List of Figures

Figure 1.1: Flow of research methodology
Figure 1.2: Research design
Figure 2.1: Total asset management manual towards best practice
Figure 2.2: A schematic diagram showing the relationship between maintenance management systems and poor service delivery, poor user satisfaction and maintenance backlogs
Figure 2.3: Types of maintenance
Figure 2.4: The numbers of maintenance projects awarded in Malaysia
Figure 2.5: Allocation for repair and maintenance works in the Tenth Malaysian Plan (2011-2015), Ninth Malaysian Plan (2000-2010) and Eighth Malaysian Plan (2001-2005)
Figure 2.6: Direct Labour Organisation
Figure 2.7: The traditional way of contracting out a project
Figure 2.8: The partnering way of contracting out a project
Figure 2.9: A Procurement Delivery System (PDS) selection process
Figure 2.10: Processes in procurement selection
Figure 2.11: The process of implementing a sourcing strategy
Figure 3.1: Classification of decision analysis methods
Figure 3.2: MCDM process
Figure 3.3: Hierarchy of Analytic Hierarchy Process (AHP)
Figure 3.4: Theoretical Framework
Figure 4.1: Sequential Design
Figure 4.2: Example of questionnaire with scale of 1 to 9 to perform pair-wise comparison
Figure 5.1: Distribution of universities’ age
Figure 5.2: Distribution of annual maintenance budget of university
Figure 5.3: Ranking of procurement methods currently employed in Malaysia’s public universities
Figure 6.1: Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities
Figure 6.2: Steps for adapting Analytic Hierarchy Process (AHP)
Figure 6.3: Hierarchy structure for selecting the most appropriate procurement method for building maintenance management of public universities in Malaysia
Figure 6.4: A model tree view of the decision hierarchy in Expert Choice software
Figure 6.5: The numeric pairwise comparison in Expert Choice software
Figure 6.6: The verbal pairwise comparison in Expert Choice software
Figure 6.7: The graphical pairwise comparison in Expert Choice software
Figure 6.8: Location of inconsistency value in Expert Choice
Figure 6.9: Sensitive Displays for Performance, Dynamics, Gradient and Head to Head performed by Expert Choice Software
List of Tables

Table 2.1: Facilities management failures on managing building features 26
Table 2.2: Categorization of public universities in Malaysia 41
Table 2.3: Allocation for Malaysian’s public universities management 44
Table 2.4: Expenditure on Maintenance of Public University Buildings 45
Table 2.5: Advantages and disadvantages of In-house strategy 53
Table 2.6: Advantages and disadvantages of outsourcing strategy 55
Table 2.7: Advantages and disadvantages of outsourcing asset maintenance 56
Table 2.8: Objectives and anticipated outcomes of outsourcing 58
Table 2.9: Main obstacles and problems of outsourcing 59
Table 2.10: Comparison between outsourcing and out-tasking 66
Table 2.11: List of procurement methods identified 70
Table 2.12: Main Procurement selection criteria 72
Table 2.13: Procurement selection criteria 73
Table 2.14: Procurement Method Selection Criteria 74
Table 2.15: Criteria that customer seeks as important in quality measures 96
Table 3.1: Sample matrix for pairwise comparison 116
Table 3.2: Scale for pairwise comparison matrix 119
Table 3.3: The consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9 121
Table 4.1: Differences between qualitative, quantitative and mixed method 134
Table 4.2: Alternative Strategies of Inquiry 136
Table 4.3: Public Universities’ Maintenance Department Name 145
Table 4.4: Pilot testing comments 150
Table 4.5: The structure of the questionnaire 151
Table 4.6: Summary of the details pertaining to the administration of the preliminary questionnaire survey 156
Table 4.7: Selected universities for structured interview 161
Table 4.8: Interviewees Profiles 162
Table 4.9: Dates of structured interview 166
Table 5.1: Distribution of respondents’ position 170
Table 5.2: Distribution of respondents’ working experience in building maintenance works 170
Table 5.3: Distribution of number of university buildings have been managed the respondents before this university 171
Table 5.4: Distribution of respondents’ education background 171
Table 5.5: Distribution of respondents’ highest academic background 171
Table 5.6: Summary of respondent’s particular and background 172
Table 5.7: Ownership of the university 173
Table 5.8: Distribution of size of the university built area 173
Table 5.9: Distribution of number of full time employee in the maintenance organization 176
Table 5.10: Relationship between size of the university built area and number of full-time employee in the maintenance organization 177
Table 5.11: Relationship between age of university and annual maintenance budget of university
