MAPPING APPROACH FOR EXAMINING WASTE MANAGEMENT WITHIN CONSTRUCTION SITES

SIM LEE GAIK

A project report submitted in partial fulfilment
of the requirement for the award of the degree of
Master of Engineering (Civil - Environmental Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER, 2005

Dedicated to my dearest father, mother, mike and siblings

ACKNOWLEDGEMENTS

First and foremost, thanks be to God for granting me the utmost courage and perseverance to complete the project report in its appointed time. Also, I would like to extend my most sincere gratitude to Associate Professor Zainudin Mohamed Shamsudin for being my pillars of strength and wisdom throughout the study. Each accomplishment, be it big or small, has always been guided by your confidence and support.

Special thanks to Mr. Alvin Ng for providing contacts of all the site managerial staffs as well as time and effort contributed at your very best capacity throughout my fieldworks. Truly, you are deeply appreciated.

Not forgetting my beloved family members and my dearest companion, indeed, your unfailing support, understanding and love have always been my best source of inspiration and faith to soar at greater heights. You were and are ever there to welcome me with warmth embrace despite my ups and downs. There are absolutely no words that could express my gratitude to you. I love all of you.

Last but no least, to the entire cohort that has contended at my side during the course of study, a trillion thanks to all of you. May He shower His blessings on each and every one of you. Again, thank you very much.

ABSTRACT

In light of increased awareness on environmental impacts from construction wastes, waste management has become an important factor in construction project management. Various waste managements have been developed by researchers to manage construction wastes. Nevertheless, less attention is given towards the management of waste handling processes on construction sites such as waste sorting and waste transport. In fact, proper flow of these processes could improve waste management effectiveness. The aim of the study is to examine waste handling process during construction through the mapping of ten project sites in Melaka using the free-flow mapping presentation technique. This will lead to the development of a proposed waste management mapping model (WMMM), which incorporates the good operations embodied in the existing practices and also the outcomes of interviews with the project proponents. The WMMM could serve as a tool assisting in planning waste management procedures as well as a vehicle for comparing waste management practices among construction sites; thus, weaknesses and good practices could be identified and improvement measures may be implemented accordingly. Personal interviews with questionnaires and on site observations were administered for data collection. Analysis was performed on results tabulated in matrix table with interpretation assisted by statistical computations. Qualitative approach was of dominant where comparative evaluation was extensively performed on the waste management practices between these ten sites. Findings revealed that the advantages of waste handling practices outnumbered the weaknesses. The WMMM was proposed based on guidelines derived from the analysis which took into account factors pertaining to cost, environmental protection and time in waste handling management. It was suggested that the proposed WMMM could be incorporated into the Environmental Impact Assessment (EIA) report to assist waste management planning. Overall, the findings of the study have contributed to the basic understanding of the waste management practices within construction sites in Malaysia.

