction Project Overheads

There were forty seven (47) items of overheads identified which are categorised into four hierarchies of construction project overheads (refer to section 2.4.3). Project overheads support most of the construction activities using relevant cost drivers through their hierarchical cost pools that include: unit-level, batch-level, project-sustaining, and facility-sustaining overheads. Unit-level overheads occur when supporting a single unit of particular activities on the basis of unit-level activity cost drivers. Batch-level overheads occur to support two or more concurrent/ parallel activities on the basis of batch-level activity cost drivers regardless of the number of construction activities within the batch. Project-sustaining overheads occur when supporting a particular package of activities on the basis of project-sustaining activity cost drivers, regardless of the number of units or batches of construction activities within the package, whereas, facility-sustaining overheads occur to support all project activities on the basis of facility-sustaining activity cost drivers, regardless of the number of units, batches, and packages of construction activities within the specific project. The occurrence of construction project overheads is discussed in the following section.

### 6.2.3. Construction Project Overheads

During the literature review stage, forty seven (47) characteristics of construction project overheads were identified. These 47 variables of project overheads were used to develop the survey questionnaire (refer to Appendix 2-a). This survey questionnaire was advised by the experts (refer to Table 4.5) during the consultation in their offices prior to the two hundred and fifty (250) questionnaires (refer to Appendix 2-a) being sent to the professionals in construction projects. The choice of 250 construction project professionals was considered to be an appropriate number of potential respondents which were *'greater than five times'* the 47 question variables, and up to one hundred and seven (107) responses were received (refer to Table 5-1). The response rate of 42.8 per cent is considered to be adequate for analysing the data set. Fellow and Liu (2008) suggest that at least 100 usable data sets are appropriate for data analysis.

The degree of agreement of the respondents for the availability of project overheads was measured using five values of Likert scales to determine weighted scores of the 47 variables of project overheads. The lowest verbal value (1) represents *'strongly disagree'* and a verbal value (2) means *'disagree'*. A *'neutral'* verbal value is represented by score (3). A higher verbal value (4) indicates 'agree' and the highest score (5) of verbal value is 'strongly agree'. The Likert scale does not represent the exact or precise verbal values of personal judgments attached on the variables to measure their absolute scales (refer to the explanation of Table 4-4 in Section 4.8.1.2). However, absolute number (1 to 5) scores of Likert scales can provide a relative difference of verbal values inherent between the variables of project overheads.

Figure 5-2 (in Chapter 5) showed the accumulated scores of 107 respondents for each of the 47 variable overheads, their weighted scores range between the lowest total score of 322 for *'Paying Supplies'* and the highest total score of 446 for *'Mobilisation and Setup Equipment'*. The relative weighted scores and range statistics were used to examine the occurrence of project overheads during the construction stage through descriptive statistic analysis (refer to Section 5.2.3).

Descriptive statistic techniques provide the basic statistics of central tendency and spread statistic measures. The central tendency analysis may include mode statistics, median, and mean, whilst spread statistics include the range statistic, variance, and standard deviation. The first three characteristics of the central tendency analysis (e.g. mode, median, and mean statistics) provided three different alternatives of central point values within the range statistic in order to measure the lowest value of *'basis point'* for determining the occurrence of project overheads during the construction stage (refer to Figure 5-3). The mode statistic did not provide an absolute or central point value by discovering seven different point values (i.e., 364, 366, 379, 389, 405, 421, and 441). However, the median value (a total score of 391) provided a similar (an approximate) result with a mean statistic of 389.809. The mean statistic is the most suitable value to be used as a central point to determine the basis point of measurement through shifting this central point to the left side of Figure 3-5, by the value of standard deviation

(33.526). The basis point of measurement is now positioned at the point value of 356.283 (389.809 - 33.526).

Eight items of project overheads are disqualified because their value positions accounted for lower values than the basis point value of measurement (each point value of the eight overheads is <356.283). Therefore, descriptive statistics have revealed the thirty-nine (39) items of construction project overheads present most often and which are categorised into four hierarchies, which are unit-level, batch-level, project-sustaining, and facility-sustaining overheads. The overhead items included in each category of project overheads are provided in Table 2-1 (in Chapter 2), and the overheads excluded those eight items of disqualified overheads, they are: paying suppliers, project sundries, hoarding screens, placing purchase orders, receiving materials, material deliveries, managing work and contract conditions. The reason for excluding these eight item overheads is because, nowadays, they are no longer used for directly supporting construction project activities. It may be more appropriate to include them in general-office expenditures rather than site-project expenses.

The 39 items of overheads that are categorised into four hierarchies as identified before (Unit-level, Batch-level, Project-sustaining, and Facility-sustaining) would therefore be specifically related to substructure activities of construction building projects. These are illustrated in Table 6.1.

***Table 6-1: The 39 Items of Construction Project Overheads***

| Categories of Site-Project Overheads | Items of Site-Project Overheads | | |
|---|---|---|---|
| **Unit Level Overheads** | • Equipment depreciations | • Direct tool sets | • Safeguards |
| **Batch Level Overheads** | • General inspections<br>• Mobilisation and setup equipment<br>• Demobilisation materials and equipment | • Drawing reviews<br>• Change orders<br>• Sample of materials<br>• Material tests | • Moving materials<br>• Quality inspections<br>• Intermediate project release |

| | | | |
|---|---|---|---|
| **Project Sustaining Overheads** | • General planning<br>• Scheduling projects<br>• Planning resources<br>• Planning costs | • Engineering costs<br>• Controlling costs<br>• Project reporting<br>• Soft drawing | • As built drawing |
| **Facility Sustaining Overheads** | • Site-office & project storage<br>• Site-project administration<br>• Site-project supervision<br>• Site-project labour<br>• First aids<br>• Project insurance<br>• Legal expenses | • Rental plant and equipment<br>• Rental land, and base camp for workers<br>• Scaffolding<br>• Temporary building<br>• Water supply | • Power and lighting<br>• Telephones and communications<br>• Security services<br>• Cleaning services<br>• Transport and haulage |

Further, the most important Critical Success Factors (CSFs) and the ABCC model are incorporated into the implementation of the cost management and controlling practices – the CMCPs' tools and techniques of construction project overheads. The following section discusses the research findings and the role of the top three CSFs for improving the management of construction project overheads.

## 6.3. The Most Critical Success Factors (CSFs) for Improving the Management of Construction Project Overheads

### 6.3.1. Overview of Critical Success Factors (CSFs)

The concept of Critical Success Factors (CSFs) has evolved since D. Ronald Daniel initiated the application of *'Success Factors'* (SFs) for McKinsey & Company in 1961. However, different managers need information from different sources to create CSFs for different organisations or projects. The CSFs' sources of information, issues, and challenges may be derived from the characteristics of the specific industry (e.g., construction building and civil engineering projects); competitiveness of organisation strategies (e.g., companies' development focus on commercial buildings of construction projects); changes to the economic market (e.g., fluctuation resource price of unstable markets); investment and technologies (e.g., intellectual and financial capitals, tangible assets, heavy equipment, modern systems, etc); temporary need of internal organisations (rental office and facilities, construction materials and labour, overheads, etc); practical policies of project management levels (implementation of construction methods, management tools and techniques), etc. (refer to Table 2-2). Therefore, based on the success factors – the SFs created by D. Ronald Daniel during the 1960s, Rockart (1979) introduced CSFs and defined as:

> *'......... the area of activities that should receive constant and careful attention from the management'* (Rockart, 1979, p.85).

The few area of activity of CSFs could typically put more focus on the direct impact of the effectiveness and efficiency of the project strategy, program, and operation that ascertains the individual manager objectives and organisational goals. CSFs are the key areas of activities that assist in achieving successful performance of the management goals (Rockart, 1982). Foster and Rockart (1989) describe CSFs as selected activities to share understanding for improving the management of the organisation's environment. There are various CSFs which may be appropriate in different areas of activities for different purposes in order to satisfy the required organisational goals. In the area of Cost Management and Controlling Practices (CMCPs), the CSFs selected by the project managers should have the most influence and directly affect the project progress and the successful cost performance of construction project overheads.

## 6.3.2. Identification of Critical Success Factors (CSFs)

Table 2-2 shows the forty (40) CSFs which were identified from the construction industry. These forty CSFs were grouped into eight (8) important CSFs on the basis of *'similarities and relationships'* of information, issues, and challenges inherent between them (refer to Figure 4-11). The eight groups of important CSFs in the area of cost management and controlling practices – the CMCPs of construction project overheads, are illustrated in Table 6-2 below.

***Table 6-2: The Eight Groups of Important CSFs with the Focus Area of Construction Project Activities***

| Groups | Important CSFs | Focus of Activity Areas | Related References |
|---|---|---|---|
| **1** | Understanding the Market Condition ***(MARCON)*** | Inform actual market resource prices to forecast realistic project costs or expenses in order to avoid financial losses, and in turn maintain project benefits including construction project overheads | Pitcher (2009); and ONS-Office for National Statistic (2009); Amiel (2011); and Hook (2011) |
| **2** | Project Development Focus ***(DEVFOC)*** | Consider a development of new commercial project types instead of restoration of artefact buildings to be financially more attractive to construction projects | Alley (2004); General UK Statistics (2007); Wates and Cridlan (2009); ONS (2010); Musa (2010); and Osborn and Sassoon (2011) |
| **3** | Requirement of Investment and Technology ***(INVTEC)*** | Represent the specific characteristics of capital-intensive projects that should be given consistent, careful and special attention to increase construction project cost savings | Lock (2004); and Walker (2007); Osborn and Sassoon (2011); Simon (2011); and Threlfall (2012) |
| **4** | Mapping local availability of required resources ***(LOCRES)*** | Balance surrounding the potential of resources to develop effective and efficient supply chains in order to reduce operational costs and improve construction project benefits | Ostwald (2001); Kim and Ballard (2002 and 2005); Sears *et al* (2008); Gould and Joyce (2009); Alarcón *et al* (2009); and Duglase (2012) |
| **5** | Managing a company's interest and project benefit ***(INTBEN)*** | Provide great opportunities to increase intellectual capital and tangible assets for construction companies in respect of common legal systems for financial benefits | Ostwald (2001); Alarcón *et al* (2009); and Skadmanis (2009) |
| **6** | Managing project complexity and intricate nature ***(PROCOM)*** | Help face the real potential challenges and opportunities of project managers in order to create efficiency and effectiveness for construction project savings | McDowel (2008); Sears *et al* (2008); CIOB (2009); Winch (2009); Gold and Joyce (2009); and Effron and Ort (2010) |
| **7** | Improving contractors' current roles | Consider the contractors' responsibility to provide accurate and competitive estimations of | Assaf *et al* (2001); Enshassi *et al* (2008); RICS (2009); and CIOB |

| | | | |
|---|---|---|---|
| | in practice ***(ROPRAC)*** | project overheads which reflect detailed processes of construction activities in order to avoid project cost distortion or cost deficits | (2009) |
| **8** | Requirement for a robust method and tool ***(METOOL)*** | Suggest that project managers should consider appropriate methods, and effective tools and techniques for improving the Cost Management and Controlling Practices (CMCPs) of construction project overheads | Akintoye and Fitzgerald (2000); Staub-French and Fischer (2002); Sutrisna (2004); Fortune (2006); Heitger (2007); and Jaya *et al* (2011b) |

Successful project progress and cost performance were assessed in respect of the specific focus of evaluation-criteria from which was determined the most important CSFs as the Decision-goals of construction projects. Figure 4-11 (in Chapter 4) represented three adjacent levels of Analytic Hierarchy Process – the AHP structures. There are four elements of specific focus of project success as the evaluation-criteria provided in Table 6-3 shows.

***Table 6-3: The Four Evaluation-criteria for the Most Important CSFs of Construction Projects***

| **Elements** | **Evaluation-criteria** | **Focus of Project Success** | **Related References** |
|---|---|---|---|
| **1st** | ***Project Type*** | Construction project types for commercial buildings that include public and private sectors (e.g. hospital, car-park, villa, hotel, and resort) | Hendrickson and Au (1989); Ostwald (2001); Gould (2005); Clough *et al* (2005); Kirkham (2007); Sears *et al* (2008); Gould and Joyce (2009); CIOB (2009); and Alarcón *et al* (2009) |
| **2nd** | ***Project Phase*** | Construction project phases for discreet construction stages that include mobilisation and construction to practical completion | Smith *et al* (2006); Philips (2009); Cartlidge (2009); and RIBA (2012) |

| | | | |
|---|---|---|---|
| 3rd | ***Project Monitoring*** | Construction project monitoring for project progress and cost performance that include cost planning and operating cycles | PMI (2008); Kerzner (2009); and Jaya *et al* (2010c and 2011a) |
| 4th | ***Project Deliveries*** | Construction project deliveries for construction methods that include Conventional Design-Bid and Build (CDBB), Design and Build (D&B) and Construction Management (CM) | Gould (2005); Sears *et al* (2008); and Gould and Joyce (2009) |

The following section discusses the result of AHP techniques in prioritising the ranking of relative importance of eight CSF-alternatives under four elements of evaluation-criteria.

### 6.3.3. The Most Important CSFs for Improving the Management of Construction Project Overheads

The most important CSFs were analysed using AHP techniques. Three main stages of AHP techniques were implemented for data during the analysis.

- Firstly, calculating the relative importance between four evaluation-criteria (i.e., *Project Type, Project Phase, Project Monitoring, and Project Deliveries*) in respect of the Decision-goal (the most important CSFs);
- Secondly, calculating the relative importance between eight CSF-alternatives (i.e., *MARCON, DEVFOC, INVTEC, LOCRES, INTBEN, PROCOM, ROPRAC,* and *METOOL*) in respect of the four different elements of Evaluation-criteria;
- Thirdly, determining the relative importance ranking of *eight CSF-alternatives* under the *four evaluation-criteria* through establishing the AHP solution tree for the most important CSFs.

#### 6.3.3.1. Relative Importance of Four Evaluation-criteria

The judgements of five experts were considered to determine the relative importance of four elements of the evaluation-criteria (refer to Table 6-3). The accumulated scores of forty variable CSFs were weighted to every element of evaluation-criteria (refer to Table 5-9). The weights of each element of four evaluation-criteria are used to develop matrix algebra through pair-wise comparisons (refer to Table 5-2 in Chapter 5).

This matrix algebra was squared and iterated twice until the last normalised eigenvectors did not show a significant change in values compared to the previous iteration (refer to Table 5-3 and Table 5-4). These normalised eigenvectors could be said to be the best eigenvector solutions and are provided in Table 6-4 below.

***Table 6-4: The Best Eigenvector Solution of Evaluation-criteria for the Decision-goal***

| RANKING | CRITERIA |
|---|---|
| 0.243043916 | **Project Types** |
| 0.260811264 | **Project Phases** |
| 0.291317466 | **Project Monitoring** |
| 0.204827355 | **Project Deliveries** |
| 100% | |

In addition, the consistency of pair-wise comparison matrices has been checked to validate the four elements of evaluation-criteria (refer to the bottom part of Appendix 4-a, and the result of *CR~0.00 per cent <10 per cent* (refer to Saaty, 1977) indicates that the individual judgements of the experts in prioritising the evaluation-criteria are considered to have near perfect consistency. The relative influence of every element of four evaluation-criteria to the CSF-alternatives in respect of the Decision-goals (the highest priority of important CSFs) can therefore be discussed here (refer to Table 5-4).

A general assumption of 100 per cent total weight was used as the principle to measure the four elements of evaluation-criteria for each of their weights of influence. It can be assumed that an average weight for each element of their influence is $\frac{\mathbf{100\%}}{\mathbf{4}} = \mathbf{25\ per\ cent.}$ This is the average weight that is equally responsible for each element of the four evaluation-criteria.

Analytic Hierarchy Process (AHP) techniques for the relative importance of evaluation-criteria (refer to Table 6-4) revealed that *Project Monitoring* (the third element of evaluation-criteria) has a relative influence of 29.13 per cent which is greater than the average weight of 25 per cent for updating the actual status of *'construction project process and cost performance'. Project Phase* (the second element of evaluation-criteria) represented a relative influence of 26.08 per cent which is also greater than 25 per cent for maintaining the *'mobilisation of project resources and construction to practical completions'* during the construction stage. These two elements of evaluation-criteria provided the most impact of the eight CSF-alternatives. *Project Type* (the first element of evaluation-criteria) with a relative effect of 24.30 per cent for *'commercial building projects'* and *Project Deliveries* (the fourth element of evaluation-criteria) provided a relative effect of 20.48 per cent for *'construction methods'.* The last two elements of evaluation-criteria (Project Type and Project Deliveries), provided less effectiveness than the average weight of 25 per cent. However, they are not necessarily unimportant when attributed by these relative measures. Therefore, all four elements of Evaluation-criteria and the eight CSF-alternatives are considered to have important interdependency in order to determine the highest priority of important CSFs.

#### 6.3.3.2. Relative Importance of Eight CSF-alternatives under Four Evaluation-criteria

One hundred and seven (107) questionnaire survey responses were collected from project professionals. They were analysed to determine the relative importance of every factor of CSF-alternatives related to each element of evaluation-criteria. Accumulated scores of forty variables of CSFs were weighted to each related group of eight CSF-alternatives in respect of four evaluation-criteria. The weights of each factor of eight CSFs-alternatives under four evaluation-criteria are used to develop pair-wise comparisons of matrix algebra. These produced four different matrix algebras of the CSF-alternatives under each element of four evaluation-criteria. These four different matrices are: the matrix algebra of eight CSF-alternatives under the evaluation-criteria of Project Types (refer to Table 6-5); secondly, the matrix algebra under Project Phases (Table 6-6); thirdly, the matrix algebra under Project Monitoring (Table 6-7); and fourthly, the Project Deliveries (refer to Table 6-8).

***Table 6-5: Four Matrix Algebras of CSFs under Project Type***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.213592 | 1.30813953 | 1.322751 | 1.470588 | 1.12069 | 1.227094 | 0.953895 | 9.61675 |
| **DEVFOC** | 0.824 | 1 | 1.07790698 | 1.089947 | 1.211765 | 0.923448 | 1.011126 | 0.78601 | 7.924202 |
| **INVTEC** | 0.764444 | 0.927724 | 1 | 1.01117 | 1.124183 | 0.856705 | 0.938045 | 0.7292 | 7.351471 |
| **LOCRES** | 0.756 | 0.917476 | 0.98895349 | 1 | 1.111765 | 0.847241 | 0.927683 | 0.721145 | 7.270263 |
| **INTBEN** | 0.68 | 0.825243 | 0.88953488 | 0.899471 | 1 | 0.762069 | 0.834424 | 0.648649 | 6.53939 |
| **PROCOM** | 0.892308 | 1.082898 | 1.16726297 | 1.180301 | 1.312217 | 1 | 1.094946 | 0.851168 | 8.5811 |
| **ROPRAC** | 0.814933 | 0.988997 | 1.06604651 | 1.077954 | 1.198431 | 0.913287 | 1 | 0.777361 | 7.83701 |
| **METOOL** | 1.048333 | 1.272249 | 1.37136628 | 1.386684 | 1.541667 | 1.174856 | 1.286404 | 1 | 10.08156 |
| Column Sum | 6.780019 | 8.228178 | 8.86921064 | 8.968279 | 9.970616 | 7.598297 | 8.319722 | 6.467427 | 65.20175 |

***Table 6-6: Four* Matrix *Algebras of CSFs under Project Phase***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.199413 | 1.3202586 | 1.315298 | 1.422997 | 1.124831 | 1.211151 | 0.950044 | 9.54399 |
| **DEVFOC** | 0.833741 | 1 | 1.1007543 | 1.096618 | 1.186411 | 0.937818 | 1.009786 | 0.792091 | 7.95722 |
| **INVTEC** | 0.757427 | 0.908468 | 1 | 0.996243 | 1.077816 | 0.851977 | 0.917359 | 0.719589 | 7.228879 |
| **LOCRES** | 0.760284 | 0.911894 | 1.0037716 | 1 | 1.081882 | 0.855191 | 0.920819 | 0.722303 | 7.256144 |
| **INTBEN** | 0.702742 | 0.842878 | 0.9278017 | 0.924316 | 1 | 0.790466 | 0.851127 | 0.667636 | 6.706967 |
| **PROCOM** | 0.889023 | 1.066305 | 1.1737401 | 1.16933 | 1.265076 | 1 | 1.076741 | 0.84461 | 8.484825 |
| **ROPRAC** | 0.825661 | 0.990308 | 1.0900862 | 1.08599 | 1.174913 | 0.928729 | 1 | 0.784414 | 7.880102 |
| **METOOL** | 1.052583 | 1.262482 | 1.3896821 | 1.384461 | 1.497822 | 1.183978 | 1.274837 | 1 | 10.04584 |
| Column Sum | 6.821462 | 8.181748 | 9.0060946 | 8.972255 | 9.706917 | 7.672989 | 8.261819 | 6.480687 | 65.10397 |

***Table 6-7: Four Matrix Algebras of CSFs under Project Monitoring***

| Alternativ | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.181963 | 1.2516854 | 1.291594 | 1.356469 | 1.123725 | 1.211528 | 0.972926 | 9.38989 |
| **DEVFOC** | 0.84605 | 1 | 1.0589888 | 1.092754 | 1.147641 | 0.950727 | 1.025014 | 0.823144 | 7.944319 |
| **INVTEC** | 0.798923 | 0.944297 | 1 | 1.031884 | 1.083714 | 0.897769 | 0.967917 | 0.777293 | 7.501797 |
| **LOCRES** | 0.774237 | 0.915119 | 0.9691011 | 1 | 1.050228 | 0.870029 | 0.93801 | 0.753275 | 7.27 |
| **INTBEN** | 0.737208 | 0.871353 | 0.9227528 | 0.952174 | 1 | 0.828419 | 0.893148 | 0.717249 | 6.922304 |
| **PROCOM** | 0.889898 | 1.051826 | 1.1138721 | 1.149387 | 1.207119 | 1 | 1.078136 | 0.865805 | 8.356042 |
| **ROPRAC** | 0.825404 | 0.975597 | 1.0331461 | 1.066087 | 1.119635 | 0.927527 | 1 | 0.803057 | 7.750452 |
| **METOOL** | 1.027828 | 1.214854 | 1.2865169 | 1.327536 | 1.394216 | 1.154995 | 1.245242 | 1 | 9.651188 |
| Column Su | 6.899548 | 8.155009 | 8.6360631 | 8.911416 | 9.359021 | 7.753191 | 8.358995 | 6.712748 | 64.78599 |

***Table 6-8: Four Matrix Algebras of CSFs under Project Deliveries***

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.215913 | 1.3448 | 1.375051 | 1.494222 | 1.150158 | 1.2297 | 0.918266 | 9.72811 |
| **DEVFOC** | 0.822427 | 1 | 1.106 | 1.130879 | 1.228889 | 0.945921 | 1.011339 | 0.755207 | 8.000662 |
| **INVTEC** | 0.743605 | 0.904159 | 1 | 1.022495 | 1.111111 | 0.855263 | 0.914411 | 0.682827 | 7.233871 |
| **LOCRES** | 0.727246 | 0.884268 | 0.978 | 1 | 1.086667 | 0.836447 | 0.894294 | 0.667805 | 7.074726 |
| **INTBEN** | 0.669244 | 0.813743 | 0.9 | 0.920245 | 1 | 0.769737 | 0.82297 | 0.614544 | 6.510484 |
| **PROCOM** | 0.869446 | 1.057171 | 1.1692308 | 1.195532 | 1.299145 | 1 | 1.069158 | 0.798382 | 8.458065 |
| **ROPRAC** | 0.813206 | 0.988788 | 1.0936 | 1.1182 | 1.215111 | 0.935316 | 1 | 0.74674 | 7.910962 |
| **METOOL** | 1.08901 | 1.324141 | 1.4645 | 1.497444 | 1.627222 | 1.252533 | 1.339155 | 1 | 10.594 |
| Column Sum | 6.734184 | 8.188183 | 9.0561308 | 9.259847 | 10.06237 | 7.745375 | 8.281027 | 6.18377 | 65.51088 |

Similar procedures as the matrix algebra analysis of relative importance of evaluation-criteria discussed in section 6.3.3.1 above, are applicable to these CSF-alternatives' matrices (refer to the matrix analysis in section 5.3.4), for squaring, iterating, and comparing the last two iterated matrices, until the relative ranking of normalised eigenvectors provides no or minimum changes to determine the best results of the eigenvector solution. The best eigenvector solutions of eight

CSF-alternatives under the first Evaluation-criteria (Project Types) were identified as the relative ranking of important CSFs and are shown in Table 5-8 and. The provisional ranking of the best eigenvector solutions of eight CSF-alternatives under the Project Types were attributed as follows: MARCON is placed on the second ranking with 14.81 per cent eigenvector, DEVFOC fifth with 12.01 per cent eigenvector, INVTEC seventh with 11.13 per cent eigenvector, LOCRES sixth with 11.20 per cent, INTBEN eighth with 10.07 per cent, PROCOM third with 13.16 per cent, ROPRAC forth with 12.08 per cent, and METOOL first with 15.53 per cent of the best eigenvector solution. The other remaining three best eigenvector solutions and their provisional ranking positions of eight CSF-alternatives (under the Project Phases, Project Monitoring, and Project Deliveries) were presented in Table 5-9 and are summarised in Table 6-9 below.

***Table 6-9: The Best Eigenvector Solution of CSF-alternatives under Evaluation-criteria***

| CRITERIA | Proj. Types | Phases | Monitoring | Deliveries |
|---|---|---|---|---|
| ALTERNATIVES | RANKING | | | |
| MARCON | 0.148112189 | 0.147208722 | 0.145532894 | 0.149111634 |
| DEVFOC | 0.120130759 | 0.120809419 | 0.121197368 | 0.120710711 |
| INVTEC | 0.111336686 | 0.109605596 | 0.11438665 | 0.108990986 |
| LOCRES | 0.111972815 | 0.111920442 | 0.112676949 | 0.108440793 |
| INTBEN | 0.100716288 | 0.103449812 | 0.107288051 | 0.099792141 |
| PROCOM | 0.131638076 | 0.130399126 | 0.129120952 | 0.129147904 |
| ROPRAC | 0.120822242 | 0.121657447 | 0.120214404 | 0.121421841 |
| METOOL | 0.155270945 | 0.154949436 | 0.149582732 | 0.162383989 |
| Column Sum | 1 | 1 | 1 | 1 |

Moreover, consistency ratios of matrices of CSF-alternatives under evaluation-criteria were mostly found very close to zero (refer to the bottom part of Table 5-9). The matrices of CSF-alternatives calculated under the Project Types represent a consistency ratio of $CR = 0.019 < 10\ per\ cent$; Project Phases, $CR = 0.021 < 10\ per\ cent$; Project Monitoring, $CR = 0.014 < 10\ per\ cent$; and Project Deliveries, $CR = 0.022 < 10\ per\ cent$. These consistency ratios indicated that the survey questionnaire was designed to observe several factors of CSF-alternatives using large numbers of variables to collect redundant responses, and consequently, more responses with detailed and actual weights were received.

Furthermore, the ranking importance of eigenvector solutions for the priority CSFs in Table 6-9 would seem to be complicated and slightly inconsistent between each one. The ranking importance of CSF-alternatives under Project Type and Project Phases is different to the ranking of Project Monitoring and Project Deliveries. For example: DEVFOC is positioned at $5^{th}$ under Project Type and project Phase, while being $4^{th}$ under Project Monitoring and $5^{th}$ under Project Deliveries. INVTEC is placed $7^{th}$ under Project Type and Project Phase, but $6^{th}$ under Project Monitoring and Project Deliveries, and so on. This complex multi-criteria decision making was resolved through AHP solution tree (refer to Figure 5-6).

#### 6.3.3.3. Relative Importance Ranking of Eight CSF-alternatives through AHP Solution Tree

Individual weights of the best eigenvector solutions for both CSF-alternatives (Table 6-9) and evaluation-criteria (Table 6-4) were restructured into adjacent matrices as presented in Table 5-10. Multiplying each row matrix of CSF-alternatives with the column matrix of evaluation-criteria has revealed the ranking importance of eight CSF-alternatives (refer to Table 5-11). The 100 per cent total weight for eight CSF-alternatives was equally distributed for each one to have an average weight of $\frac{\mathbf{100\%}}{\mathbf{8}} = \mathbf{12.50}\ \boldsymbol{per\ cent}$ (refer to the similar assumption in section 6.3.3.1). The highest priority of important CSFs was selected using the assumption of average weight principles. After it was considering the evaluation-criteria and measuring the ranking importance of CSF-alternatives on the average weight of 12.50 per cent basis, the top three priorities of important CSFs were identified (refer to Table 5-12 in Chapter 5).

Therefore, the top three priorities out of eight important CSFs that could provide the most improvement to the cost management and controlling practices – the CMCPs of construction project overheads, are:

**1st.** The requirement for a robust method and tool – METOOL implies that the project managers substantially considered the availability of appropriate methods and effective tools and techniques in order to improve the CMCPs of construction project overheads.

**2nd.** Understanding the market condition – MARCON will inform the actual resource prices to forecast realistic project costs and expenses to avoid financial losses, and in turns maintain project benefits including construction project overheads.

**3rd.** Managing project complexity - PROCOM provides the real challenges to be faced by project managers, as well as the opportunities to create individual and organisational competencies and effective CMCPs of construction project overheads.

### 6.3.4. Implication of the Most Important CSFs

The literature review identified forty important CSFs in the area of cost management and controlling practices – the CMCPs of construction project overheads. The forty variable CSFs were used to develop a consensus and a survey questionnaire with the experts related to the area. Four elements of evaluation-criteria were included (e.g., construction project types of the commercial buildings, construction project phases for the discreet construction stages, construction project monitoring for the project process and cost performance, and construction project deliveries of construction methods) to collect responses and more detailed and actual weights of information from project professionals.

This research revealed that the relative importance of CSF-alternatives can be analysed through the implementation of an Analytic Hierarchy Process (AHP) in respect of valuation-criteria of construction projects. The three most important CSFs are derived from the eight CSF-alternatives. Therefore, the top three out of eight important CSFs are METOOL, MARCON, and PROCOM, and these would provide the most effective improvement of the CMCPs' tools and techniques of construction project overheads during the construction stage of construction projects.

Construction projects would inevitably require project overheads for sustaining most of the construction activities. Project overheads are expected to be slightly higher in real projects than reported in the literature, and the management of construction project overheads is very much dependant on the top three priorities of important CSFs: firstly, METOOL for the availability of appropriate construction methods and effective tools and techniques for monitoring the status of project processes and cost performance; secondly, MARCOM for updating the regional and global market and actual resource prices in order to estimate project costs and expenses; and thirdly, PROCOM for the awareness of the intricate nature of project complexities to face the real challenges as well as opportunities of obtaining rewards.

Academics and professionals have increased their interest in project overhead research. There is a gap between project management knowledge and construction practices. Sometimes, available construction methods, tools and techniques (refer to METOOL) may be very difficult to implement, due to a focus in theoretical concern that may not satisfy practical requirements. Unstable economic conditions (refer to MARCON) and the nature of project complexity (refer to PROCOM) are difficult to anticipate, due to paying little attention to the characteristics of site-based construction processes, and inconsistencies involving CSFs to the specific area of activities. Therefore, this research creates the CSFs and the Activity-Based Cost Controlling (ABCC) model; they are incorporated into the effective tools and techniques of the Cost Management and Controlling Practices (CMCPs) in order to improve the management of construction project overheads.

## 6.4. The Activity-Based Cost Controlling (ABCC) Model for Improving the Management of Construction Project Overheads

### 6.4.1. Overview of the ABCC Model

The ABCC model was developed using three converged themes: the management of construction project overheads, the ABC system, and the CMCPs' tools and techniques (refer to Figure 5-8 in Chapter 5). Construction project overheads must be separated from the other cost components (e.g., materials, labour, contingency, and profit margins) and from a compounded contract of project prices. Project contracts normally include provision such as project administration, technical specifications, jobs, activities, durations, delivery methods, etc.

The ABC system can assign project overheads accurately and maintain most of the particular activities of construction projects on the basis of relevant features, such as reliable cost accounting, multiple cost hierarchies, diverse cost drivers, various cost objects, and transparent cost tracers (Jaya *et al.*, 2010a). The underpinning philosophy of the ABC system also represents the concept of a two-stage process of cost allocations where the costs are assigned to activities, and these activity costs are assigned to cost objects (refer to Section 2.9.1.1; Cooper and Kaplan, 1988; Glad and Baker, 1997; Innes and Mitchell, 1998; Hicks, 1999; Drury, 2008; etc). The most important aspects of the ABC system (e.g., costs, activities, jobs, projects, services, management, and control) are considered for maintaining the cost measurements of the ABCC model (refer to Jaya *et al.*, 2010b; and Figure 3-4). Cost distribution procedures of the ABCC model are appropriate to maintain the construction process which has adopted production principles (refer to Section 2.9.3.2): cost variables (input), activities with durations (process), cost performance of jobs, projects and services (output), and project management and cost control mechanisms (as the evaluation).

Therefore, the implementation of the ABCC model incorporates the effective tools and techniques of the CMCPs in order to improve the management of construction project overheads.

### 6.4.2. Implementation of the ABCC model

Figure 6-1 denotes that specific characteristics of construction project overheads (unit-level, batch-level, project-sustaining, and facility-sustaining) can be measured using the ABC features such as *overhead cost accounting* and *multiple cost hierarchies* to allocate overhead costs on the basis of *resource cost drivers*, which relate to particular activity cost pools. Every activity has each of their activity durations which can be used to calculate *ideal Quantity Drivers (QD)* and determine *ideal Cost Drivers (CD)*. Thereafter, construction project overheads can be assigned into *activity Cost Objects (CO)* by multiplying the ideal QD by the ideal CD. Activity Driver Rate (DR) per unit of activity durations would therefore be determined by dividing activity CO over *Activity Duration (AD*)* to create *project Overhead Cost Schedules (OCS).* The activity durations – AD* may be changed according to the rescheduling requirement of certain times of OCS (it should refer to the time provision of project contracts). Therefore, the ABCC model can be implemented through the effective tools and techniques of the CMCPs of construction project overheads (refer to Sections 5.4.3.1 to 5.4.3.6).

## 6.5. The Cost Management and Controlling Practices (CMCPs) Tools and Techniques of Construction Project Overheads

### 6.5.1. Overview of the CMCPs

This research has identified and documented the findings and results (for instance: Figure 6-1). The findings and results are represented as the following: the four categories of construction project overheads (refer to Section 6.2), the three priority areas of important CSFs (refer to Section 6.3), the relevant features and important aspect of the ABC system (refer to Section 2.9.1 and Section 2.9.3.2), and the ABCC model (refer to Section 6.4). The effective tools and techniques of the CMCPs incorporate the most important CSFs and the ABCC model to improve the management of project overheads during the construction stage of construction projects. The following section discusses the implementation of the CMCPs' tools and techniques on substructure activities of construction building projects.

### 6.5.2. Implementation of the CMCPs

Figure 6-1 illustrates that the implementation of the CMCPs' tools and techniques which incorporate Earned Value Measurement Systems (EVMS) and the Forecasting model, have been initiated by *scheduling overhead costs (OCS)* on an activity schedule basis. Construction project overheads are attached on every slot of construction activity durations scheduled (in this illustrated case study: per week). The case study focused on the substructure activities of construction building projects which include five particular activities with their overhead costs and durations in the bar chart schedule: Preparation (4 weeks), Precast Concrete Pile (18 weeks), Excavation & Backfill (18 weeks), Pile Cap (9 weeks), Tie Beam & Ground Slab (16 weeks) (refer to Table 5-16 in Chapter 5).

The *Overhead Cost Schedules (OCS)* accumulated particular activity overhead costs per week. The illustrated case study provides weekly cost records as categorised into *Activity Progress Values (APV)* and *Actual Project Expenses (APE)*, from which *Overhead Cost Changes (OCC)* can be calculated. The OCC represents the primary measure of cost variances which can be included in the financial figures of activity records weekly. The case study represented that *a negative value* (- an unfavourable deficit) of cost variances in the first and second weeks; *a positive value* (+ a favourable saving) of cost variances in the third and fourth weeks; and *a zero value (0 balance)* in the fifth week (refer to Section 5.4.5.2).

Project management and control mechanisms of the CMCPs have been implemented by measuring the present cost performance of the *Value-and-Schedule Ratio (VSR)* between APV and OCS (refer to Section 5.4.5.3). This ratio measurement shows that *VSR>1* in the first week (1.02) and fifth week (1.06) representing that the project status may be favourable and the activity progress exceeded the time and cost schedules; *VSR<1* in the second week (0.91) and third week (0.98) representing that the project status may be unfavourable and the activity progress lagged behind the time and cost schedules; *VSR=1* in the third week (1.00) represents the project status and the activity progress may be stable according to both cost and time schedules.

The present cost performance of substructure activities has been examined using the effective tools and techniques of the CMCPs to measure the *Value-and-Expenses Ratio (VER)* between APV and APE (refer to Section 5.4.5.3). The present ratio measurement shows in the third and fourth weeks, the *VER>1* represents rational values of 1.04 and 1.06 respectively. It can be interpreted that the project might be slightly favourable according to actual project cost expenditures. In the first and second weeks, the *VER<1* represents rational values of 0.89 and 0.96 respectively. It can be interpreted that the project might be unfavourable regarding accumulated cost expenditures. The fifth week represents *VER=1*, and this means that the project might be stable according to actual cost expenditures.

Project managers may use the VSR and VER measures of the present condition of cost performance to take appropriate managerial consideration and action if both the VSR and VER represent a consistent result of present ratio values. The VSR and VER provide a consistency ratio value during the cost performance measures in the second week (refer to Section 5.4.5.3 and Table 5-16). They provide consistency with unfavourable ratio values that represent both the VSR and VER of less than one (VSR=0.91 and VER=0.96). However, in certain times, for instance, the VSR and VER do not represent a consistent ratio value among them in both the first and third weeks. In the first week, VSR>1 (VSR=1.02) and this means that the project is favourable relating to costs and time schedules, but VER<1 (VER=0.89) meaning that the project is an unfavourable deficit. In the third week, VSR<1 (VSR=0.98) this means unfavourable cost and time schedules, but VER>1 (VER=1.04) meaning a favourable saving. The present ratios (VSR and VER) of cost performance (sometimes) provide ambiguous information for decision making. Moreover, the present ratios of cost performance represent past activity progress, and this has less value and does not relate to the future progress of cost performance. Therefore, it is important to estimate the future forecast of cost performance in order to know the future status of cost performance indices with regard to a budgeted cost at completion. In this case study, budgeted cost at completion refers to OCS at completion. It would provide a more effective solution for improving future cost performance indices through future *Estimate at Completion forecast (*$\boldsymbol{EAC}f$*)*.

Earned Value Measurement Systems (EVMS) and forecasting models were incorporated into the CMCPs' tools and techniques to estimate future cost performance indices. Estimate at Completion forecasts ($EACf$) were used to forecast the future index of cost performance indicators. The future cost performance indices indicate that the remaining construction activities can be accomplished by several different conditions of present cost performance indices. Therefore, the $EACf$ can be considered through three present conditions of cost performance indices (refer to Figure 4-13 and Section 5.4.5.4), they are:

**1.** Remaining activities that will be accomplished at the present budget rates (OCS), and const performance indices should be improved if supported by analysis of project risks, through examination of the $EAC\mathfrak{f}$ formula one; $EAC\mathfrak{f}_1 = APE + Budgeted\ OCS\ at\ Completion - APV$

**2.** Remaining activities will be accomplished at the same cumulative cost performance index of present actual project expenses ratio (VER) to the future cost performance indices which should be improved by continuing the present experience in the future expenses, through utilisation of the $EAC\mathfrak{f}$ formula two; $EAC\mathfrak{f}_2 = \frac{Budgeted\ OCS\ at\ Completion}{Cumulative\ VER}$

**3.** Remaining activities will be accomplished at efficiency rates of both the cost schedule performance (VSR) and the present actual expenses ratio (VER). Cost performance indices should be able to improve in the future especially when the cost schedule performance is expected to reflect the effort of project completion at given durations, through implementation of the $EAC\mathfrak{f}$ formula three; $EAC\mathfrak{f}_3 = APE + \frac{(Budgeted\ OCS\ at\ Completion - APV)}{Cumulative\ VSR * VER}$

The future cost performance indices were provided in Section 5.4.5.4 and analysed in Table 5-16. For example in the first week, the $EAC\mathfrak{f}$ calculation represents three different values of future cost performance indices as the following; $IDR\ 1{,}807{,}109{,}447.54; IDR\ 2{,}027{,}373{,}128.48; and\ IDR\ 1{,}982{,}958{,}081.42$ respectively, compared to budgeted OCS at completion ($OCS = 1{,}802{,}109{,}447.54$). The project benefit calculation reveals unfavourable deficits as $-IDR\ 5{,}000{,}000.00$; $\boldsymbol{-IDR\ 225{,}263{,}680.95}$; and $-IDR\ 180{,}848{,}633.88$ respectively. It indicates that the project manager should consider the maximum negative value of cost deficit which is represented by the second value of $EAC\mathfrak{f}$ ($-IDR\ 225{,}263{,}680.95$).

According to the Project Management Body of Knowledge (PMBOK® guide), the future index of cost performance approaches can provide specific characteristic and are applicable for any given project. Project managers should be given an *'early warning'* signal of future cost performances, especially if the project goes unfavourably beyond the limit of acceptable tolerances (PMI, 2008).

However, this $EACf$ approach may remain as unclear information and an inconsistent outcome for the cost performance indices among the three different $EACf$ equation outputs. Project managers should be able to provide their competencies on this inconsistency matter in order to solve the problem through implementation of a Worst Case Scenario (***WCS***). The principle of the WCS is that it enables the identification and selection of *the lowest favourable value of cost savings* or *the highest unfavourable deficits* as the basis of cost performance indicators at any point of cost measurement periods during the project duration (refer to Section 5.4.5.5 and Figure 5-7). Therefore, the CMCPs' tools and techniques of the ABCC model would provide their core competencies to improve the management of project overheads during the construction stage of construction projects.

## 6.6. Summary

This research has discussed five main components of the research findings and results in respect of the research aim and objectives, they are:

- The identification of construction project overheads which are categorised into four hierarchies (unit, batch, project, and facility levels).
- The most important CSFs for improving the management of construction project overheads which are prioritised into three areas of activities in construction projects (METOOL, MARCON, and PROCOM).
- The relevant features and important aspects of the ABC system are incorporated into the ABCC model for the cost measurement of construction project overheads.

- The ABCC model for improving the cost management and controlling practices of construction project overheads.
- The CMCPs' tools and techniques incorporate the three priorities of important CSFs for the implementation of the ABCC model on substructure activities of construction building projects.

# CHAPTER 7. CONCLUSION AND RECOMMENDATIONS

## 7.1. Introduction

The construction industry contributes a significant part of the world's Gross Domestic Product (GDP) for the economic development of any country, regionally and globally. It generated about 10 per cent of global GDP in the middle of the last decade, 11 per cent at the beginning of this decade, and is expected to rise to 13.2 per cent in the year 2020, regardless of current economic downturn. Construction projects appear to have high expenditure and are complex in nature.

Construction project operations may deal with fragmented project packages and diversified construction activities, and usually involve many participants and a wide range of related industries. These construction projects require high investment and advanced technologies which can increase construction project overheads considerably. Project overheads are allocated on a percentage basis to the contractor's building cost and common to maintain multiple cost objects, but cannot readily be distributed directly to construction activities.

The traditional costing system and current cost accounting management approaches are unable to satisfy the project cost measurement and the standard requirement on monitoring the status of project progress and cost performance in practice. Since the traditional costing system was initiated a very long time ago (Glad and Becker, 1997; and Giroux, 1999), and was established for estimating direct costs such as materials and labour (Daly, 2002), it is not applicable for assigning indirect project overheads accurately to construction activities in practice.

