



MALAYSIAN INSTITUTE OF PLANNERS

## JOURNAL OF THE MALAYSIAN INSTITUTE OF PLANNERS

### CONTENTS

Page

1. City Development Strategies (CDS) Contribution Toward Sustainable Urban Development in Developing Countries.  
*By: S. Mostafa Rasoolimanesh, Nurwati Badarulzaman & Mastura Jaafar*.....1
  2. Urban Residents' Attitudes Toward Wildlife in Their Neighbourhoods: The Sase Study of Klang Valley, Malaysia.  
*By: Nik Hanita Nik Mohamad*.....19
  3. Evaluating Stakeholders' Preferences: Reconciling Heritage and Sustainability in Kuala Lumpur Traditional Areas.  
*By: Noor Amila Wan Abdullah Zawawi & Alias Abdullah*.....37
  4. Solid Waste Generation Characteristics: The Malaysian Local Authorities' Outlook.  
*By: Muhammad Abu Eusuf, Mansor Ibrahim, Shamzani Affendy Mohd. Din & Rafikul Islam*.....51
  5. Urban Air Environmental Health Indicators: A Preliminary Set for City of Kuala Lumpur.  
*By: Oliver Ling Hoon Leh, Shaharuddin Ahmad, Kadaruddin Aiyub & Yaakob Mohd. Jani*.....77
  6. Classification of Satellite Fused Data for Land Use Mapping in Development Plan.  
*By: Norzailawati Mohd Noor, Alias Abdullah & Mazlan Hashim*.....97
- Notes to contributors and guidelines for manuscript submission.....107
- The past issues (articles).....111

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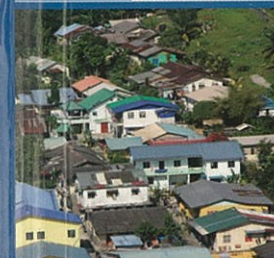


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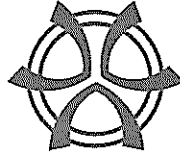
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# CONTENTS

## Journal of the Malaysian Institute of Planners

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Message from The President	V
1. City Development Strategies (CDS) Contribution Toward Sustainable Urban Development in Developing Countries. <i>By: S. Mostafa Rasoolimanesh, Nurwati Badarulzaman &amp; Mastura Jaafar</i>	1
2. Urban Residents' Attitudes Toward Wildlife in Their Neighbourhoods: The Sase Study of Klang Valley, Malaysia. <i>By: Nik Hanita Nik Mohamad</i>	19
3. Evaluating Stakeholders' Preferences: Reconciling Heritage and Sustainability in Kuala Lumpur Traditional Areas. <i>By: Noor Amila Wan Abdullah Zawawi &amp; Alias Abdullah</i>	37
4. Solid Waste Generation Characteristics: The Malaysian Local Authorities' Outlook. <i>By: Muhammad Abu Eusuf, Mansor Ibrahim, Shamzani Affendy Mohd. Din &amp; Rafikul Islam</i>	51
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Notes to contributors and guidelines for manuscript submission	107
The past issues (articles)	111

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“Whoever travels in search of knowledge is on Jihād until he returns”

*(Transmitted by Tirmidhi & Darimi)*

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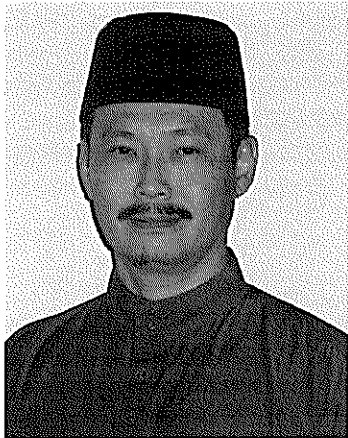
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# Message from the President

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Dear Readers,



MIP is once again proudly to riposte its ninth volume of *Planning Malaysia*. Since its inception in 2003, the Journal was well-received by the members as well as the academic fraternity. This is due to perhaps, the awareness for knowledge seeking and improvement among the members as the articles touch on wide spectrum of our daily planning issues. It is indeed a great achievement to the Institute as we strive to encourage more members and academics to write and share new ideas on planning and urban development.

As any other professional based publication, one of the main objectives of this journal is to offer a platform for town planners to share ideas and experiences on urban and regional planning matters. These ideas and thoughts may be generated from research, studies undertaken or actual hands-on experiences of planners and academics. MIP hopes the journal can offer a healthier insight to all planners so that their roles as town planners can be meaningfully appreciated by the public and authorities.

Apart from the MIP's contribution to the planning circle, *Planning Malaysia* is also extended to various planning related organizations, institutions of higher learning as well as to all members of the institute. We anticipate to eventually extending the circulation of this journal to non-planning related organizations and institutions that has an indirect role in planning within and outside the country. We hope this issue will serve the purpose and welcome any feedback for the improvement in the forthcoming issue.

As a new preside President, I would like to acknowledge and congratulate the new journal's Editor-in-Chief, Professor Dato' Dr. Mansor Ibrahim and his team for the dedication and continuous support to the Institute.

Thank you and happy reading.

**Prof. Dato' Dr. Alias Abdullah**  
PRESIDENT  
(2011-2013)





## **CITY DEVELOPMENT STRATEGIES (CDS) CONTRIBUTION TOWARD SUSTAINABLE URBAN DEVELOPMENT IN DEVELOPING COUNTRIES**

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### **Abstract**

Today one of the important concerns of cities is growth by sustainable development. However sustainable urban development has been used in various forms and explained by various definitions, this subject is accompanied by uncertainty. New approaches in urban planning have attempted to achieve sustainable development. One of these is City Development Strategies (CDS), a new strategic planning approach that has been employed in more than 200 cities worldwide to achieve sustainable growth. However, CDS achieve different levels of success in sustainability. This paper takes the initiative to investigate the contribution of CDS toward sustainable urban development by looking for inclusion of principle of sustainable urban development in CDS themes. However CDS themes are various such as sustainable urban development definitions, therefore this inclusion is different. This paper highlights this relationship and inclusion for one the latest definition of CDS presented by Cities Alliance in 2006. This definition can succeed to achieve sustainability on some aspects, especially environmental and economic sustainability and fail to achieve some ones. This output is discussed in relation to CDS themes that have been applied in developing countries.

**Keywords:** city development strategies, CDS, sustainable urban development, urban planning, developing countries, Cities Alliance.

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## **INTRODUCTION**

Developed, developing and transitional cities around the world during the past several decades have coped with global changes in the economy, institutional structures, civil society, and the environment. Nevertheless, these changes have had a significant impact on urban areas (UN-Habitat 2009). The changes in economic and institutional structures in civil society in the form and scale of environmental- and conflict-related challenges have had strongly-felt effects on urban development and socio-spatial dynamics in urban areas. As a result, the cities are in the middle of dealing with the impact of three major trends: i) globalization, ii) decentralization of responsibilities, and iii) rapid population growth (Cities Alliance 2005).

Urban planning is a tool for use in addressing the unprecedented challenges facing 21st-century cities and in promoting sustainable urban development (UN- Habitat 2009). Sustainable urban development requires that a balance be reached between economic, environmental, and social necessities. In order to achieve a balance, Local Agenda 21 (LA21) was proposed at the United Nations Conference on Environment and Development (UNCED) in 1992. LA21 is “an agenda that puts forward a vision and sets tasks in order to promote sustainable development at the local level and shows a menu of action” (Nakaguchi 2004, p. 28 cited by Tonami & Mori 2007).

Urban planning is presently regarded as a tool that attempts to convert the impact of change to priorities for the enhancement of sustainable urban development with a focus on investment and the upgrading of urban areas, infrastructure and land-use regulation (UN-Habitat 2009). Planning is currently regarded as a strategic, rather than a comprehensive, activity. Planning also highlights a developmental movement from the past to the future. The vision of the future is not a simple matter of short-term political agenda practicality. It is expected to be able to bring about long term improvements in infrastructure, environment and quality of life. City Development Strategies (CDS) is a strategic planning approach that is supported by the work of Michael Porter on urban competitiveness (1995). CDS are more responsive to the World Bank’s economic development priorities (Cities Alliance 2000) to achieve sustainable development. Until 2009, more than 200 CDS had been established and applied in different cities around the world with varying degrees of success (Keivani 2009). City Development Strategies focused through comprehensive action plans for improved urban governance, financial responsibility and the establishment of clearly articulated priorities for action and investment (Mukhija 2006). CDS is a process that is undertaken by its local stakeholders to create a vision for their city through a participatory process. It seeks to address the global changes that affect the urban area and enhance urban sustainability. The objective of this paper is to conduct a study to investigate the contribution of CDS in sustainable urban development with a focus on the inclusion of principles of urban sustainable development in CDS themes.

## **THE CONCEPTS AND PRINCIPLES OF SUSTAINABLE URBAN DEVELOPMENT (SUD)**

In an effort to define sustainable urban development (SUD), many concepts and definitions have been created. The terms urban sustainability and sustainable city apply to the appropriate conditions, such as the proper use of resources, protection of the natural environment, least possible use of non-renewable resources, economic growth and variety, community self-confidence, individual welfare, and satisfaction of basic human needs (Shen et al. 2010). According to the United Nations Sustainable Cities Program, a sustainable city has continuing access to natural resources on which its development depends. A sustainable city maintains a stable security from environmental adventures that may threaten development achievements (Whitehead 2003). According to Whitehead (2003), "it is asserted that the sustainable city represents an economic space within which the social, economic and ecological contradictions of capitalism are being managed and strategically addressed". Sustainable urbanization and sustainable urban development apply to a dynamic process towards suitable conditions, that in this process are focused on environmental, economic, social and governance sustainability as an equal concern (Shen et al. 2010).

Sustainable development needs a balance between economic, environmental, and social necessities. According to LA21, sustainability has four dimensions. They are social, economic, environmental and institutional aspects (Spangenberg, Pfahl & Deller 2002).

In order to build a sustainable urbanization, cities should develop their social and economic structures without damaging their natural environment and, instead, achieve the right balance between humans and the natural resources (Abu-Ghazalah 2008). Achieving this balance can take place with a system that combines personal opinion, which can be provided by the participation of citizens in this process, and scientific knowledge, which can be provided by scientific analysis (Jepson 2001 as cited in Roy 2009). In such a system, sustainable urban development can become a new vision that will serve to guide the planning agenda for the twenty-first century" (Beatley 1995; Beatley & Manning 1997; Berke & Conroy 2000; Berke 2002; Campbell 1996; Jepson 2004b as cited in Saha & Paterson 2008).

According to the survey by Saha & Paterson (2008), in which they reviewed Protney (2003), Jepson (2004) and Conroy (2006), four aspects of SUD have been defined. These four studies specifically looked at sustainable activities to evaluate the plans of local governments and cities for sustainable development. Therefore, we consider it to be suitable for our purpose. Because there are many definitions and indicators of SUD,

this particular set of activities and principles is used to assess cities and their plans to achieve sustainability. We can also use it to evaluate CDS as a strategic plan that is adopted to ensure sustainability.

Saha & Petarson emphasize three aspects - environment, economic and social. We also took into consideration in this paper the governance aspect of Convey (2006) that was cited in Saha & Petarson (2008) (Table 1).

## **URBAN PLANNING AS A TOOL TO ACHIEVE SUSTAINABLE URBAN DEVELOPMENT**

Urban planning is a traditional tool for achieving a balance among competing interests. It can also be an important tool for promoting interaction among planners, officials and the local community (Diamantini & Zanon 2000). Thus, urban planning can play a key role in achieving sustainable urban development. The goal of sustainable urban development is to reach a balance among the disparate interests of four groups - economic, environmental, social and governance - in order to have livable, productive and inclusive cities, towns and villages (UN-Habitat 2009). City planning leads to the evaluation of the social, economic, and environmental impacts of urban policies. It allows for a systematic analysis of the relationship between social, economic, and environmental developments. This permits a description of the mutual dependence of city planning and sustainable development at the strategic and operational level (Rotmansa, Asselta & Vellingab 2000).

Consequently, urban planning has a key role in promoting future urban and regional sustainability and a response to the global changes and major trends that affect cities, especially those in the developing world. Strategic urban planning systems have developed over the last decade(s). They often consist of a framework that is linked to a set of indicators, so that the sustainability of city policies can be evaluated (Rotmansa, Asselta & Vellingab 2000).

City Development Strategies (CDS) is an urban strategic planning approach, which was initiated in East Asia by the World Bank in 1998 to attain sustainability of growth in cities.

## **CITY DEVELOPMENT STRATEGIES (CDS) IN DEVELOPING COUNTRIES**

### **Concepts and definitions**

CDS is a process planned by the local stakeholders to formulate a vision for their city through a participatory process. This involves viewing and conducting an analysis

of the city's perspectives for development, recognizing priorities for investment and development, and implementing a vision through partnership-based approaches. It is, therefore, both a process and content to promote competitiveness, livability, management, and bankability of the respective city (Kyung-Hwan, 2002). Nonetheless, CDS processes in developing cities differ from those for developed cities, and therefore require different strategic responses. In addition, conditions in developing cities differ from those of very poor cities in Sub-Saharan Africa; those of cities that have transitional-economies, such as Prague and Sofia; and those of soon-to-be-rich cities, such as Chengdu, China (Cities Alliance 2006b).

Developed cities use CDS to promote their competitiveness, livability, and so on. Actually, developed cities have a long history of strategic planning to achieve their goals. Although the real content of CDS differs enormously between developed and developing cities, there has never been any intrinsic reason why we cannot exchange the technical processes and products adopted in developed countries for the experience in financial innovation of developing countries. Similarly, there is no intrinsic reason to prevent the exchange of comparative urban experiences or knowledge resources to be used by developing cities (Cities Alliance 2006b).

As mentioned earlier, the city development strategies approach draws significantly from Michael Porter's work that suggests that economic development strategies should be based on the competitive advantages of cities and regions and should have a more active role for the private sector, and a less involved role for governments. Many scholars disagree and argue that governments are likely to have a more involved role in successful economic development (Fainstein & Gray 1995; Goldsmith 1995, as cited in Mukhija 2006). Other critics also suggest that governments need to play a more active role to ensure that the jobs that are created are better jobs with higher wages (Schweke, 1995, as cited in Mukhija, 2006).

In order to face a competitive and unpredictable economic environment, the developing world needs to implement some effective measures to use their restricted financial and human resources to achieve the intended objectives. The capital available to any city is very elastic and only flows to cities that plan their future and can attract and keep it. An effective CDS process can both attract capital and use it effectively (Cities Alliance 2006a).

City Development Strategies provide a methodology for mayors, private sectors, and citizens to develop a sustainable vision for their cities and a strategy to achieve it. However, comprehensive approaches to connect the environmental sustainability to economic growth, poverty reduction, and the other urban challenges are not yet typical of many CDS (Cities Alliance 2006b).

However, based on Cities Alliance (2006a), there is a second trend involving the CDS process in developing countries. It is an increasing focus on enhancing a city's competitiveness, with the aim of empowering and achieving more economic growth. Experience has shown that complete understanding of local economic conditions, and an ability to identify a city's competitive advantages, is an essential basis for the development of effective strategies to enhance economic resurgence (Cities Alliance 2007).

### **CDS themes in developing countries**

CDS takes many forms, depending on the location, context and players. However, in the CDS manual, Cities Alliance (2002) in China explained that:

The process is one of preparing a long-term vision of the city's future, from which is drawn a short-term action plan. The focus of a CDS is not only on strengthening economic competitiveness. Poverty reduction, environmental, urban structure, infrastructure, and financial aspects are also covered. The process is participative, involving major stakeholders from all segments of society. The product is a development strategy that is designed to evolve as implementation proceeds and the city's competitive position changes.

There are perhaps five defining characteristics:

- The CDS process and product is owned by the city
- A CDS takes a long-term view, but concludes with an action plan;
- There is significant participation of stakeholders in the process,
- The conclusion is strategic and multi discipline in nature;
- The process drives new methods of thinking about the city's development and its sustainability
- The establishment of a sustainable vision for the city and a CDS must be the basis of sustainable development in urban management (Cities Alliance, 2006a).

Until 2009, more than 200 CDS had been established and applied in different cities around the world with varying degrees of success (Keivani 2009). It must be noted however, that a CDS process needs to be local, so that each city has its own CDS in themes and methodology (Cities Alliance 2009). In other words, the foundation of CDS in different cities is not the same as with one another. Nevertheless, in order to assess the CDS, the guideline defined by the Cities Alliance (2006b) is adopted in this paper. This guideline states, "the CDSs should sustainably enhance urban performance, measured in terms of: (i) economic growth, linked to improved livelihood opportunities; (ii) poverty prevention and alleviation; and (iii) improved environmental and public health, inclusive of poor and informal urban communities".

According to this guideline, CDS has five substantive themes which are expressed in the following and their elements have been presented in Table 2.

The five important CDS themes are:

- **Livelihood**

Livelihood covers three areas: (i) the business climate and capacity to create small-businesses. The business climate is very different in cities, which attempt to attract investment in a diversity of business climates and set aside a suitable business area in which to establish small businesses and business networks (ii) urban competitiveness. A CDS should determine a comparative and competitive advantage that creates an economic cluster in order to attract investors and achieve economic growth; and (iii) human resource development, which has a key role in preventing or relieving poverty. It fulfills its role by accessing training, and the quality thereof.

- **Environmental sustainability**

Environmental sustainability in the CDS process can be defined in three areas: (i) environmental quality, such as air & water quality, which are very important in environmental sustainability; (ii) service delivery including geographical coverage, accessibility and affordability should be sustainable, especially in developing countries. It should be noted that these concerns are very significant; and (iii) energy efficiency that affects the welfare of residents.

- **Spatial form and its infrastructure**

Urban economic competitiveness cannot be achieved and the welfare of city residents cannot be taken care of without the required infrastructures. Additionally, spatial form has a key role in urban congestion, energy efficiency accessibility and distribution of services. Therefore, it can be essential in poverty reduction.

- **Financial resources**

The financial analysis of a city determines how finance resources should be used to implement the infrastructures, and public facilities, etc. Financial analysis predicts and provides conditions necessary to attract private sector funding, issuing bonds, and financial innovation. Revenue diversity and increasing this, as well as the control of expenditures, and cash-flow management and, in summary, financial planning and budgeting, are very important in a CDS.

- **Governance**

Governance has a key role in CDS, because the local government has a close relationship with the main decision makers and can play the role of a catalyst between the public and private sectors, and civil society and the labour market. It can decrease the negative effects on low-income and vulnerable people (Cities Alliance 2006b).

## **DISCUSSION: THE INCLUSION OF SUD PRINCIPLES IN CDS THEMES**

A survey done by Saha & Petarson (2008) has been used as a basic framework to evaluate local governments' and cities' plans for sustainable development. These activities have been used to evaluate CDS as a strategic plan to move toward sustainability.

Based on the definitions and concepts of CDS reviewed in section 4.1 and sustainable urban development as described in Section 3, this section discusses how much CDS themes cover principles of sustainable urban development. This helps to identify the effect and role of CDS in sustainable urbanization. Table 3 presents the inclusion of SUD principles and activities in CDS themes. It shows each of *Livelihood, Environmental sustainability, Spatial form and its infrastructure, Financial resources, and Governance* elements (According to Table 2) how much can cover and fulfill the principles and activities of SUD. Each sustainable urban development activity has been cross-checked with the CDS themes, and the result is indicated in the Table3. Each of the CDS themes is discussed in relation to the sustainable urban development proposed by Saha & Petarson (2008).

### **Environmental protection**

Saha & Paterson define fourteen activities on this subject and classify them in five categories. A comparison of CDS themes and these activities show that eleven of the fourteen activities are taken into account by CDS themes. Five activities of this aspect of sustainable urban development are covered by the environmental sustainability theme of CDS, five activities are covered by the spatial form and its infrastructure and one activity is covered by the livelihood theme. Thus, the CDS themes can address environmental aspect of sustainability well because the most activities of SUD are included by CDS themes.

### **Economic development**

On economic development, eleven activities have been planned, ten of which are covered by CDS themes. Thus, CDS themes on livelihood, environmental sustainability, spatial form and its infrastructure and finance take into consider most of the necessary

activities to achieve sustainable urban development. Therefore, economic sustainability will be the result of this definition of CDS.

### **Social equity**

Also, eight activities of the social equity aspect of sustainable urban development are employed by the CDS themes. However, CDS themes do not adequately address minority and special groups, like women and youth. So, we can conclude that social sustainability has a lower position in this definition of CDS.

### **Governance**

Governance aspect activities are completely covered by CDS themes. This is due to the fact that one of the stress points of CDS is governance. So CDS themes take into account all activities that concern this aspect.

This comparison shows that the CDS, in accordance with the definition that we have selected, can cover sustainable urbanization well. In the themes of CDS, we can find elements that can fulfill the principles of sustainable urbanization. Nonetheless, this study has been made according to the CDS guideline that was prepared by Cities Alliance in order to establish proper CDS in developing countries. In other words, this analysis relies on the themes that should be considered when a CDS is prepared. Therefore, it is possible that some CDS cannot achieve sustainable urbanization because they have not given careful attention to the CDS themes.

## **CONCLUSION**

This paper has discussed CDS and their contribution and roles played in urban sustainable development. Sustainability in cities can be achieved through sustainable urban development and urban planning. Many researchers reviewed many concepts and activities in order to achieve sustainable urbanization. On the other hand, CDSs especially in developing countries have been developed with the objective of establishing space in order to reduce poverty, enhancing economic aspects, improving the environment, and promoting quality of life. However, CDS has different definitions for different cities and has been established based on different themes. Therefore for studying the contribution of CDS toward SUD, the definition of Cities Alliance in its guideline (2006b) has been selected. Until 2009, Cities Alliance has funded about 200 CDSs in developing countries. The definition of Cities Alliance that has been selected for this paper can be considered as a significant case study for developing countries. The inclusion of activities and principles of urban sustainable development were



probed to CDS themes and detailed elements of every theme. This paper concludes that the CDS themes can fulfill some aspects of sustainable urbanization because this approach can cover many principles and activities of these aspects of SUD; however it is feeble to address some ones like social sustainability. It shows that the majority of sustainable urbanization aspects are covered in the development of a sustainable city in developing countries by using CDS.

