

A SURVEY OF DEMOLITION WORKS IN MALAYSIA

VISVAN A/L MASALAMY @ NAVARATNAM

**A project report submitted in partial fulfilment of the
requirement for the award of the degree of
Master of Engineering (Civil – Structure)**

**Faculty of Civil Engineering
Universiti Teknologi Malaysia**

NOVEMBER 2005

To my beloved Mother and Father.

Thank you for your support, guidance and confidence in me.

I would also wish to thank God for all the help He has given me.

ACKNOWLEDGEMENT

First and foremost, I would like to convey my sincere thanks and gratitude to my supervisor, Dr. Arham Abdullah for his time and guidance, throughout the entire research.

Special appreciation also goes out to Gerbang Perdana Sdn. Bhd. and all other individuals as well as organizations which participated and contributed towards making this research a success.

Finally, my heartfelt thanks and regards to my family and friends. Your support and encouragement will never be forgotten. Thank you.

ABSTRACT

As Malaysia continues to progress towards achieving a developed status, shortage of land and space will require existing structures to be demolished, in order to make way for new development. The dilemma of insufficient land in urban areas to sustain growth and cater for increasing modernization demands will augment to a critical level. Therefore, there is dire need to expedite research in the field of demolition works within the country. This research was aimed at developing an overview as well as assessing the potential of demolition operations in Malaysia. Two varying methodologies were adopted comprising a case study and a questionnaire survey. The former looked into the Lumba Kuda Flats demolition operations which formed part of the Gerbang Selatan Bersepadu project. On the other hand, the latter targeted feedback from the local industry's professionals. The case study revealed that local contractors were capable of managing large scaled demolition projects in terms of project planning, demolition techniques, health and safety implementation as well as environmental management. All work aspects met the requirements of international standards and codes and complied with local legislation. The survey reported beneficial data which provided strong indication of the industry's capabilities and identified problems plaguing the various aspects of demolition operations. In order to overcome the limitations and barriers presently faced, local professionals needed to look beyond and consider what the global demolition market had to offer. Apart from that, active government participation was extremely necessary in certain areas to provide long term and effective solutions. The benefits offered by the research are invaluable as it serves as a strong foundation and reference for developing future specifications, standards and legislation to govern demolition operations.

ABSTRAK

Dalam usaha mencapai status negara maju, struktur – struktur sedia ada terpaksa dirobuhkan untuk memberi ruang kepada pembangunan baru disebabkan masalah kekurangan tanah. Hal ini dijangka akan menjadi kritikal di bandaraya – bandaraya pesat memandangkan dilema tanah yang terhad untuk terus menampung keperluan modenisasi yang semakin meningkat. Jesteru itu, kajian di dalam bidang kerja – kerja perobohan di negara ini adalah amat diperlukan. Kajian ini bertujuan untuk membentuk suatu gambaran menyeluruh serta menilai potensi operasi perobohan yang dijalankan di Malaysia. Dua kaedah yang berbeza ciri iaitu satu kajian kes dan satu kaji selidik telah digariskan sebagai methodologi kajian. Merujuk kepada kaedah pertama, operasi perobohan Flat Lumba Kuda yang merupakan sebahagian daripada projek Gerbang Selatan Bersepadu telah dipilih untuk kajian kes. Kaedah kedua pula lebih berteraskan maklumbalas yang diterima daripada golongan professional. Kajian kes melaporkan bahawa pihak kontraktor tempatan berkebolehan mengendalikan projek perobohan yang besar dari segi perancangan, teknik perobohan, keselamatan dan kesihatan serta pengurusan alam sekitar. Kesemua aspek kerja yang dilakukan telah memenuhi keperluan kod antarabangsa dan kriteria perundangan. Kajian soal selidik pula telah memberikan indikasi mantap akan keupayaan industri tempatan serta mengenalpasti masalah – masalah yang membelenggu aspek – aspek kerja perobohan. Sebagai langkah menangani kekangan serta halangan yang dihadapi, para professional tempatan disarankan untuk mempertimbangkan manfaat yang dapat diperolehi daripada pasaran perobohan global. Selain itu, penglibatan aktif kerajaan di dalam beberapa isu adalah amat diperlukan bagi mencari penyelesaian jangka panjang yang efektif. Dari segi sumbangannya, kajian ini dapat menjadi asas dan rujukan kukuh dalam membentuk spesifikasi kerja dan perundangan, berkaitan operasi perobohan di negara ini.