Project overheads and Critical Success Factors (CSFs) were identified and investigated in construction projects for the management of construction project overheads. Also, the CSFs and the application of the Activity-Based Costing (ABC) system for improving the management of project overheads have not yet been closely studied in construction projects. The management of construction project overheads and the ABC system were incorporated to propose the ABCC model. The CSFs and the ABCC model were incorporated into the effective tools and techniques of the Cost Management and Controlling Practices (CMCPs) to improve the management of construction project overheads. The proposed model is based on the context and principles of cost management and controlling practices which include *estimating, budgeting, and controlling* (Section 3.5 in chapter 3).

The characteristics of construction project overheads and the relevant features and important aspects of the ABC system maintained the process of the ABCC model development for improving the CMCPs. The most important CSFs were incorporated into the CMCPs' tools and techniques for the implementation of the ABCC model (Figure 6-1 in Chapter 6). These research findings and results are therefore documented as a contribution to *knowledge for reference (academic milieu)*, and *guidance for maintaining future construction projects (project practice and organisational advantages).*

### 7.1.1. Academic Milieu

Turney (1994) explained the ABC system as a reliable methodology for measuring resources, activities, and cost objects. The concept of the ABC system introduced the two-stage cost allocation process; the resource costs are assigned to particular activity pools, and activity costs are distributed to relevant cost objects (Cooper and Kaplan, 1988; Glad and Baker, 1997; Innes and Mitchell, 1998; Hicks, 1999; Drury, 2008). The underpinning philosophy of the ABC system is also described by Hicks (1999) as the jobs, projects, products or services provided by an organisation, requiring activities, and those activities cause it to incur resource costs. The concept and definition of the ABC system can be interpreted as the following: it provides relevant features such as reliable cost accounting and management, multiple cost pools, diverse cost drivers, several cost objects, and transparent cost tracers to develop cost management and controlling practices (Jaya *et al.*, 2010a). The costs are caused by activities, incurrence of the cost can therefore be managed, and the trigger of the cost should be controlled. The costs, activities, management, and control are important aspects for the management of construction project overheads (Jaya *et al.*, 2010b). These important aspects and relevant features are used to develop the ABCC model for improving the management of project overheads during the construction stage of construction projects (Jaya *et al.*, 2010c and 2011a). Therefore, the ABCC model and its application, using the CMCPs' tools and techniques of the management of construction project overheads, would be a contribution to the extended body of knowledge from the academic point of view (Jaya *et al.*, 2011b and 2012; and Figure 6-1).

### 7.1.2. Project Practices

The Critical Success Factors (CSFs) are defined as the limited number of areas, or the area of activities, that should receive constant and careful attention from management for successful competitive performance of organisations (Rockart, 1979). An explicit understanding of the CSFs can be shared among organisations, and necessary action should be taken in managing an organisation's environment (Forster and Rockart, 1989). In the context of cost management and controlling practices for monitoring the status of project progress and cost performance, the CMCPs' tools and techniques incorporate the three highest priority CSFs in order to implement the ABCC model to improve the management of project overheads (Figure 6-1). The project progress should provide the direct way to achieve affordable cost performance, such as to meet the quantity and quality of works, cost and time schedules, and budgeted cost of activities for the success of project completion and organisational advantages.

### 7.1.3. Organisational Advantages

Managing project activities should involve following the approval of clients' requirements for maintaining their projects (Walker, 2007). The roles of all project participants must be linked through agreements, convergence, and mutual understanding to commit fairly for successful project completion. The CSFs can provide explicit understanding to manage the organisational environment (Foster and Rockart, 1989). In order to prevent disputes, all project parties should take some responsibility for project overhead costs which may be incurred by inaccurate predictions, e.g., unpredictable technical problems, unforeseen underground activities, adjustment in market prices, etc. The selection of appropriate CSFs for a particular area of activities may take into account the main source of information for creating them, for instance, the characteristics of specific industries, the competitiveness of organisational strategies, the fluctuation in economic markets, investments and technologies, the temporary needs of internal organisations, the practical policy of project operational management levels, etc. The project cost management and controlling practices – the CMCPs of construction project overheads may have to refer much more to the organisational company policies of senior management levels, and not too much to an individual professional at operational level. Though this research focused on the contractor role, those contractors have to engage suppliers and consultants, and consultants also play an important role in monitoring and controlling the project on behalf of clients.

The three priority areas of important CSFs (METOOL, MARCON, and PROCOM) have been incorporated into the effective tools and techniques of the CMCPs in order to implement the ABCC model to improve the management of construction project overheads (Figure 6-1). Therefore, the three most important CSFs, the ABCC model, and the CMCPs' tools and techniques should be able to provide advantages for project participants, especially for primary contractors, specialist subcontractors, resource suppliers, consultancy firms, and client organisations.

## 7.2. The Overview of the Research Aim and Objectives

The research findings and results should be satisfactorily matched against the research aim and objectives. Chapter 1 placed the principal aim of this research: ***'to propose the Activity-Based Cost Controlling (ABCC) model for improving the management of construction project overheads'*** which focused on examining substructure activities of construction building projects. Toward achieving the research aim, five main objectives were also identified, they are:

**1.** Identification of project overheads during the construction stage.

**2.** Analysis of important CSFs for the management of construction project overheads.

**3.** Investigation of underpinning philosophy of the ABC system in construction projects.

**4.** Development of the ABCC model and implementation of the CMCPs' tools and techniques for improving the management of construction project overheads through project case studies.

**5.** Validation of development and implementation of the ABCC model through the expert interview outcomes.

### 7.2.1. The First Research Objective; Identification of project overheads

In order to satisfy the first research objective, the first research question: ***'what overheads are identified and included in construction projects?'*** has been answered by the research.

Approximately forty seven (47) items of project overheads were identified through the literature review. They have been categorised into four hierarchies, these are unit-level, batch level, project sustaining, and facility sustaining overheads (Table 7-1).

***Table 7-1: List of 47 Items of Project Overheads***

| Categories of Project Overheads | Items of Project Overheads | | |
|---|---|---|---|
| **Unit Level Overheads** | • Equipment depreciations | • Direct tool sets | • Safeguards |
| **Batch Level Overheads** | • General inspections<br>• Mobilisation and setup equipment<br>• Demobilisation materials and equipment<br>• Drawing reviews | • Change orders<br>• Sample of materials<br>• Material tests<br>• Placing purchase orders<br>• Materials deliveries | • Receiving materials<br>• Paying suppliers<br>• Moving materials<br>• Quality inspections<br>• Intermediate project release |
| **Project Sustaining Overheads** | • General planning<br>• Scheduling projects<br>• Planning resources<br>• Planning costs | • Engineering costs<br>• Controlling costs<br>• Project reporting<br>• Soft drawing | • As built drawing |
| **Facility Sustaining Overheads** | • Site-office & project storage<br>• Site-project administration<br>• Site-project supervision<br>• Site-project labour<br>• First aids<br>• Project insurance<br>• Legal expenses<br>• Rental plant and equipment | • Rental land, and base camp for workers<br>• Scaffolding<br>• Hoarding screen<br>• Temporary building<br>• Water supply<br>• Power and lighting<br>• Telephones and communications<br>• Security services | • Cleaning services<br>• Transport and haulage<br>• Managing contract conditions<br>• Project's working conditions<br>• Project sundries |

A questionnaire survey was developed in consultation with experts to collect quantitative data from project professionals. One hundred and seven (107) responses of two hundred and fifty (250) delivered questionnaires were received and considered as an adequate data set (response rate of 42.8 per cent), to be analysed (Fellow and Liu, 2008).

The descriptive statistical analysis revealed that thirty nine (39) items out of 47 project overheads were identified as most reliably present during the construction stage (Table 7-2). The other 8 items of overheads have been disqualified to maintain construction activities of the projects. They may be more focused to support general office overhead expenditures, e.g. Paying Suppliers, Project Sundries, Hoarding Screen, Placing Order, Receiving Materials, Material Deliveries, Managing Work Schedules, and Managing Contract Conditions.

***Table 7-2: List of 39 Construction Project Overheads***

| Categories of Construction Project Overheads | Items of Construction Project Overheads | | |
|---|---|---|---|
| **Unit Level Overheads** | • Equipment depreciations | • Direct tool sets | • Safeguards |
| **Batch Level Overheads** | • General inspections<br>• Mobilisation and setup equipment<br>• Demobilisation materials and equipment | • Drawing reviews<br>• Change orders<br>• Sample of materials<br>• Material tests | • Moving materials<br>• Quality inspections<br>• Intermediate project release |
| **Project Sustaining Overheads** | • General planning<br>• Scheduling projects<br>• Planning resources<br>• Planning costs | • Engineering costs<br>• Controlling costs<br>• Project reporting<br>• Soft drawing | • As built drawing |
| **Facility Sustaining Overheads** | • Site-office & project storage<br>• Site-project administration<br>• Site-project supervision<br>• Site-project labour<br>• First aids<br>• Project insurance<br>• Legal expenses | • Rental plant and equipment<br>• Rental land, and base camp for workers<br>• Scaffolding<br>• Temporary building<br>• Water supply | • Power and lighting<br>• Telephones and communications<br>• Security services<br>• Cleaning services<br>• Transport and haulage |

### 7.2.2. The Second Research Objective; Analysis of the Critical Success Factors (CSFs)

The identification of the most important CSFs in order to satisfy the second research objective entailed the second research question, which has been answered through this research; ***'What CSFs are important for improving the management of project overheads?'***

Through the literature review, forty (40) important CSFs were identified and grouped into eight categories, which are: understanding the market condition *(MARCON)*, project development focus *(DEFVOC)*, requirement of investment and technology *(INVTEC)*, mapping local availability of required resources *(LOCRES)*, company's interest and project benefit *(INTBEN)*, managing the nature of project complexity *(PROCOM)*, improving contractors' current roles in project practice *(ROPRAC)*, and the requirement for a robust method and tool *(METOOL)*. The specific focus of project success was also identified in construction projects into four e*valuation-criteria*, these are: *the Project Type* for commercial building constructions, *the Project Phase for* discrete construction stages, *the Project Monitoring* for construction activity progress and cost performance, and *the Project Deliveries* of the construction activity method.

Five experts were consulted (Table 4-5) to get their personal judgements for the evaluation-criteria. The questionnaire survey was also distributed to the 250 project professionals with 107 responses. The response rate of 42.8 per cent was considered as an appropriate data set to be analysed.

The Analytic Hierarchy Process (AHP) was used to analyse the most important of the eight CSF-alternatives in respect of the four evaluation-criteria. Each of the eight CSF-alternatives was assumed to have an average weight of 12.50 per cent. The top three priority areas of important CSFs were considered as having a greater weight than 12.50 per cent, they are: the requirement for a robust method and tool – METOOL which has a weight of 15.50 per cent to consider the available methods, tools and techniques for better CMCPs of construction project overheads; understanding the market conditions – MARCON (14.73 per cent) confirms actual resource prices for estimating practical project costs and expenses; and managing the nature of project complexity – PROCOM (13.01 per cent) provides the real challenges as well as opportunities to increase both the personnel and organisational competencies.

## 7.2.3. The Third Research Objective; Investigation of the Activity-Based Costing (ABC) System

The application of the ABC system was investigated in construction projects during the literature review stage for satisfying the third research question: '***Why and how could an underpinning philosophy of the ABC system be adapted in construction projects?'***

During the literature review, the two stage-concept of cost allocation was assessed, and this includes the resource cost being assigned to activity cost pools in the first stage, and the cost pools then being distributed to activity cost objects in the second stage. The underpinning philosophy of the ABC system was also discovered to be that the resource costs are caused by activities in order to realise projects. The incurrence of the costs can therefore be managed, and the triggers of the costs should be controlled in construction projects. The relevant features of the ABC system in construction projects include: reliable cost accounting, several cost pools, diverse cost drivers, multiple cost objects, transparent cost tracers, cost management and measurement.

Sections 2.9.3.1 and 2.9.3.2 described the process of adaptation of the ABC system from the manufacturing *'production'* principles into the *'construction'* processes, and Figure 2-3 (in Chapter 2) represents the application of the ABC system in construction projects. In addition, the ABC system provides advantages to the construction projects, where *the cost, activity, management, and control* are considered as the important aspects to develop the ABCC model for improving the management of construction project overheads, and through the implementation of the CMCPs' tools and techniques.

### 7.2.4. The Fourth Research Objective; Development of the ABCC Model and implementation of the CMCPs' Tools and Techniques

The ABCC model was developed and implemented through the effective tools and techniques of the CMCPs in order to fulfil this objective involving the fourth research question: ***'How could the ABCC model be developed and implemented on substructure activities of construction building projects, for improving the management of construction project overheads?'***

The development of the ABCC model identified three convergent themes through the literature review, there are: the management of project overheads; the ABC system; and the CMCPs of construction project overheads. Figure 3-2 (the structure of the ABCC model) and Figure 3-4 (Project cost measurement model) were developed during the literature review stage. Project cost parameters were considered, they are *project revenue, cost, expenses, profits, and project benefits*. *Project revenue* is the project contract price that comes into the construction company's income for the completion of construction activities, during the period of time. The ABCC model considers *site-project overhead costs only*, instead of the other types of construction cost components, such as materials, labour, contingency, profit, and general office overheads. *Project expenses* are the financial value incurred to purchase the utilised resources in order to accomplish construction activities. *Project profit* is the excess revenue over the total of authorised cost components, while *project benefits* are the result of the additional cost savings into, or subtractive cost deficits from, the initial profit.

*The six-steps* of the cost distribution process of the ABCC model were implemented through project case studies on the substructure activities of construction building projects, to examine the implementation of the CMCPs' tools and techniques one case study is discussed and explained as an illustrative example. The *favourable savings or unfavourable deficits* are very much dependant on the effective management and control mechanisms of the cost performance index through the implementation of the CMCPs' tools and techniques of project overheads during the construction stage.

There are two cost measurements which can be used to monitor the present status of project progress and cost performance, they are: the ratio between Activity Progress Value *(APV)* and Overhead Cost Schedule *(OCS)* named the Value and Schedule Ratio *(VSR)*; and the ratio between APV and Actual Project Expenses, called the Value and Expenses Ratio *(VER)*. These two present cost ratio indices (VSR and VER) can be used to forecast three different estimates of future cost performance indices (Estimate at Completion *forecast* - EAC*f*). The three different statuses of future cost performance indices consider three different assumptions of present conditions, therefore the future cost performance indices should be able to improve by accomplishing the remaining activities, through:

**1.** Supporting actual project cost analysis into the same present budget rates (OCS).

**2.** Continuing the same experience as the present VER into the future project expenses.

**3.** Reflecting the efficiency rates of the present cost schedule performance (VSR) and actual cost performance (VER) into the future project expenses.

The three different values of future cost performance could result in three different statuses of project cost savings or deficits with regard to budgeted cost schedules. This ambiguous cost information can be resolved through the management by exception, the Worst Case Scenario *(WCS)*, which considers the project status in both the lowest favourable savings and the highest unfavourable deficits. The project management decision should be made with the early warning of updated information of project cost performance, especially when the unfavourable project cost goes beyond an unacceptable limit. Therefore, the project benefits should enable an increased performance through the implementation of the CMCPs' tools and techniques of project overheads effectively, during the construction stage of construction projects.

### 7.2.5. The Fifth Research Objective; Validation of the ABCC Model

The ABCC model development and implementation was validated through examining experts of senior and operational managers, by answering the fifth research question, ***'How could the ABCC model be validated for improving the management of construction project overheads?'*** The advantages of the ABCC model were examined through empirical studies of the three convergent themes, they are:

1. The management of project overheads, as discussed in Section 5.5.2; Section 6.2; and Section 7.2.1.
2. The application of the ABC system, in Section 5.5.3; Section 6.4; and Section 7.2.3.
3. The implementation of the CMCPs of construction project overheads, which is presented in Section 5.5.4; Section 6.5; and Section 7.2.4.

Senior and operational managers provided expert views/ individual opinions, and 36 merging concepts were managed through content analysis, and incorporated into the ABCC model. The qualitative content analysis presentation was combined with cognitive mapping, in order to provide clearer visual graphs of cognitive presentation during the refinement stage of the ABCC model. The management of construction project overheads and the application of the ABC system in construction projects should reflect the process of development of the ABCC model for improving the cost management and controlling practices – the CMCPs of project overheads. Therefore, the expert interview outcomes of senior and operational management should enable the validation and justification of the development and implementation of the ABCC model for improving the CMCPs' tools and techniques of construction project overheads.

## 7.3. Conclusions

Construction project overheads have been identified during the literature review stage, forty seven generic overheads were identified in construction projects, from which eight overheads were disqualified through descriptive statistics analysis, due to its inconsistent occurrence in construction projects. The remaining 39 construction project overheads are most often present in construction projects and they are categorised into four hierarchies: unit level, batch level, project sustaining, and facility sustaining overheads.

Forty Critical Success Factors (CSFs) were identified and grouped into eight important CSFs during the literature review. The three most important CSFs are prioritised through Analytic Hierarchy Process (AHP) techniques (e.g., the requirement of a robust method and tools – METOOL, understanding the market condition – MARCON, and managing project complexity – PROCOM). It was considered that only a limited number of areas of activities should have constant and careful attention paid from project management in practice for improving the management of construction project overheads.

The ABC system provides a suitable concept of the 'two-stage' process of cost allocations, with relevant features and the underpinning philosophy with important aspects. The two-stage cost allocation includes: the resource costs being allocated to activity pools during the first stage and these activity costs being assigned into cost objects during the second stage, from which the relevant features have been derived as the knowledge (e.g., the reliable cost accounting system, hierarchical cost pools, diverse cost drivers, various cost objects, and transparent cost tracers). The philosophy of the ABC system is that the jobs, projects and services require activities, and these activities incur costs, or the costs are caused by activities for accomplishing the jobs, project and services from which the important aspects are considered for the management of construction project overheads (e.g., the cost, activity, management, and control). The relevant features and important aspects of the ABC system and the management of project overheads were incorporated to maintain the development of the ABCC model through utilising six-steps of the cost distribution process for the implementation of the Cost Management and Controlling Practice – CMCPs' tools and techniques of construction project overheads, they are:

**1.** Identifying project overheads and their cost accounts.

**2.** Categorising overhead cost pools related to particular activities.

**3.** Idealising quantity drivers of project overheads.

**4.** Calculating ideal cost drivers of project overheads.

**5.** Assigning project overheads to cost objects.

**6.** Determining activity driver rates of project overheads per activity duration.

Therefore, the top three priority CSFs are incorporated into the effective tools and techniques of the CMCPs for the implementation of the ABCC model to improve the management of project overheads during the construction stage.

## 7.4. Recommendations for Future Research

Five main components are fulfilled against the research aim and objectives, and these have been documented in *the area of the cost management and controlling practices – the CMCPs of* ***construction project overheads****,* e.g., the identification of construction project overheads (Section 6.2); the three priority areas of important CSFs (Section 6.3); the relevant features of the ABC system in construction projects (Section 2.9.1 and Section 2.9.3.2); the implementation of the ABCC model development (refer to Section 6.4); and the effective tools and techniques of the CMCPs for improving the management of construction project overheads (Section 6.5). These can be extended to future research on the management of ***general office overheads***.

## 7.5. Summary

This chapter summarised the main findings from the literature review, and the results from field research through a questionnaire survey, case study documentation, observations, and interviews. Project overheads were defined in general terms based on the accounting viewpoint and distributed on a percentage basis to construction activities, however, the specific characteristics of project overheads in construction projects need to be explored accordingly. This research therefore provides a better understanding of the process of management and controlling practices of construction project overheads and has made a contribution to the body of knowledge in both theory and practice within construction projects of the construction industry.

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# APPENDICES

# APPENDIX 1: AN EXAMPLE OF PROJECT COST MEASURES

# Appendix 1: The Ratio of Activity Progress Values (APV) and Actual Project Expenses (APE); an example

***Problem:***

The traditional costing system and cost accounting management approach, including unclearly defined, arbitrarily allocated, and inaccurately distributed the project overheads related to construction activities.

***Case example:***

Excavating activity: 400 m3

Excavator rent and operator rate: £500 per week (£2,000 for a month)

***Schedule:***

| **Week** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Excavation | 160 $m^3$ | 120 $m^3$ | 60 $m^3$ | 60 $m^3$ |
| Overhead Cost Scheduled *(OCS)* | £800 | £600 | £300 | £300 |

***Execution:***

| | | | | |
|---|---|---|---|---|
| Activity Progress Value *(APV)* | 120 $m^3$ | 100 $m^3$ | 100 $m^3$ | 80 $m^3$ |
| Actual Project Expenses *(AVE)* | £500 | £500 | £500 | £500 |

***Measurement:***

***Week 1:***

$APV_1 = 120m^3 * \frac{£800}{160m^3} = £600$

$AVE_1 = £500$

Value and Expenses Ratio $(VER)_1 = \frac{£600}{£500} = 1.20 > 1$ → it is ***'saving'*** (refer to section 2.7.4)

***Week 4:***

Cumulative $APV_{1-4} = (120 + 100 + 100 + 80)m^3 * \frac{£(800+600+300+300)}{(160+120+60+60)m^3} = £2,000$

Cumulative $AVE_{1-4} = £2,000$

Cumulative Value and Expenses Ratio $(VER)_{1-4} = 1$ → it stands on initial ***'planned profits'*** (refer to Section 2.7.4)

***Note:***

This measurement example would discus in more details in case study calculation examples of Cost Management and Controlling Practices (CMCPs) of project overheads in Appendix 5-d and Appendix 5-e.

# APPENDIX 2: RESEARCH INSTRUMENT

# Appendix 2-a: Survey Questionnaire

University of Salford MANCHESTER

The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

## Participant Invitation Letter

Dear Sir/Madam,

I am a PhD researcher at the School of the Built Environment, College of Science and Technology, the University of Salford, Manchester, United Kingdom, supervised by Dr. Chaminda Pathirage and Dr. Monty Sutrisna. My research aims to apply the Activity-Based Costing (ABC) system in construction projects, to develop Activity-Based Cost Controlling (ABCC) model for improving the management of project overheads during the construction stage. The specific focus will be on the substructure activities of construction building projects.

The ABCC model will be developed, implemented, and justified through project case studies. Research objectives are given below:

- Identify project overheads during the construction stage.
- Analyse the importance of Critical Success Factors (CSFs) for management of project overheads.
- Investigate the underpinning philosophy of the ABC system in construction projects.
- Develop and Implement the ABCC model on substructure activities of construction building projects.
- Justify the ABCC model for the management of project overheads through expert interviews.

I will very much appreciate your participation in this research. Please be informed, this research refers to Ethical Approval documents, such as: Participant Information Sheet, Participant Consent Form, Research Instrument, and Draft Interview Guide.

Your participation is entirely voluntarily and appropriate arrangements will be made for maintaining data storage and processing. Electronic data stored in computers and portable hard drives will be protected by personal password. Hard copy data will be locked in filling cabinets. Interview data will be managed using NVivo on a password protected computer. However, when the research is completed, all recording data will be destroyed.

I thank you very much in advance for your assistance.

Yours faithfully,

**Nyoman M Jaya**
Phd researcher

APPENDIX 2: Research Instrument

The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

## Research Instrument: Questionnaire

## Development of Activity-Base Cost Controlling (ABCC) Model to Improve the Management of Project Overheads during the Construction Stage

City and Date: ..............................................

**Identification of Respondent:**

Name : ..............................................

Organisation : ..............................................

Project : ..............................................

Current job title : ..............................................

Education : ..............................................

Experience (overall) : .............. years

Experience (in resent job) : .............. years

**Questionnaires:**

**1.** What percentage of ***general-office overhead*** is approximately added on to the building costs?

☐ Up to 5%, ☐ >5%-10%, ☐ >10%-15%, ☐ >15%-20%, ☐ >20%-25%

**2.** What percentage of ***site-project overhead*** is approximately added on to the building costs?

☐ Up to 5%, ☐ >5%-10%, ☐ >10%-15%, ☐ >15%-20%, ☐ >20%-25%

**3.** Approximately what percentage of ***project profit*** is added on to the building costs?

☐ Up to 5%, ☐ >5%-10%, ☐ >10%-15%, ☐ >15%-20%, ☐ >20%-25%

**4.** According to your expereinces, what is the percentage comparison between ***general-office*** and ***site-project*** overheads?

☐ 0%-20% : 100%-80%, ☐ >20%-40% : <80%-60%, ☐ >40%-60% : <60%-40%,

☐ >60%-80% : <40%-20%, ☐ >80%-100% : <20%-0%

1

APPENDIX 2: Research Instrument

The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

**5.** Please rank your degree of agreement on following ***items*** being included in identified ***categories*** of site-project overheads:

| Items of site-project overheads | Strongly disagree (1) | Disagree (2) | Neutral (3) | Agree (4) | Strongly agree (5) |
|---|---|---|---|---|---|
| **Unit level overheads:** activity costs that assigned by the unit of occurrences, where overhead costs are traced for every unit of outputs. | | | | | |
| • Equipment Depreciations | 1 | 2 | 3 | 4 | 5 |
| • Direct tool sets | 1 | 2 | 3 | 4 | 5 |
| • Safeguards | 1 | 2 | 3 | 4 | 5 |
| *Please state any other.....* | 1 | 2 | 3 | 4 | 5 |
| ……………………………….. | 1 | 2 | 3 | 4 | 5 |
| **Batch level overheads:** activity costs that assigned by the batch of occurrences, where overhead costs are traced for every batch of outputs, regardless the size of the batches | | | | | |
| • General inspections | 1 | 2 | 3 | 4 | 5 |
| • Mobilisation and setup equipment | 1 | 2 | 3 | 4 | 5 |
| • Demobilisation materials and equipment | 1 | 2 | 3 | 4 | 5 |
| • Drawing reviews | 1 | 2 | 3 | 4 | 5 |
| • Change orders | 1 | 2 | 3 | 4 | 5 |
| • Sample of materials | 1 | 2 | 3 | 4 | 5 |
| • Material tests | 1 | 2 | 3 | 4 | 5 |
| • Placing purchase orders | 1 | 2 | 3 | 4 | 5 |
| • Materials deliveries | 1 | 2 | 3 | 4 | 5 |
| • Receiving materials | 1 | 2 | 3 | 4 | 5 |
| • Paying suppliers | 1 | 2 | 3 | 4 | 5 |
| • Moving materials | 1 | 2 | 3 | 4 | 5 |
| • Quality inspections | 1 | 2 | 3 | 4 | 5 |
| • Intermediate project release | 1 | 2 | 3 | 4 | 5 |
| *Please state any other.....* | 1 | 2 | 3 | 4 | 5 |
| ………………………………. | 1 | 2 | 3 | 4 | 5 |
| **Project sustaining overheads:** activity costs that assigned by individual occurrences of product bases, where overhead costs are traced for every output of products, regardless the size of units and batches. | | | | | |
| • General planning | 1 | 2 | 3 | 4 | 5 |
| • Scheduling projects | 1 | 2 | 3 | 4 | 5 |
| • Planning resources | 1 | 2 | 3 | 4 | 5 |
| • Planning costs | 1 | 2 | 3 | 4 | 5 |
| • Engineering costs | 1 | 2 | 3 | 4 | 5 |
| • Controlling costs | 1 | 2 | 3 | 4 | 5 |
| • Project reporting & photos | 1 | 2 | 3 | 4 | 5 |

University of Salford MANCHESTER
The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

| | | | | | |
|---|---|---|---|---|---|
| • Soft drawing | 1 | 2 | 3 | 4 | 5 |
| • As built drawing | 1 | 2 | 3 | 4 | 5 |
| *Please state any other.....* | 1 | 2 | 3 | 4 | 5 |
| ...................................... | 1 | 2 | 3 | 4 | 5 |
| **Facility sustaining overheads:** activity costs that assigned by the facility employed for output bases, where overhead costs are traced to support a whole project. | | | | | |
| • Site-office & project storage | 1 | 2 | 3 | 4 | 5 |
| • Site-project administration | 1 | 2 | 3 | 4 | 5 |
| • Site-project supervision | 1 | 2 | 3 | 4 | 5 |
| • Site-project labour | 1 | 2 | 3 | 4 | 5 |
| • First aids | 1 | 2 | 3 | 4 | 5 |
| • Project insurance | 1 | 2 | 3 | 4 | 5 |
| • Legal expenses | 1 | 2 | 3 | 4 | 5 |
| • Rental plant and equipment | 1 | 2 | 3 | 4 | 5 |
| • Rental land and basecamp for workers | 1 | 2 | 3 | 4 | 5 |
| • Scaffolding | 1 | 2 | 3 | 4 | 5 |
| • Hoarding and screen | 1 | 2 | 3 | 4 | 5 |
| • Temporary building | 1 | 2 | 3 | 4 | 5 |
| • Water supply | 1 | 2 | 3 | 4 | 5 |
| • Power and lighting | 1 | 2 | 3 | 4 | 5 |
| • Telephones and communications | 1 | 2 | 3 | 4 | 5 |
| • Security services | 1 | 2 | 3 | 4 | 5 |
| • Cleaning services | 1 | 2 | 3 | 4 | 5 |
| • Transport and haulage | 1 | 2 | 3 | 4 | 5 |
| • Managing contract conditions | 1 | 2 | 3 | 4 | 5 |
| • Managing project's working conditions | 1 | 2 | 3 | 4 | 5 |
| • Project sundries | 1 | 2 | 3 | 4 | 5 |
| *Please state any other.....* | 1 | 2 | 3 | 4 | 5 |
| ..................................... | 1 | 2 | 3 | 4 | 5 |
| **Please insert your addition comments on these categories and items of site-project overheads:** | | | | | |

3

University of Salford MANCHESTER

The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

**6.** Please indicate (in all columns provided) the degree of importance of following ***Critical Success Factors (CSFs)*** in respect of ***Project Criteria (e.g., Project Commercial Building Types, Project Construction Phase, Project Status Monitoring, and Project Delivery)*** for improving the management of project overheads:

**(1)** Indicate: **Not important**
**(2)** Indicate: **Merely important**
**(3)** Indicate: **Moderate**
**(4)** Indicate: **Mostly important**
**(5)** Indicate: **Highly important**

| **Critical Success Factors (CSFs)** | **Project Commercial Building Type** | | | | | **Project Construction Phase** | | | | | **Project Status Monitoring** | | | | | **Project Delivery** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction Industry** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| Understanding the effect of unstable economy | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Adaptation to industrial downturns | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Rationing project job cuts and redundancy | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Project outsourcing | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Global market conditions | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Strategy of crisis recovery | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Development focus on new project | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Requirement of higher investment | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Requirement of modern technology | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Requirement of skilled human resources | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Higher quantity and quality of materials | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Local availability of required resources | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Dependency of other producer sectors | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Cyclical business and company interests | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| *Please state any other.....* | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| ....................................... | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |

APPENDIX 2: Research Instrument

University of Salford MANCHESTER
The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

| **Construction Plan** | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sophistication of client's values | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Complexity of construction operation | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Buildability of project designs | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Predictability of project costs | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Constructability of project buildings | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Intricate nature of site-based projects | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Diversifies of typical activities | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Fragmented project packages | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Reliability of project parties | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| *Please state any other...* | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| ……………………………… | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| **Construction Operation** | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** |
| Experiences of the specialist subcontractors | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Project size and scopes | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Project locations | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Project durations | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Vision and definition of project overheads | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Participant's perspectives on project overheads | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Proportional ratios of project overheads | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| The roles and current practices for project overheads | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Implication of the role and regulation on project practice | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Practical knowledge of construction process | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Adaptation of the traditional costing system | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |

5

# APPENDIX 2: Research Instrument

The University of Salford, Manchester M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment.
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alternative methods of costing system | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Updated project's activity cost data | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Specific adjustment on initial cost data | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Monitoring project status | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| *Please state any other…* | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| ……………………………… | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| **Construction cost control** | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** |
| Requirement of robust and vigorous method | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Requirement of practical cost controlling model, tool and technique | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| *Please state any other…* | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| ……………………………… | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |

**Please insert additional CSFs for improving the cost management and controlling practice of project overheads:**

6

# Appendix 2-b: Interview Guide

University of Salford MANCHESTER

The University of Salford, Manchester, M5 4WT, United Kingdom
College of Science and Technology, School of the Built Environment
Nyoman M Jaya, PhD Researcher
Office : Maxwell Building, Room 413
Phone : +44 (0) 161 295 5328
Mobile : +44 (0) 794 369 7996
Email : n.m.jaya@edu.salford.ac.uk

## Semi Structured Interview Guideline

**Development of Activity-Based Cost Controlling (ABCC) Model to Improve Management of Project Overheads during the Construction Stage**

**SECTION1: TIME AND LOCATION**

Date :
Time :
Location :

**SECTION2: INTERVIEWEE DATA**

Name :
Address :
Email :
Organisation :
Education :
Current Job title :
Profession : Academia, Consultant, Constructor, Government agent, Other.....
Work experience (overall) : years
Work experience (in recent job) : years

**SECTION 3: QUESTION**

**Part A: Project overheads**

1. Are you familiar with project overheads?
2. What type of project overheads do you know?
3. Are you aware of home-office and site-project overheads?
4. How do you allocate home office and site-project overheads in your projects?
5. What is the likelihood percentage of project overheads to total project cost?
6. Can you predict the percentage proportion (out of 100%) between home-office overheads and site-project overheads?
7. Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than to allocate them arbitrarily on direct labour basis?

**Part B: Activity-Based Costing (ABC) system**

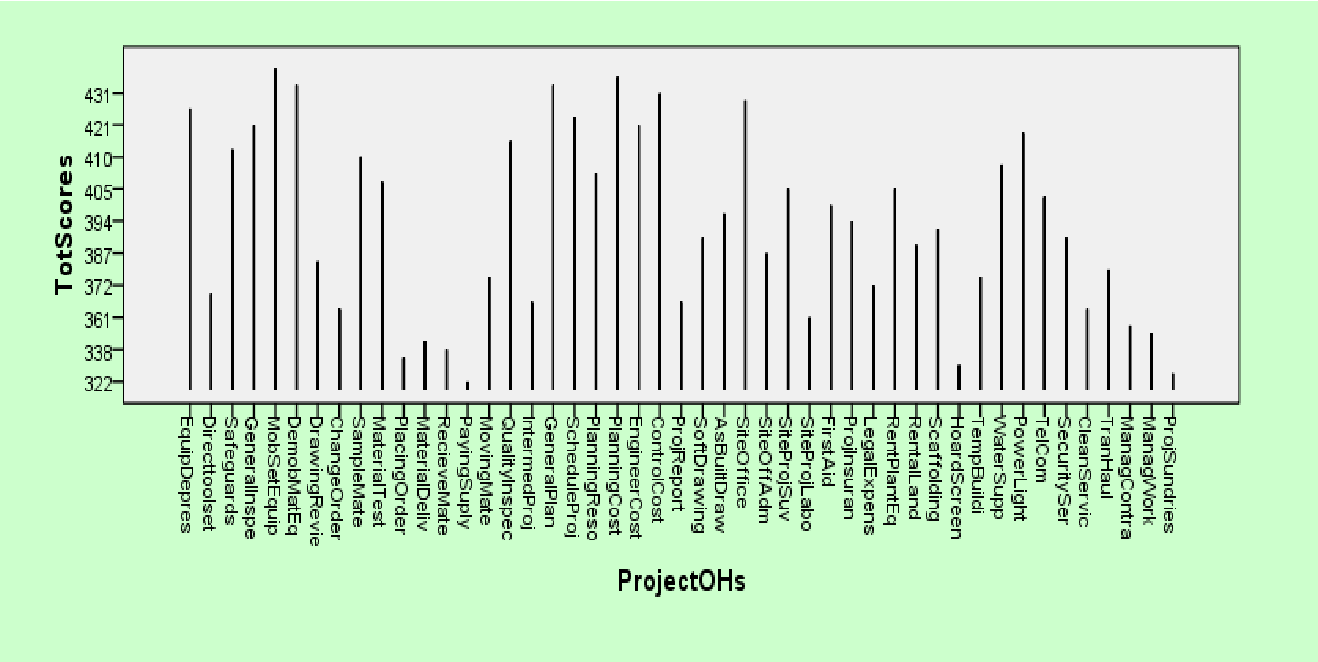
8. Are you familiar with cost controlling techniques during construction stage?
9. Which cost controlling tools and techniques do you use?
10. Are you familiar with the ABC system?
11. Is the ABC system important to be applied in construction projects?
12. What are the advantages of the ABC system?
13. What are the limitations of the ABC system?

**Part C: Cost Management and Controlling Practice**

14. Can the ABC-Control system be implemented in a construction project?
15. In which project stage does the ABC-Controlling appropriate?
16. Can you explain the advantages and disadvantages of the ABCC model?
17. Can you compare the ABCC model to other tools (e.g., EVM, TCPI, variance analysis, forecasting, etc.)?
18. Can you think of any contributions from ABCC model at organisation level, management level, and project level?

# APPENDIX 3: DESCRIPTIVE STATISTIC ANALYSIS OF PROJECT OVERHEADS

## Appendix 3-a: Descriptive Statistic Analyses for Identification and Availability of Project Overheads




**Statistics**

TotScores

| | | |
|---|---|---|
| N | Valid | 47 |
| | Missing | 0 |
| Mean | | 389.81 |
| Std. Error of Mean | | 4.891 |
| Median | | 391.00 |
| Mode | | 364[a] |
| Std. Deviation | | 33.529 |
| Variance | | 1.124E3 |
| Skewness | | -.325 |
| Std. Error of Skewness | | .347 |
| Range | | 124 |
| Minimum | | 322 |
| Maximum | | 446 |
| Sum | | 18321 |

a. Multiple modes exist. The smallest value is shown

**Descriptive Statistics**

| | N | Range | Minimum | Maximum | Sum | Mean | | Std. Deviation | Variance | Skewness | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic | Statistic | Std. Error |
| TotScores | 47 | 124 | 322 | 446 | 18321 | 389.81 | 4.891 | 33.529 | 1.124E3 | -.325 | .347 |
| Valid N (listwise) | 47 | | | | | | | | | | |

DataSet1] C:\Documents and Settings\pzp503.ISDADS\My Documents\NYOMAN'S PHD WORKS\DATA Analysis\Questionnaire SPSS\Project OH Identification 107 responses by IBM SPSS Statistics 20.sav

# APPENDIX 4: ANALYTIC HIERARCHY PROCESS (AHP) FOR CRITICAL SUCCESS FACTORS (CSFS)

# Appendix 4-a: Relative Importance of the Evaluation-criteria

Weighted Elements of the Evaluation-criteria

| aluation-criteria | Scores |
|---|---|
| Project Types | 725 |
| Project Phases | 778 |
| Project Monitoring | 869 |
| Project Deliveries | 611 |

Number of Pair-wise Comparisons (NoC):

NOC = n(n-1)/2
NOC = 4(4-1)/2
NOC = **6**

Pair-wise Comparison and Reciprocal Matrices of the Evaluation-criteria

| Criteria | Types | Phases | Monitors | Deliveries |
|---|---|---|---|---|
| Types | **725/725** | 725/778 | 725/869 | 725/611 |
| Phases | 778/725 | **778/778** | 778/869 | 778/611 |
| Monitors | 869/725 | 869/778 | **869/869** | 869/611 |
| Deliveries | 611/725 | 611/778 | 611/869 | **611/611** |
| **SUM** | **4.114483** | **3.834190** | **3.432681** | **4.882160** |

Matrix Algebra of the Evaluation-criteria

| Criteria | Types | Phases | Monitors | Deliveries |
|---|---|---|---|---|
| **Types** | **1** | 0.931877 | 0.834292 | 1.186579 |
| **Phases** | 1.073103 | **1** | 0.895282 | 1.273322 |
| **Monitors** | 1.198621 | 1.116967 | **1** | 1.422259 |
| **Deliveries** | 0.842759 | 0.785347 | 0.703107 | **1** |
| **Column Sum** | **4.114483** | **3.834190** | **3.432681** | **4.882160** |

First Iteration of Squared Matrices of the Evaluation-criteria

| Criteria | Types | Phases | Monitors | Deliveries | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|
| Types | 4 | 3.727506 | 3.337169 | 4.746318 | 15.810993 | 0.243044 |
| Phases | 4.292414 | 4 | 3.581128 | 5.093290 | 16.966831 | 0.260811 |
| Monitors | 4.794483 | 4.467866 | 4 | 5.689034 | 18.951383 | 0.291317 |
| Deliveries | 3.371034 | 3.141388 | 2.812428 | 4 | 13.324851 | 0.204827 |
| **Column Sum** | **16.457931** | **15.336761** | **13.730725** | **19.528642** | **65.054059** | **1** |

Second Iteration of Squared Matrices of the Evaluation-criteria

| Criteria | Types | Phases | Monitors | Deliveries | Row Sum | Eigenvector | Change | Ranking Importance |
|---|---|---|---|---|---|---|---|---|
| Types | **64** | 59.640103 | 53.394707 | 75.941080 | 252.975890 | 0.243044 | 0.00 | The ***3rd*** important criterion |
| Phases | 68.678621 | **64** | 57.298044 | 81.492635 | 271.469299 | 0.260811 | 0.00 | The ***2nd*** important criterion |
| Monitors | 76.711724 | 71.485861 | **64** | 91.024550 | 303.222135 | 0.291317 | 0.00 | The ***1st*** important criterion |
| Deliveries | 53.936552 | 50.262211 | 44.998849 | **64** | 213.197612 | 0.204827 | 0.00 | The ***4th*** important criterion |
| **Column Sum** | **263.326897** | **245.388175** | **219.691600** | **312.458265** | **1,040.864936** | **1** | 0.00 | |

**Consistency Check**

Need Principal Eigenvalue (the largest Eigenvalue):

| | |
|---|---|
| n = | 4 |
| λmax = | 4.000 |
| CI = (λmax - n) / (n-1) = | 0.000 |
| Random Consistency Index (RI) = | 0.90 |
| Consistency Ratio (CR) = CI/RI = | 0.000 *< 10% (**ok**)* |

# Appendix 4-b: Relative Importance of CSF-alternatives under the Project Type

Weighted Factos of CSF-alternatives under the Project Type

| CSFs | Weights |
|---|---|
| MARCON | 375.00 |
| DEVFOC | 309.00 |
| INVTEC | 286.67 |
| LOCRES | 283.50 |
| INTBEN | 255.00 |
| PROCOM | 334.62 |
| ROPRAC | 305.60 |
| METOOL | 393.13 |

Number of Pair-wise Comparisons (NoC):

| |
|---|
| NOC = n (n-1)/2 |
| NOC = 8(8-1)/2 |
| NOC = **28** |

Pair-wise Comparisons and Reciprocal Matrices of CSF-alternatives under the Project Type

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL |
|---|---|---|---|---|---|---|---|---|
| **MARCON** | | | | | | | | |
| **DEVFOC** | | | | | | **Number of Comparisons** | | |
| **INVTEC** | | | | | | | | |
| **LOCRES** | | | | | | | | |
| **INTBEN** | | | | | | | | |
| **PROCOM** | | | **Reciprocals** | | | | | |
| **ROPRAC** | | | | | | | | |
| **METOOL** | | | | | | | | |
| Column Sum | | | | | | | | |

