



An Assessment of Stormwater Management Practices in Malaysia

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INTRODUCTION

In the early 1990s, a number of Best Management Practices (BMPs) Manuals (e.g., EPA, 1997; ACT, 1994ARC, 1992) have been developed that addressed the control of urban runoff to protect receiving water quality and to mitigate flash floods in urban areas. Best practice urban stormwater management requires the development of an integrated suite of treatment measures, each designed to target specific pollutant types (Wong *et al.*, 1999). In Malaysia, traditionally the stormwater management has been practised to transport runoff as quickly as possible through the drainage system in order to prevent flooding and protect lives and property. Although public health and safety are still the most important goals, other objectives must now be met as well, such as the preservation of water quality and natural habitat. The concept of "integrated approach" to planning and designing of urban stormwater is moving away from the conventional thinking of designing for flooding to balancing the impact of urban drainage on flood control, quality management and amenity. In order to achieve these objectives, the Malaysian Government has launched the Urban Stormwater Management Manual for Malaysia (MSMA) with a new stormwater drainage design standard, effective from January 2001. The underlying design philosophy of the new 2001 Standard of "source control approach" differs significantly from the 1975 Standard's approach of "rapid discharge of runoff". The success of the implementation of this new approach is not yet known after it was launched in 2001. The initial

investigations have shown that cost implications, lack of knowledge of suitable construction details and methods, and together with the responsibility for the maintenance are the major impediments to successful Best Management Practices (BMP's) systems construction.

This paper studies the current status of stormwater management practices in Malaysia to develop an informational source for the Malaysian Government to update the existing Stormwater Management Manual for Malaysia. The purpose of the paper was to provide a comprehensive assessment of MSMA guidance and its use in Malaysia, based on information provided by key stakeholders on issues such as public awareness, design aspect, cost, maintenance and public acceptance towards the Manual. The main findings of the study could be used to develop information, tools, and guidelines for developing effective local stormwater management programs; and to provide up-to-date technical information to engineers, planners, and developers for implementing practical and effective local best management practices and related policies and programs. This study was carried out to establish the level of awareness of MSMAs, to investigate the effectiveness of the information and guidance on the practices, to investigate any misconception regarding MSMAs use and performance and to generate information on whether the developer's fears of using MSMAs have been realised.

In order to accomplish these goals more effectively, a survey was conducted on three major key stakeholder

groups i.e. developers or contractors, consultants and local authorities to identify the prominent stormwater issues across Malaysia. The results presented the findings from the first evaluation of MSMA guidance, which established the attitudes, perceptions and experiences of a wide range of practitioners and other experts. The survey methodology, results, and conclusions drawn by the research findings are summarised in this paper.

INTERPRETATION OF SURVEY RESULTS

Questionnaire responses

The survey results of stakeholders from the general public, local authority representatives, consultants, contractors and developers are discussed in this chapter. A total of 300 surveys were sent either by e-mail or post, and only 60 were returned, equating to a response rate of 20%. The 60 survey questionnaires which were returned, did not require the respondents to disclose their identities for the purpose of anonymity. However, responses have showed that 44% respondents were from local authorities, 30% general public, 21% consultants, 4% academicians and only 2% were from contractors as shown in Figure 1.

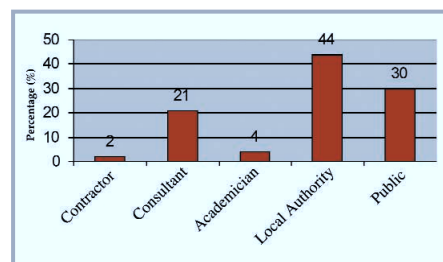


Figure 1: Percentage of respondents based on the nature of the stakeholders

Awareness and expertise of the sample population

Most respondents (about 79%) to the questionnaire were aware of the existence of the new 'Urban Stormwater Management Manual for Malaysia' (DID, 2001) which was designed to replace the 'Urban Stormwater Drainage Procedure' (1975) with effect from 1st January 2001. The survey result showed that 21% of respondents were still not aware of the new 'Urban Stormwater Management Manual for Malaysia' (MSMA) as shown in Figure 2. These findings demand the urgent need for the Government to conduct more publicity and awareness campaigns to alert the public of the existing new manual and guideline for stormwater management in Malaysia. The main obstacle that prevents the success of modern storm runoff control measures, whether by structural or non-structural measures is the lack of community participation. Therefore, the success of the new concept of stormwater management depends both on community participation and on a change in technical thinking. To incorporate storm drainage into the complete urban and environmental concept, a holistic approach to stormwater management is required.