TABLE OF CONTENTS

| CHAPTER | TITLE | PAGE |
|----------|---|-----------|
| | Supervisor's Declaration | |
| | Title Page | i |
| | Declaration of Originality and Exclusiveness | ii |
| | Dedication | iii |
| | Acknowledgement | iv |
| | Abstract (English) | v |
| | Abstrak (Bahasa Melayu) | vi |
| | Table of Contents | vii |
| | List of Tables | xi |
| | List of Figures | xiv |
| | List of Appendices | xx |
| | | |
| 1 | INTRODUCTION | 1 |
| | 1.1 Research Background and Justification | 1 |
| | 1.2 Research Aim and Objectives | 5 |
| | 1.3 Scope of Research | 6 |
| | 1.4 Research Methodology | 7 |
| | 1.5 Thesis Layout | 8 |
| | | |
| 2 | AN OVERVIEW OF THE DEMOLITION INDUSTRY | 11 |
| | 2.1 Introduction | 11 |
| | 2.2 Principles of Structural Demolition | 12 |
| | 2.3 The Demolition Process | 14 |

| | | |
|----------|--|----|
| 2.3.1 | Pre-Demolition Phase | 15 |
| 2.3.2 | Demolition Phase | 16 |
| 2.3.3 | Post-Demolition Phase | 17 |
| 2.4 | Demolition Techniques | 17 |
| 2.4.1 | Demolition by Hand | 18 |
| 2.4.1.1 | Rotary Hammer | 20 |
| 2.4.1.2 | Pneumatic Hammer | 20 |
| 2.4.1.3 | Electric Hammer | 21 |
| 2.4.1.4 | Hydraulic Hammer | 21 |
| 2.4.1.5 | Gasoline Hammer | 22 |
| 2.4.1.6 | Chipping Hammer | 22 |
| 2.4.1.7 | Cutting by Diamond Drilling and Sawing | 23 |
| 2.4.1.8 | Hydraulic Bursting | 27 |
| 2.4.1.9 | Hydraulic Crushing | 28 |
| 2.4.1.10 | Hydraulic Splitter | 28 |
| 2.4.2 | Demolition by Towers and High Reach Cranes | 30 |
| 2.4.3 | Demolition by Machines | 30 |
| 2.4.3.1 | Balling | 31 |
| 2.4.3.2 | Wire Rope Pulling | 32 |
| 2.4.3.3 | High Reach Machines | 33 |
| 2.4.3.4 | Compact Machines | 34 |
| 2.4.3.5 | Hydraulic Shear | 35 |
| 2.4.3.6 | Hydraulic Impact Hammer | 35 |
| 2.4.3.7 | Hydraulic Grinder | 36 |
| 2.4.3.8 | Hydraulic Grapple | 37 |
| 2.4.3.9 | Hydraulic Pulverizer or Crusher | 38 |
| 2.4.3.10 | Hydraulic Multi-purpose Processor | 38 |
| 2.4.3.11 | Hydraulic Pusher Arm | 39 |
| 2.4.3.12 | Demolition Pole | 40 |
| 2.4.4 | Demolition by Chemical Agents | 41 |
| 2.4.4.1 | Bursting | 41 |
| 2.4.4.2 | Hot Cutting | 43 |
| 2.4.4.3 | Explosives | 44 |

| | | |
|----------|---|-----------|
| 2.4.5 | Demolition by Water Jetting | 50 |
| 2.5 | Demolition Safety Requirements | 50 |
| 2.5.1 | Site Safety | 51 |
| 2.5.2 | Basic Hand Tools – Soft Stripping | 52 |
| 2.5.3 | Hand Powered Tools | 53 |
| 2.5.4 | Towers and Machines | 54 |
| 2.5.5 | Chemical Agents | 55 |
| 2.5.6 | Explosives | 56 |
| 2.5.7 | Personal Protective Equipment | 57 |
| 2.6 | Demolition Waste Management and Recycling | 58 |
| 2.7 | Demolition and the Environment | 65 |
| 2.7.1 | Noise | 66 |
| 2.7.2 | Dust and Grit | 67 |
| 2.7.3 | Vibration | 69 |
| 2.7.4 | Flying Debris and Air-blasts | 70 |
| 2.8 | Summary | 72 |
| 3 | RESEARCH METHODOLOGY | 73 |
| 3.1 | Introduction | 73 |
| 3.2 | Literature Review & Background Research | 73 |
| 3.3 | Case Study | 75 |
| 3.4 | Questionnaire Survey | 77 |
| 3.5 | Research Methodology Framework & Schedule | 83 |
| 3.6 | Summary | 85 |
| 4 | CASE STUDY: LUMBA KUDA FLATS DEMOLITION, GERBANG SELATAN BERSEPADU PROJECT | 86 |
| 4.1 | Introduction | 86 |
| 4.2 | Project Background | 87 |
| 4.3 | Demolition Work Program | 92 |
| 4.4 | Demolition Methodology | 94 |
| 4.5 | Demolition Health & Safety | 102 |
| 4.6 | Demolition Environmental Management | 107 |
| 4.7 | Discussion and Summary | 112 |