Matrix Algebra of CSF-alternatives under the Project Type

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.213592 | 1.30813953 | 1.322751 | 1.470588 | 1.12069 | 1.227094 | 0.953895 | 9.61675 |
| **DEVFOC** | 0.824 | 1 | 1.07790698 | 1.089947 | 1.211765 | 0.923448 | 1.011126 | 0.78601 | 7.924202 |
| **INVTEC** | 0.764444 | 0.927724 | 1 | 1.01117 | 1.124183 | 0.856705 | 0.938045 | 0.7292 | 7.351471 |
| **LOCRES** | 0.756 | 0.917476 | 0.98895349 | 1 | 1.111765 | 0.847241 | 0.927683 | 0.721145 | 7.270263 |
| **INTBEN** | 0.68 | 0.825243 | 0.88953488 | 0.899471 | 1 | 0.762069 | 0.834424 | 0.648649 | 6.53939 |
| **PROCOM** | 0.892308 | 1.082898 | 1.16726297 | 1.180301 | 1.312217 | 1 | 1.094946 | 0.851168 | 8.5811 |
| **ROPRAC** | 0.814933 | 0.988997 | 1.06604651 | 1.077954 | 1.198431 | 0.913287 | 1 | 0.777361 | 7.83701 |
| **METOOL** | 1.048333 | 1.272249 | 1.37136628 | 1.386684 | 1.541667 | 1.174856 | 1.286404 | 1 | 10.08156 |
| Column Sum | 6.780019 | 8.228178 | 8.86921064 | 8.968279 | 9.970616 | 7.598297 | 8.319722 | 6.467427 | 65.20175 |

First Iteration of Squared Matrices of CSF-alternatives under the Project Type

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 8 | 9.708738 | 10.4651163 | 10.58201 | 11.76471 | 8.965517 | 9.816754 | 7.631161 | 76.934 | 0.14797563 |
| **DEVFOC** | 5.768 | 8 | 8.62325581 | 8.719577 | 9.694118 | 7.387586 | 8.089005 | 6.288076 | 62.56962 | 0.120347 |
| **INVTEC** | 6.115556 | 7.421791 | 8 | 8.089359 | 8.993464 | 6.85364 | 6.508201 | 5.833598 | 57.81561 | 0.111203 |
| **LOCRES** | 6.048 | 7.339806 | 7.91162791 | 8 | 8.894118 | 6.777931 | 7.421466 | 5.769157 | 58.16211 | 0.11186958 |
| **INTBEN** | 5.44 | 6.601942 | 7.11627907 | 7.195767 | 8 | 6.096552 | 6.675393 | 5.189189 | 52.31512 | 0.10062343 |
| **PROCOM** | 7.138462 | 8.663181 | 9.33810376 | 10.49996 | 10.49774 | 8 | 7.76858 | 6.809343 | 68.71537 | 0.13216782 |
| **ROPRAC** | 6.519467 | 7.911974 | 8.52837209 | 8.623633 | 9.587451 | 7.306299 | 8 | 6.268455 | 62.74565 | 0.12068561 |
| **METOOL** | 8.386667 | 10.17799 | 10.9709302 | 11.09347 | 12.33333 | 9.398851 | 10.29123 | 8 | 80.65248 | 0.15512778 |
| Column Sum | 53.41615 | 65.82543 | 70.9536852 | 72.80378 | 79.76493 | 60.78638 | 64.57063 | 51.78898 | 519.91 | 1 |

Second Iteration of Squired Matrices of CSF-alternatives under Project Type

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Ror Sum | Eigenvector | Rank | Changes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 504 | 621.3592 | 669.767442 | 686.7302 | 752.9412 | 573.7931 | 608.9626 | 488.8809 | 4906.43 | 0.1481122 | 2nd | -0.0001366 |
| **DEVFOC** | 408.704 | 504 | 543.265116 | 557.1461 | 610.7294 | 465.4179 | 493.6962 | 396.5498 | 3979.51 | 0.1201308 | 5th | 0.0002163 |
| **INVTEC** | 378.7856 | 467.113 | 503.5044 | 516.3765 | 566.031 | 431.3547 | 457.5488 | 367.4779 | 3688.19 | 0.1113367 | 7th | -0.0001336 |
| **LOCRES** | 381.024 | 469.7476 | 506.344186 | 519.168 | 569.2235 | 433.7876 | 460.3757 | 369.5939 | 3709.26 | 0.1119728 | 6th | -0.0001032 |
| **INTBEN** | 342.72 | 422.5243 | 455.44186 | 466.9765 | 512 | 390.1793 | 414.0946 | 332.439 | 3336.38 | 0.1007163 | 8th | -0.0000929 |
| **PROCOM** | 449.6584 | 554.3652 | 597.554099 | 612.6891 | 671.7602 | 511.9276 | 526.6293 | 436.1214 | 4360.71 | 0.1316381 | 3rd | 0.0005297 |
| **ROPRAC** | 411.1421 | 506.8708 | 546.359623 | 560.1892 | 614.2082 | 468.069 | 496.774 | 398.8019 | 4002.41 | 0.1208222 | 4th | -0.0001366 |
| **METOOL** | 528.36 | 651.3916 | 702.139535 | 719.9221 | 789.3333 | 601.5264 | 638.3958 | 512.5101 | 5143.58 | 0.1552709 | 1st | -0.0001432 |
| Column Sum | 3404 | 4197.372 | 4524.37622 | 4639.198 | 5086.227 | 3876.056 | 4096.477 | 3302.375 | 33126.47 | 1 | | 0.0000000 |

**Consistency Check**

| Need Principal Eigenvalue, λmax (the largest eigenvalue): | |
|---|---|
| n = | 8 |
| λmax = | 7.998172 |
| CI = (λmax - n) / (n-1) = - | 0.000261 |
| Random Consistency Index (RI) = | 1.41 |
| Consistency Ratio (CR) = CI/RI = | **-0.0185% < 10% *(ok)*** |

# Appendix 4-c: Relative Importance of CSF-alternatives under the Project Phase

Weighted Factos of CSFs-alternatives under the Project Phase

| CSFs | Weights |
|---|---|
| MARCON | 408.40 |
| DEVFOC | 340.50 |
| INVTEC | 309.33 |
| LOCRES | 310.50 |
| INTBEN | 287.00 |
| PROCOM | 363.08 |
| ROPRAC | 337.20 |
| METOOL | 429.88 |

Number of Pair-wise Comparisons (NoC):

NOC = n (n-1)/2
NOC = 8(8-1)/2
NOC = **28**

Pair-wise Comparisons and Reciprocal Matrices of CSF-alternatives under the Project Phase

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL |
|---|---|---|---|---|---|---|---|---|
| **MARCON** | | | | | | | | |
| **DEVFOC** | | | | | | **Number of Comparisons** | | |
| **INVTEC** | | | | | | | | |
| **LOCRES** | | | | | | | | |
| **INTBEN** | | **Reciprocals** | | | | | | |
| **PROCOM** | | | | | | | | |
| **ROPRAC** | | | | | | | | |
| **METOOL** | | | | | | | | |
| Column Sum | | | | | | | | |

Matrix Algebra of CSF-alternatives under the Project Phase

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.199413 | 1.3202586 | 1.315298 | 1.422997 | 1.124831 | 1.211151 | 0.950044 | 9.54399 |
| **DEVFOC** | 0.833741 | 1 | 1.1007543 | 1.096618 | 1.186411 | 0.937818 | 1.009786 | 0.792091 | 7.95722 |
| **INVTEC** | 0.757427 | 0.908468 | 1 | 0.996243 | 1.077816 | 0.851977 | 0.917359 | 0.719589 | 7.228879 |
| **LOCRES** | 0.760284 | 0.911894 | 1.0037716 | 1 | 1.081882 | 0.855191 | 0.920819 | 0.722303 | 7.256144 |
| **INTBEN** | 0.702742 | 0.842878 | 0.9278017 | 0.924316 | 1 | 0.790466 | 0.851127 | 0.667636 | 6.706967 |
| **PROCOM** | 0.889023 | 1.066305 | 1.1737401 | 1.16933 | 1.265076 | 1 | 1.076741 | 0.84461 | 8.484825 |
| **ROPRAC** | 0.825661 | 0.990308 | 1.0900862 | 1.08599 | 1.174913 | 0.928729 | 1 | 0.784414 | 7.880102 |
| **METOOL** | 1.052583 | 1.262482 | 1.3896821 | 1.384461 | 1.497822 | 1.183978 | 1.274837 | 1 | 10.04584 |
| Column Sum | 6.821462 | 8.181748 | 9.0060946 | 8.972255 | 9.706917 | 7.672989 | 8.261819 | 6.480687 | 65.10397 |

First Iteration of Squared Matrices of CSF-alternatives under the Project Phase

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 8 | 9.595301 | 10.562069 | 10.52238 | 11.38397 | 8.998644 | 9.689205 | 7.600349 | 76.35192 | 0.14708038 |
| **DEVFOC** | 5.83619 | 8 | 8.8060345 | 8.772947 | 9.491289 | 7.502542 | 8.078292 | 6.336726 | 62.82402 | 0.121021 |
| **INVTEC** | 6.059419 | 7.267744 | 8 | 7.969941 | 8.622532 | 6.815819 | 7.338727 | 5.756712 | 56.83787 | 0.109490 |
| **LOCRES** | 6.082272 | 7.295154 | 8.0301724 | 8 | 8.655052 | 6.841525 | 7.366548 | 5.778424 | 58.04915 | 0.111823 |
| **INTBEN** | 5.621939 | 6.743025 | 7.4224138 | 7.394525 | 8 | 6.323729 | 6.809015 | 5.341088 | 53.65573 | 0.10335962 |
| **PROCOM** | 7.112183 | 8.530442 | 9.3899204 | 10.41438 | 10.12061 | 8 | 7.619814 | 6.756884 | 67.94423 | 0.13088425 |
| **ROPRAC** | 6.605289 | 7.922467 | 8.7206897 | 8.687923 | 9.399303 | 7.429831 | 8 | 6.32179 | 63.08729 | 0.12152809 |
| **METOOL** | 8.420666 | 10.09985 | 11.117457 | 11.07568 | 11.98258 | 9.471822 | 10.1987 | 8 | 80.36676 | 0.15481435 |
| Column Sum | 53.73796 | 65.45399 | 72.048757 | 72.83778 | 77.65534 | 61.38391 | 64.10727 | 51.89197 | 519.117 | 1 |

Second Iteration of Squired Matrices of CSF-alternatives under Project Phase

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Ror Sum | Eigenvector | Rank | Changes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 504 | 614.0993 | 675.97241 | 682.9688 | 728.5742 | 575.9132 | 600.6735 | 486.8727 | 4869.07 | 0.147209 | 2nd | -0.0001283 |
| **DEVFOC** | 413.5357 | 504 | 554.78017 | 560.6464 | 597.9512 | 472.6602 | 492.7281 | 399.5892 | 3995.89 | 0.120809 | 5th | 0.0002115 |
| **INVTEC** | 375.1832 | 457.2672 | 503.3389 | 508.6706 | 542.5069 | 428.8333 | 447.0212 | 362.4921 | 3625.31 | 0.109606 | 7th | -0.0001161 |
| **LOCRES** | 383.1832 | 466.8899 | 513.93103 | 519.2502 | 553.9233 | 437.8576 | 456.6825 | 370.1615 | 3701.88 | 0.111920 | 6th | -0.0000976 |
| **INTBEN** | 354.1822 | 431.5536 | 475.03448 | 479.9511 | 512 | 404.7186 | 422.1188 | 342.1461 | 3421.70 | 0.103450 | 8th | -0.0000902 |
| **PROCOM** | 447.9468 | 545.8034 | 600.79548 | 607.016 | 647.5473 | 511.8642 | 519.427 | 432.68 | 4313.08 | 0.130399 | 3rd | 0.0004851 |
| **ROPRAC** | 416.5246 | 507.5073 | 558.64085 | 564.4155 | 602.1123 | 475.9494 | 496.4268 | 402.3636 | 4023.94 | 0.121657 | 4th | -0.0001294 |
| **METOOL** | 530.502 | 646.3906 | 711.51724 | 718.8815 | 766.885 | 606.1966 | 632.2589 | 512.474 | 5125.11 | 0.154949 | 1st | -0.0001351 |
| Column Sum | 3425 | 4173.511 | 4594.0105 | 4641.8 | 4951.5 | 3913.993 | 4067.337 | 3308.779 | 33075.99 | 1 | | 0.0000000 |

**Consistency Check**

Need Principal Eigenvalue, λmax (the largest eigenvalue):

n = 8

λmax = 7.997929

CI = (λmax - n) / (n-1) = - 0.000296

Random Consistency Index (RI) = 1.41

Consistency Ratio (CR) = CI/RI = **-0.0210% *< 10% (ok)***

# Appendix 4-d: Relative Importance of CSF-alternatives under the Project Monitoring

Weighted Factos of CSFs-alternatives under the Project Monitoring

| CSFs | Weights |
|---|---|
| MARCON | 445.60 |
| DEVFOC | 377.00 |
| INVTEC | 356.00 |
| LOCRES | 345.00 |
| INTBEN | 328.50 |
| PROCOM | 396.54 |
| ROPRAC | 367.80 |
| METOOL | 458.00 |

Number of Pair-wise Comparisons (NoC):

NOC = n (n-1)/2
NOC = 8(8-1)/2
NOC = **28**

Pair-wise Comparisons and Reciprocal Matrices of CSFs-alternatives under the Project Monitoring

| Alternativ | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL |
|---|---|---|---|---|---|---|---|---|
| MARCON | | | | | | | | |
| DEVFOC | | | | | | **Number of Comparisons** | | |
| INVTEC | | | | | | | | |
| LOCRES | | | | | | | | |
| INTBEN | | **Reciprocals** | | | | | | |
| PROCOM | | | | | | | | |
| ROPRAC | | | | | | | | |
| METOOL | | | | | | | | |
| Column Sum | | | | | | | | |

Matrix Algebra of CSF-alternatives under the Project Monitoring

| Alternativ | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.181963 | 1.2516854 | 1.291594 | 1.356469 | 1.123725 | 1.211528 | 0.972926 | 9.38989 |
| **DEVFOC** | 0.84605 | 1 | 1.0589888 | 1.092754 | 1.147641 | 0.950727 | 1.025014 | 0.823144 | 7.944319 |
| **INVTEC** | 0.798923 | 0.944297 | 1 | 1.031884 | 1.083714 | 0.897769 | 0.967917 | 0.777293 | 7.501797 |
| **LOCRES** | 0.774237 | 0.915119 | 0.9691011 | 1 | 1.050228 | 0.870029 | 0.93801 | 0.753275 | 7.27 |
| **INTBEN** | 0.737208 | 0.871353 | 0.9227528 | 0.952174 | 1 | 0.828419 | 0.893148 | 0.717249 | 6.922304 |
| **PROCOM** | 0.889898 | 1.051826 | 1.1138721 | 1.149387 | 1.207119 | 1 | 1.078136 | 0.865805 | 8.356042 |
| **ROPRAC** | 0.825404 | 0.975597 | 1.0331461 | 1.066087 | 1.119635 | 0.927527 | 1 | 0.803057 | 7.750452 |
| **METOOL** | 1.027828 | 1.214854 | 1.2865169 | 1.327536 | 1.394216 | 1.154995 | 1.245242 | 1 | 9.651188 |
| Column Su | 6.899548 | 8.155009 | 8.6360631 | 8.911416 | 9.359021 | 7.753191 | 8.358995 | 6.712748 | 64.78599 |

First Iteration of Squared Matrices of CSF-alternatives under the Project Monitoring

| Alternativ | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 8 | 9.455703 | 10.013483 | 10.33275 | 10.85175 | 8.989796 | 9.692224 | 7.783406 | 75.11912 | 0.14542981 |
| **DEVFOC** | 5.922352 | 8 | 8.4719101 | 8.742029 | 9.181126 | 7.60582 | 8.200109 | 6.585153 | 62.7085 | 0.121403 |
| **INVTEC** | 6.391382 | 7.554377 | 8 | 8.255072 | 8.669711 | 7.182153 | 6.744368 | 6.218341 | 59.0154 | 0.114253 |
| **LOCRES** | 6.193896 | 7.320955 | 7.752809 | 8 | 8.401826 | 6.960233 | 7.504078 | 6.026201 | 58.16 | 0.112597 |
| **INTBEN** | 5.897666 | 6.970822 | 7.3820225 | 7.617391 | 8 | 6.627352 | 7.145188 | 5.737991 | 55.37843 | 0.10721206 |
| **PROCOM** | 7.119182 | 8.414609 | 8.9109767 | 10.23905 | 9.656949 | 8 | 7.631194 | 6.926436 | 66.8984 | 0.12951459 |
| **ROPRAC** | 6.603232 | 7.804775 | 8.2651685 | 8.528696 | 8.957078 | 7.420213 | 8 | 6.463241 | 62.0424 | 0.12011343 |
| **METOOL** | 8.222621 | 9.718833 | 10.292135 | 10.62029 | 11.15373 | 9.239961 | 9.961936 | 8 | 77.2095 | 0.14947678 |
| Column Su | 54.35033 | 65.24007 | 69.088505 | 72.33528 | 74.87217 | 62.02553 | 64.8791 | 53.74077 | 516.5318 | 1 |

Second Iteration of Squired Matrices of CSF-alternatives under Project Monitoring

| Alternativ | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Ror Sum | Eigenvector | Rank | Changes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 504 | 605.165 | 640.86292 | 670.6812 | 694.512 | 575.347 | 601.3643 | 498.5139 | 4790.45 | 0.145533 | 2nd | -0.0001031 |
| **DEVFOC** | 419.6409 | 504 | 533.73034 | 558.688 | 578.411 | 479.1666 | 500.5843 | 415.1827 | 3989.40 | 0.121197 | 4th | 0.0002056 |
| **INVTEC** | 396.0607 | 475.6834 | 503.7433 | 527.3026 | 545.9136 | 452.2452 | 472.4518 | 391.8175 | 3765.22 | 0.114387 | 6th | -0.0001335 |
| **LOCRES** | 390.2154 | 468.5411 | 496.17978 | 519.2662 | 537.7169 | 445.4549 | 465.5984 | 385.9679 | 3708.94 | 0.112677 | 7th | -0.0000798 |
| **INTBEN** | 371.553 | 446.1326 | 472.44944 | 494.4317 | 512 | 424.1505 | 443.3307 | 367.5086 | 3531.56 | 0.107288 | 8th | -0.0000760 |
| **PROCOM** | 448.4117 | 538.4206 | 570.18137 | 596.7127 | 617.9135 | 511.8913 | 523.1963 | 443.4937 | 4250.22 | 0.129121 | 3rd | 0.0003936 |
| **ROPRAC** | 416.3225 | 499.8825 | 529.36998 | 553.9948 | 573.6856 | 475.252 | 496.7548 | 411.7857 | 3957.05 | 0.120214 | 5th | -0.0001010 |
| **METOOL** | 518.0251 | 622.0053 | 658.69663 | 689.3446 | 713.8387 | 591.3575 | 618.0988 | 512.3864 | 4923.75 | 0.149583 | 1st | -0.0001059 |
| Column Su | 3464 | 4159.831 | 4405.2138 | 4610.422 | 4773.991 | 3954.865 | 4121.379 | 3426.656 | 32916.59 | 1 | | 0.0000000 |

**Consistency Check**

Need Principal Eigenvalue, λmax (the largest eigenvalue):

n = 8

λmax = 7.998632

CI = (λmax - n) / (n-1) = -0.000195

ındom Consistency Index (RI) = 1.41

Consistency Ratio (CR) = CI/RI = **-0.0139% < 10% *(ok)***

# Appendix 4-e: Relative Importance of CSF-alternatives under the Project Delivery

Weighted Factos of CSFs-alternatives under the Project Delivery

| CSFs | Weights |
|---|---|
| MARCON | 336.20 |
| DEVFOC | 276.50 |
| INVTEC | 250.00 |
| LOCRES | 244.50 |
| INTBEN | 225.00 |
| PROCOM | 292.31 |
| ROPRAC | 273.40 |
| METOOL | 366.13 |

Number of Pair-wise Comparisons (NoC):

NOC = n (n-1)/2
NOC = 8(8-1)/2
NOC = **28**

Pair-wise Comparisons and Reciprocal Matrices of CSF-alternatives under the Project Delivery

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL |
|---|---|---|---|---|---|---|---|---|
| MARCON | | | | | | | | |
| DEVFOC | | | | | | **Number of Comparisons** | | |
| INVTEC | | | | | | | | |
| LOCRES | | | | | | | | |
| INTBEN | | **Reciprocals** | | | | | | |
| PROCOM | | | | | | | | |
| ROPRAC | | | | | | | | |
| METOOL | | | | | | | | |
| Column Sum | | | | | | | | |

Matrix Algebra of CSF-alternatives under the Project Delivery

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum |
|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 1 | 1.215913 | 1.3448 | 1.375051 | 1.494222 | 1.150158 | 1.2297 | 0.918266 | 9.72811 |
| **DEVFOC** | 0.822427 | 1 | 1.106 | 1.130879 | 1.228889 | 0.945921 | 1.011339 | 0.755207 | 8.000662 |
| **INVTEC** | 0.743605 | 0.904159 | 1 | 1.022495 | 1.111111 | 0.855263 | 0.914411 | 0.682827 | 7.233871 |
| **LOCRES** | 0.727246 | 0.884268 | 0.978 | 1 | 1.086667 | 0.836447 | 0.894294 | 0.667805 | 7.074726 |
| **INTBEN** | 0.669244 | 0.813743 | 0.9 | 0.920245 | 1 | 0.769737 | 0.82297 | 0.614544 | 6.510484 |
| **PROCOM** | 0.869446 | 1.057171 | 1.1692308 | 1.195532 | 1.299145 | 1 | 1.069158 | 0.798382 | 8.458065 |
| **ROPRAC** | 0.813206 | 0.988788 | 1.0936 | 1.1182 | 1.215111 | 0.935316 | 1 | 0.74674 | 7.910962 |
| **METOOL** | 1.08901 | 1.324141 | 1.4645 | 1.497444 | 1.627222 | 1.252533 | 1.339155 | 1 | 10.594 |
| Column Sum | 6.734184 | 8.188183 | 9.0561308 | 9.259847 | 10.06237 | 7.745375 | 8.281027 | 6.18377 | 65.51088 |

First Iteration of Squared Matrices of CSF-alternatives under the Project Delivery

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Row Sum | Eigenvector |
|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 8 | 9.727306 | 10.7584 | 11.00041 | 11.95378 | 9.201263 | 9.837601 | 7.346125 | 77.82488 | 0.14896391 |
| **DEVFOC** | 5.75699 | 8 | 8.848 | 9.047035 | 9.831111 | 7.567368 | 8.09071 | 6.041652 | 63.18287 | 0.120938 |
| **INVTEC** | 5.94884 | 7.233273 | 8 | 8.179959 | 8.888889 | 6.842105 | 6.322614 | 5.462615 | 56.8783 | 0.108870 |
| **LOCRES** | 5.817965 | 7.074141 | 7.824 | 8 | 8.693333 | 6.691579 | 7.154353 | 5.342438 | 56.59781 | 0.108333 |
| **INTBEN** | 5.353956 | 6.509946 | 7.2 | 7.361963 | 8 | 6.157895 | 6.58376 | 4.916354 | 52.08387 | 0.09969328 |
| **PROCOM** | 6.955567 | 8.457365 | 9.3538462 | 10.66455 | 10.39316 | 8 | 7.558044 | 6.387058 | 67.7696 | 0.12971718 |
| **ROPRAC** | 6.505651 | 7.910307 | 8.7488 | 8.945603 | 9.720889 | 7.482526 | 8 | 6.038057 | 63.35183 | 0.12126118 |
| **METOOL** | 8.712076 | 10.59313 | 11.716 | 11.97955 | 13.01778 | 10.02026 | 10.71324 | 8 | 84.75204 | 0.16222311 |
| Column Sum | 53.05105 | 65.50547 | 72.449046 | 75.17907 | 80.49894 | 61.963 | 64.26032 | 49.5343 | 522.4412 | 1 |

Second Iteration of Squired Matrices of CSF-alternatives under Project Delivery

| Alternatives | MARCON | DEVFOC | INVTEC | LOCRES | INTBEN | PROCOM | ROPRAC | METOOL | Ror Sum | Eigenvector | Rank | Changes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MARCON** | 504 | 622.5476 | 688.5376 | 714.1503 | 765.0418 | 588.8808 | 609.7696 | 470.783 | 4963.71 | 0.149112 | 2nd | -0.0001477 |
| **DEVFOC** | 407.9239 | 504 | 557.424 | 578.2895 | 619.36 | 476.7442 | 493.4003 | 381.143 | 4018.28 | 0.120711 | 5th | 0.0002270 |
| **INVTEC** | 368.3189 | 455.0771 | 503.3153 | 522.1656 | 559.2392 | 430.467 | 445.4863 | 344.0828 | 3628.15 | 0.108991 | 6th | -0.0001207 |
| **LOCRES** | 366.5318 | 452.745 | 500.736 | 519.3627 | 556.3733 | 428.2611 | 443.4523 | 342.3749 | 3609.84 | 0.108441 | 7th | -0.0001074 |
| **INTBEN** | 337.2992 | 416.6365 | 460.8 | 477.9411 | 512 | 394.1053 | 408.0849 | 315.0689 | 3321.94 | 0.099792 | 8th | -0.0000989 |
| **PROCOM** | 438.1276 | 541.1825 | 598.54789 | 620.8145 | 665.0532 | 511.916 | 514.3158 | 409.1894 | 4299.15 | 0.129148 | 3rd | 0.0005693 |
| **ROPRAC** | 410.4148 | 506.9391 | 560.67467 | 581.52 | 622.9719 | 479.5244 | 496.5557 | 383.3569 | 4041.96 | 0.121422 | 4th | -0.0001607 |
| **METOOL** | 548.8608 | 677.9602 | 749.824 | 777.7164 | 833.1378 | 641.2968 | 664.0449 | 512.6872 | 5405.53 | 0.162384 | 1st | -0.0001609 |
| Column Sum | 3381 | 4177.088 | 4619.8595 | 4791.96 | 5133.177 | 3951.196 | 4075.11 | 3158.686 | 33288.55 | 1 | | 0.0000000 |

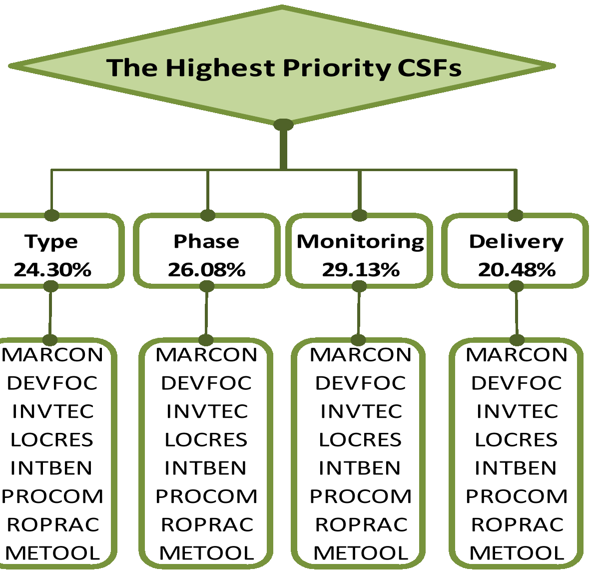
**Consistency Check**

Need Principal Eigenvalue, λmax (the largest eigenvalue):

| | |
|---|---|
| n = | 8 |
| λmax = | 7.997815 |
| CI = (λmax - n) / (n-1) = | -0.000312 |
| Random Consistency Index (RI) = | 1.41 |
| Consistency Ratio (CR) = CI/RI = | **-0.0221% < 10% *(ok)*** |

# Appendix 4-f: The Solution Matrices through the AHP Tree

AHP Solution Tree for CSF-alternatives under the Evaluation-criteria




AHP Solution Matrix of CSF-Alternatives under Evaluation-criteria

| ALTERNATIVE | Type | Phase | Monitoring | Delivery |
|---|---|---|---|---|
| | RANKING | | | |
| MARCON | 0.148112189 | 0.147208722 | 0.145532894 | 0.149111634 |
| DEVFOC | 0.120130759 | 0.120809419 | 0.121197368 | 0.120710711 |
| INVTEC | 0.111336686 | 0.109605596 | 0.11438665 | 0.108990986 |
| LOCRES | 0.111972815 | 0.111920442 | 0.112676949 | 0.108440793 |
| INTBEN | 0.100716288 | 0.103449812 | 0.107288051 | 0.099792141 |
| PROCOM | 0.131638076 | 0.130399126 | 0.129120952 | 0.129147904 |
| ROPRAC | 0.120822242 | 0.121657447 | 0.120214404 | 0.121421841 |
| METOOL | 0.155270945 | 0.154949436 | 0.149582732 | 0.162383989 |
| Column Sum | 1 | 1 | 1 | 1 |

X

| RANKING | CRITERIA |
|---|---|
| 0.243043916 | Type |
| 0.260811264 | Phase |
| 0.291317466 | Monitoring |
| 0.204827355 | Delivery |
| 100% | |

Ranking of Importance of CSF-alternatives

| | | |
|---|---|---|
| MARCON | 0.147329875 | 2nd |
| DEVFOC | 0.120737273 | 5th |
| INVTEC | 0.111293243 | 7th |
| LOCRES | 0.111440827 | 6th |
| INTBEN | 0.103154401 | 8th |
| PROCOM | 0.130071606 | 3rd |
| ROPRAC | 0.120985813 | 4th |
| METOOL | 0.154986962 | 1st |
| **CSFs** | **1** | **Ranking** |

The Priority of Importance of CSF-Alternatives

| CSFs | 1 | Order | Differences |
|---|---|---|---|
| ***METOOL*** | ***0.154986962*** | ***1st*** | |
| ***MARCON*** | ***0.147329875*** | ***2nd*** | 0.007657087 |
| ***PROCOM*** | ***0.130071606*** | ***3rd*** | 0.017258268 |
| **ROPRAC** | 0.120985813 | 4th | 0.009085793 |
| **DEVFOC** | 0.120737273 | 5th | 0.000248540 |
| **LOCRES** | 0.111440827 | 6th | 0.009296446 |
| **INVTEC** | 0.111293243 | 7th | 0.000147584 |
| **INTBEN** | 0.103154401 | 8th | 0.008138842 |

# APPENDIX 5: PROJECT CASE STUDIES

## Appendix 5-a: The Case Study Data of Project Overheads for the Resort Project (Basement/ Substructure)

# SUMMARY RESORT (BASEMENT)

| Percent | Amount Original | Category | Percent | Amount Actual |
|---|---|---|---|---|
| 8.45% | 475,589,710.00 | Labor | 8.45% | 475,589,710.00 |
| 66.70% | 3,752,193,279.32 | Material | 67.56% | 3,800,588,672.87 |
| 24.85% | 1,397,648,064.68 | Subcontractor | 24.85% | 1,397,648,064.68 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | **5,625,431,054.00** | Net Costs | | **5,673,826,447.55** |
| 4.18% | 235,384,349.08 | ALAT BANTU | 4.15% | 235,384,349.08 |
| 5.11% | 287,294,872.70 | PRELIM+fee lap./adm termin+jaminan | 4.03% | 228,603,542.86 |
| | **6,148,110,275.78** | **Subtotal** | | **6,137,814,339.48** |
| 4.35% | 426,383,737.50 | OH KANTOR = 4.35% DARI RAB | 4.35% | 426,383,737.50 |
| 21.11% | **2,069,021,569.84** | PROFIT | 21.21% | **2,079,317,506.14** |
| | **8,643,515,583.12** | **Total Estimate** | | **8,643,515,583.12** |
| 3.00% | 267,325,250.05 | PPH ( 3% DARI RC) | 3.00% | 267,325,250.05 |
| 10.00% | 891,084,166.83 | PPN ( 10% DARI RC) | 10.00% | 891,084,166.83 |
| | **9,801,925,000.00** | **Total Estimate with Taxes** | | **9,801,925,000.00** |

Actual Progress Schedule, the Resort (Basement) Project

| IDN | ACTIVITIES | DURATION | Jul-10 | | | | Aug-10 | | | | Sep-10 | | | | Oct-10 | | | | Nov-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| A.1 | Preparation | 4 | | | | | | | | | | | | | | | | | | | | |
| A.2 | Precast Concrete Pile | 18 | | | | | | | | | | | | | | | | | | | | |
| A.3 | Excavation & Back fill | 18 | | | | | | | | | | | | | | | | | | | | |
| A.4 | Pile Cap | 9 | | | | | | | | | | | | | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 16 | | | | | | | | | | | | | | | | | | | | |
| | Sub total | 65 | | | | | | | | | | | | | | | | | | | | |

APPENDIX 5: Project Case Studies

Data of Project Overheads for Basement / Substructure

| Description | Actual Quantity | UOM | Actual Costs | |
|---|---|---|---|---|
| 1st | 2nd | 3rd | 4th | |
| Upah Pekerjaan Galian dg alat *(Excavator+Opr)* | 1875.12 | m3 | 46,878,000.00 | |
| Upah Pekerjaan Pasang Bowplank *(Measurements)* | 260 | m | 780,000.00 | |
| Upah Pekerjaan Urugan Pasir dipadatkan *(Compactor+Opr)* | 389.07 | m3 | 3,501,630.00 | |
| Upah Pekerjaan Urugan tanah dipadatkan *(Compactor+Opr)* | 384.71 | m3 | 4,231,810.00 | |
| Sub. Pekerjaan Anti rayap tanah *(Anti termit soil treatment)* | 4220.33 | m2 | 35,872,805.00 | |
| Sub. Pekerjaan Pondasi Tiang Pancang *(drilling PC pile)* | 3714 | m | 1,140,158,584.68 | |
| Sub. Pekerjaan *Waterproofing* integral sistem cementaid | 765 | m2 | 221,616,675.00 | |
| *Site manager* | | | 24,300,000.00 | |
| Tunjangan jabatan SM | 5 | bln | 7,390,000.00 | |
| Tunjangan transport SM | 5 | bln | 1,050,000.00 | |
| Uang makan SM | 150 | hr | 1,800,000.00 | |
| Uang lembur SM | 160 | jam | 560,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji SM | 5 | bln | 13,000,000.00 | |
| Pelaksana sipil 1 Orang *(Civil Engineer)* | | | 10,530,000.00 | |
| Tunjangan jabatan pelaksana sipil | 5 | bln | 3,500,000.00 | |
| Uang makan pelaksana sipil | 150 | hr | 1,800,000.00 | |
| Uang lembur pelaksana | 160 | jam | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji pelaksana sipil | 5 | bln | 4,250,000.00 | |
| *Drawing* | | | 12,170,000.00 | |
| Tunjangan jabatan drawing | 5 | bln | 5,420,000.00 | |
| Uang makan drawing | 150 | hr | 1,800,000.00 | |
| Uang lembur drawing | 150 | jam | 450,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji drawing | 5 | bln | 4,000,000.00 | |
| *QS* | | | 15,150,000.00 | |
| Tunjangan jabatan QS | 5 | bln | 5,420,000.00 | |
| Tunjangan transport QS | 5 | hr | 1,050,000.00 | |
| Uang makan QS | 150 | jam | 1,200,000.00 | |
| Uang lembur QS | 160 | bln | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji QS | 5 | bln | 6,500,000.00 | |
| *Logistik* | | | 11,030,000.00 | |
| Tunjangan jabatan | 5 | bln | 4,000,000.00 | |
| Tunjangan transport Logistik | 5 | bln | 500,000.00 | |
| Uang makan | 150 | bln | 1,800,000.00 | |
| Uang lembur | 160 | jam | 480,000.00 | |
| Tunjangan jauh | 5 | bln | 500,000.00 | |
| Gaji | 5 | bln | 3,750,000.00 | |
| Pemondokan staf *(Staff house rent)* | 5 | bln | 3,750,000.00 | |
| *(Office Supplies)* | | | | 25,995,500.00 |
| Banten sehari hari | 5 | bln | 450,000.00 | 14,378,000.00 |
| Banten mulai kerja | 1 | ls | 2,500,000.00 | |
| Komputer komplit | 2 | bh | 9,000,000.00 | |
| printer | 1 | bh | 1,500,000.00 | |
| Meja kantor | 2 | bh | 500,000.00 | |
| Kursi kantor | 2 | bh | 100,000.00 | |
| Kursi plastik | 8 | bh | 240,000.00 | |
| Kertas A3 | 1 | rim | 55,000.00 | |
| Keras A4 | 1 | rim | 33,000.00 | |
| Cetak foto *(Photo print)* | 100 | lbr | 150,000.00 | |
| Tinta printer | 2 | bln | 960,000.00 | 1,282,500.00 |
| Pelubang kertas | 1 | bh | 7,500.00 | |
| Bulpoin | 2 | ls | 100,000.00 | |
| Pensil | 2 | ls | 100,000.00 | |
| Spidol | 2 | ls | 40,000.00 | |
| Stabilo warna | 2 | ls | 70,000.00 | |
| Tip ex | 1 | ls | 5,000.00 | |
| Helm proyek *(Project helmet)* | 50 | bh | 750,000.00 | |
| Sepatu konsultan *(Safety shoes)* | 1 | psg | 300,000.00 | |
| sepatu staf *(Sfety shoes)* | 5 | psg | 1,500,000.00 | |
| Tabung pemadam kebakaran *(Fire safety kit)* | 1 | bh | 600,000.00 | |

Data of Project Overheads for Basement / Substructure *(continue)*

| Description | Actual Quantity | UOM | Actual Costs | |
|---|---|---|---|---|
| 1st | 2nd | 3rd | 4th | |
| P3k *(First aids)* | 1 | ls | 50,000.00 | |
| lakban | 10 | roll | 500,000.00 | 10,135,000.00 |
| pengaris | 1 | ls | 25,000.00 | |
| Fotocopy | 500 | lbr | 300,000.00 | |
| Maff teka besar | 10 | bh | 110,000.00 | |
| Air aqua | 25 | gln | 275,000.00 | |
| Kopi | 5 | bln | 400,000.00 | |
| Gula | 5 | bln | 250,000.00 | |
| Konsumsi tenaga lembur | 1500 | bks | 7,500,000.00 | |
| Konsumsi lembur staf | 60 | bln | 600,000.00 | |
| Pemanas air konsultan dan staf | 1 | bh | 175,000.00 | |
| Sewa kendaraan stand by *(Car rent)* | 30 | hr | 4,500,000.00 | |
| Sewa kendaraan antar jemput tenaga *(Car rent)* | 30 | hr | 600,000.00 | |
| Bensin stamper | 2 | bln | 200,000.00 | 200,000.00 |
| Fee konsultan *(Specialty consultant)* | 5 | ls | 15,000,000.00 | |
| *Telepon* | 5 | bln | 10,000,000.00 | |
| KANTOR DIREKSIKET *(Site office)* | | | 8,870,642.86 | |
| Plywood 6 mm | 20 | lbr | 1,200,000.00 | |
| AC | 1 | unit | 3,000,000.00 | |
| Paku 3 cm | 1 | kg | 16,000.00 | |
| Paku 5 cm | 2 | kg | 21,785.71 | |
| Paku 7 cm | 2 | kg | 21,428.57 | |
| Paku 10 cm | 2 | kg | 21,428.57 | |
| Upah pembuatan direksiket | 102 | m2 | 4,590,000.00 | |
| GUDANG BAHAN *(Storage)* | | | 6,144,900.00 | |
| Balok 6/12 albesia | 1.64 | m3 | 1,894,200.00 | |
| Usuk 4/6 albesia | 0.78 | m3 | 859,950.00 | |
| Plywood 6 mm | 15 | lbr | 900,000.00 | |
| Plywood 8 mm | 4 | lbr | 380,000.00 | |
| Asbes gelombang | 32 | lbr | 560,000.00 | |
| Paku asbes | 2 | kg | 36,000.00 | |
| Paku 3 cm | 5 | kg | 80,000.00 | |
| Paku 5 cm | 5 | kg | 54,464.29 | |
| Paku 7 cm | 10 | kg | 107,142.86 | |
| Paku 10 cm | 10 | kg | 107,142.86 | |
| Engsel pintu | 1 | set | 30,000.00 | |
| Gembok | 1 | set | 21,000.00 | |
| Grendel kunci pintu | 1 | set | 15,000.00 | |
| Upah pembuatan gudang bahan | 20 | m2 | 1,100,000.00 | |
| KAMAR MANDI *(Toilet)* | | | 462,500.00 | |
| Bak mandi | 1 | bh | 80,000.00 | |
| Kran air | 3 | bh | 45,000.00 | |
| Gayung plastik | 3 | bh | 90,000.00 | |
| Ub.buat kamar mandi | 4.5 | m2 | 247,500.00 | |
| Sewa tanah utk Direksiket *(Land rent)* | 1 | are | 10,500,000.00 | |
| Sewa tanah utk jalan proyek *(Land rent)* | 3 | are | 31,500,000.00 | |
| Sumbangan *(Donation)* | 1 | ls | 5,000,000.00 | |
| Listrik+air *(Power+water)* | 5 | bln | 7,500,000.00 | |
| Alat komonikasi ht *(Handy talky)* | 2 | bh | 1,500,000.00 | |
| Kipem tenaga *(ID cards)* | 325 | org | 16,250,000.00 | |
| Harian gudang dan pembantu *(Cleaner)* | 5 | bln | 4,500,000.00 | |
| *(Scafolding & formwork)* | | | 83,431,250.00 | |
| Scafolding | 3312.25 | m2 | 82,806,250.00 | |
| Scafolding | 25 | m2 | 625,000.00 | |
| *(Concrete Pump)* | | | 37,035,150.00 | |
| Sewa concrete pump per m3 | 20.4 | m3 | 377,400.00 | |
| Sewa concrete pump per m3 | 16.09 | m3 | 297,665.00 | |
| Sewa concrete pump per m3 | 4.9 | m3 | 90,650.00 | |
| Sewa concrete pump per m3 | 330.31 | m3 | 6,110,735.00 | |
| Sewa concrete pump per m3 | 64.78 | m3 | 1,198,430.00 | |
| Sewa concrete pump per m3 | 713.99 | m3 | 13,208,815.00 | |
| Sewa concrete pump per m3 | 715.22 | m3 | 13,231,570.00 | |
| Sewa concrete pump per m3 | 136.21 | m3 | 2,519,885.00 | |