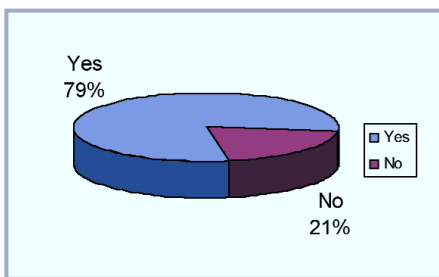


Figure 2: The Respondents Awareness on the new Urban Stormwater Management Manual for Malaysia (DID, 2001)

As shown in Figure 3, 86% of the respondents have stated that they are willing to implement the stormwater facilities in their area as suggested in new MSMA Manual. Only 5% are not willing to implement the stormwater facilities and 8% gave no response to the question. The results demonstrated that the respondents were willing to change their mindset and there is a paradigm shift for better stormwater management

practices to control local flooding and pollution problems.

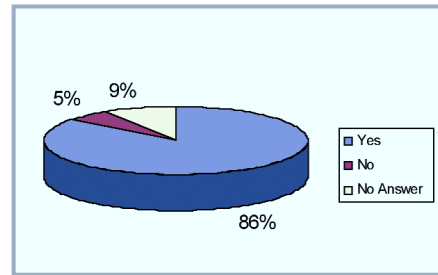


Figure 3: Respondent opinions on the willingness to implement the stormwater facilities as listed in MSMA

In order to investigate the acceptance of the respondents on the new type of drainage system, the respondents were asked to choose the house that the respondents would like to invest in; either House A with an Open Concrete Drainage System or House B with an Ecological Drainage System. Figure 4 shows that almost 89% respondents have chosen House B with an Ecological Drainage System and 9% have chosen House A with an open concrete drain. Only 2% did not answer this question. This indicates that the majority of respondents were ready to have changes in stormwater drainage infrastructure and were willing to pay for better facilities. However, the question was how much were they willing to pay for the increment of the total cost? Figure 5 shows that 41.5% respondents that have chosen House B were not willing to pay any extra cost. But, 39% of the respondents were willing to pay an addition of less than 5% of the total cost and only 12.2% of respondents were willing to pay an increment of between 5% and 20% of the total cost. As expected, only 7.3% of the respondents who have chosen house B were willing to pay an increment of more than 20% of the total construction cost.

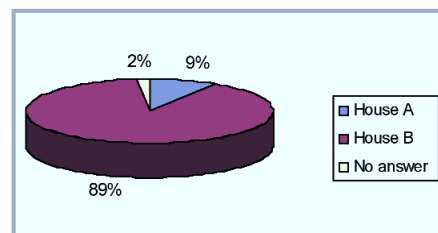


Figure 4: The result for survey Question 7: "If you're given a choice, which house would you like to invest on? (Please tick)



House A with Open Concrete Drainage System



House B with Ecological Drainage System

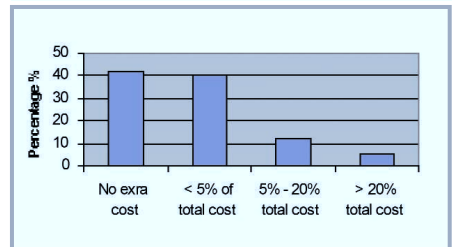


Figure 5: Respondents' willingness to pay the extra cost incurred in the construction of the new drainage

Flooding Problems

Local flooding of public, commercial, and industrial space, residences, streets and roads is widely perceived as a problem by respondents, with 87% citing that they have flooding problems in their communities. This trend showed a common problem across the country with very little geographic variation (Figure 6). 87% of surveyed respondents noted flooding problems in their communities (Figure 6) due to inadequate drainage systems such as drains, culverts, manholes, etc. Inadequate drainage system includes undersized drains and culverts due to inadequate design and construction. Therefore, local governments should improve or retrofit the existing drainage systems in order to reduce local flooding problems. In addition, the local governments should ensure that all development plans submitted for approval should include an adequate drainage system.