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**Table 1 : Sustainable Urban development Principles and Activities**

<p><b>Environmental Protection</b></p> <p><i>A. Energy Efficiency Measures</i></p> <ol style="list-style-type: none"> <li>1. Alternative energy offered to consumers</li> <li>2. Energy conservation efforts (other than green building requirements)</li> <li>3. Environmental site design regulations</li> <li>4. Green building program</li> <li>5. Renewable energy use by the city government</li> </ol> <p><i>B. Pollution Prevention and Reduction Measures</i></p> <ol style="list-style-type: none"> <li>6. Curbside recycling program</li> <li>7. Environmental education programs for the community</li> <li>8. Green procurement</li> <li>9. Water quality protection</li> </ol> <p><i>C. Open Space and Natural Resource Protection Measures</i></p> <ol style="list-style-type: none"> <li>10. Environmentally sensitive area protection</li> <li>11. Open space preservation program</li> </ol> <p><i>D. Transportation Planning Measures</i></p> <ol style="list-style-type: none"> <li>12. Operation of inner-city public transit (buses and/or trains)</li> <li>13. Transportation demand management</li> </ol> <p><i>E. Tracking Progress on Protecting the Environment</i></p> <ol style="list-style-type: none"> <li>14. Ecological footprint analysis</li> </ol>
<p><b>Economic Development</b></p> <p><i>A. Smart Growth Measures</i></p> <ol style="list-style-type: none"> <li>1. Agricultural protection zoning</li> <li>2. Brownfield reclamation</li> <li>3. Cluster or targeted economic development</li> <li>4. Eco-industrial park development</li> <li>5. Infill development</li> <li>6. Purchase of development rights and/or transfer of development rights</li> <li>7. Tax incentives for environmentally friendly development</li> <li>8. Urban growth boundary and/or urban service boundary</li> </ol> <p><i>B. Measures Promoting Local Employment/Industries</i></p> <ol style="list-style-type: none"> <li>9. Business retention programs</li> <li>10. Empowerment/enterprise zones</li> <li>11. Local business incubator programs</li> </ol>
<p><b>Social Equity</b></p> <ol style="list-style-type: none"> <li>1. Affordable housing provisions</li> <li>2. Daycare services for the service sector and low-income employees</li> </ol>

<ol style="list-style-type: none"> <li>3. Homeless prevention and intervention programs</li> <li>4. Inclusionary and incentive zoning</li> <li>5. Jobs–housing balance</li> <li>6. Living wage ordinance</li> <li>7. Mass transit access with local income subsidies</li> <li>8. Neighborhood planning</li> <li>9. Sustainable food systems or food security programs</li> <li>10. Women/minority-oriented business community development corporations (CDCs) and investment programs</li> <li>11. Youth opportunity and anti gang programs</li> </ol>
<p><b>Governance</b></p>
<ol style="list-style-type: none"> <li>1. Dispute resolution</li> <li>2. Public participation</li> <li>3. Regional coordination</li> </ol>

Source: Saha & Paterson (2008)

**Table 2 : The elements of CDS Themes based on Cities Alliance (2006)**

<p><b>Livelihood</b></p>
<p><b>A. Business Climate</b></p> <ol style="list-style-type: none"> <li>1. Incentives Offered by the Local Jurisdiction</li> <li>2. Nuisance Taxation</li> <li>3. Ease of Starting a Business</li> <li>4. Investment Approval Processes for Foreign Firms and Joint Ventures</li> <li>5. Operating Environment of Informal Sector</li> <li>6. Government Attitudes towards the Informal Sector</li> </ol> <p><b>B. Competitiveness</b></p> <ol style="list-style-type: none"> <li>1. Basic Economic Trends</li> <li>2. Diversity versus Specialization</li> <li>3. National and World-class Economic Activities</li> <li>4. Productivity Gains</li> <li>5. Economic Mix and Change</li> <li>6. Movement up the Value Chain and Cluster Deepening</li> <li>7. Rate of Start-ups and Business Deaths</li> <li>8. Foreign Direct Investment</li> <li>9. Innovation</li> <li>10. Performance of Anchor Firms</li> <li>11. Labor Market Efficiency</li> <li>12. Marketing and Promotion</li> <li>13. Attracting Talent</li> </ol>

**C. Human Resource Development**

1. Educational quality and quantity (enrolment at various levels).
2. Education–Economic Alignment
3. Access to Education
4. Financial Support to Students
5. Access to Entry-level Jobs
6. Geographic Accessibility to Labor Market

**Environmental Sustainability**

**A. Environmental Quality**

1. Air Pollution
2. Wastewater and Water Quality
3. Pollution Sources
4. Sustainability and Safety of Water Supply
5. Loss of Agricultural and Environmentally Sensitive Land
6. Amenity
7. Natural Hazards

**B. Service Delivery and Policy Frameworks**

1. Demand for Services
2. Delivery of Basic Needs
3. Health, Education, and Literacy Status
4. Quality of Basic Services
5. Delivery of Services to Migrants
6. Public Health
7. Efficiency in Delivery of
8. Maintenance
9. Energy and Environmental Policy Frameworks

**C. Energy Efficiency**

1. Energy Consumption
2. Urban Form and Energy Consumption
3. Demand Management

**Spatial Form and its Infrastructure**

**A. Infrastructure**

1. Infrastructure Delivery Performance
2. Infrastructure Delivery Modes
3. Planned Infrastructure
4. Trunk Infrastructure and Urban Form
5. Housing Supply and Demand
6. Affordable Land and Housing
7. Transportation Networks
8. Public Transportation Facilities and Services

9. Urban Nodes and Public Transport Demand
10. Major Transportation Facilities
11. Movement of Goods
12. Telecommunication Services

**B. Spatial Form**

1. Formal and Informal Spaces
2. Urban Density
3. Land and Property Value Gradients
4. Land and Housing Markets
5. Monocentric versus Multinodal Form
6. Peri-urban Spatial Form
7. Location of the Service Economy
8. Spatial Distribution of Employment and Economic Output
9. Social Geography
10. Geography of Poverty
11. Location of Slums and Squatter Areas
12. Land Readjustment
13. Destination of Migrants
14. Geography of Investment
15. Congestion.
16. The Knowledge Economy
17. Expansion Vectors
18. Street Life, Entertainment, and Recreation

**Financial resource**

**A. Local Government Financial Resources and Institutional Structures**

1. Local Government Budgets
2. Local Government Revenues and Expenditures
3. Capital Planning
4. Off-budget Revenue and Expenditures
5. Transfers
6. Extent and Impacts of Decentralisation
7. Debt
8. Access to Credit
9. Credit Rating
10. Autonomous Bodies

**B. Mobilizing Nongovernmental Capital**

1. Impact of Land Readjustment
2. Impact of Land Tenure
3. Housing Credit
4. Financing Local Infrastructure

5. Microfinance
6. Credit for Small and Medium-size Enterprises
7. Voluntary Organisation Finance

**C. Private Sector Financial Flows**

1. Foreign Direct Investment
2. Domestic Investment
3. Commercial Banking Flows

**Governance**

**A. National Urban Policy Frameworks**

1. Local Priorities and National Policies

**B. Institutional Structure and Process of Local Government**

1. Local Government Structure and Processes
2. Appointment of Officials and Governing Bodies
3. Corruption.

**C. Role of Local Government in The Context of Decentralisation**

1. Decentralisation Impacts on Local Government

**D. Metropolitan Governance**

1. Inter-jurisdictional Cooperation

**E. Capacity**

1. Capacity and Development Priorities
2. Institutional Strengthening and Building Priorities
3. Attracting and Retaining Talent

**F. Relationship with The Private Sector and Civil Society**

1. Relationship with the Private Sector
2. Modes of Private Sector Cooperation
3. Relationship with Civil Society
4. Local Government Capture

Source: Cities Alliance (2006b)

**Table 3 : Inclusion of SUD Principles and Activities in CDS Themes**

The sustainable urban Development aspects	CDS Themes				
	Livelihood	Environmental Sustainability	Spatial form	Finance Resource	Governance
<b>Environmental Protection</b>					
<i>A. Energy Efficiency Measures</i>					
1. Alternative energy offered to consumers	-	✓	-	-	-
2. Energy conservation effort	-	✓	-	-	-
3. Environmental site design regulations	-	-	✓	-	-
4. Green building program	-	-	-	-	-
5. Renewable energy use by city government	-	✓	-	-	-
<i>B. Pollution Prevention and Reduction</i>					
6. Curbside recycling program	-	-	-	-	-
7. Environmental education programs for the community	✓	-	-	-	-
8. Green procurement	-	-	-	-	-
9. Water quality protection	-	✓	-	-	-
<i>C. Open Space and Natural Resource Protection</i>					
10. Environmentally sensitive area protection	-	✓	-	-	-
11. Open space preservation program	-	-	✓	-	-
<i>D. Transportation Planning Measures</i>					
12. Operation of inner-city public transit	-	-	✓	-	-
13. Transportation demand management	-	-	✓	-	-
<i>E. Tracking Progress on Protecting the Environment</i>					
14. Ecological footprint analysis	-	-	✓	-	-



The sustainable urban Development aspects	CDS Themes				
	Livelihood	Environmental Sustainability	Spatial form	Finance Resource	Governance
<b>Economic Development</b>					
<i>A. Smart Growth Measures</i>					
1. Agricultural protection zoning	-	✓	-	-	-
2. Brownfield reclamation	-	-	✓	-	-
3. Cluster or targeted economic development	✓	-	-	-	-
4. Eco-industrial park development	-	-	-	-	-
5. Infill development	-	-	✓	✓	-
6. Purchase of Development Rights and/or Transfer of Development Rights	-	-	-	✓	-
7. Tax incentives for environmentally friendly development	✓	-	-	-	-
8. Urban growth boundary and/or urban service boundary	-	✓	✓	-	-
<i>B. Measures Promoting Local Employment/Industries</i>					
9. Business retention programs	✓	-	-	-	-
10. Empowerment/enterprise zones	-	-	✓	-	-
11. Local business incubator programs	✓	-	-	-	-



# **URBAN RESIDENTS' ATTITUDES TOWARD WILDLIFE IN THEIR NEIGHBOURHOODS: THE CASE STUDY OF KLANG VALLEY, MALAYSIA**

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## **Abstract**

Rapid urbanisation in Malaysia has resulted in the loss and fragmentation of lowland tropical forests. Due to the modification of habitat needs provided by these natural green, the diversity and population of urban wildlife have been significantly reduced. Urban parks provided are recognized as an effective urban conservation strategy to mitigate the effects of urbanisation by conserving, enhancing and creating new habitats for urban wildlife. Potential of neighbourhood green spaces to function as urban wildlife habitats has not been optimized. This research investigates urban residents' responses to different dimension of attitudes toward common wildlife; and their needs for wildlife in the contact of sustainable living in the Klang Valley. The research, has sought to investigate through a combination of surveys and observations on residents' attitudes toward urban wildlife. The findings demonstrated selective preferences towards urban wildlife while residents displayed strong preferences toward naturalistic landscape elements compared to man-made landscape elements.

**Keywords:** Sustainable urban residential, residents' attitudes, urban wildlife.

## **INTRODUCTION**

The rapid urban growth had created enormous and unprecedented pressure on land resources that resulted in a significant reduction and fragmentation of forested areas. Much has been done to ensure the awareness on importance of urban wildlife. The purpose of this paper is to investigate the residents' knowledge on the importance of wildlife, their interest and experience with common urban wildlife in the vicinity of their neighbourhoods. This paper had also sought to uncover relevant aspects of neighbourhoods that influence the residents' preference for staying in the neighbourhoods. The attitudes of residents are evaluated and used to inform subsequent efforts toward ensuring the conservation of urban wildlife. The research also investigates residents' attitudes influenced by their socio cultural and demographic diversity. The major issues and problems encountered, and solutions arrived are also discussed.

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## **SUSTAINABLE URBAN RESIDENTIAL COMMUNITY**

Sustainable housing development has become a growing concern among policy makers and practitioners of built environment (Liu, 2001; Jia, 2001). This is because human settlement is the main component in the sustainable development of society and a residential community is a place that people live in for an extensive time. Thus, long term health and prosperity ultimately rely on the ambience of the built and the natural environment surrounding the residents.

In recent years, researches have focused on outlining principles for planning and designing sustainable residential communities. Notwithstanding the different strategies adopted, there is a consensus that sustainable residential communities can be created by promoting ecological integrity and by providing for economic viability and social equity (Grant, 1996). The particular form that an urban housing exhibits is the product of the reciprocal relationship between humans and the ecological systems in the area that bind together to create an urban landscape that changes through the course of time.

Research on urban wildlife management in developed countries has identified the importance of providing wildlife habitat in neighbourhood as a strategy for sustainable community (Nilon and Pais, 1997). Harrison et al. (1987) specified the importance of providing local sites for the residents to view wildlife within one kilometer of their homes.

In the United States of America, Ahwahnee Principles were established to form the basis for sustainable communities. They identified areas including community design that are addressed by specific strategies including ample supply of green open spaces, continuous system of greenbelts as wildlife corridors, preservation of natural terrains and vegetation, and minimising of waste (Grant, 1996). The Town and Country Planning Association of the United Kingdom (2004) observed that supporting a richness of biodiversity is one way towards building more sustainable neighbourhoods. Live case studies illustrated that efforts to design green spaces in residential development for wildlife diversity should begin at the earliest stage of master planning.

In the Malaysian context, the government has formulated several national policies and guidelines for sustainable planning including Agenda 21 and Local Agenda 21. The emphasis of trends in settlement planning has shifted from that of conventional design to one that is contemporary, incorporating concerns for sustainability (Halimaton, 2007). This includes exploiting innovative designs (preservation of natural topography, sustainable open space network and optimum layout) and changing lifestyle choices (open space network, neighbourhood living and cul-de-sac vs. grid-iron-road pattern). The Department of Environment has introduced the Bandar Lestari Environment Award

to accord recognition to sustainable cities that integrate environment in their planning and design (Noor Baizzura, 2005).

Recent trends in residential development in the Klang Valley showed a paradigm shift in the perception and attitudes toward neighbourhood green spaces. Malaysian has shifted their views on landscape as living spaces that attribute to the quality of life (Kamariyah, 2003; Ismail, 2007). The emphasis is on detailed space planning where daily activities are carried out (Kamariyah, 2003). As public awareness and concern in environmental protection and stewardship escalated, more and more housing developers began looking into alternative approaches toward providing livable and sustainable residential communities.

### *Impacts of Residential Development on Urban Wildlife Habitats*

Several studies have investigated the impacts of urban residential developments on wildlife habitats and movement (Henderson and O'Herrens, 1992; Miller and Hobbs, 2002; Soule, 1991). The findings indicated that new residential developments do adversely affect wildlife habitats by degrading the key requirements of wildlife survival, thus resulting in the loss of cover and native vegetation. Miller and Hobbs (2002) cited that the linear layout of residential schemes and physical barriers such as roads, buildings and fencing also contribute significantly to the loss of wildlife. The Selangor Department of Wildlife and National Parks in Malaysia, has identified the loss and degradation of suitable habitats. According to its officer:

“Wild birds such as the Night Herons and Cattle egrets are like nomads now, migrating from one place to another for their roosting sites. The habitat for these wild birds was previously at Tasik Puteri in Rawang before disturbances in the area caused the flock migrate to its present location in Taman Garing, Rawang. Even the present site is suitable as there are frequent human disturbances...Permanent habitat is urgently needed as open spaces for protected species to breed are disappearing fast” (Abdul Jalal Kasim, Head of Investigation Unit, Department of Wildlife and Parks, 2009).

## **SIGNIFICANCE OF URBAN GREEN SPACE AS WILDLIFE HABITATS**

Urbanisation in the Klang Valley has resulted in a significant loss of wildlife habitats due to the reduction and fragmentation of natural green areas. Consequently, this has severely disrupted important wildlife movements cross natural corridors (Willmer, 2000). This issue is further compounded by the re-arrangement of habitat resources (including food, water, shelter and nesting) previously provided by the dipterocarp

forest, which is now replaced by secondary forests and the introduction of new plant species (Gilbert, 1989; Adams, 1994; Hadidian, 1992).

Notwithstanding the severe loss, degradation and fragmentation of natural habitats, extensive studies on urban green spaces in Malaysia revealed that these spaces still support selective wildlife if their ecological features are retained. A bird inventory conducted in the Forest Research Institute of Malaysia (FRIM) in 2002 recorded a total of 181 bird species from 45 families, mostly comprising lowland species while 26 migratory species were found from September to April (Ong, 2003). Similarly, an inventory of urban birds conducted in Taman Tasik Perdana identified 24 species including 11 fruitivorous, 4 insectivorous and 3 omnivorous bird species (Sharifah Dora, 2007).

These studies indicate that despite a significant loss of dipterocarp forests, existing urban green spaces including fragmented urban forests, campuses and urban parks still support wildlife. However, previous studies conducted by Yap and Sodhi (2004), Rosli (2001) and Rosli (2004) highlighted the fact that majority of urban wildlife consist of generalist and invasive species with 72 bird species (10% of total Malaysian birds) comprised introduced and invasive species. These include House Crows (*Corvus splendens*), House Sparrows (*Passer montanus*) and Rock Pigeon (*Columba livia*). The high composition of these generalist bird species indicates a high level of habitat disturbances as only the invasive species, having a generalist feeding habits can survive in a disturbed urban environment.

Displaced birds which depend on specialised diets often fail to re-establish themselves in neighbouring forests due to the restructuring of vegetation from the dipterocarp forest to secondary forest and introduced vegetation, of which they have not adapted to in their feeding habits (Rosli, 2001). As specialist bird species including kingfishers, hornbills and flycatchers have their preferences of resources available only in a particular habitat, fragmented forests thus failed to function as urban habitats. The increase in animal species categorized as endangered, vulnerable or rare, from 21 species in 1986 to 85 species in 1996, indicates that species under threat of extinction are rising at an alarming rate (Yong, 1998).

Rosli (2001) investigated the effects of forest disturbances on birds inhabiting three fragmented urban forest islands in the Klang Valley, namely the Bukit Gasing Forest Reserve, the Bukit Seputih Forest Reserve and in a patch of green area located in University of Malaya campus. The findings indicated that both migrant and large resident birds such as the Crested Serpent Eagle and the Red Jungle Fowl, are less tolerant to habitat modifications and disturbances as they require large foraging areas. Specialist birds including the White-throated Kingfishers (*Halcyon smyrnensis*) and

the Olive-backed Sunbirds (*Nectarinia jugularis*), with specific habitat requirements, have disappeared from their main ecosystem.

Based on the above findings, the research identified a gap in the pattern and distribution of green spaces that led to an investigation on the design approaches to be adopted in green space designs towards attracting a diversity of wildlife, including specialist species to return to a sustainable urban ecosystem.

## RESIDENTS' ATTITUDES ON URBAN WILDLIFE

Attitudes toward wildlife has changed from a dominating and utilitarian one to a more humanistic one defined by a strong interest and affection for individual animal (Shaw, 1985). In a survey of residents of Kansas City, 93% of the respondents described the wildlife around their homes as "enjoyable" rather than pests, and only 13% reported that they had wildlife-related problems.

Studies on attitudes recognize that basic components that make up the community's attitudes are cognitive (knowledge and value component), affective (feelings component) and behavioural in nature (the action tendency that results or experience) (Thomas and DeGraaf, 1973; Woolcott et al., 2002). In this light, the attitudes of residents can be measured using several variables comprising personal interests/desirability for each species, the social and environmental benefits brought on by wildlife and the experiences encountered by residents with wildlife.

The personal interests (feelings) of residents toward urban wildlife are influenced by demographic variables including types of dwelling, location, gender and age group (Woolcott et al., 2002; Hadidian et al., 1992). Those living in residences with ample green space such as bungalows are more likely to show interest in adopting positive behaviors, compared to those residing in apartments/townhouses. Age factor also significantly influences the typology of wildlife favoured. Children favour touching crawling smaller animals such as worms and beetles compared to older residents who favour listening to sounds made by birds and watching their movements.

The New South Wales National Parks and Wildlife Service investigated the attitudes, needs and practices of residential community on wildlife. The findings indicate that dwelling types and location have significant influence on the residents' attitudes toward urban wildlife (Woolcott et al., 2002). Those living in landed properties adopted highly positive behaviours toward wildlife.

Meanwhile, in a benchmark study on residents in Illinois, Mankin et al. (1999) observed three related factors comprising of place of residence, gender and age group

that influenced the different attitudes of residents toward wildlife. According to Butler et al., (2001), the social value of wildlife can be measured by four comprising the presence of wildlife as an indicator of an environmental quality, the ecological role by wildlife, the understanding wildlife behaviours and the existence of wildlife in a natural environment.

While the positive attitudes of urban residents are indicated by the interest and value of social benefits brought on by wildlife, the residents' tolerance are determined by the experiences encountered with wildlife (Dagg, 1970). Six categories of wildlife-related problems were identified including damage done to landscape, structures and vegetable gardens and the pollution generated by noise and foul odor (O'Donnell and Vandruff, 1983). In Malaysia, complaints were reported on the problems caused by monkeys and crows (Department of Wildlife and National Parks, 1992).

There is no consensus on the criteria that can be used to classify urban wildlife as it is ultimately the personal interest of an individual that will determine if an animal species is preferred or not (Thomas and DeGraaf, 1973). However, this research concur the view of Flint (1985) and Butler et al. (2001) to classify urban wildlife as being either favourable, a nuisance or a danger to residents. This has provided some insight into what aspects render a species acceptable in green spaces.

- a. Favourable wildlife are animals which considered friendly, attractive and desirable. This group of animals includes resident and migratory birds such as songbirds, purple herons and egrets, tortoises, beetles, butterflies, dragonflies and squirrels.
- b. Nuisance Wildlife are annoying animals with desirable attributes. They are noisy, smelly, potentially dangerous to humans pets and homes, and are dirty or unhealthy. This group of animals includes monkeys, spiders, bats, civets, crows, frogs and toads.
- c. Dangerous wildlife are undesirable animals considered destructive, treating and potentially harmful to humans, pets and homes. This group includes snakes, bees, wasps and wild boars.

The risks and losses incurred by urban residents have changed their perception toward selected wildlife as being pests and nuisance. In Malaysia, the major complaints on wildlife species are against the Long-tailed Macaque (923), civets (33), python (16), monitor lizard (2), and birds (7) (Department of Wildlife and National Parks, 1992). They have caused severe damages to plantations and buildings and they thrive on almost all food types thus rendering them a nuisance to domestic households (Siti Hawa, 2007). Although monkeys are protected under the Wildlife Protection Act, 1972 (Act 76), they are considered a bane as they are opportunistic animals that easily reproduce.

## RESEARCH METHODS

A comparative research strategy is used for this research where other factors, except residents' attitudes toward urban wildlife, in their neighbourhood, were eliminated. This required the development of a survey method, sample and site selection strategy as explained in the following sections.

### *Study Area*

The residential schemes are selected based on (a) visual evidence of urban wildlife in these residential schemes; (b) mixed residential schemes (bungalows, semi-detached and terrace houses); (c) the phases of residential units completed at least five years earlier; and (d) presence of water bodies or forests contiguous to the developments.