# Appendix 5-b: Cost Measurement and Analysis of the ABCC Model

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of tables).
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Duration (AD) / Optimum Duration (OD). | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump ren | Site manager | Civil engineer | Drawing Review | QS |
| | | | m2 | m' | m2 | month | unit | pair | unit | m2 | m2 | m2 | m2 | unit | unit | m3 | m3 | m' | m2 | m3 | month | month | month | month |
| | | | 4220.33 | 260.00 | 765.00 | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 1,875.12 | 773.78 | 3714.00 | 3,337.25 | 2,001.90 | 5.00 | 5.00 | 5.00 | 5.00 |
| A | SUBSTRUCTURE | WEEK | 4 | 4 | 16 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 20 | 20 | 19 | 17 | 17 | 20 | 20 | 20 | 20 |
| A.1 | Preparation | 4 | 4220.33 | 260.00 | | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 375.02 | 154.76 | 58.64 | | | 1.00 | 1.00 | 1.00 | 1.00 |
| A.2 | Precast Concrete Pile | 18 | | | | | | | | | | | | | | | | 3,518.53 | | | 4.50 | 4.50 | 4.50 | 4.50 |
| A.3 | Excavation & Back Fill | 18 | | | | | | | | | | | | | | 1,687.61 | 696.40 | | | | 4.50 | 4.50 | 4.50 | 4.50 |
| A.4 | Pile Cap | 9 | | | | | | | | | | | | | | | | | 1,766.78 | 1,059.83 | 2.25 | 2.25 | 2.25 | 2.25 |
| A.5 | Tie Beam & Ground Slab | 16 | | | 765.00 | | | | | | | | | | | | | | 3,140.94 | 1,884.14 | 4.00 | 4.00 | 4.00 | 4.00 |
| | SubTotal | 65 | 4220.33 | 260.00 | 765.00 | 5.00 | 50.00 | 6.00 | 1.00 | 102.00 | 20.00 | 4.50 | 400.00 | 2.00 | 350.00 | 2062.63 | 851.16 | 3577.17 | 4907.72 | 2943.97 | 16.25 | 16.25 | 16.25 | 16.25 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump ren | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.2 | Precast Concrete Pile | 18 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.3 | Excavation & Back Fill | 18 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.4 | Pile Cap | 9 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.5 | Tie Beam & Ground Slab | 16 | 8,500.00 | 3,000.00 | 289,695.00 | 750,000.00 | 15,000.00 | 300,000.00 | 600,000.00 | 86,967.09 | 307,245.00 | 102,777.78 | 105,000.00 | 750,000.00 | 46,428.57 | 22,727.27 | 9,085.79 | 318,732.15 | 17,000.00 | 12,580.00 | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| | SubTotal | | | | | | | | | | | | | | | | | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump ren | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 35,872,805.00 | 780,000.00 | - | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 8,523,272.73 | 1,406,080.00 | 18,691,124.34 | - | - | 1,495,384.62 | 648,000.00 | 748,923.08 | 932,307.69 |
| A.2 | Precast Concrete Pile | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,121,467,460.34 | - | - | 6,729,230.77 | 2,916,000.00 | 3,370,153.85 | 4,195,384.62 |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | 38,354,727.27 | 6,327,360.00 | - | - | - | 6,729,230.77 | 2,916,000.00 | 3,370,153.85 | 4,195,384.62 |
| A.4 | Pile Cap | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 30,035,250.00 | 13,332,654.00 | 3,364,615.38 | 1,458,000.00 | 1,685,076.92 | 2,097,692.31 |
| A.5 | Tie Beam & Ground Slab | 16 | - | - | 221,616,675.00 | - | - | - | - | - | - | - | - | - | - | - | - | - | 53,396,000.00 | 23,702,496.00 | 5,981,538.46 | 2,592,000.00 | 2,995,692.31 | 3,729,230.77 |
| | SubTotal | 65 | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | | | | | | | | | | Batch Level Overheads | | | | | Project Sustainning Overheads | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme | Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky | ID card | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump ren | Site manager | Civil engineer | Drawing Review | QS |
| | | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| | | | 35,872,805.00 | 780,000.00 | 221,616,675.00 | 3,750,000.00 | 750,000.00 | 1,800,000.00 | 600,000.00 | 8,870,642.86 | 6,144,900.00 | 462,500.00 | 42,000,000.00 | 1,500,000.00 | 16,250,000.00 | 46,878,000.00 | 7,733,440.00 | 1,140,158,584.68 | 83,431,250.00 | 37,035,150.00 | 24,300,000.00 | 10,530,000.00 | 12,170,000.00 | 15,150,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | | | | | | | | | | | | | | | | | | |
| A.1 | Preparation | 4 | 8,968,201.25 | 195,000.00 | - | 937,500.00 | 187,500.00 | 450,000.00 | 150,000.00 | 2,217,660.71 | 1,536,225.00 | 115,625.00 | 10,500,000.00 | 375,000.00 | 4,062,500.00 | 2,130,818.18 | 351,520.00 | 4,672,781.08 | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.2 | Precast Concrete Pile | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 62,303,747.80 | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2,130,818.18 | 351,520.00 | - | - | - | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.4 | Pile Cap | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,337,250.00 | 1,481,406.00 | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| A.5 | Tie Beam & Ground Slab | 16 | - | - | 13,851,042.19 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,337,250.00 | 1,481,406.00 | 373,846.15 | 162,000.00 | 187,230.77 | 233,076.92 |
| | SubTotal | | | | | | | | | | | | | | | | | | | | | | | |

# Appendix 5-c: Cost Measurement and Analysis of the ABCC Model *(continued)*

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side c
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

Table A: ***Quantity Drivers*** of Project Overheads related to Activities *(continue)*

| Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Duration (AD) / Optimum Duration (OD). | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
| month | month | | average | l-sum | sheet | unit-month | month | l-sum | month | month | |
| 5.00 | 5.00 | | 5.00 | 1.00 | 100.00 | 2.00 | 5.00 | 1.00 | 5.00 | 5.00 | |
| 20 | 20 | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |
| 1.00 | 1.00 | | 1.00 | 0.20 | 20.00 | 0.40 | 1.00 | 0.20 | 1.00 | 1.00 | |
| 4.50 | 4.50 | | 4.50 | 0.90 | 90.00 | 1.80 | 4.50 | 0.90 | 4.50 | 4.50 | |
| 4.50 | 4.50 | | 4.50 | 0.90 | 90.00 | 1.80 | 4.50 | 0.90 | 4.50 | 4.50 | |
| 2.25 | 2.25 | | 2.25 | 0.45 | 45.00 | 0.90 | 2.25 | 0.45 | 2.25 | 2.25 | |
| 4.00 | 4.00 | | 4.00 | 0.80 | 80.00 | 1.60 | 4.00 | 0.80 | 4.00 | 4.00 | |
| 16.25 | 16.25 | | 16.25 | 3.25 | 325.00 | 6.50 | 16.25 | 3.25 | 16.25 | 16.25 | |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities *(continue)*

| Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | |
| | | | | | | | | | | | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 15,384.62 | 461.54 | 784,615.38 | 615,384.62 | 1,538,461.54 | 461,538.46 | 276,923.08 | |
| | | | | | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(continue)*

| Assigning Overheads to Cost Objects (CO) = QD*CD | | | | | | | | | | | | Total Overheads Per Activity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | | |
| **11,030,000.00** | **15,000,000.00** | | **25,995,500.00** | **50,000.00** | **150,000.00** | **5,100,000.00** | **10,000,000.00** | **5,000,000.00** | **7,500,000.00** | **4,500,000.00** | | |
| | | | | | | | | | | | | |
| 678,769.23 | 923,076.92 | | 1,599,723.08 | 3,076.92 | 9,230.77 | 313,846.15 | 615,384.62 | 307,692.31 | 461,538.46 | 276,923.08 | | **156,415,201.85** |
| 3,054,461.54 | 4,153,846.15 | | 7,198,753.85 | 13,846.15 | 41,538.46 | 1,412,307.69 | 2,769,230.77 | 1,384,615.38 | 2,076,923.08 | 1,246,153.85 | | **1,162,029,906.49** |
| 3,054,461.54 | 4,153,846.15 | | 7,198,753.85 | 13,846.15 | 41,538.46 | 1,412,307.69 | 2,769,230.77 | 1,384,615.38 | 2,076,923.08 | 1,246,153.85 | | **85,244,533.43** |
| 1,527,230.77 | 2,076,923.08 | | 3,599,376.92 | 6,923.08 | 20,769.23 | 706,153.85 | 1,384,615.38 | 692,307.69 | 1,038,461.54 | 623,076.92 | | **63,649,127.08** |
| 2,715,076.92 | 3,692,307.69 | | 6,398,892.31 | 12,307.69 | 36,923.08 | 1,255,384.62 | 2,461,538.46 | 1,230,769.23 | 1,846,153.85 | 1,107,692.31 | | **334,770,678.69** |
| 11,030,000.00 | 15,000,000.00 | | 25,995,500.00 | 50,000.00 | 150,000.00 | 5,100,000.00 | 10,000,000.00 | 5,000,000.00 | 7,500,000.00 | 4,500,000.00 | | **1,802,109,447.54** |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week*** *(continue)*

| Determining the Driver Rates (DR) = CO/AD | | | | | | | | | | | | Total Overheads Per Activity Per Week |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Facility Sustainning Overheads | | | | | | | | | |
| Logistic | Specialty Consultan | | Office Supplies | First Aids | Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | |
| IDR | IDR | | IDR | IDR | IDR | IDR | IDR | IDR | IDR | IDR | | |
| **11,030,000.00** | **15,000,000.00** | | **25,995,500.00** | **50,000.00** | **150,000.00** | **5,100,000.00** | **10,000,000.00** | **5,000,000.00** | **7,500,000.00** | **4,500,000.00** | | |
| | | | | | | | | | | | | |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | **39,103,800.46** |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | **64,557,217.03** |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | **4,735,807.41** |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | **7,072,125.23** |
| 169,692.31 | 230,769.23 | | 399,930.77 | 769.23 | 2,307.69 | 78,461.54 | 153,846.15 | 76,923.08 | 115,384.62 | 69,230.77 | | **20,923,167.42** |
| | | | | | | | | | | | | |

# Appendix 5-d: The Cost Management and Controlling Practices (CMCPs) of Project Overheads

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| IDN | ACTIVITIES | DURATION (week) | Assigned OHs (Per Activity) | Jul-10 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 |
| A | **SUBSTRUCTURE** | | | | | | | |
| A.1 | **Preparation** | **4** | 156,415,201.85 | **39,103,800.46** | **39,103,800.46** | **39,103,800.46** | **39,103,800.46** | |
| A.2 | **Precast Concrete Pile** | **18** | 1,162,029,906.49 | | **64,557,217.03** | **64,557,217.03** | **64,557,217.03** | **64,557,217.03** |
| A.3 | **Excavation & Back fill** | **18** | 85,244,533.43 | | | **4,735,807.41** | **4,735,807.41** | **4,735,807.41** |
| A.4 | **Pile Cap** | **9** | 63,649,127.08 | | | | **7,072,125.23** | |
| A.5 | **Tie Beam & Ground Slab** | **16** | 334,770,678.69 | | | | | **20,923,167.42** |
| | SubTotal | 65 | 1,802,109,447.54 | 39,103,800.46 | 103,661,017.49 | 108,396,824.90 | 115,468,950.13 | 90,216,191.86 |
| **Cost Schedule** | | | | | | | | |
| | Overhead Cost Scheduled ***(OCS)*** | | | 39,103,800.46 | 103,661,017.49 | 108,396,824.90 | 115,468,950.13 | 90,216,191.86 |
| | Cumulative ***OCS*** | | | 39,103,800.46 | 142,764,817.95 | 251,161,642.85 | 366,630,592.98 | 456,846,784.84 |
| | Remaining ***OCS*** for Completion | | | 1,827,032,156.16 | 1,723,371,138.67 | 1,614,974,313.77 | 1,499,505,363.64 | 1,409,289,171.78 |
| **Case Study** | | | | | | | | |
| | Activity Progress Values ***(APV)*** | | | **40,000,000.00** | **90,000,000.00** | **115,000,000.00** | **120,000,000.00** | **120,000,000.00** |
| | Cumulative ***APV*** | | | 40,000,000.00 | 130,000,000.00 | 245,000,000.00 | 365,000,000.00 | 485,000,000.00 |
| | Actual Project Expenses ***(APE)*** | | | **45,000,000.00** | **90,000,000.00** | **100,000,000.00** | **110,000,000.00** | **140,000,000.00** |
| | Cumulative ***APE*** | | | 45,000,000.00 | 135,000,000.00 | 235,000,000.00 | 345,000,000.00 | 485,000,000.00 |
| | Overhead Cost Changes ***(OCC) = APV-APE*** | | | - 5,000,000.00 | - | 15,000,000.00 | 10,000,000.00 | - 20,000,000.00 |
| | Cumulative ***OCC*** | | | - 5,000,000.00 | - 5,000,000.00 | 10,000,000.00 | 20,000,000.00 | - |
| **Cost Control** | | | | | | | | |
| | Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | 1.02 | 0.91 | 0.98 | 1.00 | 1.06 |
| | Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **0.89** | **0.96** | **1.04** | **1.06** | **1.00** |
| | **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS)*:** | | | | | | | |
| | Estimate at Completion Forecast.1 ***($EACf_1$)* = APE + Budgeted OCS at Completion - APV*** | | | 1,807,109,447.54 | 1,807,109,447.54 | 1,792,109,447.54 | 1,782,109,447.54 | 1,802,109,447.54 |
| | Estimate at Completion Forecast.2 ***($EACf_2$)** = Budgeted OCS at Completion / VER*** | | | 2,027,373,128.48 | 1,871,421,349.37 | 1,728,553,959.89 | 1,703,363,724.39 | 1,802,109,447.54 |
| | Estimate at Completion Forecast.3 ***($EACf_3$)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 1,982,958,081.42 | 2,041,922,137.14 | 1,766,116,188.79 | 1,709,432,048.66 | 1,725,654,054.42 |
| | *(Budgeted OCS at Completion - APV)* | | | 1,762,109,447.54 | 1,672,109,447.54 | 1,557,109,447.54 | 1,437,109,447.54 | 1,317,109,447.54 |
| | *(VER*VSR)* | | | 0.91 | 0.88 | 1.02 | 1.05 | 1.06 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(IDR)* | - 5,000,000.00 | - 5,000,000.00 | ***10,000,000.00*** | ***20,000,000.00*** | - ***0.00*** |
| | Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **$WCS_2$** *(IDR)* | - ***225,263,680.95*** | - 69,311,901.83 | 73,555,487.65 | 98,745,723.15 | - ***0.00*** |
| | Project ***'saving or deficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(IDR)* | - 180,848,633.88 | - ***239,812,689.60*** | 35,993,258.75 | 92,677,398.88 | 76,455,393.11 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(%Budget)* | -0.28% | -0.28% | ***0.55%*** | ***1.11%*** | ***0.00%*** |
| | Project ***'saving or deficit'*** at Completion (Scenario-2): | | **$WCS_2$** *(%Budget)* | ***-12.50%*** | -3.85% | 4.08% | 5.48% | ***0.00%*** |
| | Project ***'saving ordeficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(%Budget)* | -10.04% | ***-13.31%*** | 2.00% | 5.14% | 4.24% |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***$EACf_1$ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

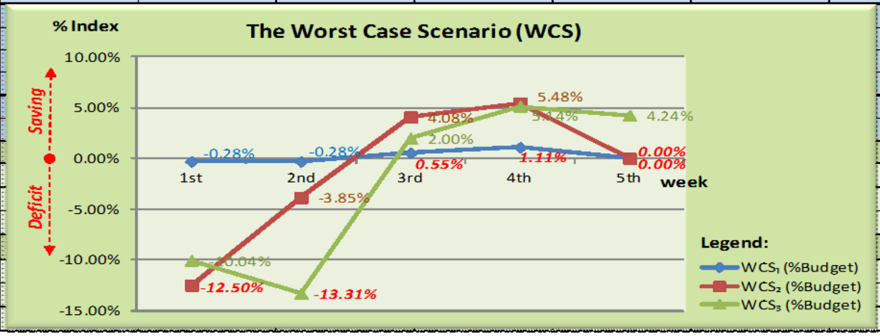
***$EACf_2$ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***$EACf_3$ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

# Appendix 5-e: The Cost Management and Controlling Practices (CMCPs) of Project Overheads *(continued)*

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads *(continue)*

| Aug-10 | | | Sep-10 | | | | Oct-10 | | | | Nov-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | 64,557,217.03 | |
| 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 | 4,735,807.41 |
| 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 | | 7,072,125.23 |
| 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 | 20,923,167.42 |
| 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 32,731,100.06 |
| 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 97,288,317.09 | 90,216,191.86 | 32,731,100.06 |
| 554,135,101.93 | 644,351,293.79 | 741,639,610.88 | 831,855,802.74 | 929,144,119.83 | 1,019,360,311.69 | 1,116,648,628.77 | 1,206,864,820.63 | 1,304,153,137.72 | 1,394,369,329.58 | 1,491,657,646.67 | 1,581,873,838.53 | 1,679,162,155.62 | 1,769,378,347.48 | 1,802,109,447.54 |
| 1,312,000,854.69 | 1,221,784,662.83 | 1,124,496,345.74 | 1,034,280,153.88 | 936,991,836.79 | 846,775,644.93 | 749,487,327.85 | 659,271,135.99 | 561,982,818.90 | 471,766,627.04 | 374,478,309.95 | 284,262,118.09 | 186,973,801.00 | 96,757,609.14 | 64,026,509.08 |
| 6th | | | | | | | 13th | 14th | 15th | 16th | 17th | 18th | 19th | 20th |
| 6th | | | | | | | 13th | 14th | 15th | 16th | 17th | 18th | 19th | 20th |




**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EACf₁** ** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***EACf₂** *** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***EACf₃** **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

## Appendix 5-f: The Case Study of the Hospital Project

# SUMMARY Hospital

| Percent | Amount Original | Category | Percent | Amount Actual |
|---|---|---|---|---|
| 7.86% | 148,083,285.80 | Labor | 7.861% | 148,083,335.50 |
| 34.91% | 657,711,873.22 | Material | 34.913% | 657,718,244.37 |
| 57.23% | 1,078,083,450.40 | Subcontractor | 57.227% | 1,078,083,450.40 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | **1,883,878,609.42** | Net Costs | | **1,883,885,030.27** |
| 5.15% | 97,019,748.39 | ALAT BANTU | 5.150% | 97,019,748.39 |
| 2.00% | 37,677,572.19 | PRELIM+fee lap./adm termin+jaminan | 2.000% | 37,677,572.19 |
| 2.00% | 37,677,572.19 | Lansiran Maetrial | 2.000% | 37,677,572.19 |
| | **2,056,253,502.19** | **Subtotal** | | **2,056,259,923.04** |
| | | | | |
| 4.785% | 112,013,544.00 | OH KANTOR = 4.785 dari RC | 4.785% | 112,013,544.00 |
| **4.38%** | **102,435,935.63** | **PROFIT** | **4.376%** | **102,429,514.78** |
| 0.00% | - | Fee | 0.000% | - |
| | **2,270,702,981.82** | **Total Estimate** | | **2,270,702,981.82** |
| | | | | |
| 3.00% | 70,227,927.27 | PPH ( 3% DARI RC) | 3.000% | 70,227,927.27 |
| 10.00% | 234,093,090.91 | PPN ( 10% DARI RC) | 10.000% | 234,093,090.91 |
| | **2,575,024,000.00** | **Total Estimate with Taxes** | | **2,575,024,000.00** |

Actual Progress Schedule, the Hospital Project

| IDN | ACTIVITIES | DURATION | Oct-10 | | | | Nov-10 | | | | Dec-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| A.1 | Preparation | 1 | ■ | | | | | | | | | | | |
| A.2 | Bore-pile Concrete | 2 | | ■ | ■ | | | | | | | | | |
| A.3 | Excavation & Backfill | 2 | | ■ | ■ | | | | | | | | | |
| A.4 | Pile Cap | 2 | | ■ | ■ | | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 4 | | ■ | ■ | ■ | ■ | | | | | | | |
| | Sub total | 11 | | | | | | | | | | | | |

**The Hospital Project**
**Actual OH Cost Accounts**

| Description | Actual Quantity | UOM | Actual Project Cost | Actual Cost Account |
|---|---|---|---|---|
| | | | | |
| ***Upah Pekerjaan Pasang Bowplank (Meaurement)*** | ***56.500*** | ***m'*** | ***141,250.00*** | ***141,250.00*** |
| Upah Pekerjaan Galian ***(Excavation + Opr)*** | ***77.02*** | ***m3*** | 2,079,540.00 | |
| Upah Pekerjaan Galian tanah ***(Excavation + Opr)*** | ***127.20*** | ***m3*** | 6,360,000.00 | ***8,439,540.00*** |
| Upah Pekerjaan Urugan Pasir ***(Compactor + Opr)*** | ***14.09*** | ***m3*** | 70,450.00 | |
| Upah Pekerjaan Urugan tanah ***(Compactor + Opr)*** | ***3.10*** | ***m3*** | 34,100.00 | |
| Upah Pekerjaan Urugan tanah ***(Compactor + Opr)*** | ***27.16*** | ***m3*** | 190,120.00 | ***294,670.00*** |
| Sub Pekerjaan Begisting Pipa ***(Bore-pile Casing)*** | 127.20 | m | 2,561,172.00 | |
| Sub. Pekerjaan Pasang Pondasi ***(Bore-pile Work*** | ***30.28*** | ***m3*** | 3,300,520.00 | ***5,861,692.00*** |
| Sub. Pekerjaan ***Waterproofing*** | ***220.20*** | ***m2*** | ***12,551,400.00*** | ***12,551,400.00*** |
| | | | | |
| **Management Staff** | | | | |
| ***Site manager*** | ***2.00*** | ***bln*** | ***13,040,000.00*** | ***13,040,000.00*** |
| Tunjangan jabatan SM | 2.00 | bln | 6,000,000.00 | |
| Tunjangan transport SM | 2.00 | bln | 840,000.00 | |
| Uang makan SM | 60.00 | hr | 720,000.00 | |
| Uang lembur SM | 80.00 | jam | 280,000.00 | |
| Tunjangan jauh | 2.00 | bln | 200,000.00 | |
| Gaji SM | 2.00 | bln | 5,000,000.00 | |
| | | | | |
| ***Pelaksana sipil 8 orang (Civil & ME Engineer) Tot 9*** | ***18.00*** | ***org.bln*** | 44,960,000.00 | ***50,580,000.00*** |
| Tunjangan jabatan pelaksana sipil | 16.00 | bln | 24,000,000.00 | |
| Uang makan pelaksana sipil | 480.00 | hr | 3,840,000.00 | |
| Uang lembur pelaksana | 640.00 | jam | 1,920,000.00 | |
| Tunjangan jauh | 16.00 | bln | 1,600,000.00 | |
| Gaji pelaksana sipil | 16.00 | bln | 13,600,000.00 | |
| Pelaksana ME 1 org (Mechanical Engineer) | | | 5,620,000.00 | |
| Tunjangan jabatan pelaksana ME | 2.00 | bln | 3,000,000.00 | |
| Uang makan pelaksana ME | 60.00 | hr | 480,000.00 | |
| Uang lembur pelaksana ME | 80.00 | jam | 240,000.00 | |
| Tunjangan jauh | 2.00 | bln | 200,000.00 | |
| Gaji pelaksana ME | 2.00 | bln | 1,700,000.00 | |
| | | | | |
| ***Drawing*** | ***2.00*** | ***bln*** | ***4,688,000.00*** | ***4,688,000.00*** |
| Tunjangan jabatan draw ing | 2.00 | bln | 2,168,000.00 | |
| Uang makan draw ing | 60.00 | hr | 480,000.00 | |
| Uang lembur draw ing | 80.00 | jam | 240,000.00 | |
| Tunjangan jauh | 2.00 | bln | 200,000.00 | |
| Gaji draw ing | 2.00 | bln | 1,600,000.00 | |
| | | | | |
| ***QS*** | ***2.00*** | ***bln*** | ***4,488,000.00*** | ***4,488,000.00*** |
| Tunjangan jabatan QS | 2.00 | bln | 2,168,000.00 | |
| Uang makan QS | 60.00 | jam | 480,000.00 | |
| Uang lembur QS | 80.00 | bln | 240,000.00 | |
| Tunjangan jauh | 2.00 | bln | 200,000.00 | |
| Gaji QS | 2.00 | bln | 1,400,000.00 | |
| | | | | |
| MEKANIK 1 org (Machine Servicer) | | | 3,420,000.00 | |
| Tunjangan transport mekanik | 2.00 | bln | 1,000,000.00 | |
| Uang makan mekanik | 60.00 | hr | 480,000.00 | |
| Uang lembur mekanik | 80.00 | jam | 240,000.00 | |
| Tunjangan jauh | 2.00 | bln | 200,000.00 | |
| Gaji Mekanik | 2.00 | bln | 1,500,000.00 | |

| | | | | |
|---|---|---|---|---|
| ADM 2 0rang (Administration) | | | 6,840,000.00 | |
| Tunjangan jabatan ADM | 4.00 | bln | 2,800,000.00 | |
| Uang makan ADM | 120.00 | hr | 960,000.00 | |
| Uang lembur ADM | 160.00 | jam | 480,000.00 | |
| Gaji ADM | 4.00 | bln | 2,600,000.00 | |
| ***Logistik 1 org (Logistic) = Total 4 org*** | ***8.00*** | ***org.bln*** | 4,120,000.00 | ***14,380,000.00*** |
| Tunjangan jabatan | 2.00 | bln | 1,600,000.00 | |
| Uang makan | 60.00 | hr | 480,000.00 | |
| Uang lembur | 80.00 | hr | 240,000.00 | |
| Tunjangan jauh | 2.00 | bln | 600,000.00 | |
| Gaji | 2.00 | bln | 1,200,000.00 | |
| | | | | |
| ***Sewa gudang untuk tempat pinishing (=Rent)*** | ***2.00*** | ***bln*** | ***1,000,000.00*** | |
| ***Pemondokan staf (Staff House Rent)*** | ***2.00*** | ***bln*** | ***1,200,000.00*** | ***2,200,000.00*** |
| ***Office Supplies*** | ***2.00*** | ***bln*** | ***40,074,500.00*** | ***40,074,500.00*** |
| Banten sehari hari | 2.00 | bln | 180,000.00 | 23,390,000.00 |
| Banten mulai kerja | 1.00 | ls | 1,100,000.00 | |
| Komputer komplit | 2.00 | bh | 12,300,000.00 | |
| printer | 2.00 | bh | 3,000,000.00 | |
| Meja kantor | 8.00 | bh | 2,000,000.00 | |
| Kursi kantor | 8.00 | bh | 1,200,000.00 | |
| Kursi plastik | 16.00 | bh | 640,000.00 | |
| Kertas A3 | 30.00 | rim | 1,650,000.00 | |
| Keras A4 | 40.00 | rim | 1,320,000.00 | |
| ***Cetak foto (Photo Printing)*** | ***250.00*** | ***lbr*** | ***375,000.00*** | ***375,000.00*** |
| Tinta printer | 2.00 | bln | 960,000.00 | 3,977,500.00 |
| Pelubang kertas | 1.00 | bh | 7,500.00 | |
| Bulpoin | 12.00 | ls | 600,000.00 | |
| Pensil | 12.00 | ls | 1,800,000.00 | |
| Spidol | 12.00 | ls | 240,000.00 | |
| Stabilo w arna | 10.00 | ls | 350,000.00 | |
| Tip ex | 4.00 | ls | 20,000.00 | |
| ***Helm proyek (Project Helmet)*** | ***350.00*** | ***bh*** | ***5,250,000.00*** | ***12,550,000.00*** |
| ***Sepatu konsultan (Safety Shoes)*** | ***1.00*** | ***psg*** | ***300,000.00*** | |
| ***sepatu staf (Safety Shoes)*** | ***20.00*** | ***psg*** | ***6,000,000.00*** | ***6,300,000.00*** |
| ***seragam staf (Staff Uniform) = helmet*** | ***35.00*** | ***pcs*** | ***2,800,000.00*** | |
| ***seragam tenaga (Worker Uniform) = helmet*** | ***300.00*** | ***pcs*** | ***4,500,000.00*** | |
| ***Tabung pemadam kebakaran (Fire Safety Kit)*** | ***3.00*** | ***bh*** | ***1,800,000.00*** | ***1,800,000.00*** |
| ***P3K (First Aids)*** | ***1.00*** | ***ls*** | ***50,000.00*** | ***50,000.00*** |
| lakban | 30.00 | roll | 1,500,000.00 | 10,907,000.00 |
| pengaris | 1.00 | ls | 25,000.00 | |
| Fotocopy | 4,000.00 | lbr | 2,400,000.00 | |
| Maff teka besar | 20.00 | bh | 220,000.00 | |
| Aqua galon | 4.00 | bh | 132,000.00 | |
| Guci air | 2.00 | bh | 170,000.00 | |
| Air aqua | 60.00 | gln | 600,000.00 | |
| Kopi | 2.00 | bln | 160,000.00 | |
| Gula | 2.00 | bln | 100,000.00 | |
| Konsumsi tenaga lembur | 525.00 | bks | 2,625,000.00 | |
| Konsumsi lembur staf | 220.00 | bln | 2,200,000.00 | |
| Konsumsi konsultan | 2.00 | bln | 600,000.00 | |
| Pemanas air konsultan dan staf | 1.00 | bh | 175,000.00 | |
| ***Sewa kendaraan stand by (Car Rent)*** | ***60.00*** | ***hr*** | ***9,000,000.00*** | |
| ***Sewa kendaraan antar jemput tenaga (Car Rent)*** | ***60.00*** | ***hr*** | ***3,600,000.00*** | |
| ***Sewa kendaraan untuk konsultan (Car Rent)*** | ***60.00*** | ***hr*** | ***9,000,000.00*** | ***21,600,000.00*** |
| Bensin untuk konsultan | 2.00 | bln | 1,600,000.00 | 1,800,000.00 |
| Bensin stamper | 2.00 | bln | 200,000.00 | |
| ***Tiket pesawat konsultan (Cosultancy Ticket)*** | ***1.00*** | ***ls*** | ***2,000,000.00*** | |
| ***fee konsultan (Consultant Fees)*** | ***2.00*** | ***bln*** | ***6,000,000.00*** | ***8,000,000.00*** |
| ***telepon (Telephone)*** | ***2.00*** | ***bln*** | ***4,000,000.00*** | ***4,000,000.00*** |

| | | | | |
|---|---|---|---|---|
| ***KANTOR DIREKSIKET (Site Office)*** | ***111.84*** | ***m2*** | ***19,881,928.57*** | ***19,881,928.57*** |
| Balok 6/12 albesia | 2.00 | m3 | 2,310,000.00 | 17,004,500.00 |
| Usuk 4/6 albesia | 3.20 | m3 | 3,528,000.00 | |
| Plyw ood 12 mm | 10.00 | lbr | 1,260,000.00 | |
| Plyw ood 9 mm | 1.00 | lbr | 95,000.00 | |
| Plyw ood 8 mm | 2.00 | lbr | 172,000.00 | |
| Plyw ood 6 mm | 2.00 | lbr | 120,000.00 | |
| Plyw ood 3 mm | 50.00 | lbr | 1,925,000.00 | |
| Papan 20x200x4000 mm | 23 | lbr | 920,000.00 | |
| Engsel pintu | 2 | set | 24,000.00 | |
| Kunci | 2 | set | 71,000.00 | |
| AC ruang konsultan | 1 | unit | 3,000,000.00 | |
| Asbes gelombang | 40.00 | lbr | 700,000.00 | |
| Paku asbes | 1.00 | kg | 18,000.00 | |
| Paku 3 cm | 5.00 | kg | 80,000.00 | |
| Paku 5 cm | 10.00 | kg | 108,928.57 | |
| Paku 7 cm | 20.00 | kg | 214,285.71 | |
| Paku 10 cm | 20.00 | kg | 214,285.71 | |
| Upah pembuatan direksiket | 102.00 | m2 | 2,244,000.00 | |
| | | | | |
| ***GUDANG BAHAN (Storage) + Safety Fence*** | ***43.65*** | ***m2*** | ***14,186,320.00*** | ***14,186,320.00*** |
| Balok 6/12 albesia | 1.64 | m3 | 1,894,200.00 | |
| Usuk 4/6 albesia | 0.78 | m3 | 859,950.00 | |
| Plyw ood 3 mm | 22.00 | lbr | 847,000.00 | |
| Plyw ood 6 mm | 8.00 | lbr | 480,000.00 | |
| Plyw ood 8 mm | 8.00 | lbr | 760,000.00 | |
| Asbes gelombang | 125.00 | lbr | 2,187,500.00 | |
| Paku asbes | 1.00 | kg | 18,000.00 | |
| Papan 20x200x4000 mm | 21.00 | lbr | 840,000.00 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Cat ruang konsultan | 4.00 | kg | 26,800.00 | |
| Gembok | 2.00 | set | 42,000.00 | |
| Grendel kunci pintu | 2.00 | set | 9,724.00 | |
| Upah pembuatan gudang bahan | 29.25 | m2 | 643,500.00 | |
| PINTU GERBANG (Main gate & Safety Fence) | | | | |
| Balok 6/12 albesia | 0.04 | m3 | 49,896.00 | |
| Usuk 4/6 albesia | 0.42 | m3 | 463,050.00 | |
| Plyw ood 3 mm | 6.00 | lbr | 231,000.00 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Kunci sepeda | 1.00 | set | 19,000.00 | |
| Roda pintu | 2.00 | bh | 70,000.00 | |
| Cat pintu gerbang | 1.00 | kg | 6,700.00 | |
| Upah pembuatan pintu gerbang | 14.400 | m2 | 144,000.00 | |
| PAGAR PENGAMAN (Safety Fence) | | | | |
| Bambu seteger | 200.00 | btg | 900,000.00 | |
| Paku asbes | 3.00 | kg | 54,000.00 | |
| Alang-alang | 410.00 | bh | 2,050,000.00 | |
| Kaw at bendrat | 20.00 | kg | 212,000.00 | |
| Ub. Pasang pagar pengaman | 190.00 | m2 | 1,330,000.00 | |
| | | | | |
| TANGGA KE LANTAI 2 (in Site Office) | | | | 2,877,428.57 |
| Balok 6/12 albesia | 1.04 | m3 | 1,201,200.00 | |
| Usuk 4/6 albesia | 0.48 | m3 | 529,200.00 | |
| Papan 20x200x4000 mm | 10.00 | lbr | 400,000.00 | |
| Paku 5 cm | 10.00 | kg | 108,928.57 | |
| Paku 7 cm | 15.00 | kg | 160,714.29 | |
| Paku 10 cm | 20.00 | kg | 214,285.71 | |
| Plyw ood 3 mm | 3.00 | lbr | 115,500.00 | |
| Ub. Buat tangga | 9.84 | m2 | 147,600.00 | |

| | | | | |
|---|---|---|---|---|
| ***KAMAR MANDI (Toilet)*** | ***4.50*** | ***m2*** | ***1,991,064.29*** | ***1,991,064.29*** |
| Balok 6/12 albesia | 0.25 | m3 | 288,750.00 | |
| Usuk 4/6 albesia | 0.20 | m3 | 220,500.00 | |
| Papan 20x200x4000 mm | 2.00 | lbr | 80,000.00 | |
| Paku 5 cm | 8.00 | kg | 87,142.86 | |
| Paku 7 cm | 16.00 | kg | 171,428.57 | |
| Paku 10 cm | 10.00 | kg | 107,142.86 | |
| Paku asbes | 0.50 | kg | 9,000.00 | |
| Asbes gelombang | 7.00 | bh | 122,500.00 | |
| Plywood 3 mm | 9.00 | lbr | 346,500.00 | |
| Engsel | 2.00 | set | 24,000.00 | |
| Kunci | 2.00 | set | 71,000.00 | |
| Bak mandi | 2.00 | bh | 160,000.00 | |
| Kran air | 2.00 | bh | 20,000.00 | |
| Toilet jongkok | 2.00 | bh | 90,000.00 | |
| PC | 1.00 | zak | 39,000.00 | |
| Pasir | 0.30 | m3 | 33,600.00 | |
| Bambu | 3.00 | btg | 13,500.00 | |
| Grendel | 2.00 | bh | 2,000.00 | |
| Gayung plastik | 2.00 | bh | 6,000.00 | |
| Ub.buat kamar mandi | 4.50 | m2 | 99,000.00 | |
| | | | | |
| ***sumbangan (Donation)*** | ***1.00*** | ***ls*** | ***5,000,000.00*** | ***5,000,000.00*** |
| ***listrik+air (Power + Water)*** | ***2.00*** | ***bln*** | ***4,000,000.00*** | ***4,000,000.00*** |
| ***sewa tanah bedeng 4 are (Land Rent)*** | ***8.00*** | ***bln*** | ***24,000,000.00*** | |
| ***bedeng tenaga (Worker Camp/ Land Rent)*** | ***1.00*** | ***ls*** | ***9,500,000.00*** | ***33,500,000.00*** |
| ***alat komonikasi ht (Handy Talky)*** | ***18.00*** | ***bh*** | ***13,500,000.00*** | ***13,500,000.00*** |
| ***kipem tenaga (ID Card)*** | ***960.00*** | ***org*** | ***48,000,000.00*** | ***48,000,000.00*** |
| ***harian gudang (2) dan pembantu surveyor (1) Worker/*** | ***6.00*** | ***org.bln*** | ***5,400,000.00*** | |
| ***harian cleaning (2 org) Cleaners)*** | ***4.00*** | ***org.bln*** | ***3,600,000.00*** | ***9,000,000.00*** |
| ***Scaffolding / Formwork*** | ***468.22*** | ***m2*** | ***7,303,247.00*** | ***7,303,247.00*** |
| Upah Pekerjaan Bekisting Plat Total | 318.25 | m2 | 5,569,357.50 | |
| Upah Pekerjaan Bekisting Pondasi Bataco Total | 34.00 | m2 | 306,000.00 | |
| Upah Pekerjaan Bekisting Ring Balok Total | 45.19 | m2 | 790,842.50 | |
| Upah Pekerjaan Bekisting Sloof Bataco Total | 70.78 | m2 | 637,047.00 | |
| ***Concrete Mixer & Pump*** | ***131.42*** | ***m3*** | ***9,660,190.00*** | ***9,660,190.00*** |
| Upah Pekerjaan Cor Beton Manual Total | 108.37 | m3 | 7,585,690.00 | |
| Upah Pekerjaan Cor Beton rabat (m3) Total | 23.05 | m3 | 2,074,500.00 | |

## The Cost Management and Analysis of the ABCC model for the CMCPs of Project Ov

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** rel
3. ***Idealising Quantity Drivers*** - ***QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Du | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | m2 | m' | m2 | month | unit |
| | | | 0 | 56.50 | 220.20 | 4.00 | 685.00 |
| A | SUBSTRUCTURE | WEEK | 1 | 1 | 4 | 1 | 1 |
| A.1 | Preparation | 1 | 0 | 56.50 | | 4.00 | 685.00 |
| A.2 | Precast Concrete Pile | 2 | | | | | |
| A.3 | Excavation & Back Fill | 2 | | | | | |
| A.4 | Pile Cap | 2 | | | | | |
| A.5 | Tie Beam & Ground Slab | 4 | | | 220.20 | | |
| | SubTotal | 11 | 1.00 | 56.50 | 220.20 | 4.00 | 685.00 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 141,250.00 | 12,551,400.00 | 2,200,000.00 | 12,550,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 1 | - | 2,500.00 | 57,000.00 | 550,000.00 | 18,321.17 |
| A.2 | Precast Concrete Pile | 2 | - | 2,500.00 | 57,000.00 | 550,000.00 | 18,321.17 |
| A.3 | Excavation & Back Fill | 2 | - | 2,500.00 | 57,000.00 | 550,000.00 | 18,321.17 |
| A.4 | Pile Cap | 2 | - | 2,500.00 | 57,000.00 | 550,000.00 | 18,321.17 |
| A.5 | Tie Beam & Ground Slab | 4 | - | 2,500.00 | 57,000.00 | 550,000.00 | 18,321.17 |
| | SubTotal | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 141,250.00 | 12,551,400.00 | 2,200,000.00 | 12,550,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 1 | - | 141,250.00 | - | 2,200,000.00 | 12,550,000.00 |
| A.2 | Precast Concrete Pile | 2 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 2 | - | - | - | - | - |
| A.4 | Pile Cap | 2 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 4 | - | - | 12,551,400.00 | - | - |
| | SubTotal | 11 | - | 141,250.00 | 12,551,400.00 | 2,200,000.00 | 12,550,000.00 |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 141,250.00 | 12,551,400.00 | 2,200,000.00 | 12,550,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 1 | - | 141,250.00 | - | 2,200,000.00 | 12,550,000.00 |
| A.2 | Precast Concrete Pile | 2 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 2 | - | - | - | - | - |
| A.4 | Pile Cap | 2 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 4 | - | - | 3,137,850.00 | - | - |
| | SubTotal | | | | | | |

## ›erheads

›ationships to substructure activities (positioned in the left-side of tables).

E, to improve the management of project overheads.