| | | |
|----------|---------------------------------------|------------|
| 5 | QUESTIONNAIRE SURVEY ANALYSIS | 119 |
| 5.1 | Introduction | 119 |
| 5.2 | General Information | 121 |
| 5.3 | Demolition Overview | 124 |
| 5.4 | Demolition Techniques | 141 |
| 5.5 | Demolition Health & Safety | 145 |
| 5.6 | Demolition Waste Management | 146 |
| 5.7 | Discussion and Summary | 151 |
| | | |
| 6 | CONCLUSION AND RECOMMENDATIONS | 165 |
| 6.1 | Introduction | 165 |
| 6.2 | Realization of Research Objectives | 165 |
| 6.3 | Recommendations for Improvement | 172 |
| 6.4 | Recommendations for Future Research | 172 |
| 6.5 | Closure | 173 |
| | | |
| | REFERENCES | 176 |
| | | |
| | APPENDIX A | 180 |
| | APPENDIX B | 186 |
| | APPENDIX C | 194 |
| | APPENDIX D | 227 |
| | APPENDIX E | 234 |

LIST OF TABLES

| TABLE NO. | TITLE | PAGE |
|------------------|---|-------------|
| 1.1 | Project Volume by State, 2000-2002. | 3 |
| 1.2 | Project Volume by Contract Category, 2000-2002. | 3 |
| 2.1 | Comparison between diamond and conventional cutting techniques. | 23 |
| 3.1 | List of organizations approached in the background research. | 74 |
| 3.2 | List of organizations approached in the case study. | 75 |
| 3.3 | List of survey respondents. | 80 |
| 3.4 | Research schedule. | 84 |
| 4.1 | Preliminary works schedule. | 92 |
| 4.2 | Physical works schedule. | 92 |
| 4.3 | Block A demolition works schedule. | 92 |
| 4.4 | Block B demolition works schedule. | 93 |

| | | |
|------|---|-----|
| 4.5 | Block C demolition works schedule. | 93 |
| 4.6 | Block D demolition works schedule. | 93 |
| 4.7 | Demolition schedule for other buildings. | 93 |
| 4.8 | Compressive strength results (<i>Tested date – 29.05.03</i>). | 96 |
| 4.9 | Hazards analysis. | 104 |
| 4.10 | Job safety analysis. | 105 |
| 4.11 | Location of air quality monitoring point. | 108 |
| 4.12 | Site temperature and relative humidity. | 109 |
| 4.13 | Air quality monitoring results. | 109 |
| 4.14 | Location of noise monitoring point. | 110 |
| 4.15 | Noise monitoring results. | 110 |
| 4.16 | Vibration monitoring results. | 111 |
| 5.1 | Categorization of respondents. | 120 |
| 5.2 | Percentage of weighted response. | 120 |
| 5.3 | Frequency ranking of reasons for demolition projects. | 126 |
| 5.4 | Frequency ranking of demolition concepts. | 141 |
| 5.5 | Frequency ranking of demolition techniques. | 142 |

| | | |
|------|--|-----|
| 5.6 | Significance ranking pertaining to demolition techniques selection criteria. | 144 |
| 5.7 | Frequency ranking of accident and injury causes. | 145 |
| 5.8 | Agreement ranking of difficulties encountered in H & S implementation. | 145 |
| 5.9 | Frequency rating of reused, recycled and disposed waste materials. | 147 |
| 5.10 | Frequency ranking of solid waste utilization. | 149 |
| 5.11 | Agreement ranking pertaining to demolition recycling conceptions. | 149 |
| 5.12 | Agreement ranking of barriers affecting demolition recycling efforts. | 150 |
| 5.13 | Frequency ranking of pollution types faced during demolition works. | 150 |
| 5.14 | Agreement ranking of setbacks faced in tackling environmental issues. | 150 |

LIST OF FIGURES

| FIGURE NO. | TITLE | PAGE |
|-------------------|--|-------------|
| 1.1 | Interrelationship between research methodologies and objectives. | 8 |
| 2.1 | Activities involved in the execution of demolition operations. | 14 |
| 2.2 | Detailed categorization of the various types of demolition techniques. | 19 |
| 2.3 | An electric hammer. | 21 |
| 2.4 | A diamond cutting machine (robore.com, 2005). | 24 |
| 2.5 | A rotary percussion drill (robore.com, 2005). | 24 |
| 2.6 | A diamond drilling machine (robore.com, 2005). | 25 |
| 2.7 | A diamond wire saw (pdworld.com, 2005). | 26 |
| 2.8 | (a) A hydraulic splitter, (b) Mechanism of operation (www.darda.de, 2005). | 29 |
| 2.9 | A tower crane (www.liebherr.fr, 2005). | 30 |