The survey is confined to six neighbourhood schemes in the Klang Valley. This is due to the more significant impact of urbanisation experienced in Klang Valley as compared to other urban areas in the country. The study areas selected are Bukit Jelutong, Shah Alam (2205 acres, 1997), Kota Kemuning, Shah Alam (1820 acres, 1995), Kota Damansara, Damansara (3925 acres, 1989), Bandar Tun Hussein Onn, Cheras (752 acres, 1990), Taman Tun Dr Ismail, Damansara (286 acres, 1974) and Taman Tun Abdul Razak, Ampang (200 hectares, 1980).

### *Sampling Method and Size*

A quota sampling method was conducted for the purpose of this study. Quota sampling is a form of non-probability sampling in which sub-samples are selected from a clearly defined group (Baker, 1999). This type of sampling is very useful where the participation of the minority group is critical. In the context of this research, the defined group was the house types that comprises of bungalows, semi-detached and terraces.

The survey involved a total of 2,857 residents comprising 600 residents (Bukit Jelutong), 546 residents (Kota Kemuning), 518 residents (Kota Damansara), 350 residents (Bandar Tun Hussein Onn), 400 residents (Taman Tun Dr Ismail) and 443 residents (Taman Tun Abdul Razak). The residents were selected based on the composition of terrace, semi-detached and bungalows types of housing.

Although Rasimah (2006) observed that a 95% level of confidence is appropriate, it is also observed that a larger sample would provide more accurate results. As it is expected that non-response will occur, this study had made allowance for the non-response by increasing the sample size.



### The Survey

Analysis focuses on the main aspects of a) the background of each residential scheme which discusses factors relating to location, type and size of housing development and the original site and environmental conditions, b) the master planning (if any) and designing of green space and waterways, and the types of habitats and common wildlife observed on sites, c) linkages within and outside of residential schemes, d) linkages to the local neighbourhoods (only for Putrajaya and Shah Alam townships.)

### RESULTS AND FINDINGS

Out of a total of 2,857 survey questionnaires distributed to the homes of the residents, 559 respondents (19.6%) responded by post. The largest group of respondents was from Taman Tun Dr Ismail (19.5%), followed closely by Kota Kemuning (18.6%), Taman Tun Abdul Razak (18.1%), Bandar Tun Hussein Onn (17.5%), Bukit Jelutong (14.5%) and Kota Damansara (11.8%).

#### Likeability Toward Neighbourhood

A majority of the residents (96.8%) enjoy staying in their neighbourhoods. There are many physical, social and cultural factors that contribute towards the residents' positive feelings toward their neighbourhoods. The respondents were given five options to choose from on aspects of neighbourhoods most preferred by them. The results were analysed based on the mean score of each aspect and tabulated in Table 1.

**Table 1:** Aspects of Neighbourhoods Most Liked (by Residential Schemes)

Residential Schemes	Location to office		Landscape		School, shops, banks		Presence of wildlife	
	Mean	St. Deviation	Mean	St. Deviation	Mean	St. Deviation	Mean	St.
Kota Kemuning	2.79	1.348	1.68	0.958	3.12	1.022	2.69	1.024
Bukit Jelutong	2.69	1.558	1.70	0.947	3.06	1.202	2.56	1.123
Kota Damansara	1.77	0.825	2.86	1.122	1.89	0.994	3.33	1.086
Bandar Tun Hussein Onn	2.08	1.351	3.17	1.053	2.20	0.909	3.77	1.227
Taman Tun Abdul Razak	2.59	1.498	1.81	0.924	2.75	1.048	2.63	1.129
Taman Tun Dr. Ismail	2.23	1.489	2.10	0.981	2.56	1.105	2.92	1.095
<b>Total</b>	<b>2.39</b>	<b>1.423</b>	<b>2.19</b>	<b>1.143</b>	<b>2.63</b>	<b>1.124</b>	<b>2.97</b>	<b>1.192</b>

The respondents chose landscape as the neighbourhood aspect they liked most (mean score: 2.19). This was followed by location to office (mean score: 2.39), schools, shops and banks (mean score: 2.63), presence of wildlife (mean score: 2.97) and others (mean score: 4.04). The results highlighted the significant role of green space in positively contributing towards good environment for the residential community.

***Urban Wildlife Mostly Favoured***

The residents’ preferences toward wildlife species are crucial in this research. Wildlife comprises numerous types of animals including those that are favourable and those considered as nuisance or dangerous species. It is pertinent to investigate the wildlife species perceived by residents to be favourable and to segregate them from the list of dangerous or nuisance wildlife. This will facilitate the research into looking at the focal species and establishing only their habitats.

**Table 2:** Common Families of Urban Wildlife Most Favoured

<b>Statements</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>
Small birds	555	6.24	0.982
Butterflies	557	6.18	1.046
Squirrels	558	4.82	1.644
Tortoise	555	3.51	1.965
Frogs	554	2.60	1.698
Monkeys	556	2.35	1.507
Crows	556	1.51	1.039
Snakes	556	1.21	0.678

Since there is no database provided by the Department of Wildlife listing the typology of urban wildlife, the researcher limits the wildlife typology of wildlife species commonly found in urban residential schemes in tropical countries only (Siti Hawa, 2007). This research assumed that the residential schemes of the Klang Valley are typified by the common wildlife. The respondents were given a list of eight wildlife species typically found in urban areas of tropical countries. These comprised birds, invertebrates including butterflies and dragonflies, amphibians and mammals. The respondents were asked to rate each species using semantic scale from ‘7’ which indicates ‘most liked’ to ‘1’ which indicates ‘do not like at all’. Table 2 illustrates the preference of residents on wildlife families where small birds are the species most preferred (mean score: 6.24), followed by butterflies (mean score: 2.6), monkeys (mean score: 2.35) and lastly, snakes (mean score: 1.21).

Factor analysis was further conducted to summarise the groupings of wildlife families into smaller categories. The results were tabulated in Table 3.

**Table 3:** Factor Analysis on Groupings of Families of Urban Wildlife

Rotated Component Matrix	Component		
	Favored animals	Nuisance animals	Dangerous
a. Animal: Small Birds	.841	.050	.054
b. Animal: Crows	-.023	.559	.546
c. Animal: Monkeys	.166	-.038	.878
d. Animal: Squirrels	.633	.179	.272
e. Animal: Frogs	.332	.778	-.070
f. Animal: Tortoise	.417	.700	-.149
g. Animal: Butterflies	.809	.136	-.051
h. Animal: Snakes	-.122	.706	.380

*Note: Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Analysis, b. Rotation converged in 5 iterations.*

Literatures on wildlife have categorized wildlife families into three broad groups of a) favourable animals, b) nuisance animals and c) dangerous animals (Butler et al., 2001; Woolcott et al., 2002; o'Donnel and VanDruff, 1983).

Table 3 deduced that small birds, squirrels and butterflies are categorized as favourable animals while crows, frogs, tortoise and snakes are grouped as nuisance. The third category categories as dangerous animals comprised monkeys. Although snakes are widely perceived as dangerous, it was placed in the same category as other nuisance animals like crows, frogs and tortoise.

***Attitudes of Residents toward Wildlife***

Three variables were used to measure the attitudes of the residents. There are awareness and feelings about wildlife; and experience (normally referring to bad experiences/problems encountered) with wildlife.



a) Awareness

Table 4: Awareness on Importance of Urban Wildlife

Statements	N	Mean	Std. Deviation
Animals are a part of nature	558	4.37	0.697
I appreciate the role of animals	557	4.25	0.812
I like to see the animals' natural behaviors	554	4.12	0.934
Good neighbourhoods have birds and other animals	556	4.05	0.928

The survey posted four statements pertaining to awareness of residents on the importance of wildlife and they were questioned on their agreement on each statement. They were provided with a likert scale where '5' indicates to 'strongly agree' to '1' indicates to 'strongly disagree'.

Table 4 tabulates the mean score for the responses and they are in the range of four which means that the residents agree on all the four aspects. The residents' high degree of awareness of the importance of wildlife may be attributed to high levels of educational levels. The research did not seek to look further into the trends between residential schemes since all the residents have unanimously agreed on all the four statements.

b) Feelings

The respondents were asked on their feelings on wildlife commonly found in their neighbourhoods. Similar to awareness, the respondents were provided four statements to express their feelings about wildlife. However, they were asked to select only one statement that encapsulates their feelings about common wildlife.

Table 5 reveals that a majority of residents (95.3%) enjoy viewing wildlife within their neighbourhoods. Nevertheless, 48.6% of the population was concerned with the problems caused by wildlife. Only a minority (4.7%) did not like having wildlife in their neighbourhoods. It may assume that these respondents may consist of residents who have experienced problems with this wildlife. The concerns are mostly unfounded because the animals they perceived as problematic are actually domesticated animals including stray cats and dogs that do not constitute wildlife.

**Table 5:** Feelings of Residents on Urban Wildlife

Statements	Percentage
I enjoy seeing the birds and other animals near my house	46.7
I enjoy seeing a few animals but concerned about the problems they caused	48.6
I generally regards all animals as nuisance/dangerous	2
I do not like having animals in my neighbourhood	2.7

**Table 6:** Feelings of Residents on Urban Wildlife Population

Statements	Percentage
Increase	59
Reduced	33
Remain the same	8

**Table 7:** The Correlation of Feelings on Urban Wildlife with the Perceptions of the Residents

Correlations		b6. Feel about the animals	Perception
Spearman's rho	b6. Feel about the animals	1.000	-.411**
	Perception	-.411**	1.000
		553	.000 553
		.000 553	558

Note: \*\*. Correlation is significant at the .01 level (2-tailed)

The respondents' feelings toward the population of common wildlife in their neighbourhoods were further explored. A majority of respondents (59%) would like to see an increase in the population of wildlife (Table 6). This reflects the increasing awareness on the psychological and social benefits brought on by the common wildlife to the residents and the local environment. Another 33.0% of the respondent would like the present population maintained whilst a minority of 8.0% respondents prefers the population to be reduced. This may be attributed to specific wildlife problems experienced by the residents.

### c) Experience

Previous studies have indicated that the experiences of the residents, normally associated with problems, significantly influenced their attitudes toward wildlife. Table 8 reveals that a majority of the respondents (60.3%) have not encountered any bad experience with wildlife in their neighbourhoods. Residents who constitute 37.9% of the respondents admit experiencing wildlife problems; however this included problems with domesticated animals including stray cats and dogs which have been wrongly perceived as wildlife by the residents. This means the actual number of residents having had any experience with wildlife is actually lower than 37.9%.

**Table 8:** Experience of Residents on Common Urban Wildlife

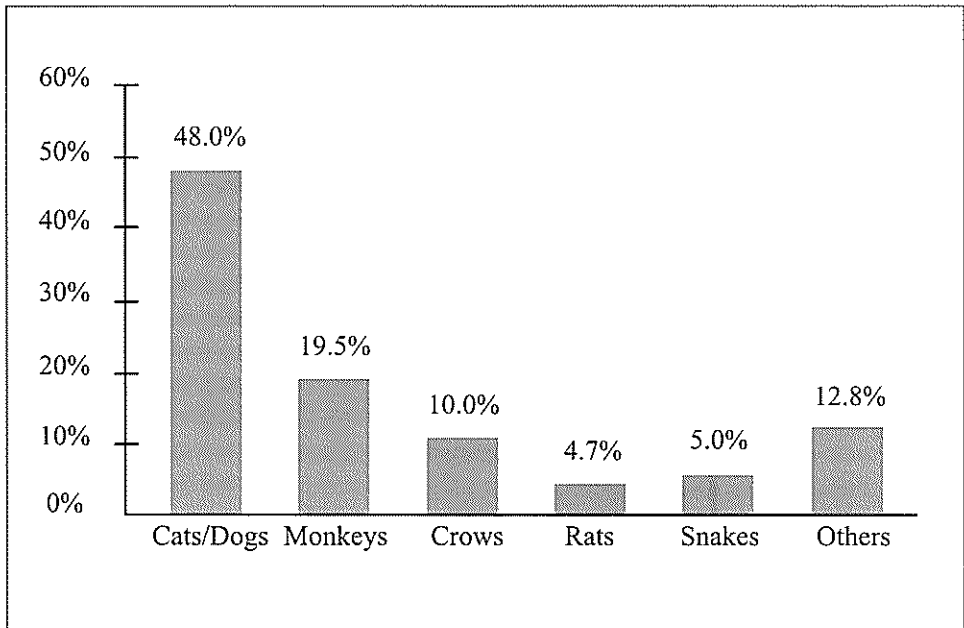
Statements	Percentage
Yes	38
No	60
Not sure	2

### d) Families of Urban Wildlife

Further analysis was conducted to observe trends between residential schemes. It was observed that among six residential schemes, the residents from Taman Tun Razak recorded the highest number of residents having had past experience with wildlife. This constituted 51.5% of the residents surveyed in the area. From the site visits conducted by the researcher at the study area, it was observed that the most common wildlife observed in Taman Tun Razak were monkeys that posed a major problem in the neighbourhood. Besides breeding in large numbers, the high population of monkeys in the area is due to the contiguity of forest to the residential scheme. Most monkeys were observed to be in forest vicinity that provides a corridor and wild patch for the primates to breed and forage.

Since there was no database provided by the Department of Wildlife and National Parks listing typology of urban wildlife, the researcher has limited the wildlife typology as wildlife species commonly found in urban residential schemes in tropical countries only. These include birds, invertebrates including butterflies and dragonflies, amphibians and mammals. However, the respondents included dogs and cats (domesticated animals) as wildlife (Figure 1).

**Figure 1:** Experience of Residents with Families of Wildlife



**e) Types of problems**

The respondents were forwarded the open-ended questions to list down the problems they experienced with urban wildlife. The answers were then categorized into four major groups of problems that comprised (a) being dangerous to human beings and pets (b) causing damage to properties, (c) being a general nuisance and (d) others. The results were tabulated in Table 9. The analysis revealed that a majority of problems are categorized as wildlife being a general nuisance (68.6%).

The wildlife also caused damage to properties which included damage to house compounds, cars, fruit trees and furniture (17.2%). Residents were also concerned about the dangers the wildlife posed to humans especially children and pets. However, this only constituted 11.8% of the complaints on wildlife. The major source of complaints was towards monkeys and snakes encroaching their residence, presumably in search for habitat needs including food and shelter. This raised fear on the safety of the occupants.

**Table 9:** Types of Problems Associated With Urban Wildlife

Statements	Percentage
Dangerous to human and pets	11.8
Damage to properties	17.2
General nuisance	68.6
Others	2.5

## DISCUSSION

The research identified positive attitudes (measures by feelings, knowledge and behavior/experience) of urban residents on common urban wildlife. These attitudes differ by socio-demographic segments such as age, gender, levels of education, household incomes, ownership of homes and length of stay in the neighbourhoods. The results indicated that the residents displayed strong preferences toward naturalistic elements for the neighbourhood landscape comprising shade trees, flowering and fruit trees, and wetlands (ponds and lakes), compared to man-made elements such as benches and fences, monuments and sculptures, and paved areas. Many residents favoured and expressed feelings of enjoying upon viewing small birds, butterflies and squirrels, and those considered a nuisance include crows, frogs and snakes and tortoise. Their enjoyment may be attributed to their appreciation of the psychological and social benefits of living with nature, including wildlife.

The research discovered that urban residents looked forward to seeing an increase in the selective wildlife population, regardless of their past experience with the wildlife. The findings from the research confirmed that there is a relationship between experience and the respondents' feeling toward animals in the neighbourhood. The respondents identified that a majority of the experiences they encountered were in fact, with domesticated animals such as dogs and cats, followed by monkeys, snakes, crows, rats and others. Other wildlife encountered included bats, squirrels, birds and foxes. Nevertheless urban residents concerned about the problems caused by other wildlife. Considered as dangerous by the residents, monkeys were the animals that the residents have encountered the most negative experiences with. The management aspects of wildlife must be integrated as part of design consideration for neighbourhood green spaces to function effectively as wildlife habitats.

## CONCLUSION

The research examined residents' attitudes toward urban wildlife in their neighbourhoods and concludes that there could be alternative views relating to the scope and process



of investigation conducted by the research. The result however revealed the positive feedback from the findings that the resident can distinguish between wildlife and more obviously the research has achieved in making a significant contribution to the study on sustainable urban neighbourhood designs.

This research has also identified the growing interest for wildlife habitat designs in urban neighbourhood amongst the stakeholders including clients (housing developers), residents and practitioners. The urban residents attitudes gauged from the survey conducted provide a deeper understanding on the importance of relationship between residents and wildlife, within the tropical context. This study supported previous research made by Dagg (1970), Brown and Dawson (1978) and Harrison et al. (1987) who emphasized that contact with nature is beneficial for human health and should be encouraged. While most urban wildlife literatures in Malaysia focused on the management aspects of invasive and dangerous wildlife species, this research has increased knowledge on the positive values of urban wildlife, and highlighted the approaches that can be taken to bring urban wildlife into neighbourhoods.

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## **EVALUATING STAKEHOLDERS' PREFERENCES: RECONCILING HERITAGE AND SUSTAINABILITY IN KUALA LUMPUR TRADITIONAL AREAS**

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### **Abstract**

Unchecked redevelopments are destroying our unique multi-cultural heritage. The subsistence of this built heritage is threatened by demolition, unsympathetic changes and rapid redevelopment pace. Escalating market value increasingly replaces these buildings with newer and higher density structures. Most often, the decisions pertaining to traditional shophouse redevelopment are based on guidelines inherited from the mono-cultural British system, whose perspectives narrowly represent the multi-cultural society in Malaysia. On top of that, involvement of direct stakeholders, namely owners and tenants, are minimal in the decision process. This paper is part of an ongoing research to provide an objective evaluation for traditional shophouse redevelopment, incorporating multiple stakeholders' preferences. It focuses on exploring conflicts and values of the stakeholders using Multiple Criteria Analysis, or MCA technique. Using a common MCA technique, the Analytical Hierarchy Process, or AHP, stakeholders' preferences on a set of criteria for redevelopment decision are derived and compared. It is found that stakeholders' preferences are dissimilar even within their homogenous groups. This study contributes to discovering the potential of MCA to increase transparency in redevelopment decisions involving built heritage and multiple stakeholders.

**Keywords:** conservation area, Kuala Lumpur, redevelopment decision, stakeholders' values, multi-cultural society, MCA, AHP

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## INTRODUCTION

Jane Jacobs [1] believed that to remain sustainable, a city must embrace its past in future planning. The past gives a sense of belonging to the society, supporting future growth. Therefore, sustainable development is balancing progressive development with conservation of important cultural values within its society [2, 3], creating a consensus of stakeholders' conflicting objectives, taking into consideration the interplay between physical, social, environmental and economic dimensions. Stakeholders comprise of people with different interests and uphold various values. Cultural values of a society are strongly associated with the physical structures, particularly the buildings [4, 5]. Evolution of architectural details of each building reflects the changing eras. Malaysia built heritage is of recent vintage when compared to world heritage city such as Jordan's ancient city Petra. Nevertheless, it should be protected. Individually, a built heritage may not be spectacular but together with its intangible resources, such as multiculturalism and ethnic diversity, they are part of the future generations. Development that continually replaces these buildings with modern structures will diminish the cultural values and disintegrate the society [6], whereby intangible heritage such as local festivities will be celebrated less and less every year. Even when it is celebrated, it lacks vigour. In a city such as Kuala Lumpur, redevelopment and conservation is a quandary. Conservation of traditional shophouse is strongly opposed by market pressure biased on economically highest and best land use. The zoning of older areas into commercial property intensifies the redevelopment pressure on this built heritage [7]. The threat of obsolescence requires traditional shophouse owners to decide on the extent of redevelopment: adaptive reuse, rehabilitate, façade conservation or total redevelopment. Conversely, total redevelopment creates an opportunity to eliminate substandard buildings, incompatible land uses and other unwanted elements [8, 9]. Perpetually increasing land prices render urban redevelopment as an attractive economic proposition. The surrounding communities also indirectly benefit from redevelopment of a site [10]. Then again, social function of a city is just as important and total redevelopment is commonly associated with gentrification. Many redevelopment examples displaced the original community and thus destroyed the social integrity in most cases [11]. The minority groups are often removed from the redeveloped areas [12] and the decision made for the greater good easily lose sight of its objective [13]. However, urban redevelopment as defined in this research could revive the social life of a place. In this respect, adaptive reuse and façade conservation are more favorable options to total redevelopment because they cause less social disturbance; a quicker and cheaper options to improve the quality of the building stock; and a better sustainable approach to urban redevelopment: it uses existing resources and produces less construction and demolition wastes [14]. Minimal social disruption is particularly important for older inner city areas because of existing community and its association with built heritage.

This paper is part of an ongoing research to provide an objective evaluation for traditional shophouse redevelopment, incorporating multiple stakeholders' preferences. It focuses on exploring conflicts and values of the stakeholders using Multiple Criteria Analysis, or MCA technique. The study is dedicated to provide a mechanism to elicit and objectively evaluate respondents' interests and values. These differences are now measurable, comparable and if wished to, can pave ways for further discussion to understand the issue. It will act as preliminary findings for political decision makers to further explore the conflict and reasons behind the conflict, thus promote a transparent and consensual decision environment.

### **Redevelopment vs. Conservation**

As Malaysia made its place in the global economy, Kuala Lumpur or fondly known as KL, experiences rapid growth far ahead of other local cities [15]. Demands for more space made older areas potential developable land via urban redevelopment. When the Government initiated integration of KL's economy with the global economy in 1980, development in KL intensified. By 1995, KL Stock Exchange or KLSE is ranked fifth in the Asia Pacific Region after Tokyo, Osaka, Hong Kong and Australia [15]. KL became center for trade, finance and commerce. Commercial land use increased more than 25 percent from 1984 to 2000 whilst other land uses decreased [7]. Rapid growth resulted in substantial and sometimes irreversible changes to its built form and socio-cultural character. The existing space, a legacy of colonial immediate past decisions, however represents different socio-economic and political forces and circumstances. The conservation guidelines imposed on these older areas are perceived as unnecessary obstacle. Some owners want the freedom to express their business identities via the outlook of their premises but others such as the pro-conservation groups are of the opinion that the original urban character should be conserved to maintain KL's unique urban identity [5]. Generally, conservation guidelines heavily emphasize on architectural significance whereas there exist many other aspects which should be objectively considered in decisions to redevelop culturally significant urban areas.