ABSTRAK

Dengan kesedaran yang semakin meningkat terhadap impak alam sekitar yang disebabkan oleh sisa pembinaan, pengurusan sisa telah menjadi salah satu faktor penting dalam pengurusan projek pembinaan. Terdapat beberapa cara pengurusan sisa yang telah dihasilkan oleh kajian sedia ada. Namun, kurang perhatian diberi kepada pengurusan aliran sisa di sekitar tapak pembinaan seperti pembahagian sisa dan pengangkutan sisa. Sebenarnya, proses aliran sisa yang berpatutan akan membawa kepada pengurusan sisa yang efektif. Tujuan kajian ini adalah untuk memeriksa proses aliran sisa semasa pembinaan melalui pemetaan sepuluh tapak bina di Melaka dengan menggunakan "free-flow mapping presentation technique". Ia akan menjurus kepada suatu cadangan model pemetaan pengurusan sisa (WMMM) yang mengambil kira amalan operasi yang baik yang terdapat dalam praktis sedia ada berserta hasil temuduga dengan pengurus projek bagi tapak-tapak yang berkaitan. WMMM yang dimaksudkan boleh berfungsi sebagai suatu alat bantuan dalam merancang prosedur pengurusan sisa serta sebagai salah satu media untuk membanding pengamalan pengurusan sisa di antara tapak pembinaan di Malaysia. Dengan itu, kelemahan and kebaikan dalam pengamalan sedia ada dapat dikenalpasti dan pembaikan dapat diimplementasi dengan sewajarnya. Temuduga secara peribadi dengan soal selidik serta pemerhatian di tapak merupakan cara-cara pengumpulan data. Analisis dilakukan terhadap keputusan temuduga yang dikemukakan dalam jadual matriks dengan interpretasi yang dibantu oleh pengiraan statistik. Pendekatan kualitatif dikatakan dominan di mana tafsiran perbandingan secara ekstensif telah dilakukan terhadap pengamalan pengurusan sisa di antara sepuluh tapak pembinaan yang dimaksudkan. Hasil kajian menunjukkan bahawa pengamalan aliran sisa yang baik mengatasi kelemahan. WMMM telah dicadang berdasarkan garis panduan yang merupakan derivatif daripada analisis yang mengambil kira faktor berkaitan kos, perlindungan alam sekitar dan masa dalam pengurusan aliran sisa. Dicadangkan juga bahawa WMMM boleh dimasukkan ke dalam Laporan Penilaian Kesan Alam Sekitar (EIA) untuk membantu perancangan pengurusan sisa. Keseluruhannya, hasil kajian telah menyumbang kepada pemahaman asas terhadap pengamalan pengurusan sisa di antara tapak pembinaan di Malaysia.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BS	-	British Standard
C&D	-	Construction and Demolition
CIDB	-	Construction Industry Development Board
CLI	-	Commercial Leasehold Improvements
CFR	-	Code of Federal Regulations
DOE	-	Department of Environment
EIA	-	Environmental Impact Assessment
ESD	-	Environmentally Sustainable Development
IBS	-	Industrialised Building Systems
K-Economy	-	Knowledge Economy
LCA	-	Life Cycle Assessment
Me	-	Median
MRF	-	Material Recovery Facilities
MS	-	Mean Score
MSW	-	Municipal Solid Waste
NR	-	Not Related
NS	-	Not Significant
OSHA	-	Occupational Safety and Health Administration
R	-	Recycle

RC	-	Reinforced Concrete
RM	-	Ringgit Malaysia
SI	-	Site Investigation
SMARTWaste	-	Site Methodology to Audit Reduce and Target Waste
U	-	Reuse
UNCED	-	United Nations Conference on Environment And Development
USEPA	-	United States Environmental Protection Agency
WCED	-	World Commission on Environment and Development
WDO	-	Waste Disposal Ordinance
WMMM	-	Waste Management Mapping Model

LIST OF SYMBOLS

 - Labour

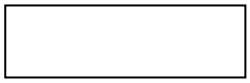
 - Handcart

 - Mechanical tool

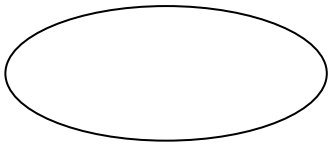
 - Lorry

 - Waste container

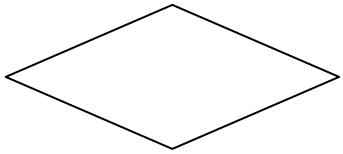
 - Rubbish bin



- Waste source



- Waste processing



- Waste destination

- Waste facilitator

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Scenario in the Construction Industry

Construction sector is perhaps one of the oldest industries established in our country. It has for many years maintained the time-tested but labour intensive traditional approach in construction and has invested little in research and development. With the current levels of quality, productivity, safety and excessive reliance on unskilled foreign workers, the state of the local construction industry is not in line with the future development of Malaysia (JURUTERA, 2004).

As the Knowledge Economy (K-Economy) enters its stride into the new millennium, technological advances shall play a major role in changing the competitive work environment in the construction industry (JURUTERA, 2004). Innovation, such as Industrialised Building Systems (IBS) that enables off-site prefabrication or pre-cast building components manufactured at factory has successfully set foot in Malaysia as a result of government's initiative but yet to garner good responses. They assure valuable advantages such as less wastage, less volume of site materials, increase environmental and construction site cleanliness and better quality control, among others though minor weaknesses have been pointed

out which could be overcome with proper work coordination. Yet, *change* is the word in relation to such innovation which is hard to swallow and difficult to gain public acceptance.