**›ration (AD) / Optimum Duration (OD).**

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| pair | unit | m2 | m2 | m2 | m2 | unit |
| **21.00** | **3.00** | **111.84** | **43.65** | **4.50** | **400.00** | **18.00** |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 21.00 | 3.00 | 111.84 | 43.65 | 4.50 | 400.00 | 18.00 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 21.00 | 3.00 | 111.84 | 43.65 | 4.50 | 400.00 | 18.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **6,300,000.00** | **1,800,000.00** | **19,881,928.57** | **14,186,320.00** | **1,991,064.29** | **33,500,000.00** | **13,500,000.00** |
| | | | | | | |
| 300,000.00 | 600,000.00 | 177,771.18 | 325,001.60 | 442,458.73 | 83,750.00 | 750,000.00 |
| 300,000.00 | 600,000.00 | 177,771.18 | 325,001.60 | 442,458.73 | 83,750.00 | 750,000.00 |
| 300,000.00 | 600,000.00 | 177,771.18 | 325,001.60 | 442,458.73 | 83,750.00 | 750,000.00 |
| 300,000.00 | 600,000.00 | 177,771.18 | 325,001.60 | 442,458.73 | 83,750.00 | 750,000.00 |
| 300,000.00 | 600,000.00 | 177,771.18 | 325,001.60 | 442,458.73 | 83,750.00 | 750,000.00 |
| | | | | | | |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **6,300,000.00** | **1,800,000.00** | **19,881,928.57** | **14,186,320.00** | **1,991,064.29** | **33,500,000.00** | **13,500,000.00** |
| | | | | | | |
| 6,300,000.00 | 1,800,000.00 | 19,881,928.57 | 14,186,320.00 | 1,991,064.29 | 33,500,000.00 | 13,500,000.00 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| 6,300,000.00 | 1,800,000.00 | 19,881,928.57 | 14,186,320.00 | 1,991,064.29 | 33,500,000.00 | 13,500,000.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **6,300,000.00** | **1,800,000.00** | **19,881,928.57** | **14,186,320.00** | **1,991,064.29** | **33,500,000.00** | **13,500,000.00** |
| | | | | | | |
| 6,300,000.00 | 1,800,000.00 | 19,881,928.57 | 14,186,320.00 | 1,991,064.29 | 33,500,000.00 | 13,500,000.00 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| unit | | m3 | m3 | m3 | m2 | m3 | | man.month |
| 960.00 | | 204.22 | 44.35 | 30.28 | 468.22 | 131.42 | | 2.00 |
| 1 | | 3 | 3 | 3 | 4 | 4 | | 5 |
| 960.00 | | 68.07 | 14.78 | 3.03 | | | | 0.40 |
| | | | | 20.19 | | | | 0.80 |
| | | 136.15 | 29.57 | | | | | 0.80 |
| | | | | | 234.11 | 65.71 | | 0.80 |
| | | | | | 468.22 | 131.42 | | 1.60 |
| 960.00 | | 204.22 | 44.35 | 23.21 | 702.33 | 197.13 | | 4.40 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 8,439,540.00 | 294,670.00 | 5,861,692.00 | 7,303,247.00 | 9,660,190.00 | | 13,040,000.00 |
| | | | | | | | | |
| 50,000.00 | | 41,325.73 | 6,644.19 | 252,499.51 | 10,398.53 | 49,005.28 | | 2,963,636.36 |
| 50,000.00 | | 41,325.73 | 6,644.19 | 252,499.51 | 10,398.53 | 49,005.28 | | 2,963,636.36 |
| 50,000.00 | | 41,325.73 | 6,644.19 | 252,499.51 | 10,398.53 | 49,005.28 | | 2,963,636.36 |
| 50,000.00 | | 41,325.73 | 6,644.19 | 252,499.51 | 10,398.53 | 49,005.28 | | 2,963,636.36 |
| 50,000.00 | | 41,325.73 | 6,644.19 | 252,499.51 | 10,398.53 | 49,005.28 | | 2,963,636.36 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 8,439,540.00 | 294,670.00 | 5,861,692.00 | 7,303,247.00 | 9,660,190.00 | | 13,040,000.00 |
| | | | | | | | | |
| 48,000,000.00 | | 2,813,180.00 | 98,223.33 | 764,568.52 | - | - | | 1,185,454.55 |
| - | | - | - | 5,097,123.48 | - | - | | 2,370,909.09 |
| - | | 5,626,360.00 | 196,446.67 | - | - | - | | 2,370,909.09 |
| - | | - | - | - | 2,434,415.67 | 3,220,063.33 | | 2,370,909.09 |
| - | | - | - | - | 4,868,831.33 | 6,440,126.67 | | 4,741,818.18 |
| 48,000,000.00 | | 8,439,540.00 | 294,670.00 | 5,861,692.00 | 7,303,247.00 | 9,660,190.00 | | 13,040,000.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 8,439,540.00 | 294,670.00 | 5,861,692.00 | 7,303,247.00 | 9,660,190.00 | | 13,040,000.00 |
| | | | | | | | | |
| 48,000,000.00 | | 2,813,180.00 | 98,223.33 | 764,568.52 | - | - | | 1,185,454.55 |
| - | | - | - | 2,548,561.74 | - | - | | 1,185,454.55 |
| - | | 2,813,180.00 | 98,223.33 | - | - | - | | 1,185,454.55 |
| - | | - | - | - | 1,217,207.83 | 1,610,031.67 | | 1,185,454.55 |
| - | | - | - | - | 1,217,207.83 | 1,610,031.67 | | 1,185,454.55 |
| | | | | | | | | |

## The Cost Management and Analysis of the ABCC

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, E
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Object***
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-c***
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anager*

Table A: ***Quantity Drivers*** of Project Overheads related to Activities

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AC** | | | | |
| **ng Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **man.month** | **man.month** | **man.month** | **man.month** | **man.month** | | **average** | **l-sum** |
| **18.00** | **2.00** | **2.00** | **8.00** | **2.00** | | **2.00** | **1.00** |
| 5 | 5 | 5 | 5 | 5 | | 5 | 5 |
| 3.60 | 0.40 | 0.40 | 1.60 | 0.40 | | 0.40 | 0.20 |
| 7.20 | 0.80 | 0.80 | 3.20 | 0.80 | | 0.80 | 0.40 |
| 7.20 | 0.80 | 0.80 | 3.20 | 0.80 | | 0.80 | 0.40 |
| 7.20 | 0.80 | 0.80 | 3.20 | 0.80 | | 0.80 | 0.40 |
| 14.40 | 1.60 | 1.60 | 6.40 | 1.60 | | 1.60 | 0.80 |
| 39.60 | 4.40 | 4.40 | 17.60 | 4.40 | | 4.40 | 2.20 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activitie

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/Q** | | | | |
| **ng Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **50,580,000.00** | **4,688,000.00** | **4,488,000.00** | **14,380,000.00** | **8,000,000.00** | | **40,074,500.00** | **50,000.00** |
| | | | | | | | |
| 1,277,272.73 | 1,065,454.55 | 1,020,000.00 | 817,045.45 | 1,818,181.82 | | 9,107,840.91 | 22,727.27 |
| 1,277,272.73 | 1,065,454.55 | 1,020,000.00 | 817,045.45 | 1,818,181.82 | | 9,107,840.91 | 22,727.27 |
| 1,277,272.73 | 1,065,454.55 | 1,020,000.00 | 817,045.45 | 1,818,181.82 | | 9,107,840.91 | 22,727.27 |
| 1,277,272.73 | 1,065,454.55 | 1,020,000.00 | 817,045.45 | 1,818,181.82 | | 9,107,840.91 | 22,727.27 |
| 1,277,272.73 | 1,065,454.55 | 1,020,000.00 | 817,045.45 | 1,818,181.82 | | 9,107,840.91 | 22,727.27 |
| | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(continu*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Assigning Overheads to Cost Objects (CO) = QD*CD** | | | | |
| **ng Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **50,580,000.00** | **4,688,000.00** | **4,488,000.00** | **14,380,000.00** | **8,000,000.00** | | **40,074,500.00** | **50,000.00** |
| | | | | | | | |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| 9,196,363.64 | 852,363.64 | 816,000.00 | 2,614,545.45 | 1,454,545.45 | | 7,286,272.73 | 9,090.91 |
| 9,196,363.64 | 852,363.64 | 816,000.00 | 2,614,545.45 | 1,454,545.45 | | 7,286,272.73 | 9,090.91 |
| 9,196,363.64 | 852,363.64 | 816,000.00 | 2,614,545.45 | 1,454,545.45 | | 7,286,272.73 | 9,090.91 |
| 18,392,727.27 | 1,704,727.27 | 1,632,000.00 | 5,229,090.91 | 2,909,090.91 | | 14,572,545.45 | 18,181.82 |
| 50,580,000.00 | 4,688,000.00 | 4,488,000.00 | 14,380,000.00 | 8,000,000.00 | | 40,074,500.00 | 50,000.00 |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-W***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Determining the Driver Rates (DR) = CO/AD** | | | | |
| **ng Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **50,580,000.00** | **4,688,000.00** | **4,488,000.00** | **14,380,000.00** | **8,000,000.00** | | **40,074,500.00** | **50,000.00** |
| | | | | | | | |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| 4,598,181.82 | 426,181.82 | 408,000.00 | 1,307,272.73 | 727,272.73 | | 3,643,136.36 | 4,545.45 |
| | | | | | | | |

## : model for the CMCPs of Project Overheads

3, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of tabl

***s - CO)*** (table C).
***ıctivity, per-week*** (table D)
*nent and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

*(continue)*

**Q) * Activity Duration (AD) / Optimum Duration (OD).**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
|---|---|---|---|---|---|---|
| sheet | unit-month | month | l-sum | month | man.month | |
| **250.00** | **6.00** | **2.00** | **1.00** | **2.00** | **10.00** | |
| 5 | 5 | 5 | 5 | 5 | 5 | |
| 50.00 | 1.20 | 0.40 | 0.20 | 0.40 | 2.00 | |
| 100.00 | 2.40 | 0.80 | 0.40 | 0.80 | 4.00 | |
| 100.00 | 2.40 | 0.80 | 0.40 | 0.80 | 4.00 | |
| 100.00 | 2.40 | 0.80 | 0.40 | 0.80 | 4.00 | |
| 200.00 | 4.80 | 1.60 | 0.80 | 1.60 | 8.00 | |
| 550.00 | 13.20 | 4.40 | 2.20 | 4.40 | 22.00 | |

*s (continue)*

**QD**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | |
|---|---|---|---|---|---|---|
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | |
| 375,000.00 | 21,600,000.00 | 4,000,000.00 | 5,000,000.00 | 4,000,000.00 | 9,000,000.00 | |
| | | | | | | |
| 681.82 | 1,636,363.64 | 909,090.91 | 2,272,727.27 | 909,090.91 | 409,090.91 | |
| 681.82 | 1,636,363.64 | 909,090.91 | 2,272,727.27 | 909,090.91 | 409,090.91 | |
| 681.82 | 1,636,363.64 | 909,090.91 | 2,272,727.27 | 909,090.91 | 409,090.91 | |
| 681.82 | 1,636,363.64 | 909,090.91 | 2,272,727.27 | 909,090.91 | 409,090.91 | |
| 681.82 | 1,636,363.64 | 909,090.91 | 2,272,727.27 | 909,090.91 | 409,090.91 | |
| | | | | | | |

*ıe)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity |
|---|---|---|---|---|---|---|---|
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | |
| **375,000.00** | **21,600,000.00** | **4,000,000.00** | **5,000,000.00** | **4,000,000.00** | **9,000,000.00** | | |
| | | | | | | | |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **174,024,307.44** |
| 68,181.82 | 3,927,272.73 | 727,272.73 | 909,090.91 | 727,272.73 | 1,636,363.64 | | **37,692,668.93** |
| 68,181.82 | 3,927,272.73 | 727,272.73 | 909,090.91 | 727,272.73 | 1,636,363.64 | | **38,418,352.12** |
| 68,181.82 | 3,927,272.73 | 727,272.73 | 909,090.91 | 727,272.73 | 1,636,363.64 | | **38,250,024.45** |
| 136,363.64 | 7,854,545.45 | 1,454,545.45 | 1,818,181.82 | 1,454,545.45 | 3,272,727.27 | | **89,051,448.91** |
| 375,000.00 | 21,600,000.00 | 4,000,000.00 | 5,000,000.00 | 4,000,000.00 | 9,000,000.00 | | **377,436,801.86** |

***eek*** *(continue)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity Per Week |
|---|---|---|---|---|---|---|---|
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | |
| **375,000.00** | **21,600,000.00** | **4,000,000.00** | **5,000,000.00** | **4,000,000.00** | **9,000,000.00** | | |
| | | | | | | | |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **174,024,307.44** |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **18,846,334.47** |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **19,209,176.06** |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **19,125,012.23** |
| 34,090.91 | 1,963,636.36 | 363,636.36 | 454,545.45 | 363,636.36 | 818,181.82 | | **22,262,862.23** |
| | | | | | | | |

# APPENDIX 5: Project Case Studies

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| IDN | ACTIVITIES | DURATION (week) | Assigned OHs (Per Activity) | Oct-10 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 |
| A | **SUBSTRUCTURE** | | | | | | | |
| A.1 | **Preparation** | 1 | 174,024,307.44 | 174,024,307.44 | | | | |
| A.2 | **Precast Concrete Pile** | 2 | 37,692,668.93 | | 18,846,334.47 | 18,846,334.47 | | |
| A.3 | **Excavation & Back fill** | 2 | 38,418,352.12 | | 19,209,176.06 | 19,209,176.06 | | |
| A.4 | **Pile Cap** | 2 | 38,250,024.45 | | 19,125,012.23 | 19,125,012.23 | | |
| A.5 | **Tie Beam & Ground Slab** | 4 | 89,051,448.91 | | 22,262,862.23 | 22,262,862.23 | 22,262,862.23 | 22,262,862.23 |
| | SubTotal | 11 | 377,436,801.86 | 174,024,307.44 | 79,443,384.98 | 79,443,384.98 | 22,262,862.23 | 22,262,862.23 |
| **Cost Schedule** | | | | | | | | |
| | Overhead Cost Scheduled ***(OCS)*** | | | 174,024,307.44 | 79,443,384.98 | 79,443,384.98 | 22,262,862.23 | 22,262,862.23 |
| | Cumulative ***OCS*** | | | 174,024,307.44 | 253,467,692.42 | 332,911,077.40 | 355,173,939.63 | 377,436,801.86 |
| | Remaining ***OCS*** for Completion | | | 203,412,494.42 | 123,969,109.44 | 44,525,724.45 | 22,262,862.23 | - |
| **Case Study** | | | | | | | | |
| | Activity Progress Values ***(APV)*** | | | 200,000,000.00 | 80,000,000.00 | 105,000,000.00 | 100,000,000.00 | 55,000,000.00 |
| | Cumulative ***APV*** | | | 200,000,000.00 | 280,000,000.00 | 385,000,000.00 | 485,000,000.00 | 540,000,000.00 |
| | Actual Project Expenses ***(APE)*** | | | 205,000,000.00 | 105,000,000.00 | 80,000,000.00 | 60,000,000.00 | 60,000,000.00 |
| | Cumulative ***APE*** | | | 205,000,000.00 | 310,000,000.00 | 390,000,000.00 | 450,000,000.00 | 510,000,000.00 |
| | Overhead Cost Changes ***(OCC) = APV-APE*** | | | - 5,000,000.00 | - 25,000,000.00 | 25,000,000.00 | 40,000,000.00 | - 5,000,000.00 |
| | Cumulative ***OCC*** | | | - 5,000,000.00 | - 30,000,000.00 | - 5,000,000.00 | 35,000,000.00 | 30,000,000.00 |
| **Cost Control** | | | | | | | | |
| | Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | **1.15** | **1.10** | **1.16** | **1.37** | **1.43** |
| | Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **0.98** | **0.90** | **0.99** | **1.08** | **1.06** |
| | **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS):*** | | | | | | | |
| | Estimate at Completion Forecast.1 ***($EACf_1$)* = APE + Budgeted OCS at Completion - APV*** | | | 382,436,801.86 | 407,436,801.86 | 382,436,801.86 | 342,436,801.86 | 347,436,801.86 |
| | Estimate at Completion Forecast.2 ***($EACf_2$)** = Budgeted OCS at Completion / VER*** | | | 386,872,721.90 | 417,876,459.20 | 382,338,578.50 | 350,199,094.51 | 356,468,090.64 |
| | Estimate at Completion Forecast.3 ***($EACf_3$)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 363,251,372.36 | 407,654,275.64 | 383,375,137.44 | 376,914,060.24 | 402,687,791.02 |
| | *(Budgeted OCS at Completion - APV)* | | | 177,436,801.86 | 97,436,801.86 | - 7,563,198.14 | - 107,563,198.14 | - 162,563,198.14 |
| | *(VER*VSR)* | | | 1.121 | 0.998 | 1.142 | 1.472 | 1.515 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(IDR)* | - 5,000,000.00 | - 30,000,000.00 | - 5,000,000.00 | 35,000,000.00 | 30,000,000.00 |
| | Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **$WCS_2$** *(IDR)* | - 9,435,920.05 | - 40,439,657.34 | - 4,901,776.65 | 27,237,707.35 | 20,968,711.21 |
| | Project ***'saving or deficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(IDR)* | 14,185,429.50 | - 30,217,473.78 | - 5,938,335.59 | 522,741.62 | - 25,250,989.16 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(%Budget)* | -1.32% | -7.95% | -1.32% | 9.27% | 7.95% |
| | Project ***'saving or deficit'*** at Completion (Scenario-2): | | **$WCS_2$** *(%Budget)* | -2.50% | -10.71% | -1.30% | 7.22% | 5.56% |
| | Project ***'saving ordeficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(%Budget)* | 3.76% | -8.01% | -1.57% | 0.14% | -6.69% |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***$EACf_1$* *** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)***.

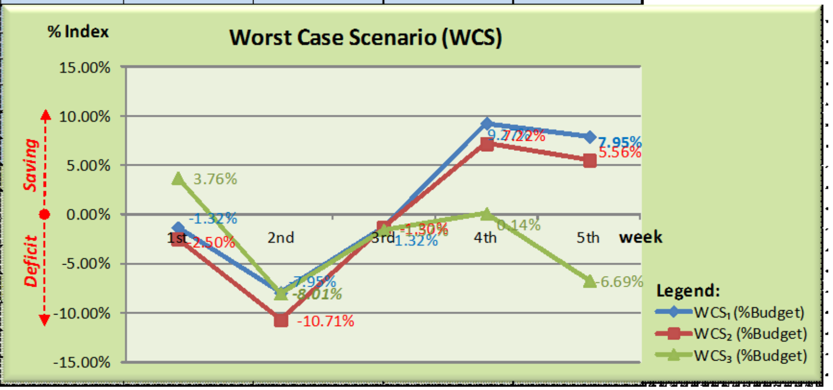
***$EACf_2$* **** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***$EACf_3$* ***** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

APPENDIX 5: Project Case Studies

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads *(continue)*

| Nov-10 | | | | Dec-10 | |
|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| 22,262,862.23 | | | | | |
| 22,262,862.23 | | | | | |
| | | | | | |
| 22,262,862.23 | | | | | |
| 377,436,801.86 | | | | | |
| - | | | | | |
| | | | | | |
| 55,000,000.00 | | | | | |
| 540,000,000.00 | | | | | |
| 60,000,000.00 | | | | | |
| 510,000,000.00 | | | | | |
| - 5,000,000.00 | | | | | |
| 30,000,000.00 | | | | | |
| | | | | | |
| 1.43 | | | | | |
| 1.06 | | | | | |
| | | | | | |
| 347,436,801.86 | | | | | |
| 356,468,090.64 | | | | | |
| 402,687,791.02 | | | | | |
| - 162,563,198.14 | | | | | |
| 1.515 | | | | | |
| 5th | | | | | |
| 30,000,000.00 | | | | | |
| 20,968,711.21 | | | | | |
| - 25,250,989.16 | | | | | |
| 5th | | | | | |
| 7.95% | | | | | |
| 5.56% | | | | | |
| -6.69% | | | | | |




**Note**: **The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EACf₁ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***EACf₂ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

**)** ***EACf₃ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

## Appendix 5-g: The Case Study of the Car-Park Project

# SUMMARY CarPark Buildings

| Percent | Amount Original | Category | Percent | Amount Actual |
|---|---|---|---|---|
| 12.83% | 519,194,992.42 | Labor | 11.783% | 476,944,406.20 |
| 55.04% | 2,227,953,085.31 | Material | 54.824% | 2,219,071,864.55 |
| 32.13% | 1,300,456,708.37 | Subcontractor | 31.638% | 1,280,563,537.74 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | **4,047,604,786.10** | Net Costs | | **3,976,579,808.49** |
| 2.55% | 103,227,347.44 | ALAT BANTU | 2.754% | 109,504,490.00 |
| 5.03% | 203,472,163.41 | PRELIM+fee lap./adm termin+jaminan | 7.182% | 285,596,471.41 |
| | **4,354,304,296.95** | **Subtotal** | | **4,371,680,769.90** |
| | | | | |
| 4.35% | 253,035,150.00 | OH KANTOR = 4.35% DARI RAB | 4.350% | 253,035,150.00 |
| 8.12% | **472,117,994.39** | PROFIT | 7.990% | **464,741,521.44** |
| 0.86% | 50,000,000.00 | FEE | 0.688% | 40,000,000.00 |
| | **5,129,457,441.34** | **Total Estimate** | | **5,129,457,441.34** |
| | | | | |
| 3.00% | 158,640,590.46 | PPH ( 3% DARI RC) | 3.000% | 158,640,590.46 |
| 10.00% | 528,801,968.20 | PPN ( 10% DARI RC) | 10.000% | 528,801,968.20 |
| | **5,816,900,000.00** | **Total Estimate with Taxes** | | **5,816,900,000.00** |

Actual Progress Schedule, the Car-Park Building Project

| IDN | ACTIVITIES | DURATION | Jul-10 | | | | Aug-10 | | | | Sep-10 | | | | Oct-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A.1 | Preparation | 2 | ■ | ■ | | | | | | | | | | | | | | |
| A.2 | Bore-pile Concrete | 4 | | | ■ | ■ | ■ | ■ | | | | | | | | | | |
| A.3 | Excavation & Backfill | 6 | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | |
| A.4 | Pile Cap | 2 | | | | ■ | | ■ | | | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 9 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | Sub total | 23 | | | | | | | | | | | | | | | | |

**The Car-Park**
**Actual OH Cost Accounts**

| Description | Actual Quantity QTY | UOM | Actual Project Cost | OH Cost Account |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| **Upah Pengukuran - Panjang (m) Total** ***(Measurement)*** | ***216.00*** | ***m'*** | ***648,000.00*** | ***648,000.00*** |
| ***Excavator and Operator*** | ***8,017.33*** | ***m3*** | ***109,209,869.82*** | ***109,209,869.82*** |
| **Upah Pekerjaan Galian dg alat + urug + angkut** ***(Excavator + Opr)*** | 6,999.98 | m3 | 69,999,783.38 | |
| **Upah Pekerjaan Galian dg Manual Total** ***(Excavator + Opr)*** | 328.53 | m3 | 8,213,250.00 | |
| **Upah Pekerjaan Galian tanah (m1) Total** ***(Excavator + Opr)*** | 688.82 | m3 | 30,996,836.44 | |
| ***Compactor + Operator*** | ***1,116.02*** | ***m3*** | ***8,129,415.00*** | ***8,129,415.00*** |
| **Upah Pekerjaan Urugan batu karang Total** ***(Compactor + Opr)*** | 0.47 | m3 | 3,525.00 | |
| **Upah Pekerjaan Urugan dgn limeStone dipadatkan Total** ***(Compactor + Opr)*** | 574.85 | m3 | 5,173,650.00 | |
| **Upah Pekerjaan Urugan kerikil / sirtu Total** ***(Compactor + Opr)*** | 0.76 | m3 | 5,700.00 | |
| **Upah Pekerjaan Urugan Pasir Total** ***(Compactor + Opr)*** | 498.80 | m3 | 2,494,000.00 | |
| **Upah Pekerjaan Urugan tanah dipadatkan Total** ***(Compactor + Opr)*** | 41.14 | m3 | 452,540.00 | |
| | | | | |
| **Sub. Pekerjaan Pondasi** ***(Bore-pilling Concrete + Machine & Equipment)*** | ***114.71*** | ***m3*** | ***21,794,900.00*** | ***21,794,900.00*** |
| **Sub. Pekerjaan lapisan asphalt sand sheet pada lantai beton dan jalan Total** ***(Waterproofing + Coating)*** | ***2,662.50*** | ***m2*** | ***103,516,748.63*** | ***103,516,748.63*** |
| | | | | |
| **Management Staff** | | | | |
| ***Site manager*** | ***4.00*** | ***bln*** | ***15,932,000.00*** | ***15,932,000.00*** |
| Tunjangan jabatan SM | 4.00 | bln | 7,200,000.00 | |
| Tunjangan transport SM | 4.00 | bln | 1,800,000.00 | |
| Uang makan SM | 120.00 | hr | 1,440,000.00 | |
| Uang lembur SM | 364.00 | jam | 1,092,000.00 | |
| Tunjangan jauh | 4.00 | bln | 400,000.00 | |
| Gaji SM | 4.00 | bln | 4,000,000.00 | |
| | | | | |
| ***Pelaksana sipil (2 Orang) (Engineer)*** | ***12.00*** | ***org.bln*** | ***22,264,000.00*** | ***22,264,000.00*** |
| Tunjangan jabatan pelaksana sipil | 8.00 | org.bln | 9,600,000.00 | |
| Uang makan pelaksana sipil | 240.00 | org.hr | 2,880,000.00 | |
| Uang lembur pelaksana | 728.00 | jam | 2,184,000.00 | |
| Tunjangan jauh | 8.00 | bln | 800,000.00 | |
| Gaji pelaksana sipil | 8.00 | bln | 6,800,000.00 | |
| **Pelaksana ME 1 org (Engineer)** | | | | |
| Tunjangan jabatan pelaksana ME | 4.00 | bln | 4,800,000.00 | |
| Uang makan pelaksana ME | 120.00 | hr | 1,440,000.00 | |
| Uang lembur pelaksana ME | 364.00 | jam | 1,092,000.00 | |
| Tunjangan jauh | 4.00 | bln | 400,000.00 | |
| Gaji pelaksana ME | 4.00 | bln | 3,400,000.00 | |

| | | | | |
|---|---|---|---|---|
| ***QS (Quantity Surveyor)*** | ***4.00*** | ***bln*** | ***10,552,000.00*** | ***10,552,000.00*** |
| Tunjangan jabatan QS | 4.00 | bln | 3,800,000.00 | |
| Tunjangan transport QS | 4.00 | bln | 420,000.00 | |
| Uang makan QS | 120.00 | hr | 1,440,000.00 | |
| Uang lembur QS | 364.00 | jam | 1,092,000.00 | |
| Tunjangan jauh | 4.00 | bln | 400,000.00 | |
| Gaji QS | 4.00 | bln | 3,400,000.00 | |
| | | | | |
| **Logistik (Logistic)** | **4.00** | **bln** | **8,852,000.00** | **8,852,000.00** |
| Tunjangan jabatan | 4.00 | bln | 3,200,000.00 | |
| Uang makan | 120.00 | hr | 960,000.00 | |
| Uang lembur | 364.00 | jam | 1,092,000.00 | |
| Tunjangan jauh | 4.00 | bln | 1,200,000.00 | |
| Gaji | 4.00 | bln | 2,400,000.00 | |
| | | | | |
| THR (Tunjangan Hari Raya) | 1.00 | LS | 9,250,000.00 | 9,250,000.00 |
| ***PERLENGKAPAN PROYEK (Office Supplies)*** | ***4.00*** | ***bln*** | ***50,605,000.00*** | ***50,605,000.00*** |
| Stampel, Bantalan dan Tinta | 1.00 | LS | 45,000.00 | 4,515,000.00 |
| Banten sehari hari | 4.00 | bln | 600,000.00 | |
| Banten mulai kerja | 1.00 | ls | 2,030,000.00 | |
| Kursi plastik | 20.00 | bh | 800,000.00 | |
| Kertas A3 | 100.00 | lbr | 50,000.00 | |
| Keras A4 | 30.00 | rim | 990,000.00 | |
| ***Cetak foto*** | ***250.00*** | ***lbr*** | ***125,000.00*** | ***275,000.00*** |
| Album Foto | 2.00 | lbr | 150,000.00 | |
| Tinta printer | 4.00 | bln | 1,400,000.00 | 2,197,500.00 |
| Pelubang kertas | 1.00 | bh | 7,500.00 | |
| Bulpoin | 6.00 | ls | 300,000.00 | |
| Spidol | 6.00 | ls | 120,000.00 | |
| Stabilo w arna | 10.00 | ls | 350,000.00 | |
| Tip ex | 4.00 | ls | 20,000.00 | |
| ***P3k (First Aids)*** | ***1.00*** | ***ls*** | ***50,000.00*** | ***50,000.00*** |
| lakban | 5.00 | roll | 250,000.00 | 34,642,500.00 |
| pengaris | 1.00 | ls | 25,000.00 | |
| Lem kertas | 2.00 | bh | 13,000.00 | |
| Fotocopy | 2,000.00 | lbr | 800,000.00 | |
| Maff teka besar | 15.00 | bh | 225,000.00 | |
| Map Kertas | 25.00 | bh | 12,500.00 | |
| Amplop | 4.00 | pac | 25,000.00 | |
| Tali rafia | 1.00 | ls | 20,000.00 | |
| Air aqua | 12.00 | gln | 132,000.00 | |
| Konsumsi tenaga lembur | 4,500.00 | bks | 22,500,000.00 | |
| Konsumsi lembur staf | 1,080.00 | bks | 8,640,000.00 | |
| Konsumsi konsultan + dinas | 4.00 | bln | 2,000,000.00 | |
| | | | | |
| ***fee konsultan + dinas (Specialty Consultancy)*** | ***4.00*** | ***bln*** | ***12,000,000.00*** | ***17,000,000.00*** |
| ***telepon*** | ***4.00*** | ***bln*** | ***6,000,000.00*** | ***6,000,000.00*** |
| Rambu - rambu Proyek | 6.00 | BH | 240,000.00 | 1,290,000.00 |
| Baliho + papan nama proyek | 3.00 | BH | 1,050,000.00 | |
| | | | | |
| ***Specialty Consultancy*** | ***4.00*** | ***bln*** | ***5,000,000.00*** | |
| Biaya Job Mix dan Tes | 1.00 | LS | 3,000,000.00 | |
| Honor team Pemeriksaan Fisik | 1.00 | LS | 1,000,000.00 | |
| Biaya PHO/FHO | 1.00 | LS | 1,000,000.00 | |

| | | | | |
|---|---|---|---|---|
| ***KANTOR DIREKSIKET (Site Office)*** | ***60.00*** | ***m2*** | ***8,778,382.35*** | ***8,778,382.35*** |
| Balok 6/12 albesia | 1.18 | m3 | 1,358,823.53 | |
| Usuk 4/6 albesia | 1.88 | m3 | 2,075,294.12 | |
| Plyw ood 6 mm | 4.00 | lbr | 240,000.00 | |
| Plyw ood 3 mm | 32.35 | lbr | 1,245,588.24 | |
| Engsel pintu | 3.00 | set | 36,000.00 | |
| Kunci | 3.00 | set | 106,500.00 | |
| Paku 5 cm | 5.88 | kg | 64,075.63 | |
| Paku 7 cm | 11.76 | kg | 126,050.42 | |
| Paku 10 cm | 11.76 | kg | 126,050.42 | |
| Upah pembuatan direksiket | 60.00 | m2 | 2,400,000.00 | |
| Instalasi listrik komplit | 1.00 | ls | 1,000,000.00 | |
| | | | | |
| ***GUDANG BAHAN (Storage)*** | ***41.40*** | ***m2*** | ***11,052,400.77*** | ***11,052,400.77*** |
| Balok 6/12 albesia | 1.51 | m3 | 1,748,492.31 | |
| Usuk 4/6 albesia | 0.72 | m3 | 793,800.00 | |
| Plyw ood 3 mm | 23.08 | lbr | 888,461.54 | |
| Plyw ood 6 mm | 7.38 | lbr | 443,076.92 | |
| Plyw ood 8 mm | 7.38 | lbr | 701,538.46 | |
| Asbes gelombang | 138.46 | lbr | 2,423,076.92 | |
| Paku asbes | 0.92 | kg | 16,615.38 | |
| Papan 20x200x4000 mm | 21.23 | lbr | 849,230.77 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Cat ruang konsultan | 3.69 | kg | 24,738.46 | |
| Gembok | 2.00 | set | 42,000.00 | |
| Grendel kunci pintu | 2.00 | set | 9,724.00 | |
| Upah pembuatan gudang bahan | 27.00 | m2 | 1,080,000.00 | |
| Instalasi listrik komplit | 1.00 | ls | 1,000,000.00 | |
| PINTU GERBANG | | | | |
| Balok 6/12 albesia | 0.04 | m3 | 49,896.00 | |
| Usuk 4/6 albesia | 0.42 | m3 | 463,050.00 | |
| Plyw ood 3 mm | 6.00 | lbr | 231,000.00 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Kunci sepeda | 1.00 | set | 19,000.00 | |
| Roda pintu | 2.00 | bh | 70,000.00 | |
| Cat pintu gerbang | 1.00 | kg | 6,700.00 | |
| Upah pembuatan pintu gerbang | 14.400 | m2 | 144,000.00 | |
| | | | | |
| ***KAMAR MANDI (Toilet)*** | *2.25* | *m2* | ***1,054,314.29*** | ***1,054,314.29*** |
| Balok 6/12 albesia | 0.28 | m3 | 324,324.00 | |
| Usuk 4/6 albesia | 0.22 | m3 | 242,550.00 | |
| Papan 20x200x4000 mm | 2.00 | lbr | 80,000.00 | |
| Paku 5 cm | 8.00 | kg | 87,142.86 | |
| Paku 7 cm | 16.00 | kg | 171,428.57 | |
| Paku 10 cm | 10.00 | kg | 107,142.86 | |
| Paku asbes | 0.50 | kg | 9,000.00 | |
| Asbes gelombang | 5.00 | bh | 87,500.00 | |
| Plyw ood 3 mm | 5.00 | lbr | 192,500.00 | |
| Engsel | 2.00 | set | 24,000.00 | |
| Kunci | 1.00 | set | 35,500.00 | |
| Bak mandi | 1.00 | bh | 80,000.00 | |
| Kran air | 1.00 | bh | 10,000.00 | |
| Toilet jongkok | 1.00 | bh | 45,000.00 | |
| PC | 1.00 | zak | 39,000.00 | |
| Pasir | 0.30 | m3 | 33,600.00 | |
| Gayung plastik | 1.00 | bh | 3,000.00 | |
| Ub.buat kamar mandi | 2.25 | m2 | 49,500.00 | |

| | | | | |
|---|---|---|---|---|
| *sumbangan (Donation)* | *1.00* | *ls* | *2,000,000.00* | *2,000,000.00* |
| *listrik+air (Power + Water)* | *4.00* | *bln* | *4,800,000.00* | *4,800,000.00* |
| *kipem tenaga (ID Card)* | *350.00* | *org* | *17,500,000.00* | *17,500,000.00* |
| *harian gudang, mekanik, Cleaner (3 org)* | *12.00* | *org.bln* | *10,800,000.00* | *10,800,000.00* |
| | | | | |
| *Scaffolding/ Formwork* | *1,294.85* | *m2* | *16,952,705.62* | *16,952,705.62* |
| Upah Pekerjaan Bekisting Balok Total | 481.74 | m2 | 9,634,701.08 | |
| Upah Pekerjaan Bekisting Pondasi Bataco Total | 335.94 | m2 | 3,023,487.92 | |
| Upah Pekerjaan Bekisting Sloof Bataco Total | 477.17 | m2 | 4,294,516.62 | |
| | | | | |
| *Conrete Pump Rent* | *1,007.06* | *m3* | *17,213,340.00* | *17,213,340.00* |
| Sew a concrete pump per m3 | 59.55 | m3 | 893,235.00 | |
| Sew a concrete pump per m3 | 51.75 | m3 | 776,250.00 | |
| Heavy Equipment | - | LS | 2,107,500.00 | |
| Sew a concrete pump per m3 | 38.25 | m3 | 573,750.00 | |
| Sew a concrete pump per m3 | 182.05 | m3 | 2,730,750.00 | |
| Sew a concrete pump per m3 | 103.07 | m3 | 1,546,050.00 | |
| Sew a concrete pump per m3 | 16.05 | m3 | 240,720.00 | |
| Sew a concrete pump per m3 | 26.66 | m3 | 399,900.00 | |
| Sew a concrete pump per m3 | 22.59 | m3 | 338,850.00 | |
| Sew a concrete pump per m3 | 41.27 | m3 | 619,110.00 | |
| Sew a concrete pump per m3 | 221.45 | m3 | 3,321,750.00 | |
| Sew a concrete pump per m3 | 72.88 | m3 | 1,093,230.00 | |
| Sew a concrete pump per m3 | 51.14 | m3 | 767,100.00 | |
| Sew a concrete pump per m3 | 9.31 | m3 | 139,710.00 | |
| Sew a concrete pump per m3 | 85.85 | m3 | 1,287,675.00 | |
| Sew a concrete pump per m3 | 8.03 | m3 | 120,450.00 | |
| Sew a concrete pump per m3 | 17.15 | m3 | 257,310.00 | |

## The Cost Management and Analysis of the ABCC model for the CMCPs of Project Ove

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** relat
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices* ***(CMCPs)*** in table E

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity Du | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | m2 | m' | m2 | month | unit |
| | | | 0 | 216.00 | 2662.50 | - | - |
| A | SUBSTRUCTURE | WEEK | 2 | 2 | 9 | 2 | 2 |
| A.1 | Preparation | 2 | 0 | 216.00 | | - | - |
| A.2 | Precast Concrete Pile | 4 | | | | | |
| A.3 | Excavation & Back Fill | 6 | | | | | |
| A.4 | Pile Cap | 2 | | | | | |
| A.5 | Tie Beam & Ground Slab | 9 | | | 2,662.50 | | |
| | SubTotal | 23 | 1.00 | 216.00 | 2662.50 | 1.00 | 1.00 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 648,000.00 | 103,516,748.63 | - | - |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 2 | - | 3,000.00 | 38,879.53 | - | - |
| A.2 | Precast Concrete Pile | 4 | - | 3,000.00 | 38,879.53 | - | - |
| A.3 | Excavation & Back Fill | 6 | - | 3,000.00 | 38,879.53 | - | - |
| A.4 | Pile Cap | 2 | - | 3,000.00 | 38,879.53 | - | - |
| A.5 | Tie Beam & Ground Slab | 9 | - | 3,000.00 | 38,879.53 | - | - |
| | SubTotal | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 648,000.00 | 103,516,748.63 | - | - |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 2 | - | 648,000.00 | - | - | - |
| A.2 | Precast Concrete Pile | 4 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 6 | - | - | - | - | - |
| A.4 | Pile Cap | 2 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 9 | - | - | 103,516,748.63 | - | - |
| | SubTotal | 23 | - | 648,000.00 | 103,516,748.63 | - | - |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helmet |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | - | 648,000.00 | 103,516,748.63 | - | - |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 2 | - | 324,000.00 | - | - | - |
| A.2 | Precast Concrete Pile | 4 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 6 | - | - | - | - | - |
| A.4 | Pile Cap | 2 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 9 | - | - | 11,501,860.96 | - | - |
| | SubTotal | | | | | | |

## erheads

tionships to substructure activities (positioned in the left-side of tables).

, to improve the management of project overheads.

**uration (AD) / Optimum Duration (OD).**

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| pair | unit | m2 | m2 | m2 | m2 | unit |
| **-** | **-** | **60.00** | **41.40** | **2.25** | **-** | **-** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| - | - | 60.00 | 41.40 | 2.25 | - | - |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 1.00 | 1.00 | 60.00 | 41.40 | 2.25 | 1.00 | 1.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **-** | **8,778,382.35** | **11,052,400.77** | **1,054,314.29** | **-** | **-** |
| | | | | | | |
| - | - | 146,306.37 | 266,966.20 | 468,584.13 | - | - |
| - | - | 146,306.37 | 266,966.20 | 468,584.13 | - | - |
| - | - | 146,306.37 | 266,966.20 | 468,584.13 | - | - |
| - | - | 146,306.37 | 266,966.20 | 468,584.13 | - | - |
| - | - | 146,306.37 | 266,966.20 | 468,584.13 | - | - |
| | | | | | | |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **-** | **8,778,382.35** | **11,052,400.77** | **1,054,314.29** | **-** | **-** |
| | | | | | | |
| - | - | 8,778,382.35 | 11,052,400.77 | 1,054,314.29 | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | 8,778,382.35 | 11,052,400.77 | 1,054,314.29 | - | - |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **-** | **8,778,382.35** | **11,052,400.77** | **1,054,314.29** | **-** | **-** |
| | | | | | | |
| - | - | 4,389,191.18 | 5,526,200.38 | 527,157.14 | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| unit | | m3 | m3 | m3 | m2 | m3 | | man.month |
| 350.00 | | 8,017.33 | 1,116.02 | 114.71 | 1,294.85 | 1,007.06 | | 4.00 |
| 2 | | 7 | 7 | 6 | 11 | 11 | | 14 |
| 350.00 | | 2,290.66 | 318.86 | 5.74 | | | | 0.57 |
| | | | | 76.47 | | | | 1.14 |
| | | 6,871.99 | 956.59 | | | | | 1.71 |
| | | | | | 235.43 | 183.10 | | 0.57 |
| | | | | | 1,059.42 | 823.95 | | 2.57 |
| 350.00 | | 9162.66 | 1275.45 | 82.21 | 1294.85 | 1007.06 | | 6.57 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 17,500,000.00 | | 109,209,869.82 | 8,129,415.00 | 21,794,900.00 | 16,952,705.62 | 17,213,340.00 | | 15,932,000.00 |
| | | | | | | | | |
| 50,000.00 | | 11,919.01 | 6,373.76 | 265,116.28 | 13,092.44 | 17,092.73 | | 2,424,434.78 |
| 50,000.00 | | 11,919.01 | 6,373.76 | 265,116.28 | 13,092.44 | 17,092.73 | | 2,424,434.78 |
| 50,000.00 | | 11,919.01 | 6,373.76 | 265,116.28 | 13,092.44 | 17,092.73 | | 2,424,434.78 |
| 50,000.00 | | 11,919.01 | 6,373.76 | 265,116.28 | 13,092.44 | 17,092.73 | | 2,424,434.78 |
| 50,000.00 | | 11,919.01 | 6,373.76 | 265,116.28 | 13,092.44 | 17,092.73 | | 2,424,434.78 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 17,500,000.00 | | 109,209,869.82 | 8,129,415.00 | 21,794,900.00 | 16,952,705.62 | 17,213,340.00 | | 15,932,000.00 |
| | | | | | | | | |
| 17,500,000.00 | | 27,302,467.45 | 2,032,353.75 | 1,520,574.42 | - | - | | 1,385,391.30 |
| - | | - | - | 20,274,325.58 | - | - | | 2,770,782.61 |
| - | | 81,907,402.36 | 6,097,061.25 | - | - | - | | 4,156,173.91 |
| - | | - | - | - | 3,082,310.11 | 3,129,698.18 | | 1,385,391.30 |
| - | | - | - | - | 13,870,395.51 | 14,083,641.82 | | 6,234,260.87 |
| 17,500,000.00 | | 109,209,869.82 | 8,129,415.00 | 21,794,900.00 | 16,952,705.62 | 17,213,340.00 | | 15,932,000.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainni |
| ID card | | Excavator + opr. | Compactor+Opr | Bore-pile machine | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 17,500,000.00 | | 109,209,869.82 | 8,129,415.00 | 21,794,900.00 | 16,952,705.62 | 17,213,340.00 | | 15,932,000.00 |
| | | | | | | | | |
| 8,750,000.00 | | 13,651,233.73 | 1,016,176.88 | 760,287.21 | - | - | | 692,695.65 |
| - | | - | - | 5,068,581.40 | - | - | | 692,695.65 |
| - | | 13,651,233.73 | 1,016,176.88 | - | - | - | | 692,695.65 |
| - | | - | - | - | 1,541,155.06 | 1,564,849.09 | | 692,695.65 |
| - | | - | - | - | 1,541,155.06 | 1,564,849.09 | | 692,695.65 |
| | | | | | | | | |

## The Cost Management and Analysis of the ABCC

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, E
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Object***
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-c***
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and *C*ost *M*anager

Table A: ***Quantity Drivers*** of Project Overheads related to Activities

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AC | | | | |
| ng Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engin | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| man.month | man.month | man.month | man.month | man.month | | average | l-sum |
| 12.00 | - | 4.00 | 4.00 | 4.00 | | 4.00 | 1.00 |
| 14 | 14 | 14 | 14 | 14 | | 14 | 14 |
| 1.71 | - | 0.57 | 0.57 | 0.57 | | 0.57 | 0.14 |
| 3.43 | - | 1.14 | 1.14 | 1.14 | | 1.14 | 0.29 |
| 5.14 | - | 1.71 | 1.71 | 1.71 | | 1.71 | 0.43 |
| 1.71 | - | 0.57 | 0.57 | 0.57 | | 0.57 | 0.14 |
| 7.71 | - | 2.57 | 2.57 | 2.57 | | 2.57 | 0.64 |
| 19.71 | 1.00 | 6.57 | 6.57 | 6.57 | | 6.57 | 1.64 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activitie

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/C | | | | |
| ng Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engin | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 22,264,000.00 | - | 10,552,000.00 | 8,852,000.00 | 17,000,000.00 | | 50,605,000.00 | 50,000.00 |
| | | | | | | | |
| 1,129,333.33 | - | 1,605,739.13 | 1,347,043.48 | 2,586,956.52 | | 7,700,760.87 | 30,434.78 |
| 1,129,333.33 | - | 1,605,739.13 | 1,347,043.48 | 2,586,956.52 | | 7,700,760.87 | 30,434.78 |
| 1,129,333.33 | - | 1,605,739.13 | 1,347,043.48 | 2,586,956.52 | | 7,700,760.87 | 30,434.78 |
| 1,129,333.33 | - | 1,605,739.13 | 1,347,043.48 | 2,586,956.52 | | 7,700,760.87 | 30,434.78 |
| 1,129,333.33 | - | 1,605,739.13 | 1,347,043.48 | 2,586,956.52 | | 7,700,760.87 | 30,434.78 |
| | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(continu*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
| ng Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engin | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 22,264,000.00 | - | 10,552,000.00 | 8,852,000.00 | 17,000,000.00 | | 50,605,000.00 | 50,000.00 |
| | | | | | | | |
| 1,936,000.00 | - | 917,565.22 | 769,739.13 | 1,478,260.87 | | 4,400,434.78 | 4,347.83 |
| 3,872,000.00 | - | 1,835,130.43 | 1,539,478.26 | 2,956,521.74 | | 8,800,869.57 | 8,695.65 |
| 5,808,000.00 | - | 2,752,695.65 | 2,309,217.39 | 4,434,782.61 | | 13,201,304.35 | 13,043.48 |
| 1,936,000.00 | - | 917,565.22 | 769,739.13 | 1,478,260.87 | | 4,400,434.78 | 4,347.83 |
| 8,712,000.00 | - | 4,129,043.48 | 3,463,826.09 | 6,652,173.91 | | 19,801,956.52 | 19,565.22 |
| 22,264,000.00 | - | 10,552,000.00 | 8,852,000.00 | 17,000,000.00 | | 50,605,000.00 | 50,000.00 |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-W***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Determining the Driver Rates (DR) = CO/AD | | | | |
| ng Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engin | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 22,264,000.00 | - | 10,552,000.00 | 8,852,000.00 | 17,000,000.00 | | 50,605,000.00 | 50,000.00 |
| | | | | | | | |
| 968,000.00 | - | 458,782.61 | 384,869.57 | 739,130.43 | | 2,200,217.39 | 2,173.91 |
| 968,000.00 | - | 458,782.61 | 384,869.57 | 739,130.43 | | 2,200,217.39 | 2,173.91 |
| 968,000.00 | - | 458,782.61 | 384,869.57 | 739,130.43 | | 2,200,217.39 | 2,173.91 |
| 968,000.00 | - | 458,782.61 | 384,869.57 | 739,130.43 | | 2,200,217.39 | 2,173.91 |
| 968,000.00 | - | 458,782.61 | 384,869.57 | 739,130.43 | | 2,200,217.39 | 2,173.91 |
| | | | | | | | |