#### **Public involvement in redevelopment decisions**

The involvement of multiple stakeholders in urban planning is an integral part in sustainable future [16]. It is an integral planning element for vibrant and sustainable urban area. Successful urban redevelopment in many countries shows that they were initiated and driven mainly by the community themselves [12, 17-19]. Unfortunately, the current planning decisions in Malaysia are exclusive to a group of stakeholders, a typical top-down planning process. Community participation in conservation is minimal [20]. Public participation in planning decisions is at best, mere formality, as can be seen in the gazetting of the Kuala Lumpur Draft Local Plan, KLDCP [21]. The members of the public are not consulted until the public viewing of the draft development plan. The subsequent processes from public objections to public hearing and report submission

on the recommended changes to the Mayor are meaningless because the final decision lies exclusively with the Mayor. Multiple stakeholders' viewpoints, which are possibly conflicting, are not appropriately incorporated nor considered.

### **Multicultural heritage**

KL's distinctive local identity is entrenched in its traditional shophouse. Diverse cultural influences are clearly manifested in the architectural details of traditional shophouse. The Malaysian built heritage is largely regarded as the product of a colonial plural society [22, 23]. The traditional shophouse with covered *kaki lima* (literally five foot) way is unique to early urban settlements in Southeast Asia, particularly Malaysia, Singapore and Thailand. The *kaki lima* is an adaptation to the local climate, hot humid and torrential rain. This oldest extant urban settlement is the repository of lifestyle from different era of small-scale economy and life style that ironically nurtured the current economic success. Apart from market and places of worship, traditional shophouse is one component of early major towns in Malaysia [24]. Many have played a central role in the life of a city for close to a century. Its floor space was designed to cater for the functions that met the needs of the then urban people. The ground floor is for business, whereas the top floor is for residential. It was extremely convenient for traders and merchants to live within the proximity of their workplace. As their businesses grew, the merchant move their residence to the outer skirt for more conducive environment. The vacant residential quarters were then converted into worker's quarters or rented outs. Over the years, traditional shophouse has played a major role in meeting housing needs for urban dwellers [6]. It has silently supported economic growth and helped businesses to sustain for generations in the rapidly developing city center.

The study area

The City Hall of Kuala Lumpur or CHKL has been rather proactive in protecting heritage buildings and areas [25]. CHKL has drafted a local plan that defines three heritage zones within the inner city center: Primary, Secondary and Tertiary Heritage Zones. The designated zones define the level of conservation enforcement. The Secondary Zone encompasses an area that is "less contiguous and contains mixture of newer and older buildings with significant historic merit". The zone is the oldest commercial area, where the most number of traditional shophouse with historical and/or architectural merits are located. It is populated with Category 3 heritage buildings: buildings with "elements or characteristics of some historical or architectural significance which are recommended to be conserved"[21].

## METHODOLOGY

The methodology in this study consists of two stages: Multiple Criteria Analysis to elicit and rank stakeholders' preferences followed by Consensus Building that establishes the correlation among those rankings.

### MCA technique

MCA is not the only tool used measure different aspects in sustainability [13]. However, it was chosen for a number of reasons. MCA effectively decomposes a decision problem in a structured manner. The process of assigning weighting factor to each criterion [26] and the need to justify criteria and weight choices can contribute to openness, traceability and accountability in the decision making process. It enables stakeholders to learn about their own preferences and of others as well. Transparency in decision making is increasingly demanded in public and private decisions that affect scarce public resources such as land and its associated uses [27]. MCA method provides insight into how different individuals approach a decision problem as well as areas and intensity of consensus or conflict among individuals. One of the most popular MCA methods is the Analytical Hierarchy Process or AHP proposed by Saaty [28]. The working principles of AHP comprise of decomposition, comparative judgment and synthesis of priorities. AHP outlines three basic steps: model building, pairwise comparison and ranking. A set of criteria is established and decomposed into different levels of independent elements, with increasing degree of specificity, known as a decision hierarchy (Figure 1). The criteria will be used to evaluate the alternatives. Comparative judgment compares the relative importance of one decision criterion to another in the same level pairwise. Stakeholders will assign weights to each criterion according to their preferences on a scale that ranges from equal importance to extreme importance, represented by number 1 to 9 respectively. Even numbers are considered as intermediate points between adjacent values.

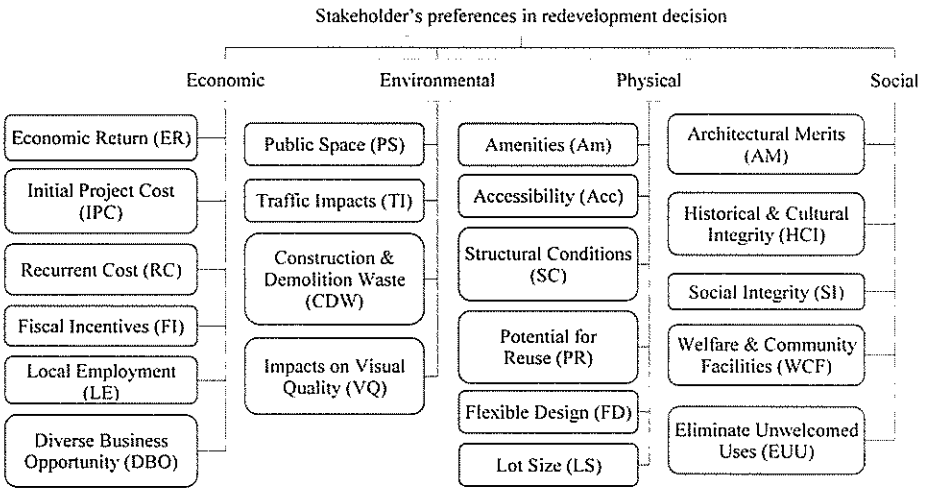
Importance Intensity	Definition
1	Criteria $i$ and $i'$ are equally important
3	Criterion $i$ is moderately more important than criterion $i'$
5	Criterion $i$ is strongly more important than criterion $i'$
7	Criterion $i$ is very strongly more important than criterion $i'$
9	Criterion $i$ is extremely more important than criterion $i'$

The strength of AHP is that decision makers are assumed to be inconsistent in their values and judgments. The method measures this inconsistency to help the stakeholder(s) learn more about the decision in question and of their own and others' biases and inconsistencies. Inconsistency Ratio  $<0.10$  indicates a reasonable level of consistency. Ratio  $\geq 0.10$



suggest revising the original pairwise comparison values. Being a mathematical decision evaluation tool, it provides a valuable means to deal with complex decision evaluation. AHP sets aside consideration for both qualitative and quantitative aspects of an evaluation. It can reduce complex decisions to a series of one on one comparison by assisting with identifying and weighting selection criteria, analyzing data collected for the criteria and expediting decision making process.

Figure 1:



**Consensus building**

Consensus building is established by creating awareness among the stakeholders of the differences within the group. It captures and subsumes conflict balancing or consensus building within the redevelopment decision process. However, in situations where stakeholder objectives and priorities are in conflict, it is difficult in practice to reach agreement on the relative importance of individual criterion. In these cases, it is more appropriate to explore the various dimensions of the conflict, as represented in criteria choices and weightings, by producing group rankings that are based on the ranks generated by individual group members. To test the significance of the association between pairs of stakeholder criteria rankings and between the ranks for individuals, Spearman's rank correlation coefficients ( $r_s$ ) were calculated for the rankings of criteria by stakeholders. The test statistic assumes that at least five pairs of observations are present and that the observations are ranked from 1 to n with many tied ranks being represented by average ranks [29]. Assuming that the number of pairs of tied ranks does not exceed 25 percent of n, the statistic has the following form [29]:

$$r_s = \left( \frac{\sum_{i=1}^n d_i^2}{n^3 - n} \right) \quad \text{Equation 1}$$

where:  $d_i^2$  is the squared difference between the rank for alternative  $i$ ;  $n$  is the number of observations. When  $n$  is greater than 10, the distribution of approaches the  $t$  distribution allowing the significance of to be tested against critical values of  $t$  as a value of  $t$  with  $n-2$  degrees of freedom [30]. The transformation  $r_s$  of values to Student's  $t$  is calculated by:

$$t = r_s \sqrt{\frac{n-2}{1-r_s^2}} \quad \text{Equation 2}$$

**Data collection**

The overall approach of this paper involves survey using questionnaire to identify stakeholders' preferences or priority for each criterion. The preferences indicated by each stakeholder are subsequently compared pairwise to other stakeholders. The consistency of evaluation is maintained through moderation by the same researcher who, while guiding the stakeholders through their input on preferences, was careful not to bias any aspect of the process. The sampling is done based on purposive sampling, meaning only selected individuals is chosen as respondent. They are owners and tenants. The questionnaire comprises three parts: the particulars of the respondent, preference weightage and open ended feedback on the criteria. The second part defined criteria weighting. The questionnaire survey was conducted as structured interview. Respondents were given a detailed explanation about the survey. Each criterion was explained in detail to ensure respondents have common understanding of the key terms and criteria to be weighed. The respondents are allowed to ask questions to remove ambiguities. This process is crucial to ensure consistent interpretations of the terminology so that the results can be analyzed in a meaningful way. Twenty individuals were approached for the structured interview but only nine responded. They are lay people, representing the community made up of owners & tenants in the study area. They were chosen based on the premise they occupy, namely the traditional shop house within traditional commercial area undergoing rapid redevelopment nearby and in the surrounding areas. This publication is one part of a research work published elsewhere.

## **MCA FRAMEWORK FOR REDEVELOPMENT DECISIONS**

### **The problem description**

Competing land use has led to increasing levels of land-related conflict: highest and best uses at the expense of heritage loss, socio-cultural changes, infrastructure limitations, opportunities for future development, and degradation of culture and social integrity. Many of the conflicts centered on the redevelopment projects within the heritage zones in Kuala Lumpur. It is difficult to balance diverse interests of the stakeholders [31] as observed in the redevelopment of Jalan Petaling, a famous bazaar shopping district. In 1992, a proposal was made to upgrade Jalan Petaling. The project took decade before implementation due to inability to reach a consensus between the business community and the local authority [32, 33]. There were issues such as fear of too many changes, uncertainties in future of business locations and distrust in intent of redevelopment. A large number of stakeholders were involved: in the year 2003, the Chinese Chambers of Association recorded 1000 registered and unregistered hawkers operating in Jalan Petaling. After multiple levels of discussion and intervention by various political parties and representatives, the project took off and finally completed in 2007 [34].

### **The stakeholders**

A stakeholder is a person who is involved in or affected by a course of action determined by a decision. The stakeholder's involvement as decision maker are often classified in relation to the level where decisions are made i.e. national, regional or local levels, the scale and durability of their decisions. Stakeholders can be classified based on the effect of the decision making [35] or decision contexts [36]. This study combines the two classifications. In this study, the stakeholders are the owner and/or tenants. The 'owners' in this study are the people carrying out business activities within the area. The study classifies the landowners/tenants in older Kuala Lumpur to be in "direct group with homogenous decision making context" [37]. The stakeholders have direct interest in the use and value increase of the building and their common objective is to optimize the land into highest and best use.

### **The criteria**

A set of criteria was identified, selected from literature and discussion with various stakeholders within the City Center. The study selected twenty-one criteria that are relevant to redevelopment decisions [37]. It is impertinent that decision evaluation considers beyond the economics aspect in land redevelopment [38-40]. The selection criteria must be as broad as possible to equally represent all aspects of consideration,

encompassing economic, social and environmental/physical dimensions, but not too broad that the evaluation becomes too complicated, leading to increased inconsistency in judgment and uncertainty [40]. The MCA technique was applied to rank the relative importance of each criterion based on each individual's preferences and underlying objectives [41]. The consensus analysis determines the correlation strength of those rankings.

**RESEARCH FINDINGS**

The fundamental elements of consensus and conflict in multiple stakeholder decision making are shown in Figures 2-5 and Table 1: the extent of agreement concerning the criteria for redevelopment decision and differentials in the relative importance of individual criteria, as expressed through weight settings. Figure 2 shows the average criteria weightage for all nine stakeholders. Economic Return is weighted as the most important by eight stakeholders; six of them give the highest priority to this criterion.

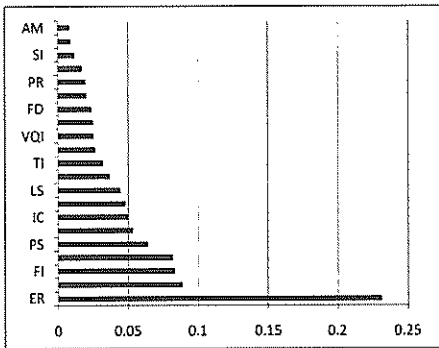


Figure 2: Overall weightage preferences

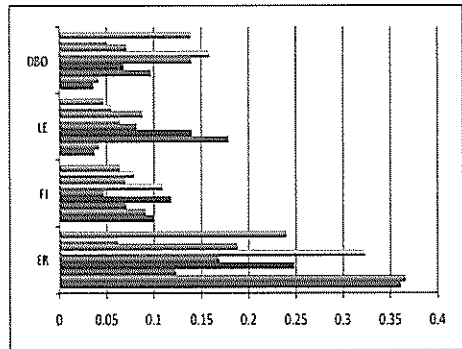


Figure 3: Criteria given highest weightage by at least three stakeholders

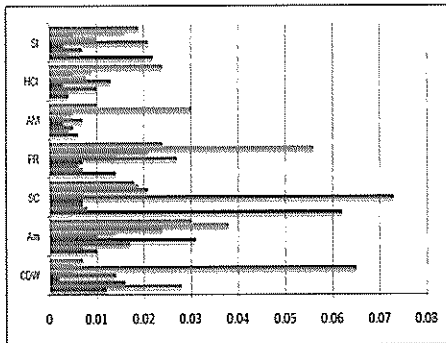


Figure 4: Criteria given lowest weightage by at least three stakeholders

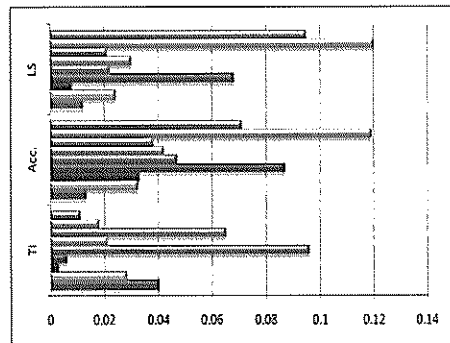


Figure 5: Criteria given mixed weightage

Legend: See Figure 1

There is more than 60 percent gap between Economic Return and the next most important criterion. This is followed by another three criteria in economic: Diversity in Business Opportunity, Fiscal Incentives and Local Employment, as shown in Figure 3. It is evident from the priority weights assignment that economic aspect is the most important factor to owners and tenants in the case study area. At the other end of the bar chart, three criteria are least preferred by the stakeholders: Architectural Merits, Historical/cultural Integrity and Social Integrity. Overall there are six least important criteria as shown in Figure 4. Eight of nine stakeholders consider Architectural Merits as the least important. Many stakeholders feel that conservation of these values is mainly the responsibilities of the Government and local authorities. Unless the benefits can be made tangible in some ways to benefit their businesses, they do not think these criteria are important. However, many verbally express willingness to cooperate in conservation efforts. Figure 5 shows three criteria that receive mixed weightage, meaning it was ranked highly important by some and of low importance by other(s). Two stakeholders feel that Lot Sizes is an important criterion. One stakeholder thinks it is the least important, whereas the other six give medium priority. Comparatively, this group of stakeholders is more homogenous compared to Professionals [37], which gives mixed weightage to five criteria: Amenities, Flexible Design, Lot Sizes, Structural Conditions and Welfare & Community Facilities.

Some understanding of each stakeholder's objectives and concerns is required to understand the origin of conflict and the rationale underlying criteria weights. Many of the owners/tenants have been operating for more than 15 years. Until the year 2000, traditional shop houses are classified as controlled premise under the Control of Rent Act 1960 (Repealed 2000). Overhead costs are low, allowing businesses to sustain despite rapid redevelopment in the surrounding areas. However, low rent gives little incentives for owners to properly maintain their premises. This has led to dilapidated states of traditional shop houses and the surrounding areas. The stakeholders wish to continue operating their businesses in the same premise regardless of whether redevelopment takes place or not. However, majority stressed the need for more public spaces and better access to the area. Owners and tenants in general perceived that conservation is the responsibility of the Government, and the planners and architects in the City Hall. They are willing to give their supports in terms of cooperation and following the guidelines set by the authorities. Architectural, historical and social were considered of low importance. This lack of perceived importance could be because of inability to directly relate these criteria to economic gain. Many stressed on the improvement on area safety. This may be because crime rates are rather high in the city center, and as a major tourist spot, such issue would definitely have negative impacts on businesses.

Table 1 shows the correlations of the stakeholders' importance ranking for consensus building. From the importance ranking of 9 stakeholders, 36 pairwise comparisons, Stakeholder 1,  $S_1$  compares to Stakeholder 2 is denoted by  $S_1-S_2$ , thus formulated as  $S_i-S_j$ , Pairwise comparisons are carried out to determine the strength and significance of

correlations between the ranks. Pairwise values confirmed strong and significant positive correlations between ranks of importance for 24 pairs at 99% confidence level, except between 12 pairs shown in Table 1. Significant positive correlations at 95% confidence level are observed between 7 compared rankings in the table, marked by YES. Ranking of importance by Stakeholder 8 ( $S_8$ ) has insignificant correlations with three other stakeholders,  $S_1$ ,  $S_3$  and  $S_7$ . Five pairwise comparisons have correlations below 95% confidence level.  $S_6$  has strong and significant correlations at 99% confidence level with all the stakeholders. Consistency Index, CI for both  $S_8$  and  $S_9$  are very high, 0.39 and 0.27 respectively, followed by  $S_3$  at 0.23. The other stakeholders have CI equal or less than 0.1.

The correlations between rankings of criteria by different stakeholders (Figures 2 to 5) are strong as indicated by Table 1. The analysis of the problem shows that this evaluation method works rather well in exposing individual and sub-group dimensions of commonality and to identify differences among individuals in a group. This study finds economic aspects as the main priority in redevelopment decisions followed by environmental aspect. Majority of the stakeholders share similar preferences. However, one third of the stakeholders have little in common with each other.

**Table 1:** Correlations of stakeholders' importance ranking

Stakeholder, $S_i$ to $S_j$	$R_s$	Student's t-statistic	Significant @95%	Significant @99%
$S_1-S_3$	0.431818182	2.08684466	YES	NO
$S_1-S_4$	0.482792208	2.403058677	YES	NO
$S_1-S_8$	0.138311688	0.608737399	NO	NO
$S_1-S_9$	0.193181818	0.858226456	NO	NO
$S_2-S_8$	0.416883117	1.99915417	YES	NO
$S_2-S_9$	0.418181818	2.006699516	YES	NO
$S_3-S_5$	0.307142857	1.406804808	NO	NO
$S_3-S_8$	0.339285714	1.572167838	NO	NO
$S_3-S_9$	0.47012987	2.321838862	YES	NO
$S_5-S_8$	0.399350649	1.898704644	YES	NO
$S_7-S_8$	0.215584416	0.962339905	NO	NO
$S_7-S_9$	0.380519481	1.793571107	YES	NO

## CONCLUSION

This paper has presented an MCA-based evaluation to urban redevelopment decision in culturally significant areas to uncover conflict and consensus in decision making. The decision-making evaluation developed in this study has potential for practical application. The framework developed in this paper may offer a way of facilitating community involvement in urban redevelopment process. The MCA model in this study is not only suitable for deciding whether redevelopment should take place; it is also useful for evaluating different schemes of redevelopment projects. Furthermore, it is possible for urban redevelopment managers or planners to use the decision-making framework as a planning and design tool. Redevelopment proposal can be evaluated from a wider angle, and refinements to the proposal can be made in order to achieve a higher rating to the redevelopment project subject to time, funds and other practical constraints. The findings in this study suggested that even those with similar interests and decision contexts can have divergent views pertaining to the relative importance of the decision criteria. This is perhaps one of the major roots of disputes over urban redevelopment and conservation efforts in present-day society. The researchers acknowledge the limitation of this study in terms of generalization the findings to other cities or urban areas. Since urban areas are complex and dynamic systems, urban redevelopment is a response to the opportunities and challenges which are manifested by urban decay in a particular space at a specific moment in time. Solutions attempted previously may have little relevance to another place and time. It is valuable to extend the investigation to explore whether stakeholders' preferences are project-, time- and/or location-specific.

## Acknowledgment

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## **SOLID WASTE GENERATION CHARACTERISTICS: THE MALAYSIAN LOCAL AUTHORITIES' OUTLOOK**

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### **Abstract**

The large and increasing amounts of municipal solid waste (MSW) generated each year in several industrialised countries have raised concerns on the economic viability and environmental acceptability of the current generation activities. The planning of an optimal regional waste management strategy requires a reliable tool for predicting the amount and the corresponding composition of MSW likely to be produced. Furthermore, for integrated solid waste management, direct and indirect participation of local government's authority is essential. This paper focuses on the existing waste management characteristics of selected local authorities in Malaysia. As a case study, the research considers three local authorities in Selangor State, namely Selayang, Klang and Subang Jaya. This research further identifies the issues concerning the environmental effects due to indiscriminate solid waste disposal. The findings of the study are expected to provide useful guidelines to the MSW policy makers.

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**Keywords:** Municipal solid waste; Local authorities; Waste characteristics; Health Impact; Landfill; Integrated waste management

## **INTRODUCTION**

Municipal solid waste resulting out of rapid urbanization has become a serious concern for government departments, as well as for the public in most of the developing countries. Rapid growth of population and industrialization cause deterioration in the environment and places serious stress on natural resources. Further, indiscriminate disposal of solid waste has been a major cause for degradation of environment in most cities of the developing world. Apparently, there are two major problems due to poor and inadequate solid waste management. One is the loss of resourceful material and other is social cost due to health impact on rag pickers, community living in dumpsite surroundings and health of general public.

Williams (1998) stated that waste is an unavoidable by-product of human activities. Economic development, urbanization and improved living standards in cities are the major reasons behind have led increase in the quantity and complexity of generated wastes. The Environmental Act (1995) in the United Kingdom defined waste as “any substance or object, which the holder discards or intends to discard”. A ‘holder’ means the producer of the waste or the person who is in possession of it, and ‘producer’ means any person whose activities produce waste, or any person who carries out pre-processing, mixing or composition of this waste. Table 1 shows the classification of waste on the basis of various factors.

The present paper focuses on solid waste whose classification uses a variety of schemes, i.e., physical (solid, liquid, gaseous), material (glass, paper, plastics), physical properties (combustible, non-combustible), origin (domestic, commercial, industrial, agricultural) and safety parameters (hazardous, radioactive).