As Malaysia is becoming a global player in construction, research and development as well as management requires serious efforts to enable us to be at par excellence with other developing and developed nations in line with the aspiration forwarded by our Minister of Public Works, Yang Berhormat Datuk Leo Moggie. The excerpt of his speech at the Opening Ceremony of Construction Industry Development Board (CIDB) Malaysia is as follows:

> "We are entering into an era of continued growth as we position ourselves into the New Millennium when we become an industrialised nation with not only manufactured goods to export but also skills and expertise to sell overseas. In order to fulfill this aspiration, the Construction Industry needs to be guided, nurtured and developed to attain the required quality and ingredient."
>
> (Datuk Leo Moggie, 1994:1)

1.2 Construction Versus Environment

The World Commission on Environment and Development has formed the basis of environmental strategy as advocated by Malaysia in its environmental policy. The National Policy on the Environment describes the objectives, principles, strategies and measures taken by the government, private sectors as well as consumers to ensure sustainable development on the Malaysian society. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland,

1987). The Bruntland Report, or Our Common Future, is the report made by the World Commission on Environment and Development in 1987. It is often called the Bruntland report after the chairperson of the commission, the then Prime Minister of Norway, Mrs Gro Harlem Bruntland. The report is one of the seminal environmental documents of the 20th century. It is representative of the growing global awareness in the second half of the century of the enormous environmental problems facing the planet, and of a growing shift towards global environmental action. The Commission's brief was to re-examine the critical environment and development problems on the planet and to formulate realistic proposals to solve them; to create a "global agenda for change". It was to work within the principle of Environmentally Sustainable Development (ESD). The report represents a collective call to action, involving all nation states as participants in finding solutions to the "tragedy of the commons". In the words of Bruntland, one of its goals was:

> "To help define shared perceptions of long-term environmental issues and the appropriate efforts needed to deal successfully with the problems of protecting and enhancing the environment, a long-term agenda for action during the coming decades, and aspirational goals of the world community."
>
> (Bruntland, 1987:ix)

It is only deemed possible when not only the government but also all other sectors of society contribute to this goal (Bossink and Brouwers, 1996). Adding to it, Clarke (2005) stated that strategic steps to achieve sustainable development should strike a balance between development and the environment where development, growth and prosperity need not and should not be in conflict with sustainability. On the other hand, Secretary of Environment and Natural Resources of Mexico, Alberto Cardenas Jimanez (2005) stressed on the role of consumers and their awareness on consumption and production pattern in preserving resources to achieve sustainable development environment through the International High-level Seminar on Sustainable Consumption and Production held in Mexico. He called on us as consumers to be conscious of environmental damage and neither changing consumption patterns nor technology change is enough on its own to reverse the

present unsustainable tendency. We need to work both sides of the equation to improve the quality of our daily life to assure the permanence of our natural resources. In the context of construction industry, consumption and production pattern may relate to the unnecessary over or under demand of construction projects which lead to wastage in raw material resources.

The construction industry is seen as one industry which has direct relation with development, and where environmentally sound results should be achieved. It involves preventing waste and stimulating the reclamation of construction and demolition wastes, which entails a reduction in the volume of waste produced during building activities, the separation of waste materials and reducing pollutive emissions into the environment during the production of building materials and the construction production process. Hence, environmental planning is integral to all construction processes that encompasses four broad interrelated functions namely, research, policy formulation, implementation and permitting (Fabrick and O'Rourke, 1982).

In Malaysia, Environmental Impact Assessment (EIA) is mandatory in accordance with the requirements of section 34A: Environmental Quality (Amendment) Act 1985 and the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987. It is a study to identify, predict, evaluate and communicate information about the impacts on the environment of a proposed project and to detail out the mitigating measures prior to project approval and implementation. Also, EIA is defined as the need to identify and predict the impact on the environment and on man's health and well being of legislative proposals, policies, programmes, projects and operational procedures, and to interpret and communicate information about the impacts (Glasson *et al.*, 1999).