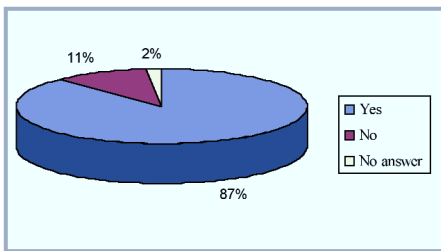


Figure 6: Local flooding problems of public, commercial, and industrial space, residences, and streets and roads due to inadequate drainage systems (drains, culverts, manholes, detention ponds, etc.)

Water Quality Issues

The survey showed that water pollution is a significant issue in communities across Malaysia. Sixty-five percent (65%) of respondents indicated that in terms of public health, aquatic environment, or citizen complaints, stream pollution is of “some” to “great” concern in their communities (Figure 7). This implies that some Malaysians were not concerned with environmental protection and the impact of pollution to the environment in the existing waterways. Consequently, the Government needs to increase public awareness on environmental protection amongst Malaysian citizens starting from primary schools. Besides that, the electronic and printing media can also play their role in educating the Malaysian citizen about environmental protection and sustainable development. In addition, for the environmental approach to be successful, a change of technical culture is

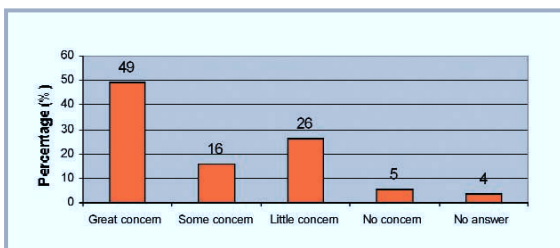


Figure 7: Concerns on river pollution

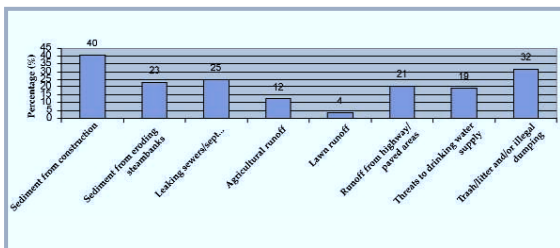


Figure 8: The respondents' opinion on major water quality problems in Malaysia

required through training (capacity building at all levels, for district engineers and urban planners) and environmental education for the public.

The most common major water quality problems indicated were construction sediment (40%), litter/illegal dumping (32%), leaking sewers (25%), eroding streambanks (23%), runoff from paved areas (21%), and threat to drinking water supply (19%) as depicted in Figure 8. This signifies the importance for the local authorities, especially DID and DOE, to develop programs for the restoration and preservation of existing rivers. With the introduction of the MSMA manual, the final effluent of stormwater would be expected to improve and in the long term, river pollution could be reduced. The result has shown that the main sources of pollutants in Malaysia originates from construction sediment. This is due to land clearing activities during the construction phase which normally is not carried out in a proper manner and would cause pollution to downstream rivers. Therefore, local councils should carry out regular inspections and step up enforcement to ensure that land clearing activities are carried out in a proper manner to minimise erosion. In addition, proper sediment and erosion control measures, including provisions for adequate silt traps, berm drains, perimeter bunds, and hydro-seeding of exposed soils, should be implemented as components in the “Erosion and Sediment Control Plan” (ESCP).

Stormwater Management Tools

In the majority of Malaysian communities 36% of respondents shown in Figure 9 stated that response to complaints and litigation appeared to be the primary mechanism used to prevent and control stormwater pollution. State and

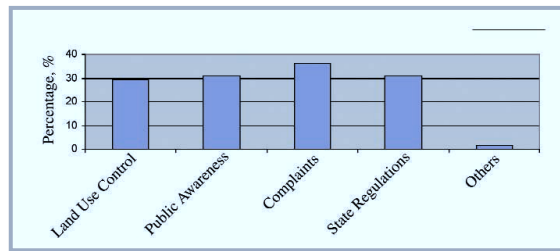


Figure 9: The respondents' opinion on methods that are being used in the community to prevent or control stormwater pollution

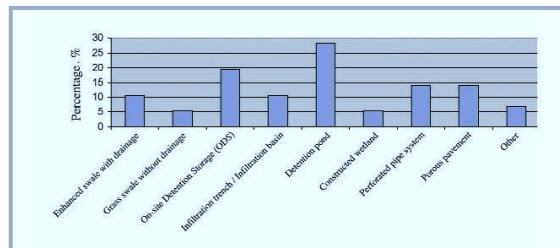


Figure 10: The respondents' experience using the stormwater management facilities as recommended in the Stormwater Management Manual for Malaysia (MSMA)

federal regulations were cited by respondents by 31% and local land use controls and ordinances were cited by respondents by 29% (Figure 9). About 31% of respondents indicated that their communities have public awareness programs (Figure 9). The results showed that all mechanisms were equally important to prevent and control stormwater pollution. However, the common practice to control stormwater pollution in Malaysia is based on complaints and litigation.