In general, municipal solid waste consists of household and commercial wastes. It may also include wastes derived from civic amenities, street sweeping, and construction and demolition wastes from local authority sources. It can vary from one country to another and even vary from one region to another within the same country. It is highly heterogeneous and its composition depends on factors such as living standards, geographical locations including cultural habits of individuals, type of housing and seasons.

## **SOLID WASTE GENERATION IN MALAYSIA: BEFORE 1990**

Solid waste management is associated with the control of generation, storage, collection, transfer and transport, processing and finally disposal of various solid wastes. Disposal

is carried in a manner that is in consonance with the best principles of public health, economics, engineering, conservation, aesthetics and environmental considerations. Kheng's (1986) estimated and projected data on the amount of solid waste generated in 20 municipalities of Malaysia are shown in Table 2.

From the amount of waste presented in Table 2, it is clear that the amount of waste in 1990 has been double the amount in 1980. This was expected with the growing urbanization and also the moderate trend of increase in waste generation at the rate of 2% per annum.

A survey of households in Klang Valley in 1978 found solid waste generation rate to be only 0.23kg/capita/day. But the generation rate was predicted to increase to 0.54kg/c/day by 1985 (Kheng, 1986). The trend in generation rates is consistent with population growth, economic growth and consumption habit of the community.

It is expected that the steady economic growth and the rapid urbanization would greatly increase the utilization of raw consumer items thus far not available in rural areas. The change of consumption pattern among the people may be a major driving force in the increasing waste generation rate. Table 3 provides the generation rate (year 1990) of solid waste in Malaysia and some other countries.

### **SOLID WASTE GENERATION IN MALAYSIA: AFTER 1990**

In the early nineties, the solid waste generation rate rose to 0.75 kg/c/day. Currently, the estimated average generation of solid waste is more than 1.0 kg/c/day. This represents a 200% increase within the last 20 years. The estimated solid waste generation in Malaysia in 1998 was approximately 15,000 tonnes/day for a population of about 16 millions. It is further estimated that out of the 15,000 tonnes/day of solid waste generated, only 11,000 tonnes/day (about 70% of the total) were collected. The remaining 30% of non-collected wastes is probably due to illegal dumping and diversion of waste during collection mainly for recycling purposes. Solid waste generation was projected to increase from 2.5 million tonnes in 1991 to 3.9 million tonnes in 2000. Over the past two decades the increased generation of solid waste has been reported not only in Malaysia but also worldwide with many ascribing it to industrialization. Since Malaysia is a multi-ethnic, multi-cultural and multi-lingual society and well-endowed with natural resources in areas such as agriculture, forestry, and minerals (Manaf et. al., 2009), which influence the generation characteristics of Malaysia Municipal Solid Waste.

Depending on the economic status of the area, the per capita solid waste generation rate varies from 0.45 to 1.44 kg/c/day. The national average generation rate estimated for 1991 to 1993 was about 0.7 kg/c/day and has increased to 0.8 kg/c/day from 1994 to 1999 and year 2000.

The national average generation rate and the amount generated is skewed towards the fast developing and urbanized regions or cities like Kuala Lumpur and cities in Klang Valley, Penang, Johor Bahru and Kuching. Table 4 shows solid waste generation at some local authorities in Malaysia in the year 2000.

Global municipal solid waste generated in 1997 was about 0.49 billion tons with an estimated annual growth rate of 3.2- 4.5% in developed nations and 2-3% in developing nation (Manaf et. al., 2009). It is a fact that rapid urbanization and industrialization have changed the characteristics of solid waste generation. With population growth at the rate of 2.4% per annum (Manaf et. al., 2009), the municipal solid waste (MSW) generation also increases, which makes MSW management critical.

The most important legislature for Solid waste management in Malaysia is as Environmental Quality Act from 1974; Action plan for beautiful and clean (ABC) Malaysia of 1988; 3rd Outline Perspective Plan (OPP3) for 2001- 2010; National Strategic Plan for solid waste of 2005; 9th Malaysian Plan for 2006- 2010; National waste minimization plan for 2006- 2020; Solid waste and public cleansing management Act from 2007.

## **IMPACT ON HEALTH**

Due to the absence of standards for handling municipal wastes, it is the municipal workers who are most affected by the occupational health hazards of waste handling activities. In addition to municipal workers, the rag pickers who operate informally for long hours rummaging through waste also suffer from various occupational health diseases. In addition to occupational and environmental health, injury issues also need to be given due consideration in the context of waste management. Contaminated leachate and surface run-off from land disposal facilities affecting downstream ground and surface water quality, volatile organic compounds and dioxins in air-emissions increasing cancer incidence and psychological stress for those living near incinerators or land disposal facilities. Drain clogging due to uncollected wastes lead to stagnant waters and hence mosquito vector breeding is few of the environmental health issues which affect the waste workers as well as general public.

Until now, landfills are the primary method adopted for disposal of Municipal Solid Waste (MSW). Although land filling is one of the cheapest ways of disposing MSW, however, the consequential environmental problems may result from contaminated sites in the future. This risk, together with the lack of adequate landfill space in many municipalities, has been one of the main reasons why in recent years numerous cities and counties in United States and Western Europe have considered incineration as an alternative to deal with MSW. But incineration is not immune of problems either. Incineration

reduces the volume of MSW by about 90%, this process produces considerable amounts of residue. In addition, heavy metals and polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are found in emissions of waste incineration plants. PCDD/Fs enter the atmosphere primarily as combustion by-products from incineration, and since these compounds are semi volatile and hydrophobic, they accumulate in organic-rich media such as soils, sediments, and biota.

Problems associated with the disposal of municipal solid waste have become a source of public concern worldwide as awareness of potential adverse environmental impacts and health threats from solid waste has increased. Communities are concerned on the generation and management of solid waste to the extent of refusing to allow new disposal sites near their homes, often after witnessing the legacy of existing facilities. Under these circumstances, the development of national policies for the management of solid waste becomes an absolute necessity. Further, there is no gainsaying of requirement of appropriate technical solutions that ensure environmental protection and proper management plans that support an acceptable solution for the disposal of municipal solid wastes.

The main objectives of the present research, in the context of selected local authorities of Malaysia, are the followings:

- To study the various characteristics of the municipal solid waste generation
- To evaluate the quantities and composition of solid waste generated
- To identify the potential business related with solid waste generation strategy
- To prescribe some recommendations for better management of MSW

#### **A BRIEF REVIEW OF PREVIOUS WORKS ON SOLID WASTE GENERATION**

Rapid urbanization and population growth in cities in developing countries is expected to bring an increase in the overall waste generation in the coming years. If these increased wastes are not properly managed, a greater danger may be imposed upon a region. Zia and Devadas (2008) have analyzed the waste management practices for Kanpur, a North Indian city and found that the overall management is inefficient, outdated and unscientific. To immediately arrest the problem, they have put forward a large number of recommendations some of which are the following:

- Source segregation of waste
- Introduction of extended producer responsibility (EPR)
- User-charge system as per the income class
- Improving the collection system
- Preparation and adoption of an integrated waste management system

- Participation of all stakeholders including informal waste-recycling sector
- Decentralized treatment plants
- Compliance of MSW rules by people and authorities

Manga *et al.* (2008) comment that inadequate financial resources, low level of enforcement of regulations and poor governance lead to poor solid waste management in many African cities. By means of a case study, the authors highlighted some of the waste management related problems in Cameroon. They conclude that in the country, solid waste management services are rudimentary, essentially collect and dump type of routine activities; current regulations do not adequately address waste handling and disposal. Further, there are inefficiencies in the implementation of wastes management policies due to the lack of coordination between several governmental agencies and the local councils.

Many solid waste disposal researchers have concluded that recycling as one of the most viable disposal strategies. According to Alhumoud (2005), recycling can be promoted by encouraging separation at the source which can be achieved through financial incentives, legislation and raising environmental awareness. However, he finds that majority of the Gulf Co-operation Council (GCC) states have not set regional or national recycling targets. Government policies on the environment exist but are poorly implemented. Public awareness programs lacked the necessary coverage, intensity and continuity to correct the apathetic public attitude towards the environment.

In addition to qualitative research as above, a number of tools have also been developed to manage MSW. The latest tools include a multiple regression model (Chang *et al.*, 2007) for lower heating value (LHV) for MSW, evolutionary simulation optimization (Huang *et al.*, 2005) for large scale planning problems and other planning applications containing significant sources of uncertainty.

Estimation of present and future waste generation and composition of different types of waste are essential for long-term efficient and economical waste management planning. These estimates are used to determine the type, size, design and location of waste treatment and disposal facilities. The statistical data on the quantification of wastes are usually by weight, although sometimes it may be more appropriate to report the data in the unit of volume. For example, plastic bottles for recycling are often reported as volume rather than weight (Agamuthu, 2001).

Analysis of the composition of wastes may also be based on the source of the waste, so that industrial waste might be analyzed in terms of chemical composition, and clinical and household wastes might be either material types such as glass, paper, metal etc. or by-product types such as glass containers, tins, etc. In addition to weight

and composition, the energy value, moisture content, volatile content and elemental composition may also be found by a series of standard tests.

There are two approaches which are generally adopted for estimating waste quantity and composition: (1) questionnaires to the producers of the waste, (2) direct analysis of the waste stream either at the point of waste production or the waste treatment facility (Williams, 1998). Usually, the questionnaire covers areas such as type and quantity of waste, the waste collection and disposal methods used by the organization, the type of containers used for the waste, general categories and subcategories of the waste, description of the process generating the waste, detailed description of the waste in terms of the percentage of components in the waste, physical form of the waste, proportion of packaging, transport methods, location of disposal site, weight of the waste, etc.

Waste properties have both engineering and economic significance. In addition to their impact on the assessment of landfill performance, the unit weight and compressibility of waste materials influence storage capacity and the resulting economic evaluation of landfill projects.

According to Fassett *et al.* (1994), the following characteristics and conditions of municipal solid waste make determination of its engineering properties difficult:

- The inconsistent and heterogeneous composition of landfill material results in widely variable properties.
- Samples of sufficient size representative of field condition are difficult to obtain.
- The erratic nature of waste particles makes sampling and testing difficult; there are no generally accepted sampling and testing procedures for waste materials.
- Waste properties change with time, depth and location.

MSW generally consists of many different constituents, and these constituents are often porous and not fully saturated. Based on an analysis of numerous types of waste and a comprehensive review of the literature, some elements are categorically identified for the classification purposes. From the observation it was found that some wastes are readily biodegradable, others are slowly biodegradable and some are not degradable. By means of compaction equipment used in most landfills at present, it is found that the compaction ratio of loose weight to compacted waste, usually remain within the range 2:1 ~ 3:1. The average unit weight of compacted solid waste is usually 55 to 70 lb/ ft<sup>3</sup> (55 ~ 70 kN/m<sup>3</sup>) for modern solid waste landfills (Xuede *et al.*, 2002).

Solid waste is a particulate material and its behaviour resembles that of soils in many ways. Like soil, the strength of MSW appears to increase with increasing normal load



applied on the waste. According to Fassett *et al.* (1994), factors believed to affect the strength properties of MSW are the following:

- The organic and the fibre content in the waste;
- The age of the waste placed in the landfills, and the extent to which it has decomposed;
- The mode of placement (i.e., compaction effort, lift thickness and amount of daily cover).

The strength of MSW is a function of the direction of shear stress and is primarily frictional in nature (Landva, 1990). Estimates of solid waste strength have been made using the following approaches (Singh and Murphy, 1990):

- Direct laboratory and field testing
- Back-calculation from failures and load tests, and
- Indirect in-situ testing

## METHODOLOGY

A complete record of data on the amounts of MSW or total solid waste generated in Malaysia is difficult to obtain. Different sources in each local authority may use a different definition of solid waste and solid waste generation. Therefore, to study various characteristics of solid waste generation in Malaysia, in the present study, we considered only three local authorities from peninsular Malaysia out of 147 in the country. These local authorities considered as representative of whole 147 authorities in Malaysia are Selayang, Klang, and Subang Jaya, all from the state of Selangor.

Malaysia is tropical country situated in the central part of Southeast Asia and it lies between the longitudes 100° and 120° east and latitudes formed by the Equator and 7° north. A characteristics tropical climate is warm and humid throughout the year, which has experienced in Malaysia. In this climate average air temperatures range from 21° to 32°C and relative humidity ranging from 80 to 90%. Rain tends to occur between November and February on the east coast of Peninsular Malaysia. On the west coast of Peninsular Malaysia, the rainy seasons are April- May and October- November.

*Selayang Local Authority:* This authority consists of one of the fastest developing lands in the Klang Valley. Within 54,559 hectare, this area consists of many potential assets in various development schemes that contribute to the country's economic foundation. Located next to Kuala Lumpur, this sub-urban area is one of the most developing corridors in the Klang Valley.

Transportation system such as Lebuhraya Utara-Selatan (PLUS Highway), Lebuhraya Kuala Lumpur-Karak, Lingkar Tengah (MRR II Highway) and Light Rail Transit System (LRT) have increased the overall transportation facility in Selayang. A good road system connecting this area with other districts had been identified as an excellent potential for Selayang to be the centre of 'Borong dan Pergudangan' (wholesale), which are now moving out of Kuala Lumpur.

*Klang Local Authority:* Klang is located in the west coast of Selangor and acts as one of the Klang Valley metropolitan areas. Located within a good communication district system, road connection and express highway had made this area with an easy access to the City Centre of Kuala Lumpur and other towns such as Shah Alam, Petaling Jaya, Putrajaya, and Cyberjaya.

The whole area under the jurisdiction of the Klang Authority is 57,117.90 hectare that consists of:

- Structure Planning Klang area – 54,917.85 hectare
- Additional area Structure Planning of Klang which consists of Structure Planning
- District of Petaling and part of the District of Klang – 2, 200.05 hectare.

The Klang town is the city centre for the Klang district. The area has become a centre for main commercial activities, district administration centre and is known as the Royal City for Selangor State. The Klang town has also been identified as the oldest town in Selangor. Based on Selangor State Development Plan, their targeted developmental activities proposed by the Klang Authority are:

- Develop as the National Port City
- Transportation centre
- Maritime and Industrial Centre
- Royal city
- Well planned residential area

The overall land use has been divided into the following zones:

- Maritime Industry Zone
- Residential Zone
- Industrial Zone
- Commercial Zone
- Reservation Zone
- Agriculture Zone

*Subang Jaya Local Authority:* Subang Jaya (MPSJ) is located in one of the most developed areas in Klang Valley. This area is situated between the border of Dewan Bandaraya Kuala Lumpur (DBKL) management area at the North East side, Majlis Perbandaran Petaling Jaya area up North, Majlis Perbandaran Shah Alam at the West, Majlis Perbandaran Kajang at the East side and Sepang district at the South.

The development of MPSJ is based on social obligation that garners towards providing the excellent community facilities especially in terms of education, health, safety and recreation. The development is also gearing up to build an image as a clean city that is harmonious with the surrounding environment.

## **STUDY PLAN**

The present research, conducted in 2009, is driven by the planning or experimental design of the waste composition study. Sound statistical experimental design can be shown in the literature to be effective in eliminating known sources of bias, guarding against unknown sources of bias, ensuring that the study provides precise information regarding the responses of interest, and guaranteeing an economical design.

Standard source categories may include single-family and multi-family residential (urban and rural), mobile homes, commercial (retail and office), institutional, and industrial. The number of sources selected for study is a function of study objectives and waste load characteristics. A thorough investigation of contracting company records, household records, and municipality information provide the background information necessary to identify all possible sources of waste generation. Changes to household categories to reflect these source/ generator categories is considered to facilitate the study.

The role of demography on solid waste generation will also be investigated in order to better characterize the waste generation activities in the entire area. Further, seasonal and economic influences play a significant role in determining the types and amounts of waste generated in an area. Ignoring their influence in planning, a wastes composition study can seriously bias results. Ideally, one sampling event per calendar season should be planned, resulting in a minimum of four sampling events in a given year.

Collection routes should be thoroughly examined to determine the types of generators represented. Certain routes may be homogeneously single family residential, and others are mixed. Mixed loads may present challenges to accurately characterizing some sources, particularly for rural areas. If mixed loads cannot be separated by source, attempts should be made during sampling to estimate the fraction of each source represented in the load. Information regarding waste receipt patterns and

procedures for weighing and recording of the data from the vehicle should be obtained from the contracting collection company and/or household records. Private collection companies should encourage providing detailed records.

Each waste generator type represents a specific proportion of the population of the geographical area to be studied. A percentage of vehicle loads representative of the waste generator category's percentage of the population should be taken to get a clear picture of that waste generator's contribution to the waste stream.

Three sets of questionnaires were developed to collect information from various stakeholders of solid waste management. These questionnaires were as follows:

- Municipal questionnaire
- Technical questionnaire
- Contractor questionnaire

## **FINDINGS AND DISCUSSION**

The data collected are presented in Tables 5, 6, 7, and 8. Table 5 shows the amounts of waste handled in the three local authorities in 2000 and 2002. On the basis of responses on municipal questionnaire, we have the following observations which are valid for all the three local authorities: Selayang, Klang, and Subang Jaya.

- A common solid waste generation takes place at the households.
- None of the local authorities categorize generated solid waste.
- Number of landfills in each of the local authorities is one.
- All three local authorities (L. As) consider 'recycling' as the major strategy to reduce MSW generation.
- All the L. As are of the opinion that privatization should be extended in solid waste management.
- All the L. As have programs to educate and raise public awareness about reducing, reusing, and recycling.
- All the L. As encourage the integration of preventive strategies internally through the use of regulations.
- All the L. As receive general circulars on solid waste generation.
- All the L. As use waste generation assessment procedure as a tool to analyze waste generation products, policies or other activities.

Some of the characteristics which are valid for only certain local authority are the following:

- Selayang L. A. adopts quantitative approach to rate contracting agency's performance, whereas, the other two L. As adopt triangulation for the same purpose
- Only Selayang considers incineration as the strategy to reduce MSW
- Only Klang receive sector specific information on solid waste generation
- Environmental impact assessment is done only by Klang

Second part of responses was collected on technical questionnaires. We have the following observations that are valid for all the three authorities:

- All the three authorities use compacting and roll off type of trucks to collect solid waste
- All the authorities are on "On Duty" to handle service during holidays
- All the three authorities use landfilling as the disposal method within the municipality
- Percentage of recycled municipal solid waste was less than 5%
- Have incineration as the vision towards municipal solid waste reduction

The observations that are not valid for all the three authorities are the following:

- Recycling as a disposal method is used by Klang and Subang Jaya, whereas Selayang does not use this
- Lack of infrastructure was cited as the major constraint by Selayang. Klang and Selayang also cited lack of funds, lack of private sector investment, land for waste disposal as the major constraints for MSW management. However, Klang cited lack of technology as the major constraint for the same
- Apart from the infrastructure, recycling also has been a goal for most of the authorities
- On the procedure of safety and health measures, 'National Institute of Safety and Health' is followed by most of the authorities. Department of Health and WHO are also followed by some of them
- On the health record keeping for workers and rag pickers, the responses are mixed

The third and final questionnaire was communicated to two contractors, namely, Alam Flora (Selayang), and Alam Flora (SJ). On most of the items, both the contractors have similar opinions. Some are discussed in the following:

- Both do not collect hazardous waste, special and clinical wastes.
- Weather, flash floods, traffic jam cause deviations from both the contractors' schedule.
- Both the contractors' drivers operate 6-12 hours a day.

- Both the contractors agree on the existence of coordinating body or agency responsible to oversee and support the implementation of official policies towards improving municipal solid waste management.
- Both of them have programs to educate and raise public awareness about reducing, reusing and recycling wastes.
- The common tools used to analyze waste generation products, policies, etc are environmental performance evaluation, environmental impact assessment, and waste generation assessment.
- Both keep health records for workers and rag pickers.

Observations that are valid for only one of the two contractors are summarized below:

- Alam Flora (SJ) has special trucks for special routes, whereas, Alam Flora (Selayang) does not have this.
- Alam Flora (Selayang) designs solid waste collection routes on the basis of load intensity, zone and vehicular capacity, but Alam Flora (SJ) does this on the basis of the latter two.
- Increasing vehicular capacity, R&D, and public awareness are Alam Flora (Selayang)'s future plan to deal with increasing amount of solid waste. On the other hand, Alam Flora (SJ) considers only increasing vehicular capacity and public awareness for the same purpose.
- Alam Flora (Selayang) follows the guidelines of National Institute of Safety and Health, Department of Health and WHO for safety and health. But Alam Flora (SJ) follows only National Institute of Safety and Health for the same purpose.

## **POLICY AND REGULATION**

Many factors affect waste management improvement activities in the developing countries. The shortage of adequate funds for waste treatment and disposal is mainly due to the low priority given to this aspect compared to other more pressing factors of development like infrastructure and industrialization. Shortage of skilled manpower is another factor especially in fast developing countries like Malaysia. Imported labour brings with associated problems such as increased vulnerability in diseases and social disorders including crime. Furthermore, lack of disposal sites is evident in some smaller nations and because of that, waste management problems have escalated. Following are some of the issues and problems in solid waste management in Malaysia:

- Lack of adequate and efficient waste disposal facilities in or outside industrial areas;
- The total amount of hazardous and toxic waste generated by industries in Malaysia is estimated at 417,000 metric tonnes per year and it is expected to increase between 8% - 9% per year;

- Exposures of man and environment to the dangers of radioactive materials;
- Disposal undertaken without proper control and supervision can cause long-term negative impact;
- Illegal and unregulated factories that produce hazardous materials add more pressure to the pollution problem in urban areas;
- Lack of comprehensive guidelines on the disposal of scheduled and hazardous wastes.

By the year 2020, the quantity of MSW generated was estimated to have increased to 31, 000 tons. Most studies on MSW generation used load- account analysis, which is based on waste collected and disposal in landfills.

## **CONCLUSIONS AND RECOMMENDATIONS**

Based on the survey data, we find that the average generation rate per person according to official census and records of the local authorities ranges from 0.6 to 0.76 kg/capita/day in the three selected local authorities, and these figures are less than those obtained through quantitative and house-to-house methods in many other studies.

The solid waste disposal method used in these municipalities is landfilling. Due to increasing population and thus solid waste increase, it is an imperative to consider the improvement of disposal of solid waste, by other disposal methods such as incineration, taking into account that the humidity in the selected area is very high and may affect the incineration efficiency. It is also necessary to improve in the 3 Rs (i.e., reduce, reuse, and recycle).

An integrated waste management (IWM) approach is currently the most desired system for solid waste management. IWM consists of the total waste management system whereby waste is managed from source to source (a cradle to grave approach). Apart from waste treatment either by traditional methods or by innovative methods, IWM also emphasizes waste minimization through waste recovery, reuse or recycle by improving the efficiency of the overall management system for all types of wastes, composting, incineration and landfilling.