Among purposes of EIA stated by Glasson *et al.* (1999) include EIA as an aid to decision-making, an aid to the formulation of development actions and an instrument for sustainable development. It is designed to follow the Integrated Planning Concept (Yong, 1987) which starts from the on set of a project until the end

of its construction phase. It is fundamental in the planning process to allow the achievement of immediate gains whilst maintaining indefinitely the productive potential of the environment thus fulfilling Principle 17 of Rio Declaration on the Environment and Development in 1992 which reads:

> "Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority."
>
> (UNCED, 1992:5)

The important outlines in the EIA procedure in Malaysia are as shown in Appendix A. Figure 1.1 below shows the issues addressed in the National Policy on the Environment as forwarded by the Ministry of Science, Technology and the Environment.

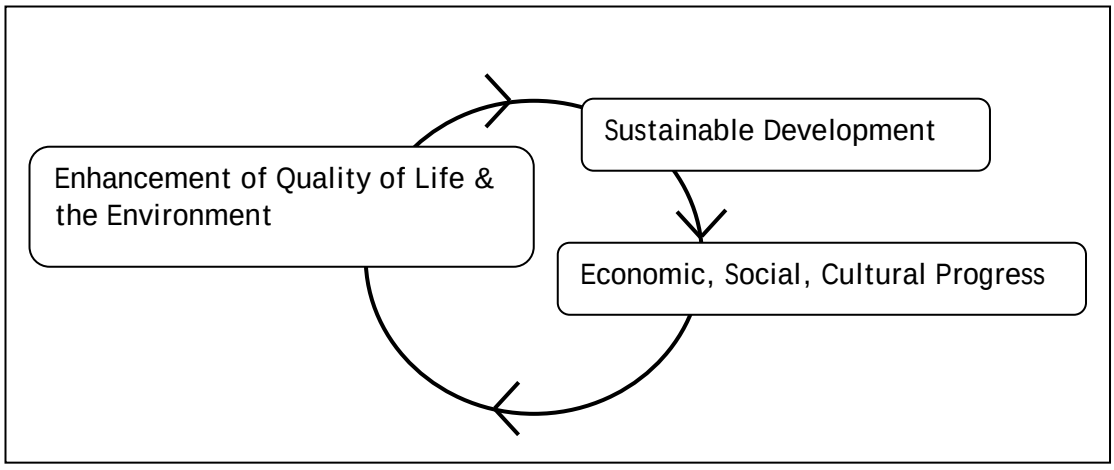


Figure 1.1: Issues Addressed in the National Policy on the Environment

(Source: National Policy on the Environment, 2002)

1.3 Research Background

Wastes from construction works contribute significantly to the polluted environment. It is important not only from the perspective of work efficiency but also concern has been growing in recent years about the adverse effect of the waste of building materials on the environment. This kind of waste typically accounts from between 15 and 30 percent of urban waste (Formoso *et al*., 2002). Studies from various countries have shown that construction wastes present a large share among all types of solid wastes. According to Bossink and Brouwers (1996), building materials waste is difficult to recycle due to high levels of contamination and a large degree of heterogeneity, and often, there is insufficient space for its disposal in large cities. Consequences of high levels of waste, both in reducing the future availability of materials and energy and in creating unnecessary demands on the transportation system, are in one way or the other, identical to the Malaysian scenario.

Findings show that existing management on construction wastes focus largely into three main areas: waste classification (such as segregating wastes into inert and non-inert materials), waste management strategies (such as avoiding waste, reducing waste, reusing waste and recycling waste) and waste disposal technologies (such as recycling of construction and demolition wastes via mechanical sorting process). Despite these research works, it is still unclear that how wastes are handled from the point of generation to disposal which is fairly important. Thus, this study will contribute to the understanding of the existing waste handling processes within construction sites in Malaysia.