## : model for the CMCPs of Project Overheads

3, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of tabl

***s - CO)*** (table C).
***ıctivity, per-week*** (table D)
*nent and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

*(continue)*

| **Q) * Activity Duration (AD) / Optimum Duration (OD).** | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Photo print** | **Car rent** | **Telephone** | **Donation** | **Power + water** | **Cleanner** | |
| **sheet** | **unit-month** | **month** | **l-sum** | **month** | **man.month** | |
| **250.00** | **-** | **4.00** | **1.00** | **4.00** | **12.00** | |
| 14 | 14 | 14 | 14 | 14 | 14 | |
| 35.71 | - | 0.57 | 0.14 | 0.57 | 1.71 | |
| 71.43 | - | 1.14 | 0.29 | 1.14 | 3.43 | |
| 107.14 | - | 1.71 | 0.43 | 1.71 | 5.14 | |
| 35.71 | - | 0.57 | 0.14 | 0.57 | 1.71 | |
| 160.71 | - | 2.57 | 0.64 | 2.57 | 7.71 | |
| 410.71 | 1.00 | 6.57 | 1.64 | 6.57 | 19.71 | |

*s (continue)*

| **ID** | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Photo print** | **Car rent** | **Telephone** | **Donation** | **Power + water** | **Cleanner** | |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | |
| **275,000.00** | **-** | **6,000,000.00** | **2,000,000.00** | **4,800,000.00** | **10,800,000.00** | |
| | | | | | | |
| 669.57 | - | 913,043.48 | 1,217,391.30 | 730,434.78 | 547,826.09 | |
| 669.57 | - | 913,043.48 | 1,217,391.30 | 730,434.78 | 547,826.09 | |
| 669.57 | - | 913,043.48 | 1,217,391.30 | 730,434.78 | 547,826.09 | |
| 669.57 | - | 913,043.48 | 1,217,391.30 | 730,434.78 | 547,826.09 | |
| 669.57 | - | 913,043.48 | 1,217,391.30 | 730,434.78 | 547,826.09 | |
| | | | | | | |

*ıe)*

| | | | | | | | **Total Overheads Per Activity** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Photo print** | **Car rent** | **Telephone** | **Donation** | **Power + water** | **Cleanner** | | |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | |
| **275,000.00** | **-** | **6,000,000.00** | **2,000,000.00** | **4,800,000.00** | **10,800,000.00** | | |
| | | | | | | | |
| 23,913.04 | - | 521,739.13 | 173,913.04 | 417,391.30 | 939,130.43 | | **82,856,319.12** |
| 47,826.09 | - | 1,043,478.26 | 347,826.09 | 834,782.61 | 1,878,260.87 | | **46,209,977.76** |
| 71,739.13 | - | 1,565,217.39 | 521,739.13 | 1,252,173.91 | 2,817,391.30 | | **126,907,941.87** |
| 23,913.04 | - | 521,739.13 | 173,913.04 | 417,391.30 | 939,130.43 | | **19,179,834.38** |
| 107,608.70 | - | 2,347,826.09 | 782,608.70 | 1,878,260.87 | 4,226,086.96 | | **189,826,003.34** |
| 275,000.00 | - | 6,000,000.00 | 2,000,000.00 | 4,800,000.00 | 10,800,000.00 | | **464,980,076.47** |

***eek*** *(continue)*

| | | | | | | | **Total Overheads Per Activity Per Week** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Photo print** | **Car rent** | **Telephone** | **Donation** | **Power + water** | **Cleanner** | | |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | |
| **275,000.00** | **-** | **6,000,000.00** | **2,000,000.00** | **4,800,000.00** | **10,800,000.00** | | |
| | | | | | | | |
| 11,956.52 | - | 260,869.57 | 86,956.52 | 208,695.65 | 469,565.22 | | **41,428,159.56** |
| 11,956.52 | - | 260,869.57 | 86,956.52 | 208,695.65 | 469,565.22 | | **11,552,494.44** |
| 11,956.52 | - | 260,869.57 | 86,956.52 | 208,695.65 | 469,565.22 | | **21,151,323.65** |
| 11,956.52 | - | 260,869.57 | 86,956.52 | 208,695.65 | 469,565.22 | | **9,589,917.19** |
| 11,956.52 | - | 260,869.57 | 86,956.52 | 208,695.65 | 469,565.22 | | **21,091,778.15** |
| | | | | | | | |

# APPENDIX 5: Project Case Studies

E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| ACTIVITIES | DURATION (week) | Assigned OHs (Per Activity) | Jul-10 | | | | Aug-10 |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| **SUBSTRUCTURE** | | | | | | | |
| **Preparation** | **2** | 82,856,319.12 | 41,428,159.56 | 41,428,159.56 | | | |
| **Precast Concrete Pile** | **4** | 46,209,977.76 | | | 11,552,494.44 | 11,552,494.44 | 11,552,494.44 |
| **Excavation & Back fill** | **6** | 126,907,941.87 | | 21,151,323.65 | 21,151,323.65 | 21,151,323.65 | 21,151,323.65 |
| **Pile Cap** | **2** | 19,179,834.38 | | | | 9,589,917.19 | |
| **Tie Beam & Ground Slab** | **9** | 189,826,003.34 | | | | | |
| SubTotal | 23 | **464,980,076.47** | 41,428,159.56 | 62,579,483.20 | 32,703,818.08 | 42,293,735.28 | 32,703,818.08 |
| **Schedule** | | | | | | | |
| Overhead Cost Scheduled ***(OCS)*** | | | 41,428,159.56 | 62,579,483.20 | 32,703,818.08 | 42,293,735.28 | 32,703,818.08 |
| Cumulative ***OCS*** | | | 41,428,159.56 | 104,007,642.76 | 136,711,460.85 | 179,005,196.12 | 211,709,014.21 |
| Remaining ***OCS*** for Completion | | | 423,551,916.91 | 360,972,433.70 | 328,268,615.62 | 285,974,880.34 | 253,271,062.26 |
| **Study** | | | | | | | |
| Activity Progress Values ***(APV)*** | | | 41,000,000.00 | 80,000,000.00 | 90,000,000.00 | 90,000,000.00 | 60,000,000.00 |
| Cumulative ***APV*** | | | 41,000,000.00 | 121,000,000.00 | 211,000,000.00 | 301,000,000.00 | 361,000,000.00 |
| Actual Project Expenses ***(APE)*** | | | 45,000,000.00 | 90,000,000.00 | 70,000,000.00 | 85,000,000.00 | 100,000,000.00 |
| Cumulative ***APE*** | | | 45,000,000.00 | 135,000,000.00 | 205,000,000.00 | 290,000,000.00 | 390,000,000.00 |
| Overhead Cost Changes ***(OCC) = APV-APE*** | | | - 4,000,000.00 | - 10,000,000.00 | 20,000,000.00 | 5,000,000.00 | - 40,000,000.00 |
| Cumulative ***OCC*** | | | - 4,000,000.00 | - 14,000,000.00 | 6,000,000.00 | 11,000,000.00 | - 29,000,000.00 |
| **Control** | | | | | | | |
| Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | **0.99** | **1.16** | **1.54** | **1.68** | **1.71** |
| Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **0.91** | **0.90** | **1.03** | **1.04** | **0.93** |
| **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS):*** | | | | | | | |
| Estimate at Completion Forecast.1 ***(EACf₁)* = APE + Budgeted OCS at Completion - APV*** | | | 468,980,076.47 | 478,980,076.47 | 458,980,076.47 | 453,980,076.47 | 493,980,076.47 |
| Estimate at Completion Forecast.2 ***(EACf₂)** = Budgeted OCS at Completion / VER*** | | | 510,343,986.37 | 518,779,424.16 | 451,757,894.20 | 447,987,449.09 | 502,333,046.60 |
| Estimate at Completion Forecast.3 ***(EACf₃)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 515,203,534.56 | 464,884,241.72 | 364,879,773.42 | 383,955,396.38 | 455,877,890.74 |
| *(Budgeted OCS at Completion - APV)* | | | 423,980,076.47 | 343,980,076.47 | 253,980,076.47 | 163,980,076.47 | 103,980,076.47 |
| *(VER*VSR)* | | | 0.902 | 1.043 | 1.589 | 1.745 | 1.578 |
| **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| Project ***'saving or deficit'*** at Completion (Scenario-1): | | **WCS₁** *(IDR)* | - 4,000,000.00 | - 14,000,000.00 | 6,000,000.00 | 11,000,000.00 | - 29,000,000.00 |
| Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **WCS₂** *(IDR)* | - 45,363,909.90 | - 53,799,347.69 | 13,222,182.27 | 16,992,627.38 | - 37,352,970.13 |
| Project ***'saving or deficit'*** at Completion (Scenario-3): | | **WCS₃** *(IDR)* | - 50,223,458.09 | 95,834.75 | 100,100,303.05 | 81,024,680.09 | 9,102,185.72 |
| **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| Project ***'saving or deficit'*** at Completion (Scenario-1): | | **WCS₁** *(%Budget)* | -0.86% | -3.01% | 1.29% | 2.37% | -6.24% |
| Project ***'saving or deficit'*** at Completion (Scenario-2): | | **WCS₂** *(%Budget)* | -9.76% | -11.57% | 2.84% | 3.65% | -8.03% |
| Project ***'saving ordeficit'*** at Completion (Scenario-3): | | **WCS₃** *(%Budget)* | -10.80% | 0.02% | 21.53% | 17.43% | 1.96% |

**: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

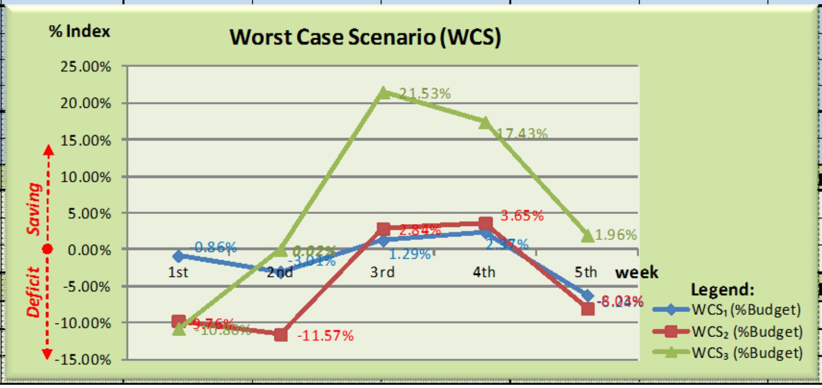
***EACf₁ ** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)***.

***EACf₂ *** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***EACf₃ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

# APPENDIX 5: Project Case Studies

| Aug-10 | | | | Sep-10 | | | | Oct-10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| 11,552,494.44 | 11,552,494.44 | | | | | | | | | | |
| 21,151,323.65 | 21,151,323.65 | 21,151,323.65 | | | | | | | | | |
| | 9,589,917.19 | | | | | | | | | | |
| | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | | |
| 32,703,818.08 | 63,385,513.42 | 42,243,101.79 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | | |
| | | | | | | | | | | | |
| 32,703,818.08 | 63,385,513.42 | 42,243,101.79 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | 21,091,778.15 | | |
| 211,709,014.21 | 275,094,527.63 | 317,337,629.43 | 338,429,407.58 | 359,521,185.72 | 380,612,963.87 | 401,704,742.02 | 422,796,520.17 | 443,888,298.32 | 464,980,076.47 | | |
| 253,271,062.26 | - 233,666,368.07 | 147,642,447.04 | 126,550,668.89 | 105,458,890.74 | 84,367,112.60 | 63,275,334.45 | 42,183,556.30 | 21,091,778.15 | - | | |
| | | | | | | | | | | | |
| **60,000,000.00** | | | | | | | | | | | |
| 361,000,000.00 | | | | | | | | | | | |
| **100,000,000.00** | | | | | | | | | | | |
| 390,000,000.00 | | | | | | | | | | | |
| - 40,000,000.00 | | | | | | | | | | | |
| - 29,000,000.00 | | | | | | | | | | | |
| | | | | | | | | | | | |
| **1.71** | | | | | | | | | | | |
| **0.93** | | | | | | | | | | | |
| | | | | | | | | | | | |
| 493,980,076.47 | | | | | | | | | | | |
| 502,333,046.60 | | | | | | | | | | | |
| 455,877,890.74 | | | | | | | | | | | |
| 103,980,076.47 | | | | | | | | | | | |
| 1.578 | | | | | | | | | | | |
| **5th** | | | | | | | **12th** | **13th** | **14th** | **15th** | **16th** |
| - 29,000,000.00 | | | | | | | | | | | |
| - 37,352,970.13 | | | | | | | | | | | |
| 9,102,185.72 | | | | | | | | | | | |
| **5th** | | | | | | | **12th** | **13th** | **14th** | **15th** | **16th** |
| -6.24% | | | | | | | | | | | |
| -8.03% | | | | | | | | | | | |
| 1.96% | | | | | | | | | | | |




**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EACf₁*** * forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***EACf₂*** ** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

) ***EACf₃*** *** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

## Appendix 5-h: The Case Study of the Villa Project

# SUMMARY Villa

| Percent | Amount Original | Category | Percent | Amount Actual |
|---|---|---|---|---|
| 10.636% | 776,915,082.89 | Labor | 10.636% | 776,915,077.75 |
| 50.192% | 3,666,341,495.63 | Material | 50.192% | 3,666,326,443.10 |
| 39.172% | 2,861,372,229.01 | Subcontractor | 39.172% | 2,861,372,438.31 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | **7,304,628,807.53** | **NET COST dc** | | **7,304,613,959.16** |
| 1.500% | 109,569,432.20 | Alat bantu | 1.500% | 109,569,432.20 |
| 5.000% | 365,231,440.68 | Preliminaries | 5.000% | 365,231,440.68 |
| 1.000% | 73,046,288.14 | Lansiran | 1.000% | 73,046,288.14 |
| | **7,852,475,968.55** | **SUBTOTAL cc** | | **7,852,461,120.18** |
| | | | | |
| 4.785% | 526,828,500.00 | OH Kantor = 4.785 dari RC | 4.785% | 526,828,500.00 |
| | | | | |
| **21.794%** | **2,399,485,531.45** | **PROFIT** | **21.794%** | **2,399,500,379.82** |
| | | | | |
| | **10,778,790,000.00** | **TOTAL ESTIMASI rev** | | **10,778,790,000.00** |
| | | | | |
| 2.100% | 231,210,000.00 | PPH ( 3% DARI RC) | 2.100% | 231,210,000.00 |
| 7.000% | 770,700,000.00 | PPN ( 10% DARI RC) | 7.000% | 770,700,000.00 |
| | **11,780,700,000.00** | **TOTAL ESTIMASI WITH TAX pp** | | **11,780,700,000.00** |

Actual Progress Schedule, the Villa Project

| IDN | ACTIVITIES | DURATION | Des-2010 | | | | Jan-11 | | | | Feb-11 | | | | Mar-11 | | | | Apr-11 | | | | May-11 | | | | Jun-11 | | | | Jul-11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 34 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A.1 | Preparation | 4 | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A.2 | Bore-pile Concrete | 20 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | |
| A.3 | Excavation & Backfill | 20 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | |
| A.4 | Pile Cap | 10 | | | | | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | ■ | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 20 | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |
| | Sub total | 74 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**The Villas**
**Actual OH Cost Accounts**

| Description | Actual Quantity | UOM | Actual Project Cost | OH Cost Account |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| ***Upah Pekerjaan Pasang Bowplank Total (Measurement)*** | ***1,586.67*** | ***m'*** | ***4,760,004.00*** | ***7,628,504.00*** |
| Upah Pekerjaan Pengukuran - M' Total | ***2,868.50*** | ***m"*** | 2,868,500.00 | |
| | | | | |
| ***Upah Pekerjaan Galian Tanah Lumpur (sawah) (Excavator + Operator)*** | ***1,958.13*** | ***m3*** | ***58,743,900.00*** | ***58,743,900.00*** |
| ***Upah Pekerjaan Urugan dgn limeStone dipadatkan (Compactor + Operator)*** | ***3,847.54*** | ***m3*** | ***42,322,940.00*** | ***54,584,640.50*** |
| Upah Pekerjaan Urugan Pasir Total ***(Compactor + Opr)*** | ***253.35*** | ***m3*** | 1,773,471.00 | |
| Upah Pekerjaan Urugan tanah dipadatkan Total ***(Compactor + Opr)*** | ***820.21*** | ***m3*** | 9,022,359.50 | |
| Upah Pekerjaan Urugan tanah tanpa dipadatkan Total ***(Compactor + Opr)*** | ***209.41*** | ***m3*** | 1,465,870.00 | |
| | | | | |
| ***Upah Pekerjaan Waterproofing plastic membran Total*** | ***62.93*** | ***m2*** | ***62,927.00*** | ***47,037,915.80*** |
| Sub. Pekerjaan Waterproofing coating Lantai & kolam Total | ***2,348.75*** | ***m2*** | 46,974,988.80 | |
| | | | | |
| ***Upah Pekerjaan Pasang Pondasi (Bore-pile Concrete Machine + Equipment)*** | ***77.17*** | ***m3*** | ***16,398,837.50*** | ***16,398,837.50*** |
| | | | | |
| ***Sub. Pekerjaan Anti Rayap Total (Anti Termites)*** | ***358.74*** | ***m2*** | ***3,443,904.00*** | ***3,443,904.00*** |
| | | | | |
| ***Site manager*** | ***7.00*** | ***bln*** | ***46,130,000.00*** | ***46,130,000.00*** |
| Tunjangan jabatan SM | 7.00 | bln | 21,000,000.00 | |
| Tunjangan transport SM | 7.00 | bln | 2,940,000.00 | |
| Uang makan SM | 210.00 | hr | 2,520,000.00 | |
| Uang lembur SM | 420.00 | jam | 1,470,000.00 | |
| Tunjangan jauh | 7.00 | bln | 700,000.00 | |
| Gaji SM | 7.00 | bln | 17,500,000.00 | |
| | | | | |
| ***Pelaksana sipil (8 Orang) Engineer*** | ***63.00*** | ***org.bln*** | ***172,758,000.00*** | ***172,758,000.00*** |
| Tunjangan jabatan pelaksana sipil | 56.00 | bln | 84,000,000.00 | |
| Uang makan pelaksana sipil | 1,680.00 | hr | 13,440,000.00 | |
| Uang lembur pelaksana | 256.00 | jam | 768,000.00 | |
| Tunjangan jauh | 56.00 | bln | 5,600,000.00 | |
| Gaji pelaksana sipil | 56.00 | bln | 47,600,000.00 | |
| **Pelaksana ME Engineer (1 org)** | | | | |
| Tunjangan jabatan pelaksana ME | 7.00 | bln | 10,500,000.00 | |
| Uang makan pelaksana ME | 210.00 | hr | 1,680,000.00 | |
| Uang lembur pelaksana ME | 840.00 | jam | 2,520,000.00 | |
| Tunjangan jauh | 7.00 | bln | 700,000.00 | |
| Gaji pelaksana ME | 7.00 | bln | 5,950,000.00 | |
| | | | | |
| ***Drawing*** | ***7.00*** | ***bln*** | ***18,088,000.00*** | ***18,088,000.00*** |
| Tunjangan jabatan draw ing | 7.00 | bln | 7,588,000.00 | |
| Uang makan draw ing | 210.00 | hr | 1,680,000.00 | |
| Uang lembur draw ing | 840.00 | jam | 2,520,000.00 | |
| Tunjangan jauh | 7.00 | bln | 700,000.00 | |
| Gaji draw ing | 7.00 | bln | 5,600,000.00 | |

| | | | | |
|---|---|---|---|---|
| ***QS*** | ***7.00*** | ***bln*** | ***20,888,000.00*** | ***20,888,000.00*** |
| Tunjangan jabatan QS | 7.00 | bln | 7,588,000.00 | |
| Tunjangan transport QS | 7.00 | bln | 3,500,000.00 | |
| Uang makan QS | 210.00 | hr | 1,680,000.00 | |
| Uang lembur QS | 840.00 | jm | 2,520,000.00 | |
| Tunjangan jauh | 7.00 | bln | 700,000.00 | |
| Gaji QS | 7.00 | bln | 4,900,000.00 | |
| | | | | |
| **MEKANIK** | | | | |
| Tunjangan jabatan mekanik | 7.00 | bln | 5,600,000.00 | 19,250,000.00 |
| Tunjangan transport mekanik | 7.00 | bln | 3,500,000.00 | |
| Uang makan mekanik | 210.00 | bln | 1,680,000.00 | |
| Uang lembur mekanik | 840.00 | jam | 2,520,000.00 | |
| Tunjangan jauh | 7.00 | bln | 700,000.00 | |
| Gaji Mekanik | 7.00 | bln | 5,250,000.00 | |
| **ADM** | | | | |
| Tunjangan jabatan ADM | 7.00 | bln | 4,900,000.00 | 17,150,000.00 |
| Tunjangan transport ADM | 7.00 | bln | 3,500,000.00 | |
| Uang makan ADM | 210.00 | hr | 1,680,000.00 | |
| Uang lembur ADM | 840.00 | jam | 2,520,000.00 | |
| Gaji ADM | 7.00 | bln | 4,550,000.00 | |
| ***Logistik*** | ***21.00*** | ***org.bln*** | ***49,616,000.00*** | ***49,616,000.00*** |
| Tunjangan jabatan | 7.00 | bln | 5,600,000.00 | 13,216,000.00 |
| Uang makan | 7.00 | bln | 56,000.00 | |
| Uang lembur | 420.00 | hr | 1,260,000.00 | |
| Tunjangan jauh | 7.00 | bln | 2,100,000.00 | |
| Gaji | 7.00 | bln | 4,200,000.00 | |
| | | | | |
| Sewa tempat pinishing | 7.00 | bln | 3,500,000.00 | |
| ***Pemondokan staf (House Rent)*** | ***7.00*** | ***bln*** | ***4,200,000.00*** | ***7,700,000.00*** |
| ***Office Supplies*** | ***7.00*** | ***bln*** | ***139,169,500.00*** | ***139,169,500.00*** |
| Banten sehari hari | 7.00 | bln | 630,000.00 | 60,740,000.00 |
| Banten mulai kerja | 1.00 | ls | 1,100,000.00 | |
| Komputer komplit | 8.00 | bh | 49,200,000.00 | |
| printer | 2.00 | bh | 3,000,000.00 | |
| Meja kantor | 8.00 | bh | 2,000,000.00 | |
| Kursi kantor | 8.00 | bh | 1,200,000.00 | |
| Kursi plastik | 16.00 | bh | 640,000.00 | |
| Kertas A3 | 30.00 | rim | 1,650,000.00 | |
| Keras A4 | 40.00 | rim | 1,320,000.00 | |
| ***Cetak foto (Photo Print)*** | ***250.00*** | ***lbr*** | ***375,000.00*** | ***375,000.00*** |
| Tinta printer | 16.00 | bln | 7,680,000.00 | 10,697,500.00 |
| Pelubang kertas | 1.00 | bh | 7,500.00 | |
| Bulpoin | 12.00 | ls | 600,000.00 | |
| Pensil | 12.00 | ls | 1,800,000.00 | |
| Spidol | 12.00 | ls | 240,000.00 | |
| Stabilo warna | 10.00 | ls | 350,000.00 | |
| Tip ex | 4.00 | ls | 20,000.00 | |
| ***Helm proyek (Project Helmet)*** | ***350.00*** | ***bh*** | ***5,250,000.00*** | ***9,750,000.00*** |
| seragam tenaga (Equiv to helmet) | ***300.00*** | ***pcs*** | ***4,500,000.00*** | |
| ***Sepatu konsultan (Safety Shoes)*** | ***1.00*** | ***psg*** | *300,000.00* | ***9,100,000.00*** |
| sepatu staf | ***20.00*** | ***psg*** | 6,000,000.00 | |
| seragam staf | 35.00 | pcs | 2,800,000.00 | |
| ***Tabung pemadam kebakaran (Fire Safety)*** | ***3.00*** | ***bh*** | ***1,800,000.00*** | ***1,800,000.00*** |
| ***P3k (Firt Aids)*** | ***1.00*** | ***ls*** | ***50,000.00*** | ***50,000.00*** |
| lakban | 30.00 | roll | 1,500,000.00 | 61,432,000.00 |
| pengaris | 1.00 | ls | 25,000.00 | |
| Fotocopy | 4,000.00 | lbr | 2,400,000.00 | |
| Map teka besar | 20.00 | bh | 220,000.00 | |

| | | | | |
|---|---|---|---|---|
| Aqua galon | 4.00 | bh | 132,000.00 | |
| Guci air | 2.00 | bh | 170,000.00 | |
| Air aqua | 250.00 | gln | 2,500,000.00 | |
| Kopi | 7.00 | bln | 560,000.00 | |
| Gula | 7.00 | bln | 350,000.00 | |
| Konsumsi tenaga lembur | 4,500.00 | bks | 22,500,000.00 | |
| Konsumsi lembur staf | 2,880.00 | bln | 28,800,000.00 | |
| Konsumsi konsultan | 7.00 | bln | 2,100,000.00 | |
| Pemanas air konsultan dan staf | 1.00 | bh | 175,000.00 | |
| ***Sewa kendaraan stand by 1 unit (Car Rent)*** | ***210.00*** | ***hr*** | ***31,500,000.00*** | ***75,600,000.00*** |
| Sewa kendaraan antar jemput tenaga 1 unit | ***210.00*** | ***hr*** | 12,600,000.00 | |
| Sewa kendaraan untuk konsultan 1 unit | ***210.00*** | ***hr*** | 31,500,000.00 | |
| Bensin untuk konsultan | 7.00 | bln | 5,600,000.00 | 6,300,000.00 |
| Bensin stamper | 7.00 | bln | 700,000.00 | |
| Tiket pesawat konsultan | 1.00 | ls | 2,000,000.00 | |
| ***fee konsultan (Specialty Consultant)*** | ***7.00*** | ***bln*** | ***21,000,000.00*** | ***23,000,000.00*** |
| ***telepon (telephone)*** | ***7.00*** | ***bln*** | ***14,000,000.00*** | ***14,000,000.00*** |
| | | | | |
| ***KANTOR DIREKSIKET (Site Office)*** | ***111.84*** | ***m2*** | ***20,424,428.57*** | ***20,424,428.57*** |
| Balok 6/12 albesia | 2.00 | m3 | 2,310,000.00 | 17,547,000.00 |
| Usuk 4/6 albesia | 3.20 | m3 | 3,528,000.00 | |
| Plywood 12 mm | 10.00 | lbr | 1,260,000.00 | |
| Plywood 9 mm | 1.00 | lbr | 95,000.00 | |
| Plywood 8 mm | 2.00 | lbr | 172,000.00 | |
| Plywood 6 mm | 2.00 | lbr | 120,000.00 | |
| Plywood 3 mm | 55.00 | lbr | 2,117,500.00 | |
| Papan 20x200x4000 mm | 30 | lbr | 1,200,000.00 | |
| Engsel pintu | 2 | set | 24,000.00 | |
| Kunci | 2 | set | 71,000.00 | |
| AC ruang konsultan | 1 | unit | 3,000,000.00 | |
| Asbes gelombang | 44.00 | lbr | 770,000.00 | |
| Paku asbes | 1.00 | kg | 18,000.00 | |
| Paku 3 cm | 5.00 | kg | 80,000.00 | |
| Paku 5 cm | 10.00 | kg | 108,928.57 | |
| Paku 7 cm | 20.00 | kg | 214,285.71 | |
| Paku 10 cm | 20.00 | kg | 214,285.71 | |
| Upah pembuatan direksiket | 102.00 | m2 | 2,244,000.00 | |
| | | | | |
| ***GUDANG BAHAN (Storage)*** | ***43.65*** | ***m2*** | ***14,945,820.00*** | ***14,945,820.00*** |
| Balok 6/12 albesia | 1.64 | m3 | 1,894,200.00 | |
| Usuk 4/6 albesia | 0.78 | m3 | 859,950.00 | |
| Plywood 3 mm | 25.00 | lbr | 962,500.00 | |
| Plywood 6 mm | 8.00 | lbr | 480,000.00 | |
| Plywood 8 mm | 8.00 | lbr | 760,000.00 | |
| Asbes gelombang | 150.00 | lbr | 2,625,000.00 | |
| Paku asbes | 1.00 | kg | 18,000.00 | |
| Papan 20x200x4000 mm | 23.00 | lbr | 920,000.00 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Cat ruang konsultan | 4.00 | kg | 26,800.00 | |
| Gembok | 2.00 | set | 42,000.00 | |
| Grendel kunci pintu | 2.00 | set | 9,724.00 | |
| Upah pembuatan gudang bahan | 29.25 | m2 | 643,500.00 | |
| **PINTU GERBANG** | | | | |
| Balok 6/12 albesia | 0.04 | m3 | 49,896.00 | |
| Usuk 4/6 albesia | 0.42 | m3 | 463,050.00 | |
| Plywood 3 mm | 6.00 | lbr | 231,000.00 | |
| Engsel pintu | 2.00 | set | 24,000.00 | |
| Kunci sepeda | 1.00 | set | 19,000.00 | |
| Roda pintu | 2.00 | bh | 70,000.00 | |
| Cat pintu gerbang | 1.00 | kg | 6,700.00 | |
| Upah pembuatan pintu gerbang | 14.400 | m2 | 144,000.00 | |

| | | | | |
|---|---|---|---|---|
| PAGAR PENGAMAN | | | | |
| Bambu seteger | 217.00 | btg | 976,500.00 | |
| Paku asbes | 3.00 | kg | 54,000.00 | |
| Alang-alang | 420.00 | bh | 2,100,000.00 | |
| Kaw at bendrat | 20.00 | kg | 212,000.00 | |
| Ub. Pasang pagar pengaman | 190.00 | m2 | 1,330,000.00 | |
| | | | | |
| TANGGA KE LANTAI 2 (include in the Site Office) | | | | 2,877,428.57 |
| Balok 6/12 albesia | 1.04 | m3 | 1,201,200.00 | |
| Usuk 4/6 albesia | 0.48 | m3 | 529,200.00 | |
| Papan 20x200x4000 mm | 10.00 | lbr | 400,000.00 | |
| Paku 5 cm | 10.00 | kg | 108,928.57 | |
| Paku 7 cm | 15.00 | kg | 160,714.29 | |
| Paku 10 cm | 20.00 | kg | 214,285.71 | |
| Plyw ood 3 mm | 3.00 | lbr | 115,500.00 | |
| Ub. Buat tangga | 9.84 | m2 | 147,600.00 | |
| | | | | |
| *KAMAR MANDI (Toilet)* | *4.50* | *m2* | *2,048,688.29* | *2,048,688.29* |
| Balok 6/12 albesia | 0.28 | m3 | 324,324.00 | |
| Usuk 4/6 albesia | 0.22 | m3 | 242,550.00 | |
| Papan 20x200x4000 mm | 2.00 | lbr | 80,000.00 | |
| Paku 5 cm | 8.00 | kg | 87,142.86 | |
| Paku 7 cm | 16.00 | kg | 171,428.57 | |
| Paku 10 cm | 10.00 | kg | 107,142.86 | |
| Paku asbes | 0.50 | kg | 9,000.00 | |
| Asbes gelombang | 7.00 | bh | 122,500.00 | |
| Plyw ood 3 mm | 9.00 | lbr | 346,500.00 | |
| Engsel | 2.00 | set | 24,000.00 | |
| Kunci | 2.00 | set | 71,000.00 | |
| Bak mandi | 2.00 | bh | 160,000.00 | |
| Kran air | 2.00 | bh | 20,000.00 | |
| Toilet jongkok | 2.00 | bh | 90,000.00 | |
| PC | 1.00 | zak | 39,000.00 | |
| Pasir | 0.30 | m3 | 33,600.00 | |
| Bambu | 3.00 | btg | 13,500.00 | |
| Grendel | 2.00 | bh | 2,000.00 | |
| Gayung plastik | 2.00 | bh | 6,000.00 | |
| Ub.buat kamar mandi | 4.50 | m2 | 99,000.00 | |
| | | | | |
| *sumbangan (Donation)* | *1.00* | *ls* | *5,000,000.00* | *5,000,000.00* |
| *listrik+air (Power and Water)* | *7.00* | *bln* | *14,000,000.00* | *14,000,000.00* |
| *sewa tanah bedeng (Land Rent for Worker Camp)* | *7.00* | *bln* | *21,000,000.00* | *30,500,000.00* |
| bedeng tenaga (Land Rent for Camp) | 1.00 | ls | 9,500,000.00 | |
| *alat komonikasi ht (Handy Talky)* | *18.00* | *bh* | *13,500,000.00* | *13,500,000.00* |
| *kipem tenaga (ID Card & Permit)* | *960.00* | *org* | *48,000,000.00* | *48,000,000.00* |
| harian gudang dan pembantu surveyor (3 org) (Eqv. | *21.00* | *bln* | 18,900,000.00 | |
| *harian cleaning (4 0rg) (Cleaner)* | *28.00* | *bln* | *25,200,000.00* | *44,100,000.00* |
| | | | | |
| *Scaffolding/ Formwork* | *2,157.62* | *m2* | *41,700,616.15* | *41,700,616.15* |
| Upah Pekerjaan Bekisting Plat Total (Playw ood on | 1,394.92 | m2 | 24,411,117.50 | |
| Upah Pekerjaan Bekisting Pondasi Bataco Total | 46.86 | m2 | 421,776.00 | |
| Upah Pekerjaan Bekisting Pondasi Bataco Total | 715.84 | m2 | 6,442,515.00 | |
| Upah Pekerjaan Bekisting Sloof Bataco Total | 778.49 | m2 | 7,006,446.00 | |
| Upah Pekerjaan Perancah Kerja dgn Scafolding Total | 976.79 | m2 | 3,418,761.65 | |
| | | | | |
| *Concrete Mixer and Pump* | *970.86* | *m3* | *74,709,480.00* | *74,709,480.00* |
| Upah Pekerjaan Cor Beton (Pure concrete) Total | *844.55* | *m3* | 63,340,950.00 | |
| Upah Pekerjaan Cor Beton rabat (m3) Total | *126.32* | *m3* | 11,368,530.00 | |

## The Cost Management and Analysis of the ABCC model for the CMCPs of Project Ov

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** rel
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices* ***( CMCPs )*** in table

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity I | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme |
| | | | m2 | m' | m2 | month | unit |
| | | | 358.74 | 4455.17 | 2411.68 | 7.00 | 650.00 |
| A | SUBSTRUCTURE | WEEK | 4 | 4 | 20 | 4 | 4 |
| A.1 | Preparation | 4 | 358.74 | 4455.17 | | 7.00 | 650.00 |
| A.2 | Precast Concrete Pile | 20 | | | | | |
| A.3 | Excavation & Back Fill | 20 | | | | | |
| A.4 | Pile Cap | 10 | | | | | |
| A.5 | Tie Beam & Ground Slab | 20 | | | 2,411.68 | | |
| | SubTotal | 74 | 358.74 | 4455.17 | 2411.68 | 7.00 | 650.00 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 3,443,904.00 | 7,628,504.00 | 47,037,915.80 | 7,700,000.00 | 9,750,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 4 | 9,600.00 | 1,712.28 | 19,504.24 | 1,100,000.00 | 15,000.00 |
| A.2 | Precast Concrete Pile | 20 | 9,600.00 | 1,712.28 | 19,504.24 | 1,100,000.00 | 15,000.00 |
| A.3 | Excavation & Back Fill | 20 | 9,600.00 | 1,712.28 | 19,504.24 | 1,100,000.00 | 15,000.00 |
| A.4 | Pile Cap | 10 | 9,600.00 | 1,712.28 | 19,504.24 | 1,100,000.00 | 15,000.00 |
| A.5 | Tie Beam & Ground Slab | 20 | 9,600.00 | 1,712.28 | 19,504.24 | 1,100,000.00 | 15,000.00 |
| | SubTotal | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 3,443,904.00 | 7,628,504.00 | 47,037,915.80 | 7,700,000.00 | 9,750,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 4 | 3,443,904.00 | 7,628,504.00 | - | 7,700,000.00 | 9,750,000.00 |
| A.2 | Precast Concrete Pile | 20 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 20 | - | - | - | - | - |
| A.4 | Pile Cap | 10 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 20 | - | - | 47,037,915.80 | - | - |
| | SubTotal | 74 | 3,443,904.00 | 7,628,504.00 | 47,037,915.80 | 7,700,000.00 | 9,750,000.00 |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff house ren | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 3,443,904.00 | 7,628,504.00 | 47,037,915.80 | 7,700,000.00 | 9,750,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 4 | 860,976.00 | 1,907,126.00 | - | 1,925,000.00 | 2,437,500.00 |
| A.2 | Precast Concrete Pile | 20 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 20 | - | - | - | - | - |
| A.4 | Pile Cap | 10 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 20 | - | - | 2,351,895.79 | - | - |
| | SubTotal | 74 | | | | | |

## verheads

ationships to substructure activities ( positioned in the left-side of tables).

E, to improve the management of project overheads.

Duration (AD) / Optimum Duration (OD).

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| pair | unit | m2 | m2 | m2 | m2 | unit |
| 21.00 | 3.00 | 111.84 | 43.65 | 4.50 | 400.00 | 18.00 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 21.00 | 3.00 | 111.84 | 43.65 | 4.50 | 400.00 | 18.00 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 21.00 | 3.00 | 111.84 | 43.65 | 4.50 | 400.00 | 18.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| 9,100,000.00 | 1,800,000.00 | 20,424,428.57 | 14,945,820.00 | 2,048,688.29 | 30,500,000.00 | 13,500,000.00 |
| | | | | | | |
| 433,333.33 | 600,000.00 | 182,621.86 | 342,401.37 | 455,264.06 | 76,250.00 | 750,000.00 |
| 433,333.33 | 600,000.00 | 182,621.86 | 342,401.37 | 455,264.06 | 76,250.00 | 750,000.00 |
| 433,333.33 | 600,000.00 | 182,621.86 | 342,401.37 | 455,264.06 | 76,250.00 | 750,000.00 |
| 433,333.33 | 600,000.00 | 182,621.86 | 342,401.37 | 455,264.06 | 76,250.00 | 750,000.00 |
| 433,333.33 | 600,000.00 | 182,621.86 | 342,401.37 | 455,264.06 | 76,250.00 | 750,000.00 |
| | | | | | | |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| 9,100,000.00 | 1,800,000.00 | 20,424,428.57 | 14,945,820.00 | 2,048,688.29 | 30,500,000.00 | 13,500,000.00 |
| | | | | | | |
| 9,100,000.00 | 1,800,000.00 | 20,424,428.57 | 14,945,820.00 | 2,048,688.29 | 30,500,000.00 | 13,500,000.00 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| 9,100,000.00 | 1,800,000.00 | 20,424,428.57 | 14,945,820.00 | 2,048,688.29 | 30,500,000.00 | 13,500,000.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| 9,100,000.00 | 1,800,000.00 | 20,424,428.57 | 14,945,820.00 | 2,048,688.29 | 30,500,000.00 | 13,500,000.00 |
| | | | | | | |
| 2,275,000.00 | 450,000.00 | 5,106,107.14 | 3,736,455.00 | 512,172.07 | 7,625,000.00 | 3,375,000.00 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| unit | | m3 | m3 | m3 | m2 | m3 | | month |
| 960.00 | | 1,958.13 | 5,130.52 | 77.17 | 2,157.62 | 970.86 | | 7.00 |
| 4 | | 24 | 24 | 22 | 21 | 21 | | 32 |
| 960.00 | | 326.36 | 855.09 | 1.05 | | | | 0.88 |
| | | | | 70.16 | | | | 4.38 |
| | | 1,631.78 | 4,275.43 | | | | | 4.38 |
| | | | | | 1,027.44 | 462.32 | | 2.19 |
| | | | | | 2,054.88 | 924.63 | | 4.38 |
| 960.00 | | 1958.13 | 5130.52 | 71.21 | 3082.31 | 1386.95 | | 16.19 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 58,743,900.00 | 54,584,640.50 | 16,398,837.50 | 41,700,616.15 | 74,709,480.00 | | 46,130,000.00 |
| | | | | | | | | |
| 50,000.00 | | 30,000.00 | 10,639.21 | 230,295.57 | 13,529.00 | 53,866.13 | | 2,849,729.73 |
| 50,000.00 | | 30,000.00 | 10,639.21 | 230,295.57 | 13,529.00 | 53,866.13 | | 2,849,729.73 |
| 50,000.00 | | 30,000.00 | 10,639.21 | 230,295.57 | 13,529.00 | 53,866.13 | | 2,849,729.73 |
| 50,000.00 | | 30,000.00 | 10,639.21 | 230,295.57 | 13,529.00 | 53,866.13 | | 2,849,729.73 |
| 50,000.00 | | 30,000.00 | 10,639.21 | 230,295.57 | 13,529.00 | 53,866.13 | | 2,849,729.73 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 58,743,900.00 | 54,584,640.50 | 16,398,837.50 | 41,700,616.15 | 74,709,480.00 | | 46,130,000.00 |
| | | | | | | | | |
| 48,000,000.00 | | 9,790,650.00 | 9,097,440.08 | 242,347.35 | - | - | | 2,493,513.51 |
| - | | - | - | 16,156,490.15 | - | - | | 12,467,567.57 |
| - | | 48,953,250.00 | 45,487,200.42 | - | - | - | | 12,467,567.57 |
| - | | - | - | - | 13,900,205.38 | 24,903,160.00 | | 6,233,783.78 |
| - | | - | - | - | 27,800,410.77 | 49,806,320.00 | | 12,467,567.57 |
| 48,000,000.00 | | 58,743,900.00 | 54,584,640.50 | 16,398,837.50 | 41,700,616.15 | 74,709,480.00 | | 46,130,000.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 48,000,000.00 | | 58,743,900.00 | 54,584,640.50 | 16,398,837.50 | 41,700,616.15 | 74,709,480.00 | | 46,130,000.00 |
| | | | | | | | | |
| 12,000,000.00 | | 2,447,662.50 | 2,274,360.02 | 60,586.84 | - | - | | 623,378.38 |
| - | | - | - | 807,824.51 | - | - | | 623,378.38 |
| - | | 2,447,662.50 | 2,274,360.02 | - | - | - | | 623,378.38 |
| - | | - | - | - | 1,390,020.54 | 2,490,316.00 | | 623,378.38 |
| - | | - | - | - | 1,390,020.54 | 2,490,316.00 | | 623,378.38 |
| | | | | | | | | |

## The Cost Management and Analysis of the ABC(

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, E
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Object***
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-***
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***Cost Manage***

Table A: ***Quantity Drivers*** of Project Overheads related to Activities

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AC** | | | | |
| **ing Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **month** | **month** | **month** | **month** | **month** | | **average** | **l-sum** |
| **63.00** | **7.00** | **7.00** | **21.00** | **7.00** | | **7.00** | **1.00** |
| 32 | 32 | 32 | 32 | 32 | | 32 | 32 |
| 7.88 | 0.88 | 0.88 | 2.63 | 0.88 | | 0.88 | 0.13 |
| 39.38 | 4.38 | 4.38 | 13.13 | 4.38 | | 4.38 | 0.63 |
| 39.38 | 4.38 | 4.38 | 13.13 | 4.38 | | 4.38 | 0.63 |
| 19.69 | 2.19 | 2.19 | 6.56 | 2.19 | | 2.19 | 0.31 |
| 39.38 | 4.38 | 4.38 | 13.13 | 4.38 | | 4.38 | 0.63 |
| 145.69 | 16.19 | 16.19 | 48.56 | 16.19 | | 16.19 | 2.31 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activitie

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/C** | | | | |
| **ing Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **172,758,000.00** | **18,088,000.00** | **20,888,000.00** | **49,616,000.00** | **23,000,000.00** | | **139,169,500.00** | **50,000.00** |
| | | | | | | | |
| 1,185,812.10 | 1,117,405.41 | 1,290,378.38 | 1,021,693.69 | 1,420,849.42 | | 8,597,343.63 | 21,621.62 |
| 1,185,812.10 | 1,117,405.41 | 1,290,378.38 | 1,021,693.69 | 1,420,849.42 | | 8,597,343.63 | 21,621.62 |
| 1,185,812.10 | 1,117,405.41 | 1,290,378.38 | 1,021,693.69 | 1,420,849.42 | | 8,597,343.63 | 21,621.62 |
| 1,185,812.10 | 1,117,405.41 | 1,290,378.38 | 1,021,693.69 | 1,420,849.42 | | 8,597,343.63 | 21,621.62 |
| 1,185,812.10 | 1,117,405.41 | 1,290,378.38 | 1,021,693.69 | 1,420,849.42 | | 8,597,343.63 | 21,621.62 |
| | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(contin*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Assigning Overheads to Cost Objects (CO) = QD*CD** | | | | |
| **ing Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **172,758,000.00** | **18,088,000.00** | **20,888,000.00** | **49,616,000.00** | **23,000,000.00** | | **139,169,500.00** | **50,000.00** |
| | | | | | | | |
| 9,338,270.27 | 977,729.73 | 1,129,081.08 | 2,681,945.95 | 1,243,243.24 | | 7,522,675.68 | 2,702.70 |
| 46,691,351.35 | 4,888,648.65 | 5,645,405.41 | 13,409,729.73 | 6,216,216.22 | | 37,613,378.38 | 13,513.51 |
| 46,691,351.35 | 4,888,648.65 | 5,645,405.41 | 13,409,729.73 | 6,216,216.22 | | 37,613,378.38 | 13,513.51 |
| 23,345,675.68 | 2,444,324.32 | 2,822,702.70 | 6,704,864.86 | 3,108,108.11 | | 18,806,689.19 | 6,756.76 |
| 46,691,351.35 | 4,888,648.65 | 5,645,405.41 | 13,409,729.73 | 6,216,216.22 | | 37,613,378.38 | 13,513.51 |
| 172,758,000.00 | 18,088,000.00 | 20,888,000.00 | 49,616,000.00 | 23,000,000.00 | | 139,169,500.00 | 50,000.00 |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-W***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Determining the Driver Rates (DR) = CO/AD** | | | | |
| **ing Overheads** | | | | | | **Facility Sustainning Overheads** | |
| **Civil & ME engin** | **Drawing Review** | **QS** | **Logistic** | **Specialty Consultan** | | **Office Supplies &** | **First Aids** |
| **IDR** | **IDR** | **IDR** | **IDR** | **IDR** | | **IDR** | **IDR** |
| **172,758,000.00** | **18,088,000.00** | **20,888,000.00** | **49,616,000.00** | **23,000,000.00** | | **139,169,500.00** | **50,000.00** |
| | | | | | | | |
| 2,334,567.57 | 244,432.43 | 282,270.27 | 670,486.49 | 310,810.81 | | 1,880,668.92 | 675.68 |
| 2,334,567.57 | 244,432.43 | 282,270.27 | 670,486.49 | 310,810.81 | | 1,880,668.92 | 675.68 |
| 2,334,567.57 | 244,432.43 | 282,270.27 | 670,486.49 | 310,810.81 | | 1,880,668.92 | 675.68 |
| 2,334,567.57 | 244,432.43 | 282,270.27 | 670,486.49 | 310,810.81 | | 1,880,668.92 | 675.68 |
| 2,334,567.57 | 244,432.43 | 282,270.27 | 670,486.49 | 310,810.81 | | 1,880,668.92 | 675.68 |
| | | | | | | | |

## : model for the CMCPs of Project Overheads

3, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of ta

*:s - CO)* (table C).
*activity, per-week* (table D)
*ment and **C**ontrolling **P**ractices (**CMCPs**)* in table E, to improve the management of project overheads.