We put forward the following recommendations for more efficient solid waste management.

- Monitoring and evaluation unit at solid waste management's contracting companies should avoid conflict of interest at their facilities. This is best done if the government obliged all contracting companies to include a governmental

monitoring and evaluation unit at their facilities for transparency and optimum results.

- Recycling is one of the most desired and effective methods for solid waste disposal. A minimum of 10% should be targeted in the near future.
- More awareness on solid waste management should be created to individual citizens and organisations so that everyone avoids wastes thereby reducing solid waste.
- Systematic safety and health procedures should be applied specially on worker and rag pickers.
- Appropriate statistical models should be used to measure the effectiveness of solid waste disposal on soil, ground water and air.
- Further studies on the collection and disposal of solid waste should be carried out in order to smooth out and integrate the solid waste management activities.

The findings of the present study may provide useful guidelines to the policy makers on the effective management of MSW in Malaysian. Modification of MSW generation rates is caused by the demographic factors and facilities.

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**Table 1:** Classification of Waste

No.	Factor	Waste
1	Origin	<ul style="list-style-type: none"> <li>• Clinical</li> <li>• Household</li> <li>• Urban</li> <li>• Industrial</li> </ul>
2	Form	<ul style="list-style-type: none"> <li>• Liquid</li> <li>• Solid</li> <li>• Gaseous</li> <li>• Slurry</li> <li>• Powder</li> </ul>
3	Properties	<ul style="list-style-type: none"> <li>• Toxic</li> <li>• Reactive</li> <li>• Acidic</li> <li>• Alkaline</li> <li>• Inert</li> <li>• Volatile</li> <li>• Carcinogenic</li> </ul>
4	Legal	<ul style="list-style-type: none"> <li>• Special</li> <li>• Controlled</li> <li>• Household</li> <li>• Industrial</li> <li>• Commercial</li> </ul>

**Table 2:** Aggregate amount of solid waste in 20 municipalities of Malaysia (up to 1990)

No.	Year	Amount of solid waste (million tons)
1	1970	0.363
2	1980	1.093
3	1990	2.005

**Table 3:** Generation rate of solid waste in Malaysia and some other countries (1990)

No.	Country	Kg/ c/ day	Volume/day/l
1	Malaysia	0.7	3.5
2	Singapore	0.85	4.25
3	Philippines	0.5	2.00
4	United kingdom	0.845	6.40
5	USA	1.25	12.00

**Table 3:** Solid waste generated at various local authorities in Malaysia (2000-2010)

States	2000			2001			2010		
	Population	Waste (t/day)	Waste (kg/c/d)	Population	Waste (t/day)	Waste (kg/c/d)	Population	Waste (t/day)	Waste (kg/c/d)
Selangor	3,325,261	2826	0.8499	3,408,393	2955	0.8670	5,460,000	6670	1.2216
Johor	2,252,882	1915	0.8500	2,309,204	2002	0.8670	3,350,000	3463	1.03358
Sabah	2,115,546	1481	0.7000	2,688,000	2064	0.7679	3,210,000	3257	1.0146
Sarwak	2,007,528	1405	0.6999	2,052,528	1437	0.7000	2,470,000	1797	0.7275
Perak	1,796,471	1527	0.8500	1,841,559	1597	0.8672	2,350,000	2412	1.0262
Kedah	1,557,259	1324	0.8502	1,596,190	1384	0.8671	1,950,000	2023	1.0372
Kuala Lumpur	1,400,000	2520	1.8000	1,435,000	2935	1.8362	1,670,000	3620	2.1680
Labuan	66,146	46	0.6954	67,812	49	0.7129	90,000	75	0.8283
P. Pinang	1,279,470	1083	0.8504	1,311,457	1137	0.8670	1,560,000	1600	1.0254
Kelantan	1,216,769	1034	0.8498	1,247,148	1081	0.8667	1,540,000	1586	1.0298
Pahang	1,126,000	957	0.8484	1,154,150	1001	0.8673	1,500,000	1541	1.0270
Terengganu	1,038,436	883	0.8503	1,064,397	923	0.8672	1,040,000	1064	1.0233
N. Sembilan	90,597	757	0.8500	912,862	791	0.8665	1,020,000	1050	1.0294
Melaka	605,361	515	0.850	620,495	538	0.8670	820,000	842	1.0272
Perlis	230,000	196	0.852	235,750	204	0.8653	260,000	275	1.0552
Putrjaya	-	-	-	-	-	-	89,000	74	0.8300

Source: Manaf, L. A et al (2009), Malaysian Government (2006), Zaini S. (2011)

**Table 5:** Amount of waste handled in Year (2000 ~2010)

Local Authority	Total Amount of Solid Waste (Ton/year)	Total Amount of Solid Waste (Ton/Day)	Population (c)	Solid Waste Generation Rate (kg/c/Year)	Solid Waste Generation Rate (kg/c/Day)
<b>Selayang</b>					
2000	97,090	266	416,837	233.60	0.64
2002	122,640	336	441,847	277.4	0.76
2010	196,005	537	559,000	350.4	0.96
<b>Subang Jaya</b>					
2000	105,485	289	437,121	240.9	0.66
2002	131,765	361	463,348	284.7	0.78
2010	208,415	571	583,000	357.7	0.98
<b>Klang</b>					
2000	123,005	337	562,239	219.0	0.60
2002	141,255	387	595,973	237.3	0.65
2010	223,577	612	747,000	299.3	0.82

**Table 6:** Municipal questionnaire data

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
1	Municipal solid waste generation <ul style="list-style-type: none"> <li>• Household</li> <li>• Industrial</li> <li>• Municipal</li> </ul>	✓	✓	✓
2	Average MSW generation			
3	Does municipality categorize generated solid waste? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	✓	✓	✓

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
4	Rating of contracting agency's performance <ul style="list-style-type: none"> <li>• Quantitative</li> <li>• Qualitative</li> <li>• Triangulation</li> </ul>	✓	✓	✓
5	No. of landfill <ul style="list-style-type: none"> <li>• One</li> <li>• Two</li> <li>• More than two</li> </ul>	✓	✓	✓
6	Strategy on the reduction of MSW <ul style="list-style-type: none"> <li>• Incineration</li> <li>• More land filling</li> <li>• Recycling</li> </ul>	✓	✓	✓
7	Do you think that privatization should be extended in SWM <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	✓	✓	✓
8	Is there any coordinating body or agency responsible to oversee and support the implementation of official policies towards improving MSWM? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	✓	✓	✓
9	Does your municipality have programs to educate and raise public awareness about reducing, reusing and recycling waste? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	✓	✓	✓
10	Please indicate whether you have encouraged the integration of preventive strategies internally through the use of <ul style="list-style-type: none"> <li>• Regulations</li> <li>• Financial incentives</li> <li>• Institute building</li> <li>• An environmental management system</li> </ul>	✓	✓	✓

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
11	What kind of information do you regularly receive on SWG? <ul style="list-style-type: none"> <li>• Sector specific</li> <li>• General circulation</li> <li>• Investment</li> <li>• Technical</li> </ul>	✓	✓ ✓	✓
12	Do you use tools such as the following to analyze waste generation products, policies, or other activities? <ul style="list-style-type: none"> <li>• Environmental performance evaluation</li> <li>• Environmental accounting</li> <li>• Environmental impact assessment</li> <li>• Life cycle assessment</li> <li>• Waste generation assessment</li> <li>• Eco labeling</li> <li>• Eco design</li> </ul>	✓	✓ ✓ ✓	✓ ✓ ✓

**Table 7:** Technical questionnaire data

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
1	Types of trucks used in the collection of solid waste <ul style="list-style-type: none"> <li>• Compacting</li> <li>• Roll off</li> <li>• Both of the above</li> <li>• Other (please specify)</li> </ul>	✓ ✓ ✓	✓ ✓ ✓ Open truck Tractors	✓ ✓ ✓ Open tipper
2	How do you handle service during holiday? <ul style="list-style-type: none"> <li>• On Duty</li> <li>• Stand-By</li> <li>• Off Duty</li> </ul>	✓	✓ ✓	✓

**Table 7:** Technical questionnaire data

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
3	Average percentage of MSW composition <ul style="list-style-type: none"> <li>• Paper</li> <li>• Plastic</li> <li>• Glass/Ceramic</li> <li>• Metals</li> <li>• Textile/Leather</li> <li>• Food waste</li> <li>• Rubber</li> <li>• Garden waste</li> <li>• Construction/demolition debris</li> <li>• Wood</li> <li>• Garbage</li> <li>• Miscellaneous</li> </ul>	15 15 5 5 5 40      15	18 17 3 2 2 25 2 26	
4	Types of disposal methods used within the municipality <ul style="list-style-type: none"> <li>• Land filling</li> <li>• Recycling</li> <li>• Incineration</li> </ul>	✓  	✓ ✓ 	✓ ✓ 
5	Percentage of recycled municipal solid waste <ul style="list-style-type: none"> <li>• Less than 5%</li> <li>• 5% - 10%</li> <li>• 10% - 20%</li> <li>• More than 20%</li> </ul>	✓  	✓  	✓  
6	Maintained parameters: engineering properties of MSW <ul style="list-style-type: none"> <li>• Moisture content</li> <li>• Unit weight</li> <li>• Bulk density</li> <li>• Porosity</li> <li>• Hydraulic conductivity</li> <li>• Field capacity</li> <li>• Compressibility</li> <li>• Shear stress</li> </ul>	✓      	✓      	✓      

No.	Characteristics	Local Authority		
		Selayang	Klang	Subang Jaya
7	Major constraints faced in municipal solid waste management <ul style="list-style-type: none"> <li>• Lack of infrastructure</li> <li>• Lack of funds</li> <li>• Lack of technology</li> <li>• Lack of private sector investment</li> <li>• Other (please specify)</li> </ul>	✓	✓ ✓	Lack of public awareness
8	Vision towards municipal solid waste reduction <ul style="list-style-type: none"> <li>• Incineration</li> <li>• More land filling</li> <li>• Recycling</li> </ul>	✓	✓ ✓	✓ ✓
9	Procedures for safety and health measures municipality/company follows regarding solid waste management <ul style="list-style-type: none"> <li>• National Institute of Safety and Health</li> <li>• Department of Health</li> <li>• WHO</li> <li>• Other (please specify)</li> </ul>	✓	✓	✓  Medical check ups every 6 months
10	Do you keep health records for workers and rag pickers for disease associated with municipal solid waste? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	✓	✓	✓



**Table 8:** Contractor questionnaire data

No.	Characteristics	Local Authority	
		Alam Flora (Selayang)	Alam Flora (Petaling Jaya)
1	Municipal solid waste generation <ul style="list-style-type: none"> <li>• Household</li> <li>• Industrial</li> <li>• Municipal</li> <li>• Others</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul> Bulky waste/ Garden waste	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul> Institutional/ Commercial
2	Are there any contractual exclusions of waste generator type that you don't serve? <ul style="list-style-type: none"> <li>• Hazardous waste</li> <li>• Special waste</li> <li>• Clinical waste</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul>
3	Types of trucks used <ul style="list-style-type: none"> <li>• Compacting</li> <li>• Both</li> <li>• Roll off</li> <li>• Others</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul> Open trucks	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul> Open trucks
4	Are there special trucks for special routes? If so, what are they? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> </ul>
5	How do you design solid waste collection route? <ul style="list-style-type: none"> <li>• Load intensity</li> <li>• On the basis of zone</li> <li>• Vehicle capacity</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> </ul>
6	What factors influence deviations from your schedule? <ul style="list-style-type: none"> <li>• Weather</li> <li>• Flash floods</li> <li>• Traffic jam</li> <li>• Others</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul> Lorry breakdown
7	How do you handle service during a holiday? <ul style="list-style-type: none"> <li>• On duty</li> <li>• Stand-by</li> <li>• Off duty</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> </ul>

No.	Characteristics	Local Authority	
		Alam Flora (Selayang)	Alam Flora (Petaling Jaya)
8	What hours and days do your drivers operate? • 1-6 hours • 6-18 hours • 6-12 hours • 18-24 hours	✓	✓
9	What are your company's future plan to deal with increasing amount of solid waste? • Increase vehicular capacity • R&D • Public awareness	✓ ✓ ✓	✓ ✓ ✓
10	Is there any coordinating body or agency responsible to oversee and support the implementation of official policies towards improving municipal solid waste management? • Yes • No	✓	✓
	Does your municipality have programs to educate and raise public awareness about reducing, reusing and recycling waste? • Yes • No	✓	✓
11	What kind of information do you regularly receive on SWG? • Sector specific • General circulation • Investment • Technical	✓ ✓	✓
12	Do you use tools such as the following to analyze waste generation products, policies, or other activities? • Environmental performance evaluation • Environmental accounting • Environmental impact assessment • Life cycle assessment • Waste generation assessment • Eco labeling • Eco design	✓ ✓ ✓	✓ ✓ ✓

No.	Characteristics	Local Authority	
		Alam Flora (Selayang)	Alam Flora (Petaling Jaya)
	Procedures for safety and health measures municipality/company follows regarding solid waste management • National Institute of Safety and Health • Department of Health • WHO • Other (please specify)	✓ ✓ ✓	✓
	Do you keep health records for workers and rag pickers for disease associated with municipal solid waste? • Yes • No	✓	✓



## **URBAN AIR ENVIRONMENTAL HEALTH INDICATORS: A PRELIMINARY SET FOR CITY OF KUALA LUMPUR**

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### **Abstract**

Environmental health as an aspect of concern on healthy environment, involves relationship between environment and human health. It comprises the aspects of human health and diseases that are determined by factors in the environment, as well as the characteristics of environmental conditions which affect the quality of health. Generally, urban ambient air is more polluted than overall atmosphere. It is due to higher concentration of human activities and more rapid urban development in urban areas. Urban areas produced air pollutants with higher rate as compared to less developed areas and natural environment. Furthermore, the atmosphere has always been one of the most convenient places to dispose of unwanted materials, which includes burning activities. It changes the natural combination of gases in the air and causes higher rate of urban air pollution. Besides, the air pollutants are likely to circulate and remain in the urban environment due to the “dust dome” phenomenon. Air pollutants are potentially affecting human health. Epidemiologic and laboratory studies demonstrate that ambient air pollutants contribute to various negative health problems, especially on the respiratory

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and cardiovascular systems, skin, and eyes. Research was carried out in developing a set of environmental health indicators for urban air. The determination of environmental health for urban air involves the identification of air-related health conditions and air quality. The preliminary indicators were formulated to examine the air environmental health conditions and issues in city of Kuala Lumpur. Environmental health indicators are providing useful information for decision-makers, and helping in generating discussion among people of different backgrounds.

**Keywords:** Municipal solid waste; Local authorities; Waste characteristics; Health Impact; Landfill; Integrated waste management

## INTRODUCTION

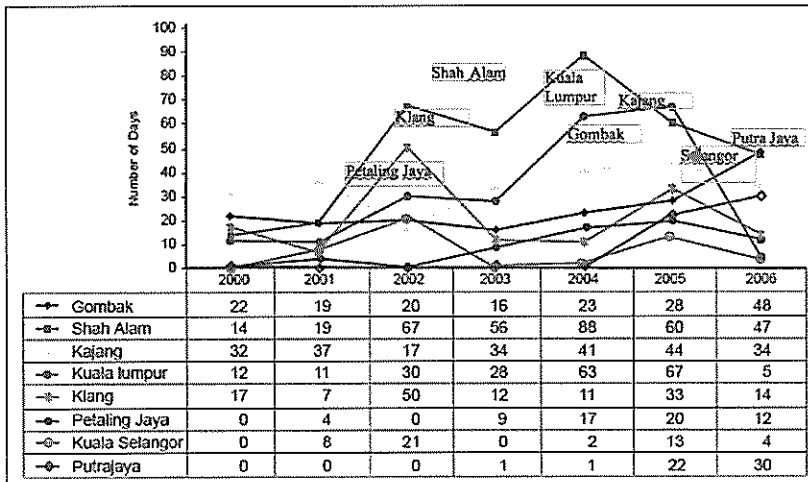
The atmosphere is composed of gas molecules held close to earth's surface by a balance between gravitation and thermal movement of air molecules (Botkin & Keller, 2003). It consists of a number of gases including nitrogen (78%), oxygen (21%), carbon dioxide (0.03%), and less than 1% of argon, neon, helium, cryton and xenon (Koren, 1980). Water vapour is also present in the lower level of atmosphere (Botkin & Keller, 2003). In general, majority of air pollutants are very low in percentage (dry air by volume) in the overall ambient air, which are only 0.00002% of nitrous oxides ( $N_2O$ ), 0.00001% of carbon monoxide (CO), 0.000002% of ozone ( $O_3$ ), 0.0000001% of nitrogen dioxide ( $NO_2$ ), 0.00000006% of nitric oxide (NO), and 0.00000002% of sulphur dioxide ( $SO_2$ ) (Gupta & Asher, 1998). However, the high growing trend of air pollutant such as carbon dioxide ( $CO_2$ ) was observed. The concentration of  $CO_2$  in the atmosphere had increased about 10% during the twentieth century (Koren, 1980).

"Urban" in local context, had been defined by JPBD (2006) as, "a gazetted area with its adjacent built-up and consolidated areas located within the urban limits which is including settlement and committed areas that have been approved, with minimum population of 10,000 people, with at least 60% of population are employed (15 years and above) in non-agricultural activities, with estimated population density of 50-60 persons per hectare, and with urban amenities". Urban ambient air is regarded as the most polluted air environment as compared to suburban and rural areas. This was due to higher concentrations of human activities in the urban areas that were capable to produce more pollutants. Study in city of Kuala Lumpur (Ling et al., 2010) with the assistance of Spearman correlation tests indicated a significant and strong positive relationship between the number of unhealthy/hazardous days and urban land uses for the period of 1999/2000 to 2005. The unhealthy/hazardous days were measured by using Air Pollution Index (API) with the five parameters (i.e.  $PM_{10}$ , CO,  $NO_2$ ,  $O_3$  and  $SO_2$ ). The urban land uses were referred to shopping floor spaces, office floor spaces and industrial units.

Urban developments and activities change natural combination of gases in the air, and cause higher contamination of pollutants in the air. For instance, the annual mean concentrations of NO<sub>2</sub> were ranged from 0.4 µg/m<sup>3</sup> to 9.4 µg/m<sup>3</sup> in natural background areas. However, outdoor ambient urban levels had an annual mean ranging from 20 µg/m<sup>3</sup> to 90 µg/m<sup>3</sup>, and hourly maximum concentrations were ranging from 75 µg/m<sup>3</sup> to 1,015 µg/m<sup>3</sup> (Forastiere et al., 2006). The air pollutants are likely to circulate and remain in the urban environment due to the “urban heat island” and “dust dome” phenomena, and the air pollutants were consistently high as compared to the surrounding areas (Purdom, 1980; Sham, 1989; Kinney & O’Neill, 2006).

In the period of 2000 to 2005, based on API, city of Kuala Lumpur and city of Shah Alam were experiencing high number of unhealthy days. In general, during the six years period, city of Kuala Lumpur was the second top city in term of the number of unhealthy days as compared to the other cities or towns in Klang Valley (Figure 1). However, in 2006, the number of unhealthy days in Kuala Lumpur was decreased significantly to 5 days only as compared to 67 days in 2005 and 63 days in 2004 (DOE, 2007a).

**Figure 1:** The number of unhealthy days in cities or towns in Klang Valley



In recent years, urban dwellers in Malaysia were voicing out their complaints on the unacceptable air pollutions and the potential health impacts. In 2004, statistics for Kuala Lumpur showed that out of the total 381 environmental complaints received, 70.6% was for air pollution, and 10.5% for bad odour (Iktisas, 2006). The number of complaints on air pollution was further increased in 2006 with 385 complaints out of the total of 498 environmental complaints (77.3%). The number of complaints on bad odour was maintained at 40 cases or 8.03% in 2006 (DOE KL, 2006).

Studies by World Health Organisation (WHO, 2007) in various parts of the world showed that more than 80% of diseases were due to environmental risk factors. Globally, nearly one quarter of all deaths and of the total disease burden can be attributed to the environment. Moreover, slightly more than one-third of the disease burden among children was due to environmental risk factors (WHO, 2007). The estimated annual global burden of disease attributable to urban air pollution is 13 deaths per 100,000 inhabitants, and 7,865,000 Disability Adjusted Life Years (DALYs) or 128 DALYs per 100,000 people (Hambling & Slaney, 2007).

The aspect of concern on healthy environment and the relationship between environment and human health has been called as “environmental health” (CDC, 2006). It comprises the aspects of human health and diseases that are determined by factors in the environment, as well as the characteristics of environmental conditions which affect the quality of health (Purdum, 1980). Determination of environmental health can be defined as combination of identification of “human health conditions” (health effect) and “environmental quality/conditions” (*equation 1*).

$$\text{Environmental Health} = \text{Human Health} + \text{Environmental Conditions} \quad (1)$$

With the focus on urban air environmental health indication, air-related health indicators were used instead of overall health conditions of general public. Meanwhile, general environmental conditions were replaced by air quality indicators (*equation 2*).

$$\text{Air Environmental Health indicators} = \text{Air-related Health Indicators} + \text{Air Quality Indicators} \quad (2)$$

## OBJECTIVE AND METHODS

Study was carried out to develop a preliminary set of urban air environmental health indicators for city of Kuala Lumpur. The process involves a literature review on the impact of air pollution on human health, and review on the existing environmental health indicators established in Malaysia and other parts of the world. The review was not only focusing on the indicators which directly called as “environmental health indicators”, but also those listed under the title of “sustainability”, “public health”, “urban indicators”, or “air quality” which were related to the indication of environmental health of the urban air.

## IMPACT OF AIR POLLUTION ON HUMAN HEALTH

Clean air is a basic precondition of human health. Generally, cities were engulfed by air pollutant which was identified as one of the main causes of human diseases.

The primary emissions of sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), CO, respirable particulates (PM), and metals (such as lead and cadmium) were severely polluting cities and towns in Asia, Africa, Latin America, and Eastern Europe (Christiani & Woodin, 2002).

Respiratory and cardiovascular diseases are especially relevant to air pollution susceptibility worldwide (Kinney & O'Neill, 2006). Research had shown that many air pollutants especially CO, O<sub>3</sub> and fine particulate matter (PM<sub>2.5</sub>) may contribute to the onset or aggravation of heart diseases (US EPA, 2003; Utell et al., 2006; Samet et al., 2006). Studies on the laboratory animals and human populations showed significant association between acute cardiovascular system effects (such as heart rate variability, HRV) and air pollutant levels (such as PM<sub>10</sub> and O<sub>3</sub>) (Saldiva et al., 2006).