As Malaysia is stepping into the era of globalisation in its own space and dimension, waste management in construction activities should not be neglected. But, it should be vastly addressed for the aim of protecting the environment in line with the National Policy on the Environment by the Ministry of Science, Technology and the Environment as mentioned earlier. The National Policy on the Environment seeks to integrate environmental considerations into development activities and in all

related decision-making processes, to foster long-term economic growth and human development and to protect and enhance the environment. It compliments and enhances the environmental dimension of other existing national policies, such as those on forestry and industry and takes cognisance of international conventions on global concerns (National Policy on the Environment, 2002).

1.4 Statement of Needs

The development of the National Policy on the Environment marked the milestone of environmental management in Malaysia. It envisages sustainable growth and environment to be integrated into the development process. Although there is yet to have specific policy in relation to construction industry in Malaysia, it should be treated and understood as under the roof of "development" and synonym to the word "industry" mentioned.

Adherence to the increasing awareness towards protecting the environment in development, Environmental Management System (EMS) emerges as a tool to enable organisations to systematically manage the environment that receives or possibly receives the impact from their conducts, through self-commitment and provision of resources (Siah, 2005). According to Voorhees and Woellner (1997), significant input, commitment, and leadership from top management are necessary to make an environmental management system successful.

ISO 14001 serves as a model in EMS for an integrated of management systems that identify, control and monitor environmental risks. It is applicable to all types and sizes of organisations, which is suitable for both manufacturing and service sector, for example, construction. In view of this, according to Department of Standard Malaysia (DSM, 2004), the number of organisations certified for ISO

14001, as on 30th June 2004 are three hundred and four and they are certified for three hundred and ten scopes as per Table 1.1. However, only seven are of construction related scopes when construction organisations are blooming like mushrooms throughout the country. Urgency has risen beyond words on the alarmingly low environmental awareness among them and environmental management has to be implemented at the nearest time to minimise environmental risks and liabilities produced from this industry.

Various studies have shown that construction business is a large contributor to waste generation as addressed in the prior section. In order to improve the control of construction wastes, existing research works have developed numerous management methods which will be discussed in the following chapter. Nevertheless, as mentioned, it appears that the existing waste management methods give less attention to the management of waste handling processes on construction site. In fact, construction wastes pass through a number of handling processes from their generation to final disposal. More often than not, these processes can induce various factors affecting waste management effectiveness thus proper flow of these processes is important. Previous study conducted by McDonald and Smithers (1998) suggested that a proper waste management plan can contribute significantly to eliminate waste source and can result in up to 50 percent cost savings for waste handling charges, 15 percent volume reduction of waste generation prior to recycling on site and 43 percent waste reduction for landfill.

However, there is a lack of methodology in providing guidelines on how to produce a proper waste management plan (Shen *et al.*, 2004) and in fact, one of the major hindrances to waste minimisation on construction sites is the lack of waste management strategies. The study seeks to identify alternative tool assisting in planning waste management procedures on site which also serves as a vehicle to compare the waste management practices between construction sites in Malaysia. It is viable in the planning process prior to the implementation of a project and may be integrated into the EIA report.

Table 1.1: List of ISO 14001Certified Scopes (as on 30th June 2004)

No.	Description	No. of Scope	No.	Description	No. of Scope
1.	Agriculture, fishing	-	21.	Aerospace	-
2.	Mining & quarrying	6	22.	Other transport equipment	5
3.	Food products, beverages & tobacco	40	23.	Manufacturing not elsewhere classified	1
4.	Textiles & textile products	-	24.	Recycling	8
5.	Leather & leather products	-	25.	Electricity supply	12
6.	Wood & wood products	1	26.	Gas supply	1
7.	Pulp, paper & paper products	12	27.	Water supply	-
8.	Publishing companies	1	28.	Construction	7
9.	Printing companies	-	29.	Wholesale & retail trade; repair of motor vehicles, motorcycles & personal & household goods	2
10.	Manufacture of coke & refined petroleum products	2	30.	Hotels & restaurants	6
11.	Nuclear fuel	-	31.	Transport, storage & communication	6
12.	Chemicals, chemical products & fibres	15	32.	Financial intermediation; real estate, renting	1
13.	Pharmaceuticals	1	33.	Information technology	-
14.	Rubber & plastic products	31	34.	Engineering services	-
15.	Non-metallic mineral products	1	35.	Other services	5
16.	Concrete, cement, lime, plaster, etc	8	36.	Public administration	6
17.	Basic metals & fabricated metal products	20	37.	Education	-
18.	Machinery & equipment	8	38.	Health & social work	-
19.	Electrical & optical equipment	103	39.	Other social services	1
20.	Shipbuilding	-		**Total**	310