| | | |
|------|--|----|
| 2.10 | (a) Balling machine, (b) Demolition ball (demolitionx.com, 2005). | 32 |
| 2.11 | Wire rope pulling technique (Code of Practice for Demolition Hong Kong, 1988). | 33 |
| 2.12 | Volvo's EC 460B high reach wrecker (volvoce.com, 2005). | 34 |
| 2.13 | (a) A skid steer loader, (b) A telescopic handler (komatsu.com, 2005). | 34 |
| 2.14 | (a) A rebar shear, (b) A plate and tank shear (genesis-europe.com, 2005). | 35 |
| 2.15 | (a) Hydraulic impact hammer in primary breaking, (b) Hydraulic impact hammer in secondary breaking (rammer.com, 2005). | 36 |
| 2.16 | Genesis's Cyclone grinder (genesisequip.com, 2005) | 37 |
| 2.17 | (a) Allied's fixed grapple (alliedcp.com, 2005); (b) Genesis's rotating grapple (genesis-europe.com, 2005). | 37 |
| 2.18 | Allied's RC series hydraulic pulverizer (alliedcp.com, 2005). | 38 |
| 2.19 | NPK's hydraulic multi-processor (www.npke.nl, 2005). | 39 |
| 2.20 | (a) Pushing-in by hydraulic pusher arm, (b) Pulling-out by hydraulic pusher arm (Code of Practice for Demolition Hong Kong, 1988). | 40 |
| 2.21 | Demolition pole machine with a rotating boom (alliedcp.com, 2005). | 40 |

| | | |
|----------|--|----|
| 2.22 | (a) A toppling chimney, (b) A toppling water tank (implosionworld.com, 2005). | 47 |
| 2.23 | A shattering bridge pier (implosionworld.com, 2005). | 48 |
| 2.24 | A residential building imploding (implosionworld.com, 2005). | 49 |
| 2.25 | A medical center progressively collapsing (implosionworld.com, 2005). | 49 |
| 2.26 | Hand operated pressurized water jetting (conjet.com, 2005). | 50 |
| 2.27 | Proper protective gear while conducting hot cutting operations (demolitionx.com, 2005). | 57 |
| 3.1 | Case study methodology framework. | 77 |
| 3.2 | Stratified sample. | 78 |
| 3.3 | Weighted mean formula. | 81 |
| 3.4 | Questionnaire survey methodology framework. | 82 |
| 3.5 | Overall research methodology framework. | 83 |
| 4.1 | GSB project layout. | 88 |
| 4.2(a-d) | Demolition of the Tanjung Puteri Bridge in progress. | 89 |
| 4.3(a-b) | Demolition of Malaya Hotel in progress. | 89 |
| 4.4 | Aerial view of the Lumba Kuda project site. | 91 |

| | | |
|-----------|---|-----|
| 4.5 | Lumba Kuda project site layout. | 91 |
| 4.7 | Concrete slab coring works in progress. | 97 |
| 4.8(a-d) | Concrete core specimens taken at various locations. | 97 |
| 4.9(a-f) | Demolition operations at Block A. | 98 |
| 4.10(a-f) | Demolition operations at Block B. | 99 |
| 4.11(a-f) | Demolition operations at Block C. | 100 |
| 4.12(a-f) | Demolition operations at Block D. | 101 |
| 4.13 | Locations of environmental monitoring points within the GSB site. | 107 |
| 4.14 | Air monitoring works in progress. | 109 |
| 4.15 | Noise monitoring works in progress. | 111 |
| 4.16 | Vibration monitoring works in progress. | 112 |
| 5.1 | Percentage of weighted response. | 121 |
| 5.2 | Categorization of respondents departments. | 122 |
| 5.3 | Respondents working experience. | 122 |
| 5.4 | Execution mode of demolition projects. | 123 |
| 5.5 | Extensiveness rating of demolition works. | 124 |
| 5.6 | Frequency rating of demolition project job scopes. | 125 |

| | | |
|------|--|-----|
| 5.7 | Agreement rating of demolition misconceptions. | 127 |
| 5.8 | Quality rating of government participation in demolition projects. | 128 |
| 5.9 | Demolition projects by structural categorization. | 129 |
| 5.10 | Types of structures demolished in the Civil & Infrastructure category. | 129 |
| 5.11 | Composition of Civil & Infrastructure demolition debris | 130 |
| 5.12 | Age of structures demolished in the Civil & Infrastructure category. | 131 |
| 5.13 | Types of structures demolished in the Public category. | 131 |
| 5.14 | Composition of Public demolition debris. | 132 |
| 5.15 | Age of structures demolished in the Public category. | 133 |
| 5.16 | Types of structures demolished in the Residential category. | 133 |
| 5.17 | Composition of Residential demolition debris. | 134 |
| 5.18 | Age of structures demolished in the Residential category. | 135 |
| 5.19 | Types of structures demolished in the Commercial category. | 135 |
| 5.20 | Composition of Commercial demolition debris. | 136 |
| 5.21 | Age of structures demolished in the Commercial category. | 137 |

| | | |
|------|---|-----|
| 5.22 | Types of structures demolished in the Industrial category. | 137 |
| 5.23 | Composition of Industrial demolition debris. | 138 |
| 5.24 | Age of structures demolished in the Industrial category. | 139 |
| 5.25 | Types of structures demolished in the Specialized category. | 139 |
| 5.26 | Composition of demolition debris in the Specialized category. | 140 |
| 5.27 | Age of structures demolished in the Specialized category. | 141 |
| 5.28 | Respondents' capability rating of demolition techniques. | 144 |
| 5.29 | Response percentage pertaining to the issue of proper deconstruction. | 146 |
| 5.30 | Response percentage pertaining to the issue of on-site separation. | 146 |
| 5.31 | Frequency rating of reused/ recycled waste materials. | 148 |
| 5.32 | Frequency rating of disposed waste materials. | 148 |