Hence, there is a need to have a change in the way stormwater pollution is controlled by implementing prevention techniques because of the cost for cleaning the stormwater once it is polluted; it is very expensive to restore water back to its original conditions.

The new MSMA manual requires engineers to become more innovative and creative in their design by using different techniques as suggested in the new Manual MSMA based on site conditions and suitability of the soils. The aim is to control the stormwater at the source with the target to reduce the generated runoff from post-development to pre-development level and to improve the stormwater runoff quality. The result from the survey (Figure 10) has shown that 28% of respondents have experience using detention ponds,

19% of respondents have experience using On-site Detention (OSD) and 14% have experience using perforated pipe systems and porous pavements. Only 11% have experience using infiltration facilities such as grass swales and infiltration trenches. The survey has also shown that only 5% of the respondents have experience using wetlands as a stormwater technique in any new development project.

At the beginning when the MSMA was launched, it is expected that developers in particular would oppose "green soft-engineered" systems i.e. retention ponds, wetlands and swales. Most developers perceive that these systems take more time and effort to develop, and that they cost more in terms of land acquisition and maintenance. However, open and above ground systems should be easier to maintain than below ground systems, and the engineering of swales is comparatively simple and cost effective (Mohd Sidek *et al.*, 2004; Lloyd *et al.*, 2001). Moreover, these "green soft-engineered" systems allow the relevant local authorities to rapidly identify and rectify pollution incidents. Amongst the stormwater management facilities suggested in the MSMA manual, wetland is not the popular choice in any new development in Malaysia due to lack of knowledge and design standards and procedures. Current design guidelines for wetland and pond systems in MSMA manual are still very much in their infancy and are based primarily on performance curves from overseas.

Barriers to Stormwater Management

One of the objectives of the survey was to identify the barriers to the successful implementation of stormwater management in Malaysia. The initial investigations have shown that cost implications, lack of knowledge of suitable construction details and methods, and together with the responsibility for the maintenance were the major impediments to successful MSMA facilities systems. Basically, the barriers to stormwater management have been grouped into different categories such as education or lack of information

regarding stormwater management, funding, enforcement, limited staff and lack of regulations. The result has shown that the concerns over education or lack of information regarding stormwater management, funding and enforcement were the three most significant barriers to managing stormwater in local Malaysian communities. Education or lack of information regarding stormwater management concerns were indicated by 39% of respondents, funding were indicated by 35% of respondents and enforcement were indicated by 33% of respondents as shown in Figure 11. The less important barriers appeared to be limited staff (26%) and lack of regulations (19%) as shown in Figure 11. Generally, these trends shows that the lack of information on the detail design, cost, maintenance, etc, related to stormwater management facilities were the main barrier to its successful implementation in Malaysia.

In order to increase the knowledge of the public about stormwater management, the Government must actively provide a variety of information by means of local council public relation activities. Active cooperation with the media, namely newspapers, television, radio, magazines, etc. to provide information would also be effective. The local authorities can hold public meetings, road shows, demonstrations and events to alert the public of new concepts of stormwater management. The motivation and awareness of the public is essential for wider acceptance of stormwater management concepts to ensure the successful use of the Urban Stormwater Management Manual (MSMA) in Malaysia.

Based on the survey, funding was one of the barriers for the implementation of stormwater management in the community. In order to encourage people to install stormwater facilities in their community, subsidies should be given. The Government should appropriate the construction cost of infiltration facilities in its budget to provide subsidies for local authorities