Table 5.12: Relationship between the size of the university built area and annual maintenance budget of university
Table 5.13: Distribution on method to estimate universities’ maintenance budget
Table 5.14: Ranking of procurement selection criteria
Table 5.15: Ranking of building maintenance procurement method
Table 5.16: Distribution on procurement methods currently employed in Malaysia’s public universities
Table 5.17: Distribution on ways to select procurement method
Table 5.18: Distribution on reason to outsource building maintenance services
Table 5.19: Respondents’ opinion on the adequacy of the number of employee for the selected procurement
Table 5.20: Respondents’ opinion on the reasonability of procurement adapted
Table 5.21: Respondents’ satisfaction with the procurement method employed
Table 5.22: Respondents’ opinion on the statement that In-house is the most suitable procurement strategy for university as university should not expose to external parties
Table 5.23: The availability of guidance to select the most suitable procurement method
Table 5.24: The availability of decision making theory or tools in selecting procurement strategy for university
Table 5.25: The availability of useful procedure to select the most appropriate procurement method for building maintenance
Table 5.26: The suitability of Analytic Hierarchy Process (AHP) to be used as a tool to select the most suitable procurement method
Table 5.27: Ranking of measure of procurement method performance
Table 6.1: Final Procurement Method Selection Criteria
Table 6.2: Final Procurement Method Alternative
Table 6.3: List of criteria
Table 6.4: List of alternatives
Table 6.5: Scale for pairwise comparison matrix
Table 6.6: The Consistency Index (RI) of a randomly generated reciprocal matrix within a scale of 1 to 9
Table 6.7: Interviewees Profile
Table 6.8: All vector of priorities for main criteria, sub criteria and alternative
Table 6.9: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.10: Vector of overall priorities with respect to main criteria
Table 6.11: Result of Selection
Table 6.12: All vector of priorities for main criteria, sub criteria and alternative
Table 6.13: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.14: Vector of overall priorities with respect to main criteria
Table 6.15: Result of Selection
Table 6.16: All vector of priorities for main criteria, sub criteria and alternative
Table 6.17: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.18: Vector of overall priorities with respect to main criteria
Table 6.19: Result of Selection
Table 6.20: All vector of priorities for main criteria, sub criteria and alternative
Table 6.21: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.22: Vector of overall priorities with respect to main criteria
Table 6.23: Result of Selection
Table 6.24: All vector of priorities for main criteria, sub criteria and alternative
Table 6.25: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.26: Vector of overall priorities with respect to main criteria
Table 6.27: Result of Selection
Table 6.28: All vector of priorities for main criteria, sub criteria and alternative
Table 6.29: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.30: Vector of overall priorities with respect to main criteria
Table 6.31: Result of Selection
Table 6.32: All vector of priorities for main criteria, sub criteria and alternative
Table 6.33: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.34: Vector of overall priorities with respect to main criteria
Table 6.35: Result of Selection
Table 6.36: All vector of priorities for main criteria, sub criteria and alternative
Table 6.37: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.38: Vector of overall priorities with respect to main criteria
Table 6.39: Result of Selection
Table 6.40: All vector of priorities for main criteria, sub criteria and alternative
Table 6.41: Vector of overall priorities and ranking of Clients’ Requirements sub criteria
Table 6.42: Vector of overall priorities with respect to main criteria
Table 6.43: Result of Selection
Table 6.44: Summary results to compare all interviewees’ priority vector to select the most appropriate procurement method for different type of building maintenance services
Table 6.45: Summary results to compare all interviewees’ priority vector to select the most appropriate procurement method for different type of building maintenance services
Table 6.46: Procurement Methods Comparison (Actual versus Proposed)
Table 6.47: Nine universities evaluation towards Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities
Table 7.1: List of final procurement selection criteria
Table 7.2: List of final alternative 290
Table 7.3: Selected procurement selection criteria and procurement options for the proposed decision making framework 294