LIST OF APPENDICES

| APPENDIX | TITLE | PAGE |
|-----------------|---|-------------|
| A | Articles and statistics that support the research justification. | 180 |
| B | Questionnaire survey sample | 186 |
| C | Questionnaire survey analysis. | 194 |
| D | Photographs and supporting articles that relate to the reasons for demolition operations in Malaysia. | 227 |
| E | Photographs and relevant articles that illustrate demolition works done by local authorities. | 234 |

CHAPTER 1

INTRODUCTION

1.1 Research Background and Justification

Most demolition practices that had been carried out within the last 20 years or so, had little significance in the sense that they did not require high skill and technology. Demolition mainly focused on minor and simple structures such as wooden squatter houses, one or two storey fire damaged buildings as well as dilapidated structures from the past. New projects catering for residential, commercial and industrial development still had sufficient unused land allocations for their construction.

Turning the attention towards the present time, we can note that the situation now, is of somewhat different. An apparent observation can be made in terms of infrastructure development. Road networks of the past are no longer capable of sustaining the substantial increase of vehicle volume. There has been extensive upgrading and building of new highways to ease traffic congestion. These works required land acquisitions from private parties as well as involved a considerable amount of demolition operations. An ideal case to illustrate this was the construction

of the 21km New Pantai Expressway (NPE) that literally cut through the entire length of the Old Klang Road in Kuala Lumpur.

Further, there has been a steady increase in development projects both from government and private sectors partly due to economic prosperity as well as political stability. Based on statistics obtained from the Construction Industry Development Board (CIDB), it is clear that from Table 1.1, the total nationwide project volume rose by 15.4 % between years 2000-2001 and a lower 5.1 % between years 2001-2002. States such as Melaka, Negeri Sembilan, Sabah and Selangor recorded high increases with percentages of 138.2 %, 70.3 %, 76.3 % and 31.6 % respectively, between years 2001-2002. From Table 1.2, the figures indicate that from years 2000-2001, projects categorized under infrastructure, maintenance, mixed development, residential and non-residential experienced a huge boom in volume. But however from years 2001-2002, the industry's pace slowed down with only residential projects being extensively undertaken, i.e. an increase of 71.4 %.

It is important to note that the growth of the construction sector has a very direct link towards demolition operations in the country. This is particularly true in urban areas where the utilization of more space for development will eventually lead to shortage of land. Areas experiencing depleting space will turn to redevelopment to sustain growth as well as cater for increasing market demands. This phenomenon has already begun and is expected to intensify in the near future. A present case to describe this would be the proposed demolition of the Pekeliling Flats comprising 7 blocks of 17 storey buildings and 4 blocks of 4 storey shop houses in the heart of Kuala Lumpur to make way for a mixed commercial and housing project. An article of the proposed demolition project is enclosed in Appendix A-A1.

Based on statistics of land use obtained from the Federal Department of Town and Country Planning for Peninsular Malaysia, it is apparent that from Appendix A-A2, the percentages of 'Built Up' land for Pulau Pinang, Selangor and Kuala Lumpur

Table 1.1: Project Volume by State, 2000-2002.

| States | 2000 | 2001 | 2002 |
|---------------------|-------------|-------------|-------------|
| Johor | 441 | 516 | 596 |
| Kedah | 165 | 347 | 296 |
| Kelantan | 94 | 204 | 232 |
| W.P Labuan | 5 | 3 | 6 |
| Melaka | 57 | 76 | 181 |
| Negeri Sembilan | 139 | 155 | 264 |
| Pahang | 207 | 280 | 347 |
| Perak | 301 | 363 | 326 |
| Perlis | 28 | 32 | 51 |
| Pulau Pinang | 178 | 199 | 284 |
| Sabah | 218 | 219 | 386 |
| Sarawak | 212 | 228 | 299 |
| Selangor | 849 | 969 | 1275 |
| Terengganu | 103 | 130 | 232 |
| Wilayah Persekutuan | 1304 | 1241 | 442 |
| Total | 4301 | 4962 | 5217 |

Source: 2001-2002 Construction Industry Forecast Report, CIDB.

Table 1.2: Project Volume by Contract Category, 2000-2002.

| Category | 2000 | 2001 | 2002 |
|-------------------|-------------|-------------|-------------|
| Infrastructure | 1187 | 1387 | 1278 |
| Maintenance | 139 | 166 | No Data |
| Mixed Development | 60 | 94 | 105 |
| Non-residential | 1828 | 2273 | 1993 |
| Residential | 969 | 1030 | 1765 |
| Landscape | No Data | No Data | 55 |
| Others | 118 | 12 | 21 |
| Total | 4301 | 4962 | 5217 |

Source: 2001-2002 Construction Industry Forecast Report, CIDB.