Furthermore, epidemiologic and laboratory studies demonstrated that ambient air pollutants (e.g. PM, O<sub>3</sub>, SO<sub>2</sub> and NO<sub>2</sub>) contributed to various respiratory problems including bronchitis, emphysema, and asthma (Romieu, 1999; Botkin & Keller, 2003; US EPA, 2007; WHO, 2005a; Forastiere et al., 2006; Utell et al., 2006). People suffering from respiratory diseases (e.g. asthma) are the most likely to be affected by air pollution (Botkin & Keller, 2003).

For instance, a long term study on residents of six US cities (in 1974, involving 8000 subjects over a period of 14–16 years) showed that subjects living in the more polluted cities have a higher risk of hospitalisation and early death from pulmonary and heart diseases as compared to those living in the less polluted cities. The relationship between air pollution and mortality was much stronger for the fine particle component than for the gaseous pollutants (NIEHS, 2007). In Asian cities, a study of the relationship between PM<sub>10</sub> concentrations and the number of patients (2005/2006 in Korea) showed positive correlation coefficients in the eight cities except for Busan, for 2005 (Dong et al., 2007).

In Malaysia, there are a very limited number of studies that relate air pollution to the impact on health. A few studies have examined possible health effects of the 1997 forest fires in this country. Besides, data on health impact during 2005 haze episode was also collected. During the haze episodes, there were a high increased number of asthma, acute respiratory infection (ARI) and conjunctivitis cases in both West Malaysia and East Malaysia (Rafia et al., 2003; Norela et al., 2008). For example, during the 1997 haze episode, the number of respiratory disease outpatients visited the Kuala Lumpur General Hospital increased from 250 to 800 per day. In Selangor, asthma cases increased from only 912 in June to more than 5,000 in September, 1997. The total number of ARI cases increased from about 6,000 to more than 30,000 during the same period (Rafia et al., 2003).



Another study in Malaysia was carried out to identify risk factors in childhood asthma through case studies at Ipoh General Hospital (Shamarina, 1998) via self-administered questionnaires (among 32 parents / guardians of patients who were 1 to 16 years old). The study found that common risk factors among the patients include family history of asthma (65.7%), allergic to dust (53.1), location of house (37.5% near factories; 34.4% near main roads), and the presence of smoker or ex-smoker in the house (65.7%; father 53.1%, mother 6.3%). It showed that majority of young asthmatic patients were allergic to air pollutants (dust) and a high percentage of them lived near to the source of air pollution (factories and main roads). Shamarina (1998) explained that asthmatic patients who lived in areas located in the vicinity of factories or main roads were three times as likely to be severe asthmatics compared to asthmatics who did not live in such areas.

Exposure to air pollution is not limiting to inhalation alone, it is referring to contact with any part of the human body (Janssen & Mehta, 2006). Therefore, beside the respiratory and cardiovascular effects occurring due to inhalation, it also can result in eye or skin irritation (Janssen & Mehta, 2006; Botkin & Keller, 2003), such as conjunctivitis (MOH, 2004; Rafia et al., 2003). Besides, exposure to O<sub>3</sub> also increased the risks of skin cancer (DOS, 2001). Besides, the effects of air pollutants on human health are also depending on the doses or concentrations of the air pollutants, and other factors including the individual susceptibility (Botkin & Keller, 2003).

## **ENVIRONMENTAL HEALTH INDICATORS**

Indicators are measurements selected to represent a large phenomenon of interest. An indicator points to certain issue or certain condition in certain city. It provides useful information for decision makers, not just data (Peterson et al., 1999), and can generate discussion among people with different backgrounds and viewpoints (Andrew, 1998).

Environmental indicators evolved during the 1970s when the environment became a mainstream issue and governments responded with environmental assessment legislation and processes. In the 1980s, two approaches arrived, which were sustainable development and healthy communities. Sustainable development indicators are now commonly used at the national, regional and local levels in many nations. The healthy community model continues to frame analysis, although it seems to have been eclipsed since the late 1990s by the quality of life model (Seasons, 2005). In the past 20 years, some of the most interesting theoretical advances in broad-based indicator development have been the promotion of a capabilities approach; the synthesis of economic, quality of life and environmental indicators under the banner of sustainability; and experimentation with participatory methodologies (Keough, 2005).

Besides the broad-based sustainable indicators and quality of life indicators, there are also more specified or focused indicators which have been developed and used for the issues of environmental health, such as Environmental Health Indicator by WHO, the adaptation by WHO-Europe and New Zealand, and the Environmental Public Health Indicators by Atlanta.

In this study, preliminary set of environmental health indicators was developed for the aspect of urban air. It includes two major components which are air quality indicators and air-related health indicators. In selecting and proposing environmental health indicators, the following points were taken into consideration:

- i. The link between the proposed indicator and the human health issue, and the ability to determine the impact on health when using the proposed indicator.
- ii. The feasibility of using the proposed indicator. After the formation of preliminary indicators, the indicators are tested in Kuala Lumpur before being refined. However, this paper is not aimed to discuss on this matter.
- iii. Scientific basis.

The explanation of the formation of preliminary indicators was divided into two major parts which were “air quality indicators” and “air-related health indicators”.

## **Air Quality Indicators**

### **A review of existing air quality indicators for environmental health**

In general, for the purpose of indicating urban air quality level for environmental health or sustainability, the five pollutants (PM, O<sub>3</sub>, CO, SO<sub>2</sub>, NO<sub>2</sub>) and API (or Air Quality Index, AQI) are usually selected. For example, an indicator of ambient air quality as proposed by WHO Environmental Health Indicators (Briggs, 1999) is “mean annual or percentile concentration of six major ambient air pollutants”, which are covering O<sub>3</sub>, CO, particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>, SPM), SO<sub>2</sub>, NO<sub>2</sub> and lead (Pb). Indicators have been proposed by Briggs (1999) and Gosselin et al. (2001) as “number of days/hours in excess of air pollution standard”. They are similar to the New Zealand, Seattle, US and other indicators, such as:

- a. New Zealand: number of days exceeding WHO guidelines for the major five pollutants, which are PM<sub>10</sub>, O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, and CO (Hambling & Slaney, 2007);
- b. Seattle, Washington, US: number of “good” air quality days in the calendar year (Peralta, 2003);
- c. Atlanta: annual high levels of criteria pollutants: PM<sub>10</sub>, O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, CO and Pb (CDC, 2006);

- d. US EPA (2003): number and percentage of days that metropolitan statistical areas have Air Quality Index (AQI) values greater than 100 (under 100, the air quality is considered good or moderate); number of people living in areas with O<sub>3</sub> (8 hour average) and PM<sub>2.5</sub> levels above the National Ambient Air Quality Standards (NAAQS);
- e. Gosselin et al. (2001) for the US-Mexico region: percentage of children living in counties in which concentrations of air pollutants are exceeded air quality standards;
- f. Kuching Healthy City (Malaysia): number of pollution free days in a month; number of areas with air pollution in a month (Andrew, 1998);
- g. Selangor Sustainable Development Indicators: total number of days with API exceeding an unhealthy level; SO & NO pollution levels in Petaling Jaya & Shah Alam; small particulate matter & PM<sub>10</sub> concentrations (Selangor State Government, 2001);
- h. Malaysian Sustainable City Award ('Bandar Lestari' Environment Award): number of days exceeding standards for CO and NO<sub>x</sub> concentrations in ambient air, for selected year (Tan et al., 2006);
- i. Malaysian Urban Indicators Network (MURNInet): average API value in a year (Kamalruddin, 2005).

In KL, environmental targets and indicators were proposed by the Kuala Lumpur Local Plan's study team in its Finding Report (AJM, 2006). There was only one indicator which measured the "state" of urban air environmental health, and none for the measurement of health effects. API was suggested as an indicator, to achieve the following target: "strive for API to be within the good range for 20% of the year and within the moderate range for the remaining 80% of the year".

As a reference to the various air quality indicators chosen by various organisations at local and international levels, the indicator and target proposed by AJM (2006) for KL are the most appropriate to be adopted for this study. This is because they were designed based on a target for better air environment for KL city. The indicator is an accumulative of other individual indicators to form a target oriented indicator. By choosing API to form air quality indicators, PM10, CO, NO2, O3 and SO2 were chosen as air quality parameters. These five pollutants have the potential to affect human health.

The target is not too high as compared to the previous air quality level. KL's air quality level (2000 to 2003) with an unhealthy API level was only 10% or less, and the remaining days were moderate or good. It was not too far from the targeted standard (good range for 20% of the year and within the moderate range for the remaining 80% of the year). This is a reasonable target for KL. As compared to Singapore (a

neighbouring city-country), for the period of 2000 to 2003, Singapore city’s ambient air had already experienced 88% (or about 320 days) “good days”, while KL city had only about 12% (or 42 days) “good days”. In terms of unhealthy days, KL experienced about 9% or 20 days while Singapore did not experience any unhealthy days (AJM, 2006).

**A review of urban air quality**

The formation of air quality indicators for Kuala Lumpur should take into consideration the common air pollution in urban areas. Based on the ambient air quality data for 2000 and 2006 (DOE, 2007b), the more significant ambient air pollutant in Kuala Lumpur were NO<sub>2</sub> and O<sub>3</sub>, followed by PM and CO. Majority of air pollutants in urban areas were contributed by mobile sources (transportation) and stationery sources (power stations, industrial fuel burning process, domestic fuel burning) (Sivertsen, 2006; Harrison, 2006). In Malaysia, about 80% of air pollutants were contributed by mobile sources (Table 1). Transportation (mobile sources) and stationery sources contribute to the high percentage of total pollutant emissions in urban areas for PM, CO, NO<sub>2</sub>, O<sub>3</sub> and SO<sub>2</sub>. Therefore, the concentrations of these pollutants were higher in urban as compared to rural areas.

In United Kingdom (UK), the United States (US), Belgium, Germany, Finland and Italy, transportation sector along had contributed to more than half of the total emissions of CO and NO<sub>2</sub> (Harrison, 2006). Actually, the principal sources of CO and NO<sub>2</sub> were traffic (EPU, 2006), and to a lesser extent industries, shipping and households (Sivertsen, 2006) and power generation (DO<sub>s</sub>, 2001). For SO<sub>2</sub>, majority were contributed by power plants followed by industries, and others such as hotels and commercial premises (EPU, 2006; Harrison , 2006).

**Table 1:** Emissions of air pollutants by sources in Malaysia, 1995, 1998, 1999 & 2005.

Sources	1995		1998		1999		2005	
	'000 tonnes	%	'000 tonnes	%	'000 tonnes	%	'000 tonnes	%
Mobile sources	3,386.00	84.30	2,402.80	73.80	2,563.10	81.66	1,537.98	82.37
Stationery sources	477.57	11.89	706.50	21.70	461.40	14.70	329.21	17.63
Burning of wastes	153.14	3.81	146.50	4.50	114.20	3.64		
<b>Total</b>	<b>4,016.71</b>	<b>100.00</b>	<b>3,255.80</b>	<b>100.00</b>	<b>3,138.70</b>	<b>100.00</b>	<b>1,867.19</b>	<b>100.00</b>

Note:

Mobile sources : vehicles

Stationary sources : power stations, industrial fuel burning process, & domestic fuel burning

Burning of wastes : burning of municipal & industrial wastes

Source : DOS, 2001; 2006

## **Proposed air quality indicators for Kuala Lumpur**

The proposed preliminary air quality indicators for Kuala Lumpur are explained as follows:

- i. Trends of average concentrations of air pollutants (SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, CO), in order to observe the change of air quality during the whole period of the study as well as in the dry and wet seasons.
- ii. Total number (or percentage) of good, moderate, unhealthy, very unhealthy, hazardous or emergency API days in the dry and wet seasons, as well as during the whole period of the study. The percentage of good, moderate, unhealthy, very unhealthy, hazardous or emergency days would determine the level of air quality for a period. The proposed KL's environmental target for air quality is to be used to indicate the "excellent" air quality level, which is a good range of API for 20% of the year (or a period) and within the moderate range for the remaining 80% of the year (or a period). The proposed classifications of air quality levels for this indicator are shown in Table 2.

**Table 2:** Proposed classifications of air quality level

<b>Classification</b>	<b>Criteria (air quality condition)</b>
Excellent	Good API days for 20% or more of a year (or any period) and the remaining days are moderate. No unhealthy/hazardous/emergency days.
Good	Good API days for 10 to <20% of a year (or any period) and the remaining days are moderate. No unhealthy/hazardous/emergency days.
Moderate	Good API days for <10% of a year (or any period) and the remaining days are moderate; or Unhealthy API days for <10% of a year (or any period) and the remaining days are moderate or good.
Unhealthy	Unhealthy API days for 10 to <20% of a year (or any period) and the remaining days are moderate or good.
Hazardous	Unhealthy API days for 20% or more of a year (or any period) and the remaining days are moderate or good; or any very unhealthy, hazardous or emergency API days in a period.

- iii. Total number (or percentage) of good, moderate, unhealthy, very unhealthy, hazardous or emergency API days for every single pollutant (i.e. SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, CO) in the dry and wet season, as well as during the whole period of the study. The percentage of good, moderate, unhealthy, very unhealthy, hazardous or emergency days would determine the level of air quality for a period. The same methodology and classification as in “indicator ii” is to be used. The reason for “indicator iii” in addition to “indicator ii” is to assist the discussion of the potential source and factors of air pollution which are related to the urban development and activities.
- iv. Percentage of the city’s population living in areas where the air quality outside the housing is experiencing unhealthy, very unhealthy, hazardous or emergency API levels.
- v. Percentage of people frequently exposed to air pollution (as self-reported) in relation to the total population.

### **Air-related Health Indicators**

#### **A review of existing air-related health indicators**

International indicators such as Environmental Health Indicators for the WHO European Region (WHO-Europe, 2002) had been formulated with limited parameters which were using common readily available data for international comparison. However, it also consisted of indicators for individual countries. Other than Europe, there are Environmental Health Indicators in various countries, such as New Zealand (Hambling & Slaney, 2007), Atlanta (US) and Seattle (US). The localised environmental health indicators were also formulated with readily available data especially from hospital records for the purpose of monitoring environmental health conditions. Summary of the air-related health indicators are shown in Table 3 (first and second columns).

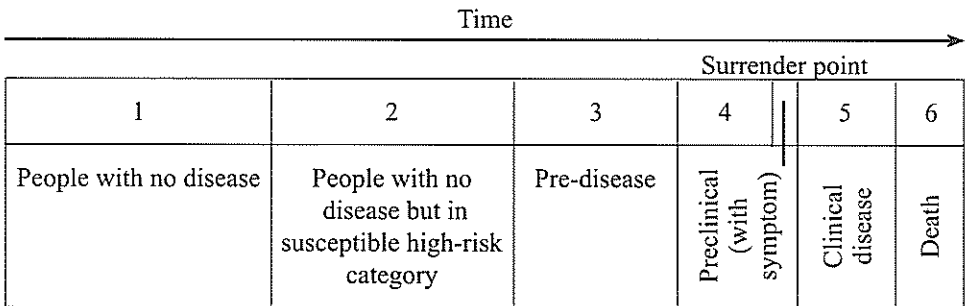
#### **Preclinical health conditions or ill-symptoms as health indicator**

For a good health indicator, the measurement should not only focus on the diagnosed illnesses (clinical), but also the preclinical health conditions or ill-symptoms. The total impact of air pollution on the population is likely to be dominated by the less severe health effects such as sub-clinical (preclinical) and symptomatic events (Gouveia & Maisonet, 2006). The proportion of the exposed population affected by these outcomes is much larger than those affected by more severe events such as emergency admissions to hospitals and deaths. It is important to consider that some of the less severe effects may lead to chronic effects later in life (Gouveia & Maisonet, 2006). Hence, health

indicators should include the identification of ill-symptoms (preclinical) besides the frequency of medication use, and the rates of hospitalisation and visits to hospitals/clinics (clinical).

According to the Disease Spectrum (Figure 2), patients will enter the stage 4 (preclinical) before they are diagnosed with any illness. In stage 4, as the symptoms become gradually more marked and perhaps troublesome, the patient decides that something is wrong and seeks medical advice (the ‘surrender point’). With that, the stage of recognised ill-health (stage 5 – clinical disease) has been reached, but that is a relatively late stage in the total process and opportunities for prevention have been lost (Rowland and Cooper, 1983).

**Figure 2:** The Disease Spectrum



Source: Rowland and Cooper, 1983

**Proposed air-related health indicators for Kuala Lumpur**

By referring to the proven relationship between air pollution and human health and the established related international and local indicators, preliminary air-related health indicators were formulated in this study. However, one of the major differences (improvement) in the newly formulated indicators (for this study in KL) as compared to other indicators was that the indicators did not only focus on the diagnosed disease (clinical), but also covered the preclinical health conditions or illness symptoms. Table 3 shows the proposed preliminary set of air-related health indicators (third column of Table 3), and the indicators proposed by others (first and second columns of Table 3).

**Table 3:** Air-related health indicators

Existing established indicators	Organisation / source	Proposed preliminary indicators for KL
Number of cases & number of deaths for acute respiratory infections (ARI) in a year.	WHO (2005b) for Singapore	1. ARI rate (incidence, hospitalisation, outpatient visit or deaths) per 10,000 people (all age).
Incidence of morbidity due to the ARI in children under 5 years, & the elderly.	WHO Environmental Health Indicators (Briggs, 1999)	2. ARI incidence, hospitalisation or outpatient visits rate among children below the age of 5, & 13 (per 10,000; children) 3. ARI incidence, hospitalisation or outpatient visits rate among the elderly (age 65 & above) per 10,000 people;
Incidence of mortality due to the ARI in children under 5 years, or disease-specific mortality.	WHO Environmental Health Indicators (Briggs, 1999)	4. ARI mortality rate among children below the age of 5, & 13; 5. Asthmatic mortality rate among children below the age of 5, & 13;
Number of asthma case to 10,000 population.	MURNInet, (Kamalruddin 2005)	6. Hospitalisation, outpatient visits or emergency unit visits rate for asthma cases (per 10,000 people);
Rate of hospitalization of children for asthma (children 0-14).	Seattle's Environmental health indicators (Peralta, 2003); Gosselin et al. (2001)	7. Hospitalisation, outpatient visits or emergency unit visits rate among children due to asthma (below the age of 5, & 13) and the elderly (aged 65 & above) per 10,000 children or people;
Hospitalisation / occurrence of morbidity or mortality due to: - Carbon monoxide poisoning - Lead poisoning (in children). Consultation / emergency department visits for possible poisoning in a child, including lead poisoning.	Atlanta's Environmental Public Health Indicators (Centers for Disease Control and Prevention, 2006)	<i>This indicator focuses on impact on health from specific sources of pollution, which has been included in other indicators for ambient air: Lead concentration in Malaysian urban areas (ambient air) is far lower than standard (DOS 2006). Besides, primary sources of lead exposure (for most US children) are deteriorating lead-based paint &amp; lead-contaminated</i>



Existing established indicators	Organisation / source	Proposed preliminary indicators for KL
		<i>dust &amp; soil; others were child-oriented products &amp; possible drinking water (US EPA 2007)</i>
Number of asthma-related deaths.		8. Asthma-related death rate (per 10,000 people);
Incidence of asthma.		<i>Taken into account in constructing indicators (emergency unit visits).</i>
Rates of hospitalisation & emergency department visits for acute asthma events.		
Number of work days missed because of asthma.		9. Number of work days missed per patient due to asthma; 10. Rate of work days missed due to asthma (per 10,000 people);
Number of school days missed because of asthma.		11. Number of school days missed per patient due to asthma; 12. Rate of school days missed due to asthma per 10,000 school children;
Proportion of population filling prescription for asthma medication.		13. Increase of severity of chronic respiratory/cardiac illness due to air pollution (or haze), as measured by increase in intake of medicine (%)
Number of admissions for coronary heart disease.	Kuching Healthy City (Andrew, 1998)	<i>Combined with other indicators</i>
Incidents of cardiovascular & respiratory events (unusual event, outdoor air standards are exceeded).	Atlanta's Environmental Public Health Indicators (CDC, 2006)	<i>Combined with other indicators</i>
Acute cardiovascular & respiratory events.		15. Rate of lung cancer patients among non-smokers, and rate of mortality;
Cancer incidence & mortality rates, lung cancer in non-smokers, etc.		

Existing established indicators	Organisation / source	Proposed preliminary indicators for KL
Number of peoples visit to hospital due to asthma, upper respiratory infections (URI) & conjunctivitis.	Malaysian Government (Norlela et al., 2005)	16. Incidence, hospitalisation or outpatient visits rate due to conjunctivitis (per 10,000 people).
Emergency consultations for asthma, bronchitis, cardio-pulmonary disease	Gosselin et al. (2001)	17. Non-asthmatic chronic respiratory rate for hospitalisation, outpatient visits or emergency visits (per 10,000 people).
Annual number of hospital admissions for respiratory diseases (per 100,000 population)	Environmental Health Indicators for New Zealand (Hambling & Slaney, 2007)	18. Hospitalisation, outpatient visits or emergency visits rate due to cardiac diseases (per 10,000 people).
Annual number of hospital admissions for diseases of the circulatory system (per 100k. p.)		
Annual number of hospital admissions for asthma (per 100k. p.)		
		<i>Combined with other indicators</i>
Annual mortality rate due to respiratory diseases; or cardiovascular diseases (per 100,000 population)	Environmental Health Indicators for New Zealand (Hambling & Slaney, 2007)	20. Mortality rate due to respiratory diseases ( <i>bronchitis, emphysema, COPD, etc</i> ); and cardiac diseases.
Annual prescription rate for asthma medication (per 100k. p.)		
		<i>Combined with other indicators</i>

**Note:**

1. Any illness experienced and lasting for a period within 14 days was considered as an episode/ case of acute event, such as ARI. This is similar to the definition used by the Institute of Public Health, Malaysia. The majority of ARI episodes lasted within a duration of 14 days and was an acute, self limiting condition (IPH, 2008).
2. Rates of illness in these indicators are calculated as ratios of illness cases among respondents to total number of respondents (or any segment of respondents) which may consist of repeated cases of the same respondent. Thus, these indicators are not aimed at reflecting the prevalence rate of disease.