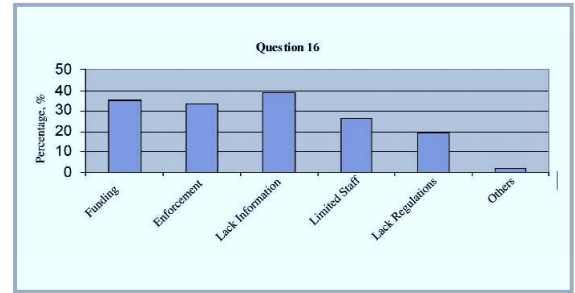


Figure 11: Barriers that may exist for stormwater management in the community

to actively encourage the construction of such facilities. Using this subsidy, the local authorities could install such facilities in public facilities and could also offer the subsidy to residents who install such facilities. This subsidy could motivate the people and accelerate the acceptance of stormwater management concepts in Malaysia. The Government should also increase the fund for flood mitigation works and consider treating drainage works as part of the basic infrastructure in terms of cost. In addition, lack of enforcement is one of the barriers that hinder the success of stormwater management. One way is to engage an independent drainage consultant by the local authority to review any development project of more than 50 hectares and to carry out periodic audits of the project to ensure compliance to the local authority regulations and to report to the authority on any non-compliance. Another deterrent highlighted during the survey was the procedure of obtaining approval from the relevant authorities. Thus, the approval process should be simplified and any red tape in the approval process should be minimised to encourage the implementation of the MSMA manual.

Many respondents also felt that a lack of information or clarity about who was responsible for the adoption and maintenance of MSMA facilities had been the main deterrent to their use. Land take was also found to be a significant deterrent. This indicated that whilst designers or developers could identify potential improvements, the biggest deterrent would be the worry of adoption and maintenance of the facilities.

SUGGESTED IMPROVEMENTS TO THE STORMWATER MANAGEMENT MANUAL FOR MALAYSIA (MSMA)

The following list of potential improvements to the guide is derived from suggestions made by respondents within their completed questionnaires, or during workshops and interviews (Table 1). They are not presented in any particular order, and for the sake of brevity, several comments have been omitted. These suggestions do however

represent the most frequently recorded comments.

DISCUSSIONS

Based on a review of the storm water management survey and discussions with the relevant parties, four major issues as shown in Figure 12 have been identified as the most important to address in advancing the concept of MSMA. Thus, the key components to successfully integrating environmentally-friendly drainage systems into urban

development projects are the regulatory framework; assessment and costing; technology and design; and marketing and acceptance.

Currently in Malaysia, the responsibilities for water supply, stormwater and wastewater management are separated within or between organisations. This fragmentation of responsibilities creates difficulties in getting different organisational sectors to work together in a positive manner across administrative boundaries. Therefore, good stormwater management requires a collaborative approach between state and local authorities to create an effective operating environment for MSMA practices. Furthermore, the effective and successful of stormwater management program requires the collaboration between all parties with multi-disciplinary backgrounds. Policy, codes and guidelines need to be amended to facilitate this. Implementation of this policy will require standards and approval procedures to be redrafted to incorporate MSMA planning and treatment measures. A key issue is the skills and capability of engineers from DID to approve new projects based on “control at source” approach. To overcome this, the government should implement education and training programs for key stakeholders and provide guidelines for assessment and approval standards to address these types of issues.

Local authorities are generally responsible for approving development applications and specifying the development standards to be met. These standards are often based on rigid engineering conventions and do not allow for an innovative or integrated approach to water management. It has been realised that the skill and culture of local authorities were not generally sufficient to support the changes required to assess and implement projects involving MSMA. This creates a reluctance to accept the perceived risks involved in approving and implementing MSMA projects. A series of training workshops and road shows to be organised by DID and many more series of training should be conducted in the

Table 1: Suggested improvements to guidance of MSMA manual

General MSMA Guidance	MSMA Design Manual
1. Provide information on the cost of the MSMA facilities.	1. Reduce the cost of the manual and provide greater access to guidance (e.g. via the Internet.)
2. Make available information on Malaysian case studies.	2. Revise the selection of MSMA facilities available in the manual.
3. Provide detailed information on the maintenance procedures and responsible agency.	3. Include more case studies and practical examples.
4. Provide on-line access on the MSMA database for the benefit of the users.	4. Specify types of MSMA stormwater facilities that are acceptable in different scenarios.
5. Produce and regularly update a summary of available guidance.	5. Provide more information on the design of inlets and outlets.
6. Address inconsistencies in advice provided by stakeholders.	6. Provide more design examples and system performance (e.g. infiltration basin and infiltration trench.)
7. Regularly obtain feedback on the use of the manual and other guidance on MSMA.	7. Provide examples for calculation of different runoff estimation hydrograph method in Chapter 14 (e.g. Non-linear reservoir, Kinematic Wave method and Rational Method Hydrograph method).
8. Regularly review the quality of guidance in light of increasing MSMA experience.	8. Provide examples for hydrologic or hydraulic routing method (e.g. Muskingum method).
9. Arrange training events for all stakeholders, and short seminars to raise awareness of MSMA (e.g. Short courses by IEM, CPD BEM program.)	9. Improve explanations of hydraulic calculations in the example. Make corrections to the errors in the design examples (Chapter 14).
10. Provide key facts or simple brochures for every stormwater facility as a supplement to the MSMA manual.	10. Include more details on the ecological aspects of MSMA (e.g. habitat enhancement).
11. Produce a “landscaping specification” for MSMA.	11. Improve the quality of particular drawings to illustrate the stormwater treatment train and its use.
12. Improve the style of writing of the manual because it is difficult to understand (not user friendly) especially for first time users.	12. Introduce “stormwater management” as an elective subject during final year in the University to prepare future engineers with the latest design standards and practices.