* **Note:** Non-residential covers Industrial, Commercial, Administration, Social Facilities, Agriculture and Security.

are at a staggering 28.3 %, 16.5 % and 63.5 % respectively. 'Built Up' is defined to cover commercial, residential and industrial development. Therefore, it is no surprise that recently, Federal Territories Minister Tan Sri Isa Samad stated that Kuala Lumpur is facing serious land shortage and subsequently, 39 hectares of land at the Bukit Gasing Forest Reserve had to be de-gazetted for development purposes. In addition, the Sungai Buloh and Bukit Cherakah Forest Reserves in Selangor have not been spared either. Relevant articles are enclosed in Appendix A-A3, A4 & A5.

Visualizing into the next 20 years or more, there will be a major problem. The dilemma of insufficient land in developed states for future or new projects is forecasted to augment to a critical level. Considering this fact, the questions to ask are, "What do we do now?" and "What are our options?" The answer is pretty obvious. Existing structures will have to be demolished to meet the demanding needs of modernization and progress. Demolition will play a significant role in future nation building. Our country will be evolving from the present developing status to the future developed state. This statement is not an imagination of the thought, but rather a fact supported by the aims of the government in realizing its Vision 2020 objectives. In fact, the first product of Vision 2020 will materialize on 31 August 2005 with Selangor being declared a developed state by Prime Minister, Datuk Seri Abdullah Ahmad Badawi. The supporting article is enclosed in Appendix A-A6.

Bearing all these matters in mind, there has been no initiative taken to address the problem. The first clear reason is that there is insufficient or probably no information on the subject of demolition in Malaysia. This was proven by the fact that searches and inquiries on the topic from established organizations such as the Institute of Engineers, Malaysia (IEM), "Jabatan Kerja Raya (JKR)", "Pusat Khidmat Kontraktor (PKK)" and CIDB yielded disappointing results. The second reason being, that the current state of demolition operations is very much illusive. The subject is not often talked about and lacks publicity. The third is that there are no major government policies and regulations on the matter. This fact was further

confirmed by discussions with an officer from the Research and Development Unit of the Town and Country Planning Department, Kuala Lumpur.

There is a dire need to expedite research in the field of demolition works in the country. We still have time to conduct research and prepare for future demands. From the discussions stated above, it is apparent that there are many areas in which research and studies can be focused on. But however, as a first step towards addressing the problem, knowledge on the subject has to be initially acquired. Therefore, this research is focused on capturing and acquiring information and perspective from the local industry. Only by assessing the current image of the operations, can better understanding be achieved and improvements be made and explored.

The weight of the arguments and opinions presented for the case is hoped to have justified the need for research. The contributions of this research can be seen in terms of benefits gained by both the nation and the individual.

1.2 Research Aim and Objectives

This research is aimed at developing an overview as well as assessing the potential of demolition operations in Malaysia. It intends to generate perspective insight into the current state of demolition works which in turn, will be beneficially applied to serve as a solid platform for future research and development. Essentially, the objectives of this research are classified to the following:

- to study the characteristics, processes, techniques and requirements of crucial aspects in the execution of demolition operations,

- to capture and illustrate the actual practice of demolition works done by a local contractor,
- to establish statistical data through feedback obtained from the local industry.

1.3 Scope of Research

For the purpose of this research, the scope of study shall cover these two main areas:

- *Case Study*

The case study will be based on a current project in the country with reference to a conventional form of building structure. Attention shall be focused on the aspects and organizations involved in the execution phase of the project. Apart from this, the project shall be selected considering factors such as the degree of cooperation anticipated from the project parties as well as time and convenience.

- *Questionnaire Survey*

The targeted survey participants would be randomly chosen from developed states comprising Pulau Pinang, Perak, Kuala Lumpur, Selangor, Negeri Sembilan, Melaka and Johor. The sample shall be of a moderate size with sufficiently varied characteristics to be able to reflect a miniature replica of the industry's professionals. In addition, the survey shall also be unbiased and consider aspects of monetary implications.

1.4 Research Methodology

This section briefly outlines the research methodologies that were used in fulfilling the objectives set out in this research. However, Chapter 3 will provide detailed descriptions and further discuss the topic.

- *Literature Review*

Extensive literature review was executed to obtain information which primarily aided in developing a better understanding of the research subject. In addition, it also provided an overview of the demolition industry and enabled specific areas of concern to be highlighted to form research components.

- *Case Study*

A case study was conducted on a selected demolition project in Malaysia to illustrate the characteristics of demolition operations. The aim of the case study was to capture first hand information and data from the source itself.