*: (continue)*

**Q) * Activity Duration (AD) / Optimum Duration (OD).**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner |
|---|---|---|---|---|---|
| sheet | unit-month | month | l-sum | month | man.month |
| **250.00** | **21.00** | **7.00** | **1.00** | **7.00** | **49.00** |
| 32 | 32 | 32 | 32 | 32 | 32 |
| 31.25 | 2.63 | 0.88 | 0.13 | 0.88 | 6.13 |
| 156.25 | 13.13 | 4.38 | 0.63 | 4.38 | 30.63 |
| 156.25 | 13.13 | 4.38 | 0.63 | 4.38 | 30.63 |
| 78.13 | 6.56 | 2.19 | 0.31 | 2.19 | 15.31 |
| 156.25 | 13.13 | 4.38 | 0.63 | 4.38 | 30.63 |
| 578.13 | 48.56 | 16.19 | 2.31 | 16.19 | 113.31 |

*:s (continue)*

**QD**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner |
|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR |
| 375,000.00 | 75,600,000.00 | 14,000,000.00 | 5,000,000.00 | ############# | 44,100,000.00 |
| | | | | | |
| 648.65 | 1,556,756.76 | 864,864.86 | 2,162,162.16 | 864,864.86 | 389,189.19 |
| 648.65 | 1,556,756.76 | 864,864.86 | 2,162,162.16 | 864,864.86 | 389,189.19 |
| 648.65 | 1,556,756.76 | 864,864.86 | 2,162,162.16 | 864,864.86 | 389,189.19 |
| 648.65 | 1,556,756.76 | 864,864.86 | 2,162,162.16 | 864,864.86 | 389,189.19 |
| 648.65 | 1,556,756.76 | 864,864.86 | 2,162,162.16 | 864,864.86 | 389,189.19 |
| | | | | | |

*ue)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity |
|---|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | | |
| **375,000.00** | **75,600,000.00** | **14,000,000.00** | **5,000,000.00** | **#############** | **44,100,000.00** | | |
| | | | | | | | |
| 20,270.27 | 4,086,486.49 | 756,756.76 | 270,270.27 | 756,756.76 | 2,383,783.78 | | **221,635,268.78** |
| 101,351.35 | 20,432,432.43 | 3,783,783.78 | 1,351,351.35 | 3,783,783.78 | 11,918,918.92 | | **184,473,922.58** |
| 101,351.35 | 20,432,432.43 | 3,783,783.78 | 1,351,351.35 | 3,783,783.78 | 11,918,918.92 | | **262,757,882.85** |
| 50,675.68 | 10,216,216.22 | 1,891,891.89 | 675,675.68 | 1,891,891.89 | 5,959,459.46 | | **122,962,081.60** |
| 101,351.35 | 20,432,432.43 | 3,783,783.78 | 1,351,351.35 | 3,783,783.78 | 11,918,918.92 | | **292,962,079.00** |
| 375,000.00 | 75,600,000.00 | 14,000,000.00 | 5,000,000.00 | ############# | 44,100,000.00 | | **1,084,791,234.81** |

*'eek (continue)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity Per Week |
|---|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | | |
| **375,000.00** | **75,600,000.00** | **14,000,000.00** | **5,000,000.00** | **#############** | **44,100,000.00** | | |
| | | | | | | | |
| 5,067.57 | 1,021,621.62 | 189,189.19 | 67,567.57 | 189,189.19 | 595,945.95 | | **55,408,817.19** |
| 5,067.57 | 1,021,621.62 | 189,189.19 | 67,567.57 | 189,189.19 | 595,945.95 | | **9,223,696.13** |
| 5,067.57 | 1,021,621.62 | 189,189.19 | 67,567.57 | 189,189.19 | 595,945.95 | | **13,137,894.14** |
| 5,067.57 | 1,021,621.62 | 189,189.19 | 67,567.57 | 189,189.19 | 595,945.95 | | **12,296,208.16** |
| 5,067.57 | 1,021,621.62 | 189,189.19 | 67,567.57 | 189,189.19 | 595,945.95 | | **14,648,103.95** |
| | | | | | | | |

APPENDIX 5: Project Case Studies

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| IDN | ACTIVITIES | DURATION | Assigned OHs | Dec-10 | | | | Jan-11 |
|---|---|---|---|---|---|---|---|---|
| | | (week) | (Per Activity) | 1 | 2 | 3 | 4 | 5 |
| A | **SUBSTRUCTURE** | | | | | | | |
| A.1 | **Preparation** | **4** | 221,635,268.78 | **55,408,817.19** | **55,408,817.19** | **55,408,817.19** | **55,408,817.19** | |
| A.2 | **Precast Concrete Pile** | **20** | 184,473,922.58 | | | **9,223,696.13** | **9,223,696.13** | **9,223,696.13** |
| A.3 | **Excavation & Backfill** | **20** | 262,757,882.85 | | | | | **13,137,894.14** |
| A.4 | **Pile Cap** | **10** | 122,962,081.60 | | | | | |
| A.5 | **Tie Beam & Ground Slab** | **20** | 292,962,079.00 | | | | | |
| | SubTotal | 74 | ***1,084,791,234.81*** | 55,408,817.19 | 55,408,817.19 | 64,632,513.32 | 64,632,513.32 | 22,361,590.27 |
| **Cost Schedule** | | | | | | | | |
| | Overhead Cost Scheduled ***(OCS)*** | | | 55,408,817.19 | 55,408,817.19 | 64,632,513.32 | 64,632,513.32 | 22,361,590.27 |
| | Cumulative ***OCS*** | | | 55,408,817.19 | 110,817,634.39 | 175,450,147.71 | 240,082,661.04 | 262,444,251.31 |
| | Remaining ***OCS*** for Completion | | | 1,029,382,417.61 | 973,973,600.42 | 909,341,087.09 | 844,708,573.77 | 822,346,983.50 |
| **Case Study** | | | | | | | | |
| | Activity Progress Values ***(APV)*** | | | **100,000,000.00** | **70,000,000.00** | **140,000,000.00** | **110,000,000.00** | **40,000,000.00** |
| | Cumulative ***APV*** | | | 100,000,000.00 | 170,000,000.00 | 310,000,000.00 | 420,000,000.00 | 460,000,000.00 |
| | Actual Project Expenses ***(APE)*** | | | **90,000,000.00** | **60,000,000.00** | **120,000,000.00** | **60,000,000.00** | **100,000,000.00** |
| | Cumulative ***APE*** | | | 90,000,000.00 | 150,000,000.00 | 270,000,000.00 | 330,000,000.00 | 430,000,000.00 |
| | Overhead Cost Changes ***(OCC) = APV-APE*** | | | 10,000,000.00 | 10,000,000.00 | 20,000,000.00 | 50,000,000.00 | - 60,000,000.00 |
| | Cumulative ***OCC*** | | | 10,000,000.00 | 20,000,000.00 | 40,000,000.00 | 90,000,000.00 | 30,000,000.00 |
| **Cost Control** | | | | | | | | |
| | Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | 1.80 | 1.53 | 1.77 | 1.75 | 1.75 |
| | Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **1.11** | **1.13** | **1.15** | **1.27** | **1.07** |
| | **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS)*:** | | | | | | | |
| | Estimate at Completion Forecast.1 ***($EACf_1$)* = APE + Budgeted OCS at Completion - APV*** | | | 1,074,791,234.81 | 1,064,791,234.81 | 1,044,791,234.81 | 994,791,234.81 | 1,054,791,234.81 |
| | Estimate at Completion Forecast.2 ***($EACf_2$)** = Budgeted OCS at Completion / VER*** | | | 976,312,111.33 | 957,168,736.59 | 944,818,172.25 | 852,335,970.21 | 1,014,043,980.36 |
| | Estimate at Completion Forecast.3 ***($EACf_3$)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 938,806,841.02 | 1,088,753,501.94 | 1,005,520,522.41 | 950,752,662.26 | 1,145,777,083.78 |
| | *(Budgeted OCS at Completion - APV)* | | | 1,702,109,447.54 | 1,632,109,447.54 | 1,492,109,447.54 | 1,382,109,447.54 | 1,342,109,447.54 |
| | *(VER*VSR)* | | | 2.01 | 1.74 | 2.03 | 2.23 | 1.88 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(IDR)* | 10,000,000.00 | 20,000,000.00 | 40,000,000.00 | 90,000,000.00 | 30,000,000.00 |
| | Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **$WCS_2$** *(IDR)* | 108,479,123.48 | 127,622,498.21 | 139,973,062.56 | 232,455,264.60 | 70,747,254.44 |
| | Project ***'saving or deficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(IDR)* | 145,984,393.79 | - 3,962,267.14 | 79,270,712.40 | 134,038,572.54 | - 60,985,848.97 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(%Budget)* | 0.92% | 1.84% | 3.69% | 8.30% | 2.77% |
| | Project ***'saving or deficit'*** at Completion (Scenario-2): | | **$WCS_2$** *(%Budget)* | 10.00% | 11.76% | 12.90% | 21.43% | 6.52% |
| | Project ***'saving ordeficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(%Budget)* | 13.46% | -0.37% | 7.31% | 12.36% | -5.62% |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

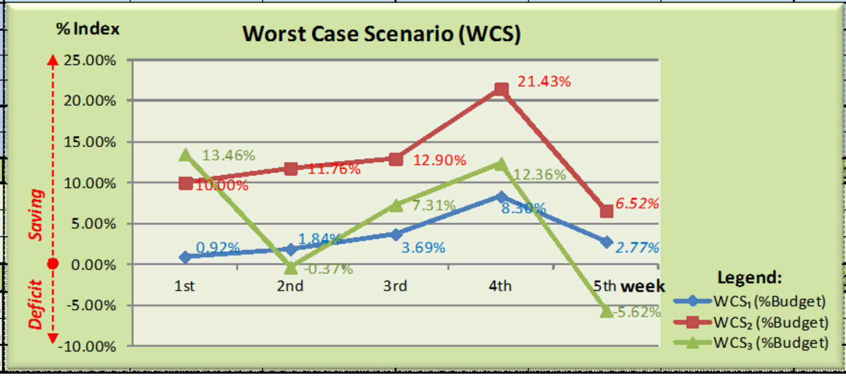
***$EACf_1$ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)*** .

***$EACf_2$ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***$EACf_3$ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads *(continue)*

| Jan-11 | | | | Feb=11 | | | | Mar-11 | | | | Apr-11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 | 9,223,696.13 |
| 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 | 13,137,894.14 |
| | 12,296,208.16 | | 12,296,208.16 | | 12,296,208.16 | | 12,296,208.16 | | 12,296,208.16 | | 12,296,208.16 | | 12,296,208.16 |
| | | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 | 14,648,103.95 |
| 22,361,590.27 | 34,657,798.43 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 |
| | | | | | | | | | | | | | |
| 22,361,590.27 | 34,657,798.43 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 |
| 262,444,251.31 | 297,102,049.74 | 334,111,743.96 | 383,417,646.34 | 420,427,340.56 | 469,733,242.95 | 506,742,937.17 | 556,048,839.55 | 593,058,533.77 | 642,364,436.15 | 679,374,130.37 | 728,680,032.75 | 765,689,726.98 | 814,995,629.36 |
| 822,346,983.50 | 787,689,185.07 | 750,679,490.85 | 701,373,588.46 | 664,363,894.24 | 615,057,991.86 | 578,048,297.64 | 528,742,395.26 | 491,732,701.04 | 442,426,798.66 | 405,417,104.43 | 356,111,202.05 | 319,101,507.83 | 269,795,605.45 |
| | | | | | | | | | | | | | |
| 40,000,000.00 | | | | | | | | | | | | | |
| 460,000,000.00 | | | | | | | | | | | | | |
| 100,000,000.00 | | | | | | | | | | | | | |
| 430,000,000.00 | | | | | | | | | | | | | |
| - 60,000,000.00 | | | | | | | | | | | | | |
| 30,000,000.00 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 1.75 | | | | | | | | | | | | | |
| 1.07 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 1,054,791,234.81 | | | | | | | | | | | | | |
| 1,014,043,980.36 | | | | | | | | | | | | | |
| 1,145,777,083.78 | | | | | | | | | | | | | |
| 1,342,109,447.54 | | | | | | | | | | | | | |
| 1.88 | | | | | | | | | | | | | |
| 5th | | | | | | | 12th | 13th | 14th | 15th | 16th | 17th | 18th |
| 30,000,000.00 | | | | | | | | | | | | | |
| 70,747,254.44 | | | | | | | | | | | | | |
| - 60,985,848.97 | | | | | | | | | | | | | |
| 5th | | | | | | | 12th | 13th | 14th | 15th | 16th | 17th | 18th |
| 2.77% | | | | | | | | | | | | | |
| 6.52% | | | | | | | | | | | | | |
| -5.62% | | | | | | | | | | | | | |




**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EACf₁ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)***.

***EACf₂ ***** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***)*** ***EACf₃ ****** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VEI***

| | | | May-11 | | | | Jun-11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **9,223,696.13** | **9,223,696.13** | **9,223,696.13** | **9,223,696.13** | **9,223,696.13** | | | | | | |
| **13,137,894.14** | **13,137,894.14** | **13,137,894.14** | **13,137,894.14** | **13,137,894.14** | **13,137,894.14** | **13,137,894.14** | | | | |
| **12,296,208.16** | | **12,296,208.16** | | **12,296,208.16** | | **12,296,208.16** | | | | |
| **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | **14,648,103.95** | | |
| 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 27,785,998.09 | 40,082,206.25 | 14,648,103.95 | 14,648,103.95 | | |
| | | | | | | | | | | |
| 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 37,009,694.22 | 49,305,902.38 | 27,785,998.09 | 40,082,206.25 | 14,648,103.95 | 14,648,103.95 | | |
| 814,995,629.36 | 852,005,323.58 | 901,311,225.96 | 938,320,920.18 | 987,626,822.56 | 1,015,412,820.65 | 1,055,495,026.91 | 1,070,143,130.86 | 1,084,791,234.81 | | |
| 269,795,605.45 | 232,785,911.23 | 183,480,008.85 | 146,470,314.63 | 97,164,412.24 | 69,378,414.15 | 29,296,207.90 | 14,648,103.95 | - | | |
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| **18th** | **19th** | **20th** | **21st** | **22nd** | **23rd** | **24th** | **25th** | **26th** | **27th** | **28th** |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **18th** | **19th** | **20th** | **21st** | **22nd** | **23rd** | **24th** | **25th** | **26th** | **27th** | **28th** |
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tio ***(VSR and VER)***

# Appendix 5-i: The Case Study of the Hotel Project

## SUMMARY Hotel

| Percent | Original Budget | Category | Percent | Projected Budget |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | | | | |
| 5.472% | 491,448,677.94 | Labor | 7.512% | 674,669,592.61 |
| 36.290% | 3,259,185,749.72 | Material | 37.382% | 3,357,277,458.32 |
| 58.238% | 5,230,367,635.62 | Subcontractor | 55.501% | 4,984,534,982.27 |
| | | | | |
| | **8,981,002,063.28** | **NET COST** | | **9,016,482,033.20** |
| 3.007% | 270,027,596.00 | Alat bantu | 4.505% | 406,205,200.00 |
| 5.011% | 450,045,993.00 | Preliminaries | 6.104% | 550,389,564.58 |
| | | | | |
| | **9,701,075,652.28** | **TOTAL NET COST** | | **9,973,076,797.78** |
| | | | | |
| 7.500% | 937,500,000.00 | OH Kantor = 7.5 dari RC | 7.500% | 937,500,000.00 |
| | | | | |
| | | | | |
| **11.891%** | **1,486,424,347.72** | **PROFIT** | **9.715%** | **1,214,423,202.22** |
| | | | | |
| | **12,125,000,000.00** | **TOTAL ESTIMASI** | | **12,125,000,000.00** |
| | | | | |
| 3.000% | 375,000,000.00 | PPH ( 3% DARI RC) | 3.000% | 375,000,000.00 |
| 10.000% | 1,250,000,000.00 | PPN ( 10% DARI RC) | 10.000% | 1,250,000,000.00 |
| | **13,750,000,000.00** | **TOTAL ESTIMASI WITH TAX** | | **13,750,000,000.00** |

Actual Progress Schedule, the Hotel Project

| IDN | ACTIVITIES | DURATION | Jan-11 | | | | Feb-11 | | | | Mar-11 | | | | Apr-11 | | | | May-11 | | | | Jun-11 | | | | Jul-11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | SUBSTRUCTURE | Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| A.1 | Preparation | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A.2 | Bore-pile Concrete | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A.3 | Excavation & Backfill | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A.4 | Pile Cap | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A.5 | Tie Beam & Ground Slab | 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Sub total | 58 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**The Hotel Project**
**Actual OH Cost Accounts**

| Description | Actual Quantity | UOM | Actual Project Cost | Overhead Cost Account |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Upah pekerjaan pembersihan dan pengukuran uitzet *(Measurement)* | *2,400.00* | *m2* | *3,600,000.00* | *3,600,000.00* |
| | | | | |
| Upah Pekerjaan Buangan Tanah Out site Total *(Excavator + Opera* | *427.23* | *m3* | 10,680,700.00 | *76,785,598.00* |
| Upah Pekerjaan Galian dg Manual Total *(Excavator + Operator)* | *479.02* | *m3* | 66,104,898.00 | |
| | | | | |
| Sewa stamper *(Compactor)* | 15.00 | hr | 3,000,000.00 | *10,185,940.00* |
| Upah Pekerjaan Urugan dgn limeStone dipadatkan *(Compactor + C* | *493.93* | *m3* | 5,927,160.00 | |
| Upah Pekerjaan Urugan Pasir *(Compactor + Opr)* | *86.71* | *m3* | 693,700.00 | |
| Upah Pekerjaan Urugan tanah dipadatkan *(Compactor + Opr)* | *47.09* | *m3* | 565,080.00 | |
| | | | | |
| Sub. Pekerjaan *Drilling of bored pile, dia. 300 mm, 10m depth (ir* | *1,120.00* | *m* | 95,200,000.00 | *95,200,000.00* |
| | | | | |
| Sub. Pekerjaan Pekerjaan Anti rayap tanah *(Anti Termites for Soil* | *547.68* | *m2* | 4,107,614.25 | *4,107,614.25* |
| | | | | |
| *Waterproofing* | *499.70* | *m2* | *26,930,000.00* | *26,930,000.00* |
| Sub. Pekerjaan *Waterproofing* coating cement base ex. sikatop T | 76.30 | m2 | 1,526,000.00 | |
| Sub. Pekerjaan *Waterproofing* membran Total | 402.85 | m2 | 24,171,000.00 | |
| Sub. Pekerjaan *Waterproofing* membran ex. fosfroc Total | 20.55 | m2 | 1,233,000.00 | |
| | | | | |
| *Car Rent (5 unit x 6 month)* | *36.00* | *unt.bln* | *153,000,000.00* | *153,000,000.00* |
| Sewa kendaraan stand by (Car Rent 2 unit) | 180.00 | hr | 36,000,000.00 | |
| Sewa kendaraan antar jemput tenaga (Car Rent 2 unit) | 180.00 | hr | 54,000,000.00 | |
| Sewa kendaraan angkut material dari gudang (Car Rent 2 unit). | 180.00 | hr | 63,000,000.00 | |
| | | | | |
| *SITE MANAGER* | *6.00* | *bln* | *39,540,000.00* | *39,540,000.00* |
| Tunjangan jabatan SM | 6.00 | bln | 18,000,000.00 | |
| Tunjangan transport SM | 6.00 | bln | 2,520,000.00 | |
| Uang makan SM | 180.00 | hr | 2,160,000.00 | |
| Uang lembur SM | 360.00 | jam | 1,260,000.00 | |
| Tunjangan jauh | 6.00 | bln | 600,000.00 | |
| Gaji SM | 6.00 | bln | 15,000,000.00 | |
| | | | | |
| *PELAKSANA SIPIL (8 Orang) Engineer* | *54.00* | *bln* | *154,980,000.00* | *154,980,000.00* |
| Tunjangan jabatan pelaksana sipil | 48.00 | bln | 72,000,000.00 | |
| Uang makan pelaksana sipil | 1,440.00 | hr | 11,520,000.00 | |
| Uang lembur pelaksana | 2,880.00 | jam | 8,640,000.00 | |
| Tunjangan jauh | 48.00 | bln | 4,800,000.00 | |
| Gaji pelaksana sipil | 48.00 | bln | 40,800,000.00 | |
| *PELAKSANA MEKANIK & ELEKTRIK (ME) Engineer* | | | | |
| Tunjangan jabatan pelaksana ME | 6.00 | bln | 9,000,000.00 | |
| Uang makan pelaksana ME | 180.00 | hr | 1,440,000.00 | |
| Uang lembur pelaksana ME | 360.00 | jam | 1,080,000.00 | |
| Tunjangan jauh | 6.00 | bln | 600,000.00 | |
| Gaji pelaksana ME | 6.00 | bln | 5,100,000.00 | |
| | | | | |
| *ARSITEK / DRAWING* | *6.00* | *bln* | *15,504,000.00* | *15,504,000.00* |
| Tunjangan jabatan drawing | 6.00 | bln | 6,504,000.00 | |
| Uang makan drawing | 180.00 | hr | 1,440,000.00 | |
| Uang lembur drawing | 720.00 | jam | 2,160,000.00 | |
| Tunjangan jauh | 6.00 | bln | 600,000.00 | |
| Gaji drawing | 6.00 | bln | 4,800,000.00 | |
| | | | | |
| *QUANTITY SURVEYOR (QS)* | *6.00* | *bln* | *17,904,000.00* | *17,904,000.00* |
| Tunjangan jabatan QS | 6.00 | bln | 6,504,000.00 | |
| Tunjangan transport QS | 6.00 | bln | 3,000,000.00 | |
| Uang makan QS | 180.00 | jam | 1,440,000.00 | |
| Uang lembur QS | 720.00 | bln | 2,160,000.00 | |
| Tunjangan jauh | 6.00 | bln | 600,000.00 | |
| Gaji QS | 6.00 | bln | 4,200,000.00 | |
| | | | | |
| *ADMINISTRASI (Administration)* | | | | |
| Tunjangan jabatan ADM | 6.00 | bln | 4,200,000.00 | |
| Tunjangan transport ADM | 6.00 | bln | 3,000,000.00 | |
| Uang makan ADM | 180.00 | hr | 1,440,000.00 | |
| Uang lembur ADM | 360.00 | jam | 1,080,000.00 | |
| Gaji ADM | 6.00 | bln | 3,900,000.00 | |

| | | | | |
|---|---|---|---|---|
| ***LOGISTIK*** | ***12.00*** | ***bln*** | | ***24,408,000.00*** |
| Tunjangan jabatan | 6.00 | bln | 4,800,000.00 | |
| Uang makan | 6.00 | bln | 48,000.00 | |
| Uang lembur | 180.00 | hr | 540,000.00 | |
| Tunjangan jauh | 6.00 | jam | 1,800,000.00 | |
| Gaji | 6.00 | bln | 3,600,000.00 | |
| | | | | |
| ***KONSUMSI TENAGA & KANTOR (OFFICE SUPPLIES)*** | ***6.00*** | ***bln*** | | ***46,101,500.00*** |
| Banten sehari hari | 6.00 | bln | 600,000.00 | 4,190,000.00 |
| Banten mulai kerja | 1.00 | ls | 1,500,000.00 | |
| Kertas A3 | 20.00 | rim | 1,100,000.00 | |
| Keras A4 | 30.00 | rim | 990,000.00 | |
| ***Cetak foto (Photo Print)*** | ***50.00*** | ***lbr*** | ***75,000.00*** | ***75,000.00*** |
| Catridge printer | 1.00 | bh | 720,000.00 | 3,936,500.00 |
| Tinta printer | 10.00 | bln | 3,100,000.00 | |
| Pelubang kertas | 1.00 | bh | 7,500.00 | |
| Bulpoin | 1.00 | ls | 50,000.00 | |
| Spidol | 1.00 | ls | 20,000.00 | |
| Stabilo warna | 1.00 | ls | 35,000.00 | |
| Tip ex | 1.00 | ls | 4,000.00 | |
| ***Helm proyek (Helmet)*** | ***20.00*** | ***bh*** | ***200,000.00*** | ***200,000.00*** |
| ***P3k (First Aids)*** | ***1.00*** | ***ls*** | ***85,000.00*** | ***85,000.00*** |
| lakban | 3.00 | roll | 15,000.00 | 37,975,000.00 |
| pengaris | 1.00 | ls | 5,000.00 | |
| Fotocopy | 500.00 | lbr | 200,000.00 | |
| Maff teka besar | 8.00 | bh | 80,000.00 | |
| Aqua galon | 2.00 | bh | 80,000.00 | |
| Dispenser | 1.00 | bh | 135,000.00 | |
| Air aqua | 200.00 | gln | 2,500,000.00 | |
| Kopi | 10.00 | bln | 500,000.00 | |
| Gula | 10.00 | bln | 500,000.00 | |
| Konsumsi tenaga lembur | 3,600.00 | bks | 21,600,000.00 | |
| Konsumsi lembur staf | 6.00 | bln | 3,360,000.00 | |
| Konsumsi konsultan | *6.00* | *bln* | 9,000,000.00 | |
| ***fee konsultan (Specialty Consultancy)*** | 1.00 | lot | ***25,000,000.00*** | ***25,000,000.00*** |
| ***telepon Telephone)*** | ***6.00*** | ***bln*** | ***9,000,000.00*** | ***9,000,000.00*** |
| | | | | |
| KANTOR DIREKSIKET & GUDANG (Site office & Storage) | 39.44 | m2 | 11,965,079.85 | |
| ***Site Office*** | ***18.00*** | ***m2*** | | ***5,460,736.24*** |
| ***Storage*** | ***21.44*** | ***m2*** | | ***6,504,343.61*** |
| BALOK SESEH 6 X 12 X 4.00 | 1.01 | M3 | 1,400,000.00 | |
| USUK 4 X 6 X 4.00 KRUING | 2.01 | M3 | 6,922,080.00 | |
| LAMPU ROTARY MERAH | 1.00 | BH | 115,000.00 | |
| BOX MCB 12 GROUNFOS | 1.00 | BH | 105,000.00 | |
| MCB 16A / 3 PHASE | 1.00 | BH | 175,000.00 | |
| MCB 10A / 1 PHASE | 9.00 | BH | 315,000.00 | |
| KABEL NYM 2 X 1.5 | 2.00 | ROLL | 930,000.00 | |
| STEKER ARDE | 10 | BH | 65,000.00 | |
| STOP KONTAK LUBANG 3 | 10 | BH | 95,000.00 | |
| ISOLASI | 2 | ROLL | 11,000.00 | |
| D.L 212 PUTIH / KCL | 4 | BH | 110,000.00 | |
| D.L 889/ZTL PUTIH | 5.00 | BH | 147,500.00 | |
| TRAVO ELEKTONIK | 9.00 | BH | 247,500.00 | |
| BALON HALOGEN 20 W / 12 V | 9.00 | BH | 67,500.00 | |
| SAKLAR ENGKEL OB BRC | 1.00 | BH | 14,500.00 | |
| SAKLAR SERI OB BRC | 2.00 | BH | 30,000.00 | |
| TRIPLEK 4 MM | 15.00 | LBR | 690,000.00 | |
| TRIPLEK 3 MM | 15.00 | LBR | 540,000.00 | |
| PAKU 7 CM | 15.00 | KG | 145,999.95 | |
| PAKU 10 CM | 15.00 | KG | 145,999.95 | |
| PAKU 5 CM | 15.00 | KG | 145,999.95 | |
| ASBES GELOMBANG | 30.00 | LBR | 645,000.00 | |
| PAKU PAYUNG | 1.00 | KG | 18,000.00 | |
| SAPU IJUK | 1.00 | BH | 10,000.00 | |
| SAPU LIDI | 1.00 | BH | 3,500.00 | |
| SIKAT WC | 1.00 | BH | 25,000.00 | |
| STOP KONTAK | 1.00 | BH | 6,000.00 | |
| GEMBOK | 3.00 | BH | 37,500.00 | |
| OPERVALL | 3.00 | BH | 9,000.00 | |
| SAKLAR MATSUKA | 1.00 | BH | 6,000.00 | |
| ISOLASI UNIBEL | 1.00 | BH | 5,500.00 | |
| ENGSEL 3 IN | 3.00 | PCS | 33,000.00 | |
| KLEM IMUNDK 10MM | 1.00 | KTK | 11,000.00 | |

| | | | | |
|---|---|---|---|---|
| KRAN 1/2 | 3.00 | BH | 60,000.00 | |
| SILENT K | 1.00 | BH | 8,500.00 | |
| KNEE 1 | 4.00 | BH | 14,000.00 | |
| KNEE 1/2 | 1.00 | BH | 5,000.00 | |
| DMX DRY | 1.00 | BH | 50,000.00 | |
| POMPA DISTRIBUSI GROUNFOS JDF 05 | 1.00 | UNIT | 1,525,000.00 | |
| Upah pembuatan direksikeet + gudang | 39.44 | m2 | 3,043,209.73 | |
| | | | | |
| BEDENG TENAGA & TOILET (House/ Camp for Worker & Toilet) | 74.89 | m2 | 20,465,695.00 | |
| ***House Camp for Worker (6 month)*** | ***66.89*** | | | ***18,279,481.09*** |
| ***Toilet 2 unit*** | ***8.00*** | ***m2*** | | ***2,186,213.91*** |
| TUZEN KLEP ONDA 1 | 1.00 | m3 | 48,000.00 | 14,622,970.00 |
| BALL VAVLE PVC POLOS 1 | 1.00 | m3 | 27,500.00 | |
| KRAN ONDA BL 1/2 | 5.00 | lbr | 105,000.00 | |
| POMPA AIR JFT PC-260 BIT + tangki 19 ltr shimizu | 1.00 | kg | 1,225,000.00 | |
| PAKU SENG RRT 2 | 6.00 | kg | 162,000.00 | |
| BALL VALVE 1/2 PVC | 1.00 | kg | 17,500.00 | |
| LEM WAVIN | 1.00 | kg | 27,500.00 | |
| SEAL TAPE ONDA | 5.00 | bh | 7,500.00 | |
| PIPA 1/2 AW WAVIN | 3.00 | lbr | 37,044.00 | |
| KNEE 1/2/TSR | 4.00 | set | 3,888.00 | |
| TEE 1/2 TSR | 1.00 | set | 1,323.00 | |
| KNEE 1/2 DD | 2.00 | bh | 1,890.00 | |
| STYROBOND | 20.00 | LTR | 400,000.00 | |
| BEDEG 2 X 3 | 660.00 | M2 | 4,290,000.00 | |
| BAMBU STEGER | 500.00 | BTG | 3,250,000.00 | |
| BATAKO LUBANG | 500.00 | BJ | 875,000.00 | |
| KWH METER 1 PHASEII | 1.00 | BH | 165,000.00 | |
| KABEL NYM 2 X 1,5 | 2.00 | ROLL | 1,070,000.00 | |
| BOX MCB 4 GROUP OB | 1.00 | BH | 37,500.00 | |
| MCB 10 A / 1 PHASE MG | 3.00 | BH | 115,500.00 | |
| STOP KONTAK LUBANG 3 | 5.00 | BH | 47,500.00 | |
| SAKLAR ENGKEL OB | 15.00 | BH | 187,500.00 | |
| FITTING GANTUNG | 15.00 | BH | 67,500.00 | |
| DOP CLEAR 15 W | 15.00 | BH | 97,500.00 | |
| ISOLASI UNIBEL | 2.00 | BH | 12,000.00 | |
| ASBES GELOBANG | 100.00 | LBR | 2,150,000.00 | |
| R.VALVE PVC ONDA 1 | 1.00 | BH | 16,425.00 | |
| LEM KUBOTA | 1.00 | BH | 64,900.00 | |
| KRAN ONDA 1/2 BC | 10.00 | BH | 112,500.00 | |
| ***TABUNG 190 PEMADAM KEBAKARAN (Fire Safety)*** | ***2.00*** | ***BH*** | ***1,500,000.00*** | ***1,500,000.00*** |
| EJECTOR + VENTURY | 1.00 | BH | 100,000.00 | 5,842,725.00 |
| FOOT KLEP 1 YORK | 1.00 | BH | 20,000.00 | |
| LIME STONE | 64.15 | M3 | 3,528,250.00 | |
| CLOSET JONGKOK | 2.00 | pcs | 135,000.00 | |
| Upah pembuatan bedeng | 74.89 | m2 | 2,059,475.00 | |
| | | | | |
| ***SUMBANGAN (Donation)*** | ***1.00*** | ***ls*** | ***2,000,000.00*** | ***2,000,000.00*** |
| ***AIR & LISTRIK (Water & Electric)*** | ***6.00*** | ***bln*** | ***7,200,000.00*** | ***7,200,000.00*** |
| ***Sewa tanah untuk bedeng luas 5 are selama 1 th (Land Rent)*** | ***5.00*** | ***are*** | ***42,500,000.00*** | ***47,500,000.00*** |
| Sewa tanah untuk direksikeet 6 bln | 1.00 | ls | 5,000,000.00 | |
| ***Kipem tenaga (ID Card and Legal Permit)*** | ***225.00*** | ***org*** | ***11,250,000.00*** | ***11,250,000.00*** |
| ***Harian gudang ,mekanik, waker dan cleaner:*** | ***30.00*** | ***org.bl*** | ***28,800,000.00*** | ***28,800,000.00*** |
| Harian gudang 1 org untuk di proyek selama 6 bln | 6.00 | bln | 7,200,000.00 | |
| Harian gudang 1 org untuk di bedeng selama 6 bln | 6.00 | bln | 7,200,000.00 | |
| Harian mekanik 1 org untuk di proyek selama 6 bln | 6.00 | bln | 7,200,000.00 | |
| Harian waker 1 org untuk di proyek selama bln | 6.00 | bln | 3,600,000.00 | |
| Harian waker 1 org untuk di proyek selama 6 bln | 6.00 | bln | 3,600,000.00 | |
| | | | | |
| ***Scaffolding/ Formwork*** | ***287.79*** | ***m2*** | ***5,922,623.00*** | ***5,922,623.00*** |
| Upah Pekerjaan Bekisting Sloof Total | 34.55 | m2 | 604,625.00 | |
| Upah Pekerjaan Bekisting Sloof Bataco (kayu) Total | 253.24 | m2 | 5,317,998.00 | |
| | | | | |
| ***Concrete Mixer and Pump*** | ***56.57*** | ***m3*** | ***5,254,440.00*** | ***5,254,440.00*** |
| Upah Pekerjaan Cor Beton Manual Plat Total | 29.30 | m3 | 2,637,000.00 | |
| Upah Pekerjaan Cor Beton rabat (m3) Total | 27.27 | m3 | 2,617,440.00 | |

## The Cost Management and Analysis of the ABCC model for the CMCPs of Project Ov

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, B, C, and D), and their cost of ***cause-and-effect*** rel
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Objects - CO)*** (table C).
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-activity, per-week*** (table D)
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and ***C****ost* ***M****anagement and* ***C****ontrolling* ***P****ractices* ***(CMCPs)*** in table

Table A: Ideal ***Quantity Drivers*** of Project Overheads related to Activities

| IDN | ACTIVITIES | DURATION | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AQ) * Activity I | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff/Worker h | Project Helme |
| | | | m2 | m2 | m2 | month | unit |
| | | | 547.6819 | 2400.00 | 499.70 | 16.00 | 20.00 |
| A | SUBSTRUCTURE | WEEK | 5 | 5 | 13 | 5 | 5 |
| A.1 | Preparation | 5 | 547.6819 | 2400.00 | | 16.00 | 20.00 |
| A.2 | Precast Concrete Pile | 15 | | | | | |
| A.3 | Excavation & Back Fill | 18 | | | | | |
| A.4 | Pile Cap | 7 | | | | | |
| A.5 | Tie Beam & Ground Slab | 13 | | | 499.70 | | |
| | SubTotal | 58 | 547.68 | 2400.00 | 499.70 | 16.00 | 20.00 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activities

| IDN | ACTIVITIES | DURATION | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/QD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff/Worker h | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 4,107,614.25 | 3,600,000.00 | 26,930,000.00 | 18,279,481.09 | 200,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 5 | 7,500.00 | 1,500.00 | 53,892.34 | 1,142,467.57 | 10,000.00 |
| A.2 | Precast Concrete Pile | 15 | 7,500.00 | 1,500.00 | 53,892.34 | 1,142,467.57 | 10,000.00 |
| A.3 | Excavation & Back Fill | 18 | 7,500.00 | 1,500.00 | 53,892.34 | 1,142,467.57 | 10,000.00 |
| A.4 | Pile Cap | 7 | 7,500.00 | 1,500.00 | 53,892.34 | 1,142,467.57 | 10,000.00 |
| A.5 | Tie Beam & Ground Slab | 13 | 7,500.00 | 1,500.00 | 53,892.34 | 1,142,467.57 | 10,000.00 |
| | SubTotal | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity

| IDN | ACTIVITIES | DURATION | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff/Worker h | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 4,107,614.25 | 3,600,000.00 | 26,930,000.00 | 18,279,481.09 | 200,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 5 | 4,107,614.25 | 3,600,000.00 | - | 18,279,481.09 | 200,000.00 |
| A.2 | Precast Concrete Pile | 15 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - |
| A.4 | Pile Cap | 7 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 13 | - | - | 26,930,000.00 | - | - |
| | SubTotal | 58 | 4,107,614.25 | 3,600,000.00 | 26,930,000.00 | 18,279,481.09 | 200,000.00 |

Table D: Schedulling the ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-Week***

| IDN | ACTIVITIES | SCHEDULING | Determining the Driver Rates (DR) = CO/AD | | | | |
|---|---|---|---|---|---|---|---|
| | | | Unit Level Overheads | | | | |
| | | | Anti termites fo | Measurements | Water proofing | Staff/Worker h | Project Helme |
| | | | IDR | IDR | IDR | IDR | IDR |
| | | | 4,107,614.25 | 3,600,000.00 | 26,930,000.00 | 18,279,481.09 | 200,000.00 |
| A | SUBSTRUCTURE | WEEK | | | | | |
| A.1 | Preparation | 5 | 821,522.85 | 720,000.00 | - | 3,655,896.22 | 40,000.00 |
| A.2 | Precast Concrete Pile | 15 | - | - | - | - | - |
| A.3 | Excavation & Back Fill | 18 | - | - | - | - | - |
| A.4 | Pile Cap | 7 | - | - | - | - | - |
| A.5 | Tie Beam & Ground Slab | 13 | - | - | 2,071,538.46 | - | - |
| | SubTotal | 58 | | | | | |

## verheads

ationships to substructure activities ( positioned in the left-side of tables).

E, to improve the management of project overheads.

Duration (AD) / Optimum Duration (OD).