(Source: DSM, 2004)

1.5 Objectives of Study

The pace of changes and development of the Malaysian economy have been rapid and have inevitably boost competitiveness in the construction industry. Implicitly, they show the anticipation of a vast increase in quantity of construction waste generation, which will lead to detrimental environmental impacts if not properly managed. While meeting the needs of the present without jeopardising the ability of future generation to meet their own needs, effective waste management strategies within construction site should be developed and implemented. One of the ways to achieve it is to formulate alternative method that could assist in the planning of waste management procedures within construction sites. Hence, the objectives of the study are three fold:

1) to investigate and compare the flow processes of construction wastes within ten selected project sites in Melaka, Malaysia via mapping, with the assistance of free-flow mapping presentation technique;
2) to identify weaknesses and advantages embodied in the existing waste management practices within these sites; and,
3) to propose an effective waste management mapping model (WMMM) based on good operations embodied in the existing practices and also the outcomes of interviews with the project proponents as well as observations on sites.

1.6 Scopes of Study

The study focuses on construction sites in Melaka, reasons mainly due to site accessibility and availability of contact. In this case, ten project sites had been selected. They were made up of mainly housing development with others namely factory, four-storey office complex, high-rise apartment and mixed development. As construction sites are public restricted areas because of their nature of hazards, co-

operation from the site managerial staff is vital to ensure the smooth flow of survey process. In addition, majority of the construction activities involved in Malaysia are governed by standard and specification stated in the British Standard (BS). Henceforth, in general, waste handling processes on construction sites are somewhat similar to a certain extent based on types of waste produced. However, it is not appropriate to assume the generalisation of the findings obtained. Some reasons will be elaborated in the following section.

Secondly, surveys will be conducted only during the construction stage of project sites. Construction stage refers particularly to the building or construction of sub-structures, super-structures and architectural elements such as finishes. Surveys carried out at these phases enable on-site observations to be conducted simultaneously.

Surveys in the forms of questionnaires and personal interviews are conducted with the proponents who are undertaking the referenced projects. Proponents mentioned refer precisely to the site managerial staffs concerned such as project manager, project or site engineer as well as site supervisor.

1.7 Limitations of Study

Although an attempt will be made to gain an overall view of the waste management practices within construction sites, the results of the study should be interpreted with a high degree of caution. This is because the study is only being conducted within construction sites located in the vicinity of Melaka. As a result, it does not clearly represent all samples of construction sites in Malaysia or even in the state of Melaka itself. Due to the somewhat limited scope of sampling location

selected, the generalisation of the findings in the construction sector as a whole may not be made.

The second limitation is the time constraint. The insufficient of time is one of the major limitations to the study as it limits the number of sites as well as targeted sample covered. Comprehensive survey requires on site observation for many months to obtain verification of findings attained from the questionnaires. Thus, it may affect the validity and the reliability of the study that depends heavily on the elements of sincerity and unbiased responds from the site managerial staffs.

Thirdly, the ten project sites have an unequal distribution of cases as shown in Figure 1.2. Number in parenthesis beside each case indicates the number(s) of project site involved. The distribution and limited sampling location do give a glimpse of the current waste management practices within construction sites but is in no way reflective of the actual overall scenario. Thus, it is hope that a more comprehensive survey and research work are to be conducted in future to obtain more accurate data and results.