- *Questionnaire Survey*

A questionnaire survey was carried out to tap information from the local construction industry. The survey was intended to aid in establishing statistical data through feedback obtained from Malaysian industry professionals.

Figure 1.1 illustrates the interrelationship between the methodologies chosen and the specific objectives.

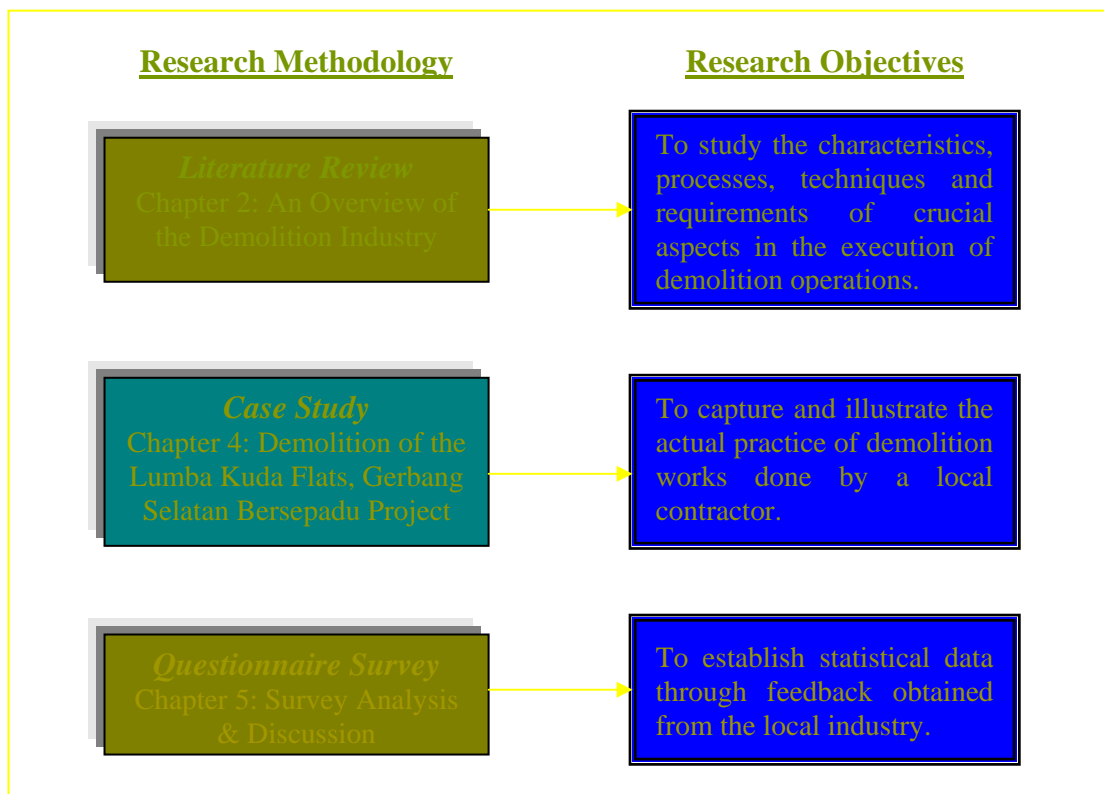


Figure 1.1: Interrelationship between research methodologies and objectives.

1.5 Thesis Layout

This section generally highlights the categorization of the thesis contents in terms of defined and systematic chapters. The thesis is divided into six chapters and a summary of each chapter is presented herein:

- **Chapter 1: *Introduction***

This chapter provides an introductory view into the subject of demolition as well as discusses the research background and provides justification to the research. Apart from that, it introduces the research aim, objectives and work scope as well as highlights the methodologies adopted in order to fulfill the objectives outlined.

- **Chapter 2: *An Overview of the Demolition Industry***

This chapter elaborates on the overall perception and components that make up the demolition industry. The chapter begins with defining the principles of structural demolition and stressing on the aspects involved in the demolition process. In addition, the various types of demolition techniques and safety requirements are also brought to attention. Further subsequent explanations are then given on the topics of demolition waste management and recycling as well as related environmental issues.

- **Chapter 3: *Research Methodology***

The contents of this chapter basically touch on the measures employed to achieve the desired research results. It provides detailed description on the approaches and methods implemented to gather information and data from various sources. The chapter then proceeds to illustrate the overall methodology framework and schedule required for undertaking the research.

- **Chapter 4: *Case Study: Demolition of the Lumba Kuda Flats, Gerbang Selatan Bersepadu Project.***

This chapter provides a surface level account of the actual practice of demolition works based on a selected demolition project in Malaysia. It describes thoroughly the concepts, techniques and necessary aspects of the works during the execution of the project.

- **Chapter 5: *Survey Analysis & Discussion***

This chapter portrays the analysis performed on the survey questionnaires retrieved from the respondents. It classifies the analyzed information in terms of percentage and ranking computations. The results are presented in various graphical forms with supporting discussions.