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| pair | unit | m2 | m2 | m2 | m2 | unit |
| **21.00** | **2.00** | **18.00** | **21.44** | **8.00** | **500.00** | **18.00** |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 21.00 | 2.00 | 18.00 | 21.44 | 8.00 | 500.00 | 18.00 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 21.00 | 2.00 | 18.00 | 21.44 | 8.00 | 500.00 | 18.00 |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **1,500,000.00** | **5,460,736.24** | **6,504,343.61** | **2,186,213.91** | **47,500,000.00** | **-** |
| | | | | | | |
| - | 750,000.00 | 303,374.24 | 303,374.24 | 273,276.74 | 95,000.00 | - |
| - | 750,000.00 | 303,374.24 | 303,374.24 | 273,276.74 | 95,000.00 | - |
| - | 750,000.00 | 303,374.24 | 303,374.24 | 273,276.74 | 95,000.00 | - |
| - | 750,000.00 | 303,374.24 | 303,374.24 | 273,276.74 | 95,000.00 | - |
| - | 750,000.00 | 303,374.24 | 303,374.24 | 273,276.74 | 95,000.00 | - |
| | | | | | | |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **1,500,000.00** | **5,460,736.24** | **6,504,343.61** | **2,186,213.91** | **47,500,000.00** | **-** |
| | | | | | | |
| - | 1,500,000.00 | 5,460,736.24 | 6,504,343.61 | 2,186,213.91 | 47,500,000.00 | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | 1,500,000.00 | 5,460,736.24 | 6,504,343.61 | 2,186,213.91 | 47,500,000.00 | - |

| Safety shoes | Fire Safety kit | Site office | Storage | Toilet | Land rent | H-Talky |
|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | IDR |
| **-** | **1,500,000.00** | **5,460,736.24** | **6,504,343.61** | **2,186,213.91** | **47,500,000.00** | **-** |
| | | | | | | |
| - | 300,000.00 | 1,092,147.25 | 1,300,868.72 | 437,242.78 | 9,500,000.00 | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| unit | | m3 | m3 | m' | m2 | m3 | | month |
| 225.00 | | 906.25 | 627.73 | 1120.00 | 287.79 | 56.57 | | 6.00 |
| 5 | | 20 | 20 | 20 | 18 | 18 | | 31 |
| 225.00 | | 226.56 | 156.93 | 16.80 | | | | 0.97 |
| | | | | 840.00 | | | | 2.90 |
| | | 815.62 | 564.96 | | | | | 3.48 |
| | | | | | 111.92 | 22.00 | | 1.35 |
| | | | | | 207.85 | 40.85 | | 2.52 |
| 225.00 | | 1042.19 | 721.89 | 856.80 | 319.76 | 62.85 | | 11.23 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 11,250,000.00 | | 76,785,598.00 | 10,185,940.00 | 95,200,000.00 | 5,922,623.00 | 5,254,440.00 | | 39,540,000.00 |
| | | | | | | | | |
| 50,000.00 | | 73,677.42 | 14,110.05 | 111,111.11 | 18,521.83 | 83,602.86 | | 3,522,241.38 |
| 50,000.00 | | 73,677.42 | 14,110.05 | 111,111.11 | 18,521.83 | 83,602.86 | | 3,522,241.38 |
| 50,000.00 | | 73,677.42 | 14,110.05 | 111,111.11 | 18,521.83 | 83,602.86 | | 3,522,241.38 |
| 50,000.00 | | 73,677.42 | 14,110.05 | 111,111.11 | 18,521.83 | 83,602.86 | | 3,522,241.38 |
| 50,000.00 | | 73,677.42 | 14,110.05 | 111,111.11 | 18,521.83 | 83,602.86 | | 3,522,241.38 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 11,250,000.00 | | 76,785,598.00 | 10,185,940.00 | 95,200,000.00 | 5,922,623.00 | 5,254,440.00 | | 39,540,000.00 |
| | | | | | | | | |
| 11,250,000.00 | | 16,692,521.30 | 2,214,334.78 | 1,866,666.67 | - | - | | 3,408,620.69 |
| - | | - | - | 93,333,333.33 | - | - | | 10,225,862.07 |
| - | | 60,093,076.70 | 7,971,605.22 | - | - | - | | 12,271,034.48 |
| - | | - | - | - | 2,072,918.05 | 1,839,054.00 | | 4,772,068.97 |
| - | | - | - | - | 3,849,704.95 | 3,415,386.00 | | 8,862,413.79 |
| 11,250,000.00 | | 76,785,598.00 | 10,185,940.00 | 95,200,000.00 | 5,922,623.00 | 5,254,440.00 | | 39,540,000.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Batch Level Overheads | | | | | | Project Sustainn |
| ID card & Permit | | Excavator + opr. | Compactor+Opr | Drilling machine f | Scafolding & for | Concrete pump rent | | Site manager |
| IDR | | IDR | IDR | IDR | IDR | IDR | | IDR |
| 11,250,000.00 | | 76,785,598.00 | 10,185,940.00 | 95,200,000.00 | 5,922,623.00 | 5,254,440.00 | | 39,540,000.00 |
| | | | | | | | | |
| 2,250,000.00 | | 3,338,504.26 | 442,866.96 | 373,333.33 | - | - | | 681,724.14 |
| - | | - | - | 6,222,222.22 | - | - | | 681,724.14 |
| - | | 3,338,504.26 | 442,866.96 | - | - | - | | 681,724.14 |
| - | | - | - | - | 296,131.15 | 262,722.00 | | 681,724.14 |
| - | | - | - | - | 296,131.15 | 262,722.00 | | 681,724.14 |
| | | | | | | | | |

## The Cost Management and Analysis of the ABC(

1. ***Identify*** project overheads and its cost accounts.
2. ***Categorise*** overhead ***Cost Pools - CP (*** placed up-side of table A, E
3. ***Idealising Quantity Drivers - QD*** (table A).
4. ***Calculating ideal Cost Drivers - CD*** (table B).
5. ***Assigning*** accounted overheads to related activities ***(Cost Object***
6. ***Determining*** the result of ***Driver Rates*** of project overheads ***per-***
7. ***Designing*** the ***Overhead Cost Schedule (OCS)*** and *Cost Manage*

Table A: ***Quantity Drivers*** of Project Overheads related to Activities

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Idealising Quantity Drivers (QD) = Actual Quantity of Overheads (AC | | | | | |
| ing Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engine | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| month | month | month | month | month | | average | l-sum |
| 54.00 | 6.00 | 6.00 | 12.00 | 6.00 | | 6.00 | 1.00 |
| 31 | 31 | 31 | 31 | 31 | | 31 | 31 |
| 8.71 | 0.97 | 0.97 | 1.94 | 0.97 | | 0.97 | 0.16 |
| 26.13 | 2.90 | 2.90 | 5.81 | 2.90 | | 2.90 | 0.48 |
| 31.35 | 3.48 | 3.48 | 6.97 | 3.48 | | 3.48 | 0.58 |
| 12.19 | 1.35 | 1.35 | 2.71 | 1.35 | | 1.35 | 0.23 |
| 22.65 | 2.52 | 2.52 | 5.03 | 2.52 | | 2.52 | 0.42 |
| 101.03 | 11.23 | 11.23 | 22.45 | 11.23 | | 11.23 | 1.87 |

Table B: Ideal ***Cost Drivers*** of Project Overheads Related to Activitie

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Calculating ideal Cost Driver (CD) = Actual Cost of Overheads (AC)/C | | | | | |
| ing Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engine | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 154,980,000.00 | 15,504,000.00 | 17,904,000.00 | 24,408,000.00 | 25,000,000.00 | | 46,101,500.00 | 85,000.00 |
| | | | | | | | |
| 1,533,965.52 | 1,381,103.45 | 1,594,896.55 | 1,087,137.93 | 2,227,011.49 | | 4,106,742.82 | 45,431.03 |
| 1,533,965.52 | 1,381,103.45 | 1,594,896.55 | 1,087,137.93 | 2,227,011.49 | | 4,106,742.82 | 45,431.03 |
| 1,533,965.52 | 1,381,103.45 | 1,594,896.55 | 1,087,137.93 | 2,227,011.49 | | 4,106,742.82 | 45,431.03 |
| 1,533,965.52 | 1,381,103.45 | 1,594,896.55 | 1,087,137.93 | 2,227,011.49 | | 4,106,742.82 | 45,431.03 |
| 1,533,965.52 | 1,381,103.45 | 1,594,896.55 | 1,087,137.93 | 2,227,011.49 | | 4,106,742.82 | 45,431.03 |
| | | | | | | | |

Table C: The ***Cost Objects*** of Project Overheads Per Activity *(contin*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Assigning Overheads to Cost Objects (CO) = QD*CD | | | | |
| ing Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engine | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 154,980,000.00 | 15,504,000.00 | 17,904,000.00 | 24,408,000.00 | 25,000,000.00 | | 46,101,500.00 | 85,000.00 |
| | | | | | | | |
| 13,360,344.83 | 1,336,551.72 | 1,543,448.28 | 2,104,137.93 | 2,155,172.41 | | 3,974,267.24 | 7,327.59 |
| 40,081,034.48 | 4,009,655.17 | 4,630,344.83 | 6,312,413.79 | 6,465,517.24 | | 11,922,801.72 | 21,982.76 |
| 48,097,241.38 | 4,811,586.21 | 5,556,413.79 | 7,574,896.55 | 7,758,620.69 | | 14,307,362.07 | 26,379.31 |
| 18,704,482.76 | 1,871,172.41 | 2,160,827.59 | 2,945,793.10 | 3,017,241.38 | | 5,563,974.14 | 10,258.62 |
| 34,736,896.55 | 3,475,034.48 | 4,012,965.52 | 5,470,758.62 | 5,603,448.28 | | 10,333,094.83 | 19,051.72 |
| 154,980,000.00 | 15,504,000.00 | 17,904,000.00 | 24,408,000.00 | 25,000,000.00 | | 46,101,500.00 | 85,000.00 |

Table D: The ***Driver Rates*** of Project Overheads, ***Per-Activity, Per-W***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Determining the Driver Rates (DR) = CO/AD | | | | |
| ing Overheads | | | | | | Facility Sustainning Overheads | |
| Civil & ME engine | Drawing Review | QS | Logistic | Specialty Consultan | | Office Supplies & | First Aids |
| IDR | IDR | IDR | IDR | IDR | | IDR | IDR |
| 154,980,000.00 | 15,504,000.00 | 17,904,000.00 | 24,408,000.00 | 25,000,000.00 | | 46,101,500.00 | 85,000.00 |
| | | | | | | | |
| 2,672,068.97 | 267,310.34 | 308,689.66 | 420,827.59 | 431,034.48 | | 794,853.45 | 1,465.52 |
| 2,672,068.97 | 267,310.34 | 308,689.66 | 420,827.59 | 431,034.48 | | 794,853.45 | 1,465.52 |
| 2,672,068.97 | 267,310.34 | 308,689.66 | 420,827.59 | 431,034.48 | | 794,853.45 | 1,465.52 |
| 2,672,068.97 | 267,310.34 | 308,689.66 | 420,827.59 | 431,034.48 | | 794,853.45 | 1,465.52 |
| 2,672,068.97 | 267,310.34 | 308,689.66 | 420,827.59 | 431,034.48 | | 794,853.45 | 1,465.52 |
| | | | | | | | |

## : model for the CMCPs of Project Overheads

3, C, and D), and their cost of ***cause-and-effect*** relationships to substructure activities ***(*** positioned in the left-side of tab

*s* ***- CO)*** (table C).
***activity, per-week*** (table D)
*ment and* ***C****ontrolling* ***P****ractices (* ***CMCPs*** *)* in table E, to improve the management of project overheads.

*(continue)*

**Q) * Activity Duration (AD) / Optimum Duration (OD).**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner |
|---|---|---|---|---|---|
| sheet | unit-month | month | l-sum | month | man.month |
| 50.00 | 36.00 | 6.00 | 1.00 | 6.00 | 30.00 |
| 31 | 31 | 31 | 31 | 31 | 31 |
| 8.06 | 5.81 | 0.97 | 0.16 | 0.97 | 4.84 |
| 24.19 | 17.42 | 2.90 | 0.48 | 2.90 | 14.52 |
| 29.03 | 20.90 | 3.48 | 0.58 | 3.48 | 17.42 |
| 11.29 | 8.13 | 1.35 | 0.23 | 1.35 | 6.77 |
| 20.97 | 15.10 | 2.52 | 0.42 | 2.52 | 12.58 |
| 93.55 | 67.35 | 11.23 | 1.87 | 11.23 | 56.13 |

*s (continue)*

**QD**

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner |
|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR |
| 75,000.00 | ############## | 9,000,000.00 | 2,000,000.00 | 7,200,000.00 | 28,800,000.00 |
| | | | | | |
| 801.72 | 2,271,551.72 | 801,724.14 | 1,068,965.52 | 641,379.31 | 513,103.45 |
| 801.72 | 2,271,551.72 | 801,724.14 | 1,068,965.52 | 641,379.31 | 513,103.45 |
| 801.72 | 2,271,551.72 | 801,724.14 | 1,068,965.52 | 641,379.31 | 513,103.45 |
| 801.72 | 2,271,551.72 | 801,724.14 | 1,068,965.52 | 641,379.31 | 513,103.45 |
| 801.72 | 2,271,551.72 | 801,724.14 | 1,068,965.52 | 641,379.31 | 513,103.45 |
| | | | | | |

*ie)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity |
|---|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | | |
| 75,000.00 | ############## | 9,000,000.00 | 2,000,000.00 | 7,200,000.00 | 28,800,000.00 | | |
| | | | | | | | |
| 6,465.52 | 13,189,655.17 | 775,862.07 | 172,413.79 | 620,689.66 | 2,482,758.62 | | 166,499,627.37 |
| 19,396.55 | 39,568,965.52 | 2,327,586.21 | 517,241.38 | 1,862,068.97 | 7,448,275.86 | | 228,746,479.89 |
| 23,275.86 | 47,482,758.62 | 2,793,103.45 | 620,689.66 | 2,234,482.76 | 8,937,931.03 | | 230,560,457.78 |
| 9,051.72 | 18,465,517.24 | 1,086,206.90 | 241,379.31 | 868,965.52 | 3,475,862.07 | | 67,104,773.77 |
| 16,810.34 | 34,293,103.45 | 2,017,241.38 | 448,275.86 | 1,613,793.10 | 6,455,172.41 | | 151,553,151.29 |
| 75,000.00 | ############## | 9,000,000.00 | 2,000,000.00 | 7,200,000.00 | 28,800,000.00 | | 844,464,490.10 |

*'eek* *(continue)*

| Photo print | Car rent | Telephone | Donation | Power + water | Cleanner | | Total Overheads Per Activity Per Week |
|---|---|---|---|---|---|---|---|
| IDR | IDR | IDR | IDR | IDR | IDR | | |
| 75,000.00 | ############## | 9,000,000.00 | 2,000,000.00 | 7,200,000.00 | 28,800,000.00 | | |
| | | | | | | | |
| 1,293.10 | 2,637,931.03 | 155,172.41 | 34,482.76 | 124,137.93 | 496,551.72 | | 33,299,925.47 |
| 1,293.10 | 2,637,931.03 | 155,172.41 | 34,482.76 | 124,137.93 | 496,551.72 | | 15,249,765.33 |
| 1,293.10 | 2,637,931.03 | 155,172.41 | 34,482.76 | 124,137.93 | 496,551.72 | | 12,808,914.32 |
| 1,293.10 | 2,637,931.03 | 155,172.41 | 34,482.76 | 124,137.93 | 496,551.72 | | 9,586,396.25 |
| 1,293.10 | 2,637,931.03 | 155,172.41 | 34,482.76 | 124,137.93 | 496,551.72 | | 11,657,934.71 |
| | | | | | | | |

APPENDIX 5: Project Case Studies

Table E: The Cost Management and Controlling Practices (**CMCPs**) of Project Overheads

| IDN | ACTIVITIES | DURATION (week) | Assigned OHs (Per Activity) | Jan-11 1 | 2 | 3 | 4 | Feb-11 5 |
|---|---|---|---|---|---|---|---|---|
| A | **SUBSTRUCTURE** | | | | | | | |
| A.1 | **Preparation** | **5** | 166,499,627.37 | **33,299,925.47** | **33,299,925.47** | **33,299,925.47** | **33,299,925.47** | **33,299,925.47** |
| A.2 | **Precast Concrete Pile** | **15** | 228,746,479.89 | | | | | |
| A.3 | **Excavation & Backfill** | **18** | 230,560,457.78 | | | **12,808,914.32** | **12,808,914.32** | **12,808,914.32** |
| A.4 | **Pile Cap** | **7** | 67,104,773.77 | | | | | |
| A.5 | **Tie Beam & Ground Slab** | **13** | 151,553,151.29 | | | | | |
| | SubTotal | **58** | ***844,464,490.10*** | 33,299,925.47 | 33,299,925.47 | 46,108,839.80 | 46,108,839.80 | 46,108,839.80 |
| **Cost Schedule** | | | | | | | | |
| | Overhead Cost Scheduled ***(OCS)*** | | | 33,299,925.47 | 33,299,925.47 | 46,108,839.80 | 46,108,839.80 | 46,108,839.80 |
| | Cumulative ***OCS*** | | | 33,299,925.47 | 66,599,850.95 | 112,708,690.74 | 158,817,530.54 | 204,926,370.33 |
| | Remaining ***OCS*** for Completion | | | 811,164,564.63 | 777,864,639.15 | 731,755,799.36 | 685,646,959.56 | 639,538,119.77 |
| **Case Study** | | | | | | | | |
| | Activity Progress Values ***(APV)*** | | | **33,000,000.00** | **60,000,000.00** | **55,000,000.00** | **45,000,000.00** | **20,000,000.00** |
| | Cumulative ***APV*** | | | 33,000,000.00 | 93,000,000.00 | 148,000,000.00 | 193,000,000.00 | 213,000,000.00 |
| | Actual Project Expenses ***(APE)*** | | | **35,000,000.00** | **70,000,000.00** | **40,000,000.00** | **35,000,000.00** | **40,000,000.00** |
| | Cumulative ***APE*** | | | 35,000,000.00 | 105,000,000.00 | 145,000,000.00 | 180,000,000.00 | 220,000,000.00 |
| | Overhead Cost Changes ***(OCC) = APV-APE*** | | | - 2,000,000.00 | - 10,000,000.00 | 15,000,000.00 | 10,000,000.00 | - 20,000,000.00 |
| | Cumulative ***OCC*** | | | - 2,000,000.00 | - 12,000,000.00 | 3,000,000.00 | 13,000,000.00 | - 7,000,000.00 |
| **Cost Control** | | | | | | | | |
| | Value and Scheduled Performance Ratio ***(VSR) = APV/OCS*** | | | 0.99 | 1.40 | 1.31 | 1.22 | 1.04 |
| | Value and Expenses Performance Ratio ***(VER) = APV/APE*** | | | **0.94** | **0.89** | **1.02** | **1.07** | **0.97** |
| | **Estimate at Completion (EAC) forecasts for the Bast Case Solution *(BCS)*:** | | | | | | | |
| | Estimate at Completion Forecast.1 ***(EAC $f_1$)* = APE + Budgeted OCS at Completion - APV*** | | | 846,464,490.10 | 856,464,490.10 | 841,464,490.10 | 831,464,490.10 | 851,464,490.10 |
| | Estimate at Completion Forecast.2 ***(EAC $f_2$)** = Budgeted OCS at Completion / VER*** | | | 895,644,156.17 | 953,427,650.11 | 827,346,966.65 | 787,583,462.27 | 872,216,844.23 |
| | Estimate at Completion Forecast.3 ***(EAC $f_3$)*** = APE + [(Budgeted OCS at Completion - APV) / (VER * VSR)]*** | | | 903,466,250.31 | 712,582,312.24 | 664,638,062.46 | 679,973,601.42 | 847,494,979.15 |
| | *(Budgeted OCS at Completion - APV)* | | | 811,464,490.10 | 751,464,490.10 | 696,464,490.10 | 651,464,490.10 | 631,464,490.10 |
| | *(VER*VSR)* | | | 0.93 | 1.24 | 1.34 | 1.30 | 1.01 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(IDR)* | - 2,000,000.00 | - 12,000,000.00 | 3,000,000.00 | 13,000,000.00 | - 7,000,000.00 |
| | Project ***'saving or deficiit'*** at Completion (Scenario-2): | | **$WCS_2$** *(IDR)* | - 51,179,666.07 | - 108,963,160.01 | 17,117,523.45 | 56,881,027.83 | - 27,752,354.13 |
| | Project ***'saving or deficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(IDR)* | - 59,001,760.21 | 131,882,177.86 | 179,826,427.64 | 164,490,888.68 | - 3,030,489.05 |
| | **The Worst Case Scenario *(WCS)* for Estimating Project Benefits at Completion:** | | **Week** | **1st** | **2nd** | **3rd** | **4th** | **5th** |
| | Project ***'saving or deficit'*** at Completion (Scenario-1): | | **$WCS_1$** *(%Budget)* | -0.24% | -1.42% | 0.36% | 1.54% | -0.83% |
| | Project ***'saving or deficit'*** at Completion (Scenario-2): | | **$WCS_2$** *(%Budget)* | -6.06% | -12.90% | 2.03% | 6.74% | -3.29% |
| | Project ***'saving ordeficit'*** at Completion (Scenario-3): | | **$WCS_3$** *(%Budget)* | -6.99% | 15.62% | 21.29% | 19.48% | -0.36% |

**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

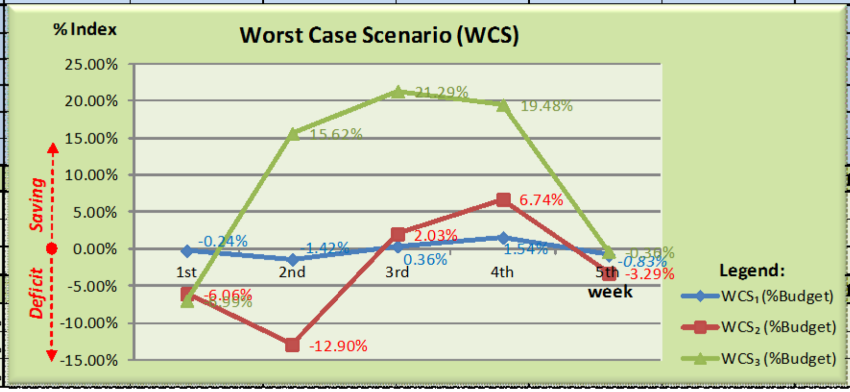
***EAC $f_1$*** * forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)***.

***EAC $f_2$*** ** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

***EAC $f_3$*** *** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VER)***

# APPENDIX 5: Project Case Studies

| Feb-11 | | | | Mar-11 | | | | Apr-11 | | | | May-11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| | | | | | | | | | | | | | |
| 33,299,925.47 | | | | | | | | | | | | | |
| | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 | 15,249,765.33 |
| 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 | 12,808,914.32 |
| | | | 9,586,396.25 | | 9,586,396.25 | | 9,586,396.25 | | 9,586,396.25 | | 9,586,396.25 | | 9,586,396.25 |
| | | | | | | | | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 |
| 46,108,839.80 | 28,058,679.65 | 28,058,679.65 | 37,645,075.90 | 28,058,679.65 | 37,645,075.90 | 28,058,679.65 | 37,645,075.90 | 39,716,614.36 | 49,303,010.61 | 39,716,614.36 | 49,303,010.61 | 39,716,614.36 | 49,303,010.61 |
| | | | | | | | | | | | | | |
| 46,108,839.80 | 28,058,679.65 | 28,058,679.65 | 37,645,075.90 | 28,058,679.65 | 37,645,075.90 | 28,058,679.65 | 37,645,075.90 | 39,716,614.36 | 49,303,010.61 | 39,716,614.36 | 49,303,010.61 | 39,716,614.36 | 49,303,010.61 |
| 204,926,370.33 | 232,985,049.98 | 261,043,729.63 | 298,688,805.53 | 326,747,485.17 | 364,392,561.07 | 392,451,240.72 | 430,096,316.62 | 469,812,930.98 | 519,115,941.60 | 558,832,555.96 | 608,135,566.57 | 647,852,180.93 | 697,155,191.55 |
| 639,538,119.77 | 611,479,440.12 | 583,420,760.47 | 545,775,684.57 | 517,717,004.93 | 480,071,929.03 | 452,013,249.38 | 414,368,173.48 | 374,651,559.12 | 325,348,548.50 | 285,631,934.14 | 236,328,923.53 | 196,612,309.17 | 147,309,298.55 |
| | | | | | | | | | | | | | |
| 20,000,000.00 | | | | | | | | | | | | | |
| 213,000,000.00 | | | | | | | | | | | | | |
| 40,000,000.00 | | | | | | | | | | | | | |
| 220,000,000.00 | | | | | | | | | | | | | |
| - 20,000,000.00 | | | | | | | | | | | | | |
| - 7,000,000.00 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 1.04 | | | | | | | | | | | | | |
| 0.97 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 851,464,490.10 | | | | | | | | | | | | | |
| 872,216,844.23 | | | | | | | | | | | | | |
| 847,494,979.15 | | | | | | | | | | | | | |
| 631,464,490.10 | | | | | | | | | | | | | |
| 1.01 | | | | | | | | | | | | | |
| 5th | | | | | | | 12th | 13th | 14th | 15th | 16th | 17th | 18th |
| - 7,000,000.00 | | | | | | | | | | | | | |
| - 27,752,354.13 | | | | | | | | | | | | | |
| - 3,030,489.05 | | | | | | | | | | | | | |
| 5th | | | | | | | 12th | 13th | 14th | 15th | 16th | 17th | 18th |
| -0.83% | | | | | | | | | | | | | |
| -3.29% | | | | | | | | | | | | | |
| -0.36% | | | | | | | | | | | | | |




**Note: The *EAC* formulas are adapted from Earned Value Management (EVM) and Forcasting (PMI, 2008):**

***EACf₁ ** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished at the present budget rate ***(OCS)***.

***EACf₂ *** forecast for future Estimate to Completion (ETC); remaining activities will be acomplished at the same present index of activity values and actual expenses ratio ***(VER)***

) ***EACf₃ **** forecast for future Estimate to Completion (ETC); remaining activities will be accomplished by considering both present indices of cost schedules and actual expenses ratio ***(VSR and VEF***

| | | | Jun-11 | | | | Jul-11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **15,249,765.33** | **15,249,765.33** | **15,249,765.33** | | | | | | | | |
| **12,808,914.32** | **12,808,914.32** | **12,808,914.32** | | | | | | | | |
| **9,586,396.25** | | **9,586,396.25** | | | | | | | | |
| **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | **11,657,934.71** | | | |
| 49,303,010.61 | 39,716,614.36 | 49,303,010.61 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | | | |
| | | | | | | | | | | |
| 49,303,010.61 | 39,716,614.36 | 49,303,010.61 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | 11,657,934.71 | | | |
| 697,155,191.55 | 736,871,805.91 | 786,174,816.53 | 797,832,751.24 | 809,490,685.96 | 821,148,620.67 | 832,806,555.39 | 844,464,490.10 | | | |
| 147,309,298.55 | 107,592,684.19 | 58,289,673.57 | 46,631,738.86 | 34,973,804.14 | 23,315,869.43 | 11,657,934.71 | - | | | |
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| **18th** | **19th** | **20th** | **21st** | **22nd** | **23rd** | **24th** | **25th** | **26th** | **27th** | **28th** |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **18th** | **19th** | **20th** | **21st** | **22nd** | **23rd** | **24th** | **25th** | **26th** | **27th** | **28th** |
| | | | | | | | | | | |
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| | | | | | | | | | | |

tio ***(VSR and VER)***

# APPENDIX 6: EXPERT INTERVIEW OUTCOMES ON DEVELOPMENT OF THE ABCC MODEL

# Appendix 6-a: Sample of Expert Interview Transcription

The University of Salford, Manchester, United Kingdom
School of the Built Environment
Nyoman M Jaya, PhD Researcher
Office: Maxwell Building, Room: 413, Phone: +44 (0) 161 295 5328, Mobile: +44 (0) 794 369 7996, Email: n.m.jaya@edu.salford.ac.uk

## Semi Structured Interview Transcriptions

**Application of the Activity-Based Costing (ABC) System in the Construction Industry:**

**Development of the Activity-Based Cost Controlling (ABCC) Model to Improve the Management of Project Overheads during the Construction Stage**

### SECTION1: TIME AND LOCATION

Date : omitted
Time : -
Location : -

### SECTION2: INTERVIEWEE DATA

Name : anonymous
Address : -
Email : -
Organisation : -
Education : -
Current Job title : -
Profession : Academia, Consultant, Constructor, Government agent, Other............
Work experience (overall) : -
Work experience (in recent job) : -

### SECTION 3: QUESTION

### Part A: Management of Project Overheads

***1.*** *Are you familiar with project overheads?*

**[A]** Yes, ......

***2.*** *What type of project overheads do you know?*

**[A]** Those which occur "above the line" and are clearly and unambiguously chargeable to the project and the project alone as a part of Cost of Goods Sold - COGS. Examples would be the project manager, project controls department, safety, health and the environment – SHE.

Those which occur "below the line" and are generally known as "home office overhead". This includes any services provided in support of projects, for examples, HR, Accounting, Insurance, Sales and Marketing which are not clearly attributable or billable to any specific project.

University of Salford MANCHESTER
The University of Salford, Manchester, United Kingdom
School of the Built Environment
Nyoman M Jaya, PhD Researcher
Office: Maxwell Building, Room: 413, Phone: +44 (0) 161 295 5328, Mobile: +44 (0) 794 369 7996, Email: n.m.jaya@edu.salford.ac.uk

***3.*** *Are you aware of home-office and site-project overheads?*

**[A]** Yes, was explained as examples before

***4.*** *How do you allocate home office and site-project overheads in your projects?*

**[A]** For anything on site, it gets charged above the line as a Cost of Goods Sold – COGS. For any costs "below the line", we make every attempt to isolate them and charge them against the project. That is, the costs of preparing the bid IF we win the project is charged against COGS, but the costs of preparing the bids we didn't win are allocated on the basis of the value of the project as a function of the gross sales. Value of each project divided by Total value of all projects equal to % share of the home office called "below the line" costs.

***5.*** *What is the likelihood percentage of project overheads to construction costs?*

**[A]** For a company doing about 1-2 million USD per year in gross revenues, with a typical project being between $50,000 to $500,000 USD, the project overhead runs between 14% to 18%, with a median of 16%, while the home office overhead runs between 15% to 20%, with a median of 16% also. For bidding purposes, total overhead is budgeted at 33%. Note that larger or smaller companies will probably have different percentages

***6.*** *Can you predict the percentage proportion (out of 100%) between home-office overheads and site-project overheads?*

**[A]** As previous calculations

***7.*** *Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than to allocate them arbitrarily on direct labour basis?*

**[A]** Yes, We not only allocate overhead on an activity by activity basis, but also profit and contingency, Risk.

## Part B: Activity-Based Costing (ABC) system

***8.*** *Are you familiar with cost controlling techniques during construction stage?*

**[A]** Yes, and we apply them as rigorously as practical.

***9.*** *Which cost controlling tools and techniques do you use?*

**[A]** We use Activity Based Costing, combined with Earned Value Management.

***10.*** *Are you familiar with the ABC system?*

**[A]** Yes. We have been using this system in our company for over 17 years and prior to that, I used it in another construction company I owned. See my website ..........

***Note****: I found the website:* *http://www.pm*******day.net/featured_papers/2007/may.htm*

***11.*** *Is the ABC system important to be applied in construction projects?*

**[A]** We believe it is essential, especially in the world of "hard money", it means Firm Fixed Price or Unit in Place Contracting.

***12.*** *What are the advantages of the ABC system?*

**[A]** It enables fast and very accurate bidding on projects and it enables companies to quickly see what their "core competencies" are..... those activities they make money on, and those

The University of Salford, Manchester, United Kingdom
School of the Built Environment
Nyoman M Jaya, PhD Researcher
Office: Maxwell Building, Room: 413, Phone: +44 (0) 161 295 5328, Mobile: +44 (0) 794 369 7996, Email: n.m.jaya@edu.salford.ac.uk

activities which should be outsourced – subcontracted, OR..... better methods be developed to make them more cost effective – profitable.

***13.** What are the limitations of the ABC system?*

**[A]** There is a point of diminishing returns where tracking costs at the activity level becomes counterproductive. That is......., it is not cost effective to track the costs of nails or other fasteners - consumables, to the activity level.

It requires management to fill in time cards, which many don't like to do as the allocation of their time is somewhat subjective. Attending a pre-bid conference is pretty clear, but what about phone conversations or email communications between a client and the sales manager or finance people. To remedy this problem, billing systems such as those used by lawyers need to be implemented in home offices. For companies which do cost plus contracting, these systems are usually in place, including charging such things as photocopying and time spent researching answers to questions.

## Part C: Cost Management and Controlling Practices

***14.** Can the ABC-Control system be implemented in a construction project?*

**[A]** Absolutely, and without question to the system, as it has been done for at least 60 years, if not more. An excellent example is the RS Means Database, using CSI's Masterformat.

***15.** In which project stage does the ABC-Controlling appropriate?*

**[A]** The data generated by the ABC method makes cost estimating, at both the conceptual estimate level using CSI's Uniformat or Omniclass Table 23 as the basis for top down estimates or using CSI's Masterformat or Omniclass Table 22 as the basis for detailed, "bottom up" estimating methods. But the real value comes in controlling the execution project, if, combined with Earned Value Management, ABCC can provide near real time status reporting to both on site and home office as to whether the project is in trouble or not, but more importantly, if it is in trouble, ABCC can quickly point out the problems which need management attention. Manage by exception.

***16.** Can you explain the advantages and disadvantages of the ABCC model?*

**[A]** Review the examples previously given.

**17.** *Can you compare the ABCC model to other tools (e.g., EVM, TCPI, variance analysis,* forecasting, etc.)?

**[A]** They are complimentary and synergistic.

**18.** *Can you think of any contributions from ABCC model at the organisation level, project* practice, and academic milieu?

**[A]** I ........., ABC system has been used in construction for as long as I have been involved as a general contractor more than XX years and while it may not have been called this name, as evidenced by the RS Means Cost Data, I think it provides ample proof that the concepts underlying ABC have been part and parcel of construction for at least 100 years. To see more on this topic, Gary Cokins is perhaps the best single reference for Activity Based Costing applied in Project Management as opposed to operations management.

***Note**: I have used Gary Cockins's books as a reference to this research.*

## Appendix 6-b: Senior Management Perspectives for Validation of Development of the ABCC Model

| Themes | Questions | Interview Summary (concepts) from Senior Management |
|---|---|---|
| Management of Project Overheads | Q1: Are you familiar with project overheads? | Available overhead terms |
| | Q2: What types of project overheads do you know? | Incurrence overheads on both the general-office and site-projects |
| | Q3: Are you aware of general-office and site-project overheads? | Common practice of overheads in construction projects |
| | Q4: How do you allocate general-office and site-project overhead in your projects? | Percentage overhead basis of project costs |
| | Q5: What is the likelihood percentage of project overheads to total construction cost? | About 14 per cent to 33 per cent overheads of project costs |
| | Q6: Can you predict the percentage proportion (out of 100 per cent) between general-office and site-project overheads? | Proportional overheads in both categories (general-office and site-project) |
| | Q7: Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than allocate them arbitrarily on direct labour basis? | Overhead cost drivers on activity-to-activity basis |
| The Activity-Based Costing (ABC) System | Q8: Are you familiar with cost controlling techniques? | Rigorous and practical costing |
| | Q9: Which cost controlling tools and techniques do you use? | Combination of several costing systems |
| | Q10: Are you familiar with the ABC system? | Reliable cost accounting systems |
| | Q11: Is the ABC system important to be applied in construction projects? | Essential methods to anticipate world *'hard money'* |
| | Q12: What are the advantages of the ABC system? | Very accurate identification on weaknesses and *'core competencies'* |
| | Q13: What are the limitations of the ABC system? | A counterproductive tracer on activity cost of small items |
| Cost Management and Controlling Practices | Q14: Can the ABC-control system be implemented in construction projects? | An excellent sample to cost management and controlling databases |
| | Q15: In which project stage does the ABC-Controlling model appropriate? | Point out the problem quickly through *'management by exception'* |
| | Q16: Can you explain the advantages and disadvantages of the ABCC model? | Robust and practical tools and techniques, for particular construction activities |
| | Q17: Can you compare the ABCC model to other tools (e.g., EVM, TCPI, Variance analysis, forecasting, etc.)? | *'Complementary and synergistic'* to other tools and techniques |
| | Q18: Can you explain of any contributions from the ABCC model at organisation level, management level, and project level? | Whilst, *'it may not have been called'* the ABCC model |
| **Note** | Q1 to Q18 (= question numbers 1 to 18) | |

# Appendix 6-c: Operational Management Perspectives for Validation of Development of the ABCC model

| Themes | Questions | Interview Summary (concepts) from Operational Management |
|---|---|---|
| Management of Project Overheads | Q1: Are you familiar with project overheads? | Inevitable costs of running construction business |
| | Q2: What types of project overheads do you know? | Office related and project related costs |
| | Q3: Are you aware of general-office and site-project overheads? | Costs incurred on operating the construction company and executing a specific project |
| | Q4: How do you allocate general-office and site-project overhead in your projects? | Percentage overhead calculations to project costs |
| | Q5: What is the likelihood percentage of project overheads to total construction cost? | About 15 per cent to 35 per cent overheads of project costs |
| | Q6: Can you predict the percentage proportion (out of 100 per cent) between general-office and site-project overheads? | Up to 10 per cent general-office and 25 per cent site-project overheads of project costs |
| | Q7: Would you prefer to assign site-project overheads accurately based on activity cost drivers, rather than allocate them arbitrarily on direct labour basis? | Activity cost databases and updated market prices based |
| The Activity-Based Costing (ABC) System | Q8: Are you familiar with cost controlling techniques? | Project cost proposal, cost efficiency and effectiveness controls |
| | Q9: Which cost controlling tools and techniques do you use? | Comparison between several costing alternatives for the cost variances |
| | Q10: Are you familiar with the ABC system? | Concern measuring resource costs reflecting construction process and outputs |
| | Q11: Is the ABC system important to be applied in construction projects? | Specific unit costs rather than just total costs |
| | Q12: What are the advantages of the ABC system? | Detailed activity costs on *'WBS lowest level'* |
| | Q13: What are the limitations of the ABC system? | Scientific approaches and complex implementations |
| Cost Management and Controlling Practices | Q14: Can the ABC-control system be implemented in construction projects? | Construction process and performance improvements |
| | Q15: In which project stage does the ABC-Controlling model appropriate? | Construction budgeting and operating cost controls |
| | Q16: Can you explain the advantages and disadvantages of the ABCC model? | Internal cost monitoring and management uses but incompatible with external reporting |
| | Q17: Can you compare the ABCC model to other tools (e.g., EVM, TCPI, Variance analysis, forecasting, etc.)? | Harmony with cost performance management systems |
| | Q18: Can you explain of any contributions from the ABCC model at organisation level, management level, and project level? | Companies' policy, research & development, and personal changes on *'think and act'* |
| **Note** | Q1 to Q18 (= question numbers 1 to 18) | |

# APPENDIX 7: PUBLICATION

# Appendix 7: Publications

1. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2010a. A Critical Review on Application of Activity-Based Costing in the Construction Industry. Proceeding: ©2010 CIB, ISBN 978-1-905732-90-6, CIB World Congress 2010, 10th-13th May 2010, the Lowry, Salford Quays, United Kingdom.

2. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2010b. An Application of the Activity-Based Costing for the Management of Project Overheads to Increase Profit during the Construction stage. Proceeding: ©University of Salford, ISBN 978-1-4477-8072-4, pp.248-266, SPARC 2010 Conference, 10th -11th June 2010, Mary Seacole, the University of Salford, United Kingdom.

3. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2010c. The Development of a Conceptual Framework on Activity-Based Cost Controlling Model for better Management of Project Overheads during the construction Stage. Conference paper in: TIIMI 2010 International Scientific Conference, 3rd- 5th December 2010, London, UK.

4. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2011a. Analysis of Critical Success Factors for Improving the Management of Project Overheads during the Construction Stage in the Construction Industry. Proceeding: ©University of Salford 2011, ISBN: 978-1-907842-17-7, pp.3-18, 10th International Postgraduate Research Conference (IPGRC) 2011, 14th -15th September 2011, Mary Seacole Building, the University of Salford, Greater Manchester, England, United Kingdom.

5. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2011b. The Activity-Based Cost Controlling Model for Improving the Management of Project Overheads to Enhance Sustainable Construction in Indonesia. eBook: Mapping the

Potentials, ©Scientifica Books Ltd., 1st November 2011, Cambridge - UK, ISBN-13: 978-1467984393 and ISBN-10: 1467984396, pp.116-140.

6. Jaya, N.M., Pathirage, C.P., and Sutrisna, M., 2012. Activity-Based Cost Controlling (ABCC) Model for Management of Project Overheads during the Construction Stage. The University of Salford, College of Science and Technology, Research Showcase, 20th June 2012 at Media City UK.

7. Jaya, N.M., and Pathirage, C.P., 2013. Analytic Hierarchy Process for Prioritising Critical Success Factors to Improve the Management of Project Overheads. Proceeding: 11th International Postgraduate Research Conference (IPGRC), pp. 13-29 of 1,157 pages, 8th – 10th 2013, Media City, United Kingdom.

8. Jaya, N.M., and Pathirage, C.P., 2013. An Activity-Based Cost Controlling (ABCC) Model for the Management of Construction Project Overheads. The University of Salford, College of Science and Technology, Dean's Annual Research Showcase, 19th June 2013 at Lady Hale Building, United Kingdom.

9. Jaya, N.M., and Pathirage, C.P., 2013. An Identification of Construction Project Overheads for Sustaining the Cost Management and Controlling Practices. Journal paper.

10. Jaya, N.M., and Pathirage, C.P., 2013. Critical Success Factors for Improving the Cost Management and Controlling Practices of Construction Project Overheads. Journal paper.

# APPENDIX 8: ADMINISTRATION AND PROGRESS

# Appendix 8-a: Internal Evaluation Confirmation

University of Salford
MANCHESTER

PJF/InternalEvaluation

7 June 2012

Mr Nyoman Jaya
21 Beechfield Street
Manchester
M8 0SG

Dear Mr Jaya,

I am pleased to inform you that you have satisfied the Board of Assessors for your Internal Evaluation, which took place recently, in accordance with the requirements of the regulations for the degree of PhD. This was confirmed at the last meeting of the Postgraduate Research Awards Board. You may therefore continue your course of advanced study and research.

Yours sincerely

Paul Farrall
Senior Information Officer
Student Information Directorate

cc: Supervisor: Dr Chaminda Pathirage, School of the Built Environment
Research Administrator: Cheryl Batley, College of Science & Technology
File

*Students have the right to appeal against any decision of the Postgraduate Research Awards Board. If you wish to lodge an appeal, you must do so by submitting your appeal in writing, no later than ten days after the publication of your results, to the Senior Assistant Secretary (Academic Appeals), Governance Services Unit, Acton Square, University of Salford, M5 4WT. The Appeals Procedure and Pro-Forma can be accessed from http://www.governance.salford.ac.uk/page/student_policies or a copy obtained from the Governance Services Unit.*

For enquiries please contact
Paul Farrall, Senior Information Officer, Student Information Directorate
2nd Floor Humphrey Booth House, The Crescent, Salford M5 4WT
Telephone 0161 295 5090 Facsimile 0161 295 5258, E-mail sid-studentrecords@salford.ac.uk

University of Salford, The Crescent, Salford, M5 4WT, United Kingdom
t: +44 (0)161 295 5000 www.salford.ac.uk

## Appendix 8-b: The Most Innovative Methodology Award

University of Salford MANCHESTER

**11th INTERNATIONAL POSTGRADUATE RESEARCH CONFERENCE 2013**

MANCHESTER, 8-10 APRIL 2013

School of the Built Environment (SOBE) University of Salford awarded this award certificate to :

N.M. Jaya

for

*The Built & Human Environment Review award for the Most innovative methodology*

At

11th International Postgraduate Research Conference (IPGRC) 2013

**Prof. VIAN AHMED**
IPGRC 2013 Conference Chair

## Appendix 8-c: Documentation of the Research Findings and Results