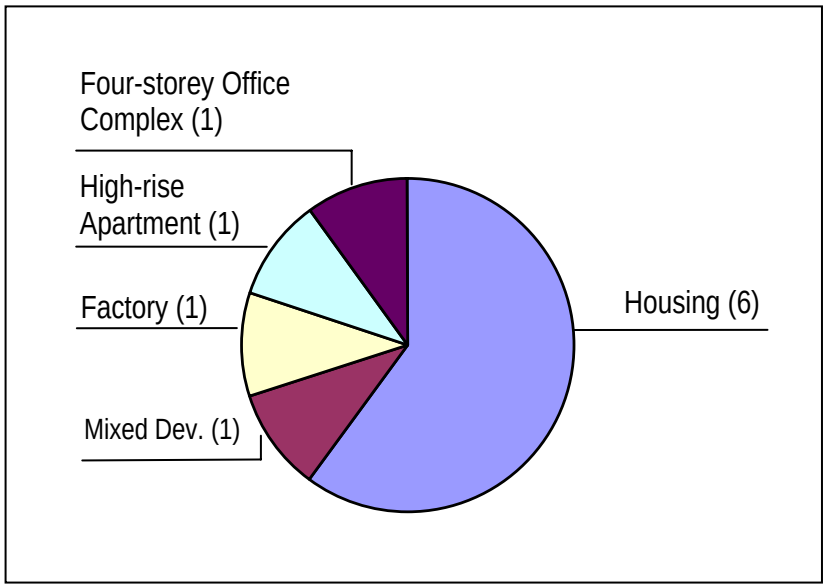


Figure 1.2: Distribution of Cases

Figure 1.2 shows a distribution of six housing developments (60 percent), one office complex (10 percent), one high-rise apartment (10 percent), one factory (10 percent) and one mixed development (10 percent). This accounts to a total of ten project sites as stated.

REFERENCES

Alreck P. L. and Settle R. B. (2004). *The Survey Research Handbook*. 3rd ed. New York: McGraw-Hill/Irwin Series in Marketing.

Anon (2005). *Reduce Waste, Recycle Usable*. Nation, June 19. Malaysia: The Star, 14-15.

Bossink, B. A. G. and Brouwers, H. J. H. (1996). Construction Waste: Quantification and Source Evaluation. *Journal of Construction Engineering and Management*. 122(1): 55-60.

Bruntland, G. (1987). *Our Common Future: The World Commission on Environment and Development*. Oxford: Oxford University Press.

Clarke, B. (2005). Strategic Steps. *Water & Waste Treatment*. (48)4: 12.

Craighill, A. and Powell, J. C. (1999). A Lifecycle Assessment and Evaluation of Construction and Demolition Waste. *Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia and University College London*. Working Paper WM 99-03: 1-49.

Craven, E. J., Okraglik, H. M. and Eilenberg, I. M. (1994). Construction Waste and a New Design Methodology. *Proceedings of the First International Conference of CIB TG 16 on Sustainable Construction*. November 6-9. Tampa, Florida: Kibert, C. J., ed., 89-98.

Department of Environment (2005). *Stop Open Burning*. Malaysia: Poster.

Fabrick, M. N. and O'Rourke J. J. (1982). *Environmental Planning for Design and Construction*. USA: John Wiley & Sons, Inc.

Faniran, O. O. and Caban, G. (1998). Minimizing Waste on Construction Project Sites. *Engineering, Construction and Architectural Management.* 5(2): 182-188.

Fatta, D., Papadopoulos, A., Avramikos, E., Sgourou, E., Moustakas, K., Kourmoussis, F., Mentzis, A. and Loizidou, M. (2003). Generation and Management of Construction and Demolition Waste in Greece—An Existing Challenge. *Resources, Conservation and Recycling*. 40(1): 81-91.

Formoso, C. T., Soibelman, L. M., Cesare, C. D. and Isatto, E. L. (2002). Material Waste in Building Industry: Main Causes and Prevention. *Journal of Construction Engineering and Management*. 128(4): 316-325.

Glasson, J., Therivel, R. and Chadwick, A. (1999). *Introduction to Environmental Impact Assessment*. 2nd ed. London: UCL Press Limited.

Goetz, B. F. (1998). Construction Wastes. In: Ostler, N. K. ed. *Industrial Waste Stream Generation*. Upper Saddle River, N. J.: Prentice Hall.