- **Chapter 6: *Conclusions and Recommendations***

This final chapter presents a summary of the research findings and provides conclusion. It also expresses the extent of which the objectives have been achieved as well as suggests recommendations for future research and development.

REFERENCES

1. British Standards Institution. *Code of Practice for Demolition*. London, BS 6187. 1982
2. British Standards Institution. *Code of Practice for Demolition*. London, BS 6187. 2000
3. British Standards Institution. *Safe Use of Explosives in the Construction Industry*. London, BS 5607. 1988
4. Standards Australia International. *The Demolition of Structures*. Sydney, AS 2601. 2001
5. Building Department Hong Kong. *Code of Practice for Demolition Hong Kong*. 1998
6. Department of Labour New Zealand. *Approved Code of Practice for Demolition*. Wellington. 1994
7. Arham Abdullah. *Intelligent Selection of Demolition Techniques*. Ph.D. Thesis. Loughborough University; 2003
8. The National Federation of Demolition Contractors. *The First Fifty Years 19941-1991*. Booklet. The National Federation of Demolition Contractors (NFDC). Middlesex, 1991

9. Construction Industry Training Board. *Scheme for the Certification of Competence of Demolition Operatives*. Construction Industry Training Board (CITB). Norfolk, 2001
10. The National Association of Demolition Contractors. *10 Common Misconceptions about the Demolition Industry*. Booklet. The National Association of Demolition Contractors (NADC). Doyleston, 1996
11. M. A. Perkin. *Demolition of Concrete Structures by the Use of Explosives*. Explosives Engineering Handbook – Technical Paper No. 3. Institute of Explosives Engineers, 1989
12. U. S. Department of Energy. *Modified Brokk Demolition Machine with Remote Operator Console*. Innovative Technology Summary Report. Idaho, 2001
13. The National Federation of Demolition Contractors. *NFDC Yearbook*. Middlesex, 2000
14. The National Federation of Demolition Contractors. *NFDC Yearbook*. Middlesex, 2001
15. CIRIA Publications. *Stage C4 – Demolition and Site Clearance*. CIRIA Publication C528
16. R. G. Dorman. *Dust Control and Air Cleaning*. Pergamon Press. 1974
17. Richard A. Young & Frank L. Cross. *Specifying Air Pollution Control Equipment*. Marcel Dekker Inc. 1982
18. P. H. McGauhey. *Engineering Management of Water Quality*. McGraw-Hill Inc. 1968

19. T. H. Y. Tebbutt. *Principles of Water Quality Control*. Pergamon Press. 1971
20. Marshall Sittig. *Pollution Detection and Monitoring – Environmental Technology Handbook*. Noyes Data Corporation. 1974
21. S. A. Petruszewicz & D. K. Longmore. *Noise and Vibration Control for Industrialists*. Elek Science. 1974
22. Harold W. Lord, William S. Gatley & Harold A. Evensen. *Noise Control for Engineers*. McGraw-Hill Inc. 1980
23. Albert Thumann & Richard K. Miller. *Secrets of Noise Control*. The Fairmont Press. 1976
24. Paul N. Cheremisinoff & Angelo C. Morresi. *Air Pollution Sampling & Analysis Deskbook*. Ann Arbor Science. 1978
25. R. E. Munn. *The Design of Air Quality Monitoring Networks*. Macmillan Publishers Ltd. 1981
26. Robert K. Yin. *Case Study Research – Design and Methods*. Sage Publications. 1994
27. Robert E. Stake. *The Art of Case Study Research*. Sage Publications. 1995
28. Charles H. Backstrom & Gerald Hursh-Cesar. *Survey Research*. John Wiley & Sons. 1981
29. Floyd J. Fowler. *Survey Research Methods*. Sage Publications. 1984
30. Donald S. Tull & Gerald S. Albaum. *Survey Research-A Decisional Approach*. Intext Educational Publishers. 1973

31. Sushil Bhandari. *Engineering Rock Blasting Operations*. A. A. Balkema. 1997
32. Imperial Chemical Industries (ICI). *Blasting Practice*. Nobel's Explosives Company Ltd. 1972
33. Thomas W. Mangione. *Mail Surveys-Improving the Quality*. Sage Publications. 1995
34. Mark S. Litwin. *How to Measure Survey Reliability and Validity*. Sage Publications. 1995
35. Arlene Fink. *How to Report on Surveys*. Sage Publications. 1995
36. Herbert F. Weisberg & Bruce D. Bowen. *An Introduction to Survey Research and Data Analysis*. W. H. Freeman and Company. 1977
37. Jeffrey Jarrett & Arthur Kraft. *Statistical Analysis for Decision Making*. Allyn and Bacon. 1989
38. Murray R. Spiegel. *Theory and Problems of Statistics*. McGraw-Hill Book Company. 1992
39. W. M. Harper. *Statistics*. Longman Group UK Limited. 1991
40. Richard I. Levin & David S. Rubin. *Statistics for Management*. Prentice Hall. 1998