In the establishment of air-related health indicators, children (< age of five and 13) and the elderly ( $\geq$  age of 65) were given special attention with specific indicators for them, such as ARI rate and asthmatic rate. This was because, these groups of children and the elderly were observed to have higher rate (or higher risk) of respiratory illness as compared to others in Malaysia and abroad. For instance, in Malaysia, the highest incidence of ARI as per NHMS III (in 2006) was in the age group of 1 to 4 years with 29.7%, followed by infants (< 1 year) with 24.9% (IPH, 2008). However, the age group of 55 to 64 years and above 65 years were identified with the lowest ARI incidence rate (10.7% and 11.7% respectively in 2006). Besides, a study in 1997 showed that the estimated average prevalence rate of asthma (self-reported) in Malaysia was between 3.9% and 4.4% (mean 4.2%). However, for children under 5 years it was 4.5% (higher rate than average), and for adults it was 4.1% (Rozlan et al., 1999).

Furthermore, as compared to some countries as stated in Table 4, Malaysian children under 5 years are at a higher risk of getting ARI. In countries abroad, every year, around 150 000 children under-5 in countries in the Americas die from pneumonia (80%-90% of all deaths from ARI) (Benguigui, no date). Among the children under five years, in all developing countries (in 1995), the second largest cause of death after “neonatal” causes (32%), was ARI (24% of the 10.7 million deaths) (WHO-NHD, 2000).

**Table 4:** ARI prevalence among children under five years

Country	% of children < 5 years with ARI (2 weeks prior to survey)	Year (study conducted)
Nepal	34.1	1996
India	19.3	1999
Bangladesh	18.3	2000
Philippine	16.2	1999
Vietnam	9.3	2000
Indonesia	9.0	1999
Malaysia (MHNS)	28.0	1986/87
Malaysia (MHNS II)	39.3	1996
Malaysia (MHNS III)	28.8	2006

Source: IPH, 2008

In a study of respiratory effects from haze episodes in Malaysia (based on Melaka and Klang government hospitals data), Norela et al. (2008) found that the most affected age in the haze episode were the children aged under 12 years. Besides, survival analyses indicated that for persons over the age of 65, prior hospitalisations for respiratory diseases were significantly more likely than others to be re-hospitalised (Norela et

al. 2008). Therefore, even though the elderly ( $\geq 65$  years old) were identified to have a lower ARI incidence rate in Malaysia, they were more susceptible to respiratory infections, partly because of an age-related decline in specific immune responsiveness (Utell et al. 2006).

## CONCLUSION

Preliminary urban air environmental health indicators were developed based on the relationship between environment and human health. It consists of two major groups of indicators which are air quality indicators and air-related health indicators. Related indicators proposed locally and internationally were reviewed together with research findings on the subject matter. However, the proposed preliminary set of indicators required a wide range of health data which are not 100% readily available in our country. For the purpose of the comprehensive identification of urban air environmental health, questionnaire survey from house to house is necessary to be carried out. Environmental health indicators are believed to be an important measurement tool to provide quantified and summarised information for decision makers, politicians, planners, and public to understand the environmental health conditions of a particular area. It helps for continuous improvement of human living environment especially in the urban environment.

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## **CLASSIFICATION OF SATELLITE FUSED DATA FOR LAND USE MAPPING IN DEVELOPMENT PLAN**

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### **Abstract**

Land use mapping in development plan basically provides resources of information and important tool in decision making. In relation to this, fine resolution of recent satellite remotely sensed data have found wide applications in land use/land cover mapping. This study reports on work carried out for classification of fused image for land use mapping in detail scale for Local Plan. The LANDSAT TM, SPOT Pan and IKONOS satellite were fused and examined using three data fusion techniques, namely Principal Component Transform (PCT), Wavelet Transform and Multiplicative fusing approach. The best fusion technique for three datasets was determined based on the assessment of class separabilities and visualizations evaluation of the selected subset of the fused datasets, respectively. Principal Component Transform has been found to be the best technique for fusing the three datasets, where the best fused data set was subjected to further classification for producing level of land use classes while level II and III pass on to nine classes of detail classification for local plan. The overall data classification accuracy of the best fused data set was 0.86 (kappa statistic). Final land use output from classified data was successfully generated in accordance to local plan land use mapping for development plan purposes.

**Keywords:** Data fusion, classification, remote sensing, land use mapping, development plan

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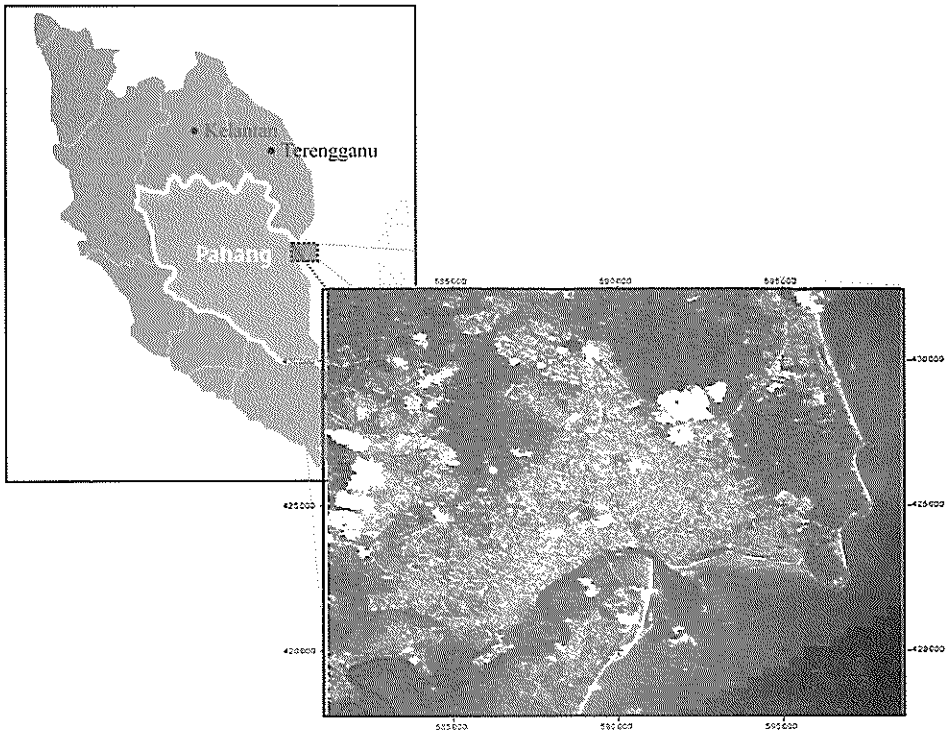
## INTRODUCTION

Satellite Image fusion aims at the generation of a single image from multiple image data for the extraction of information of higher quality (Pohl, 1999). Parallel with this development, emphasis on techniques that guarantee a better image for classification in urban/regional is urgently needed. In remote sensing, fusing high resolution multispectral images becomes popular since it can produce high spatial resolution multispectral images which can meet the requirement of classification of land use for development plan purposes. There are many types of fusion techniques which already tested by previous researcher and various image fusion and algorithm have been proposed which included three types of methods used in this study respectively (refer Pohl, 1999). In the context of the needs of urban/regional planning aspect, the fusion techniques determination is becoming very crucial in providing a better image with complete information in one solution. Fusion of multi sensor data becomes promising, through combining registered images generated by different imaging systems, images fusion can produce new images with more complete information that are more suitable for vision perception, object detection and automation target which can be utilized fully to produce a better classification for land use mapping purposes (Li et al, 2005) which currently not fully explored in Malaysian perspectives.

When we look at the effective planning, land use maps are of vital importance in the development of urban planning especially in developing countries. Section III in Malaysia Town and Country Planning Act 1976 (Act 172) states that land use map was crucially necessary for the preparation of development plan. The development plan generally defines as a blueprint document to guide development along the desired line for a particular horizon year. It has been practiced into tiered hierarchy of National Physical plan, structure plan, local plan and special area plan which utilized the small to big scale maps which also required the low to high resolution imagery in remote sensing perspective. In accordance, the land use map was considered as the base map to generate the other maps and also used as spatial tools to predict the future development. That was the requirement in development plan to fulfill the answer of stakeholders who used this detailed maps on clarifying land use in their own lot and make any objection or suggestion for the proposal plan.

The objective of this study is to map land use to be utilized in development plan using fused image sets of IKONOS, SPOT panchromatic and LANDSAT TM which derived from using (a) PCT (b) Wavelet Transform and; (c) Multiplicative approach. The study area is located in Kuantan district (03°52N,103°17E and 03°45N,103°23E) southeast of Pahang state, Malaysia. It covers about 14ha<sup>2</sup> classes made of mainly built up areas such as residential, industrial, commercial, institution, and recreational areas and un-built features such as agriculture, forest, vacant land and water bodies.

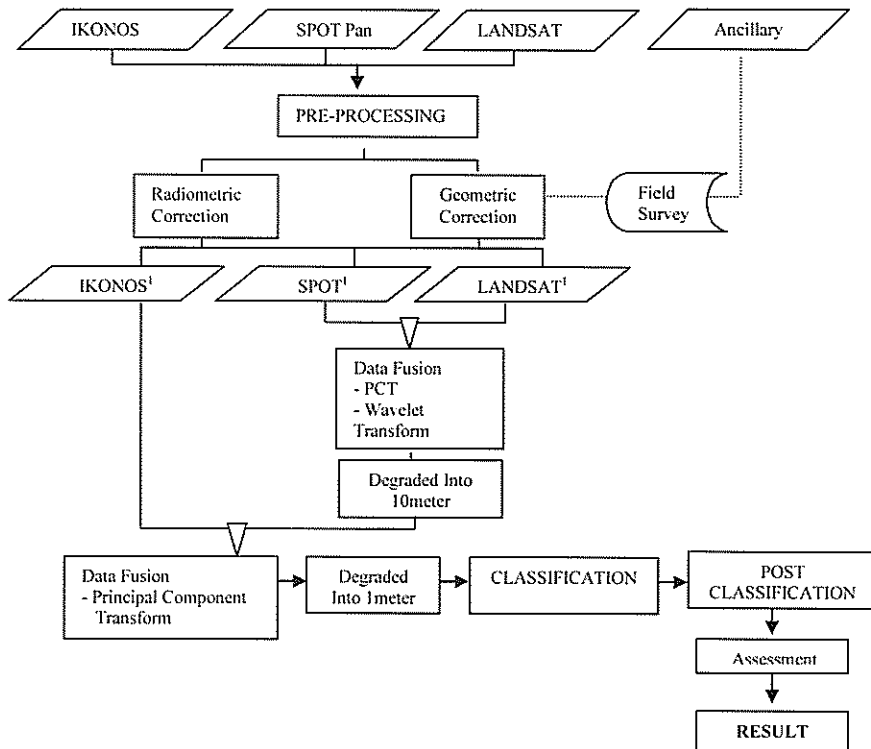
**Figure 1:** Location of Study Area



## MATERIAL AND METHOD

Three image sets used in this study were acquired in 2004 and provided by the Malaysian Centre of Remote Sensing (MACRES). The ancillary information to support these imagery were also collected from secondary sources which include road network, urban map and topographic map. This information was used as guidance and parameter during pre-processing image. LANDSAT TM, SPOT Panchromatic and IKONOS were geo-referenced using image to map approach using 2<sup>nd</sup> order polynomial transformation function, and later resampled with the nearest neighbor interpolation. The image to map procedures have been applied to the IKONOS, SPOT panchromatic and LANDSAT TM image using a set of ground control point area which appear in the same place both in the imagery and known location in corresponding map as ancillary in rectification process (Figure 2).

**Figure 2 :** Methodology employed in this study



Apart from the geometric correction, radiometric enhancement was also performed. The atmospheric correction was applied to LANDSAT TM to remove noise that was caused by the atmospheric effect to the image. This situation must be considered properly because the serious atmospheric attenuation may have impact on classification accuracy within a scene if it varies significantly. While the SPOT panchromatic image is also subjected to image enhancement, it can contribute more to enhance spatial element into the kernel output. We used cost model approach to remove this error to attain a good result.

Three data fusion approach was conducted using ERDAS Imagine software package, table 1 shows the process performed to the different images of SPOT Panchromatic and IKONOS. For this study, image of 1 meter, 10 meter and 30meter were used to merge with double data set to get a better

image with more spatial details. These techniques involve the Principle Component Transform, Wavelet transform and Multiplicative.

**Table 1 :** Data Fusion techniques examined

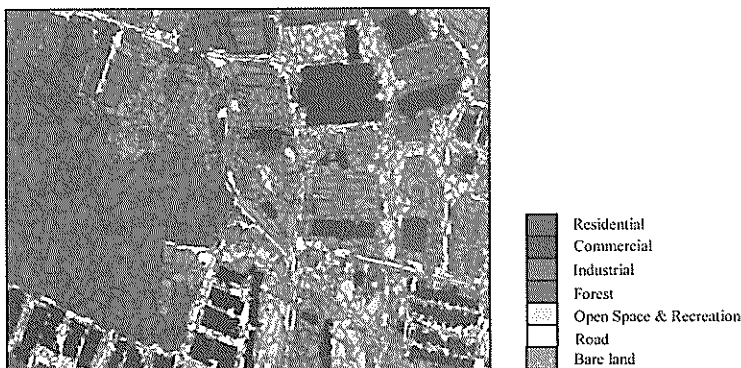
Process	Original Data Fused/ Resolution	Technique #	Result Band/Resampled Grid
1 <sup>st</sup> process fusing	LANDSAT TM/(30m) and SPOT Pan/ (10m)	PCT	6/10m
		Wavelet Transform	6/10m
		Multiplicative	6/10m
2 <sup>nd</sup> process fusing	LANDSAT TM/(30m) + SPOT Pan/(10m) and IKONOS (1m)	PCT	6/1m
		Wavelet Transform	6/1m
		Multiplicative	6/1m

Note :

# PCT – Principal Component Transform

The result of final fused image from Principal Component Transform has been classified further in classification stage. The supervised classification techniques have been chosen for this study. The Ecognition software that supports different supervised classification techniques and different method to train and build-up knowledge have been used for this classification of image object (Blaschke, 2010). Post classification was employed in GIS software which merged on vector data to produce a land use map for local plan requirement through K-mean classification approach. The assessment on statistical validation has been performed to assess the accuracy of output for this study (figure 3).

**Figure .3 :** A section of the study area showing the classification.



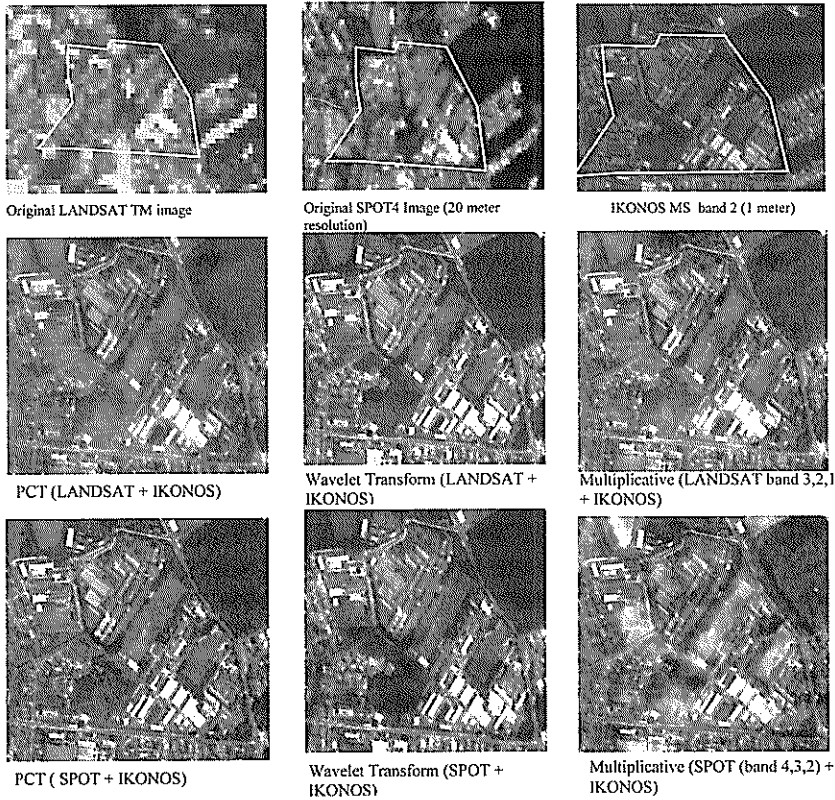
## **RESULT, ASSESSMENT AND DISCUSSION**

### **Result and Assessment**

The result of data pre-processing shows all data sets have been successfully corrected. All the three images set were fused to be transformed to local mapping coordinate system with RMSE 0.5 pixels. Results of three fusion techniques are shown in Figure 3. The visual comparison method is used to assess all the fusion techniques. The fusion of IKONOS and SPOT images allows a segregation of land use for level I when Principal Component Transform (PCT) was used. Level II and some of level III classes are well enhanced. Similar result of fused is obtained in the LANDSAT TM and IKONOS image set. Visual images interpretation show that merged image of LANDSAT TM/IKONOS and SPOT4/IKONOS depicted better spatial and spectral detailness (figure 4). Building, roads and crossroad can be identified easily from the merged image sets compared to the original data. Information content for LANDSAT TM improved significantly by merging LANDSAT TM and IKONOS.

The spectral reparability among land use was also carried out for the derived merged data sets. Best average separabilities among land use classes are fused in the PCT merged data set (Table 2). Using the ground truth gathered from field verification, the result of classification has been tested on paired sample t-test for reliabilities. Table 3 summarizes the analysis which clearly shows the reliability of the classified urban local plan using fused image set. The correlation shows the ability of the result to maintain correlation image classes using 95% confidence level. This result obtained 37.80 for standard error mean. It reveals that 0.995 values capable to maintain excellent correlation.

Figure 4 : Parts of result of fused imaged and originals subject of 300 x 300 Pixels.



Two types of assessment performed in this study were data set fusion and data classification. A total of 10 classes identified from ground truth in-situ survey were used in the analysis using divergence technique. This measurement can be considered as an priori estimate of the likelihood of correct classification between groups of different feature combinations. Table 2 shows that principal component transform was the best technique of 1862/2000 for classes separabilities using three best combination for each image sets.

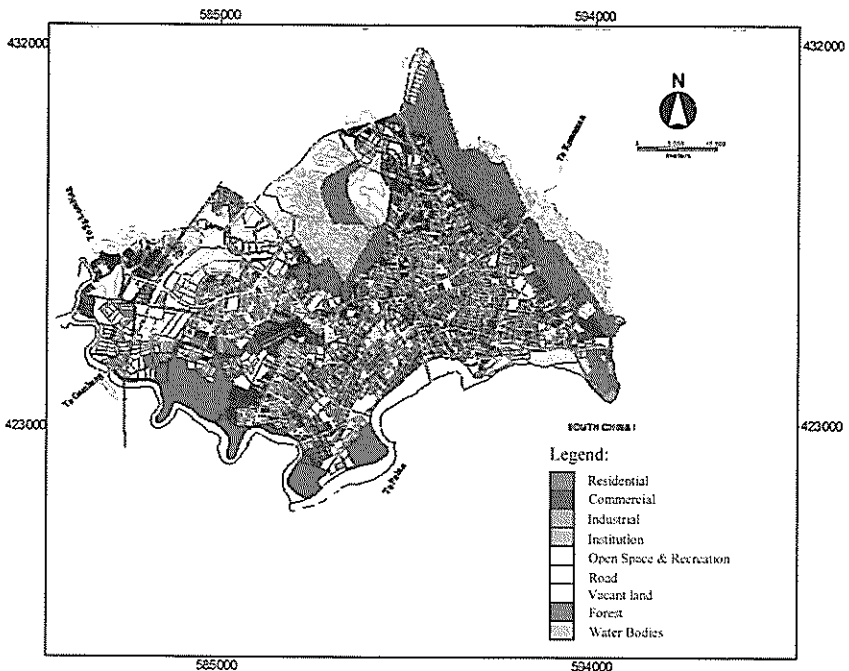
Table 2: Summary of divergence analysis carried out within fused image set against original image set

Image Sets	Average Divergence
Original LANDSAT	1913
Principal Component Transform fused set	1862
Multiplicative approach fused set	1810
Wavelet Transform fused set	1729

**Table 3 :** Reliabilities of fused image classification for deriving land use map by significant test (T-test) of the result obtained.

	Paired Differences					Corre lation
	No.Of Class	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
				Lower	Upper	
Pair 1 Existing - Image	11	125.35	37.80	-84.2108	84.2108	.995

The fused output of this study is shown in Figure.5. The land use map was edited using post processing GIS approaches.



**Figure 5 :** Classified Fused Image Derived using PCT

The result of this study clearly indicates that, data fusion is one of the important elements in producing a detailed land use classes of the urban local plan. Merging process must consider the spatial interaction to issues on radiometric integrity. However, the result of Wavelet Transform and Multiplicative shows poor color fidelity

(incomplete retention of multispectral information). In addition, the assessment for this study, requires more appropriate mathematical approaches because the result was very complex due to the different sources of data involved and other factors to guarantee the accuracy of the results. The post processing strategy has proven to be particularly effective for generating interclass boundaries. The necessary object was not detected during the fusion and classification process that compensate from the GIS database in a coarse manner. This study indicated the utilization of remote sensing imagery fulfilled the demands required in town planning fields particularly on land use mapping for development plan. The strength aspect of: (1) frequent/continuous update of the information database; (ii) collection of information in areas, where due to the economic and geographic context it would be difficult to gather the appropriate data (especially in developing countries); and (iii) reduction of the information input and extraction shows the potential of remote sensing in town planning.

Finally, for this study we also have presented a preliminary result on the study of fusion of multisensor image for land use mapping for urban and regional planning. The main aim of the research was to compare the performances of different data fusion techniques for enhancement of different surface features and evaluate the features obtained by the fusion techniques in terms of separation of urban land use classes to be utilize in mapping for development plan purposes. Specifically, three fusion techniques which consist of Principal Component Transform, Wavelet Transform and Multiplicative were examined. Although fusion method demonstrated different result, detailed analysis of each image revealed that image obtained by the PCT fusion applied in this study. The assessments also indicated the PCT is an adequate approach for merging LANDSAT TM, SPOT and IKONOS in producing a detailed land use mapping for development plan purposes.

## CONCLUSION

Field of urban planning may be thought of as a process for determining appropriate future action through a sequence of choices. To make these choices uncertain conditions, planners need to collect comprehensive information about the past, the present and the future. The relationship between planning and remote sensing techniques, it can be agree that land use classification is more detailed using remote sensing tools and provides planners with new direction to implement their work efficiently especially in handling base-map in development plan process. However, the implementation of innovative technology such as remote sensing, involves far more than hardware and software decision. This study of fusion between type of satellite imageries is one alternative to show the effectiveness of remote sensing into urban planning application. We still are seeking the implementation rest on thorough and systematic evaluation encompassing planning, operational, organizational, institutional, personnel, financial



and technical aspects to develop these tools broadly in the planning field, as well as developing the technology for planning and management purposes.

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