Huang, W. L., Lin, D. H., Chang, N. B. and Lin, K. S. (2002). Recycling of Construction and Demolition Waste Via a Mechanical Sorting Process. *Resources, Conservation and Recycling*. 37(1): 23-37.

Jimanez, A. C. (2004). International High-level Seminar on Sustainable Consumption and Production. *Industry and Environment*. 27(4): 3.

Magdich, P. (1995) Construction and Demolition. In: Higgins, T. E. ed. *Pollution Prevention Handbook*. Florida: Lewis Publishers. 389-394.

Malaysia (1989). *Environmental Quality Act 1974 - Environmental Quality (Schedule Wastes) Regulations, 1989*. P.U.(A)139 1989.

Malaysia (2002). N*ational Policy on the Environment.* Bangi: Ministry of Science, Technology and the Environment.

Masood, A., Ahmad, T., Arif, M. and Mahdi, F. (2002). Waste Management Strategies for Concrete. *Environmental Engineering Policy*. 3:15-18.

McDonald, B. and Smithers, M. (1998). Implementing a Waste Management Plan during Construction Phase of a Project. *Journal of Construction Management and Economics*. (16)1: 71-78.

McGrath, C. (2001). Waste Minimization in Practice. *Resource, Conservation and Recycling*. 32: 227-238.

Moggie, L. (1994). *Opening Ceremony of CIDB*. Kuala Lumpur: Construction Industry Development Board (CIDB).

Ohno, T. (1988). *Toyota Production System*. Cambridge Mass: Productivity.

Perdan, S. (2004). Introduction to Sustainable Development. In: Azapagic, A, Perdan, S. and Clift, R. ed. *Sustainable Development in Practice: Case Studies for Engineers and Scientists*. England: John Wiley & Son Ltd. 1-28.

Poon, C. S., Ann Yu, T. W. and Ng, L. H. (2001). On-site Sorting of Construction and Demolition Waste in Hong Kong. *Resources, Conservation and Recycling*. 32: 157-172.

Powers, S. E. and Williamson, A. A. (2004). Life-Cycle Management. In: O'brien & Gere and Bellandi, R. ed. *Strategic Environmental Management for Engineers*. Hoboken, N. J.: John Wiley & Sons, Inc. 71-121.

Shen, L. Y., Vivian Tam, W. Y., Tam, C. M. and Drew, D. (2004). Mapping Approach for Examining Waste Management on Construction Sites. *Journal of Construction Engineering and Management*. 130(4): 472-481.

Siah Bee Yong (2005). *The Roles of Manufacturers in Achieving Effective ISO 14001 Certification*. Universiti Teknologi Malaysia: Master's Thesis.

Spivey, D. A. (1974). Construction Solid Waste. *Journal of Construction Division, American Society of Civil Engineering,* 100(4): 501–506.

Tchobanoglous, G., Theisen, H. and Vigil, S. A. (1993). *Integrated Solid Waste Management-Engineering Principles and Management Issues*. Singapore: McGraw-Hill, Inc.

The Institution of Engineers, Malaysia (2004). The Industrialisation of Construction Industry through IBS Roadmap 2003-2010. *JURUTERA*. 2004 (7): 28-29.

UNCED (1992). *The Rio Declaration - Report of the United Nations Conference on Environment and Development*. Rio de Janeiro: United Nations publication.

Voorhees, J., and Woellner, R. A. (1997). *International Environmental Risk Management: ISO 14000 and the Systems Approach.* Florida: CRC Press LLC.

Weber, W. J., Jang, Y. C., Townsend, T. G. and Laux, S. (2002). Leachate from Land Disposed Residential Construction Waste. *Journal of Environmental Engineering*. 128 (3): 237-245.

Wong Shae Lynn (2004). *Recruitment and Selection Technique: An Empirical Study in Penang, Malaysia, amongst Electrical and Electronic Engineers in the Manufacturing Sector*. Universiti Teknologi Malaysia: Master's Thesis.

Yong K. T. (1987). *Environmental Impact Assessment – Procedure and Impact Requirements in Malaysia.* Kuala Lumpur: Department of Environment.