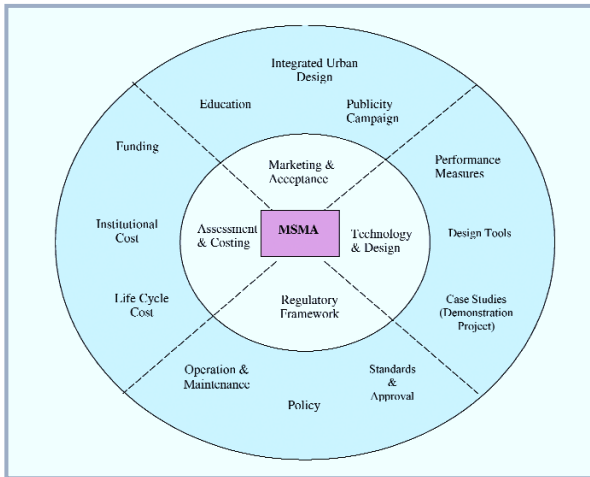


Figure 12: Key components to successfully integrating environmentally-friendly drainage systems into urban development projects

future to raise workplace skills of employees to a level suitable to meet MSMA assessment and approval needs.

Another issue that needs to be addressed is the technology and design aspect of the MSMA. Two key issues in the design and construction stages of urban stormwater management schemes that can influence the long-term effectiveness of the system are the use of multi-disciplinary design teams

and the protection of BMPs during construction activities. The need to incorporate multi disciplinary design teams is highlighted in Figure 13 as part of the planning, design and assessment of stormwater management schemes. Figure 13 shows the new procedure for implementing the MSMA concept in a new development area and the need to integrate the component of Best Planning Practices (BPPs) and Best Management Practices (BMPs) in

implementing and advancing the MSMA concept. It is now required for any big government project (>50 hectares) to submit the Environmental Management Plan (EMP) as well the Environmental Impact Assessment (EIA) to the local authority for approval as part of the environmental protection. In addition, the developer needs to submit the Erosion and Sediment Control Plan (ESCP) with consideration of the

construction sequence of the various MSMA elements to protect them from sediment loads. This ESCP plan should be submitted together with the drainage submission report to DID for approval.

At the moment, there is limited quantitative data on the long-term performance of MSMA technology in Malaysia. A lack of information on operation and maintenance practices for BMPs leads to concerns within local authorities about the long-term viability and costs associated with stormwater management schemes. The awareness of operation and maintenance practices by operations and maintenance staff is critical to guarantee the success of MSMA projects. Some possible strategies to clearly define operation and maintenance procedures include providing staff education and training, developing inspection routines, preparing checklists with clearly identifiable indicators of inadequate system performance, preparing provisional action plans to promote prompt action to rectify problems as they arise and developing a clear life cycle cost for each of the MSMA facilities. These activities aim to ensure that the staff clearly understands the objectives of MSMA and are familiar with the maintenance programs associated with MSMA.

Finally, community education about MSMA has many issues to address; from empowering the community with a sense of ownership of their local stormwater assets to informing the community about future changes to water resource management. Community education will help reduce public concerns generated by the unfamiliar aspects of stormwater management concepts. Ultimately, individuals should be sufficiently informed so that the community can accept the new drainage system concepts using a source control approach as recommended in the New Stormwater Management Manual for Malaysia (MSMA).

The major challenge ahead now is modifying institutional frameworks, amending urban planning regula-

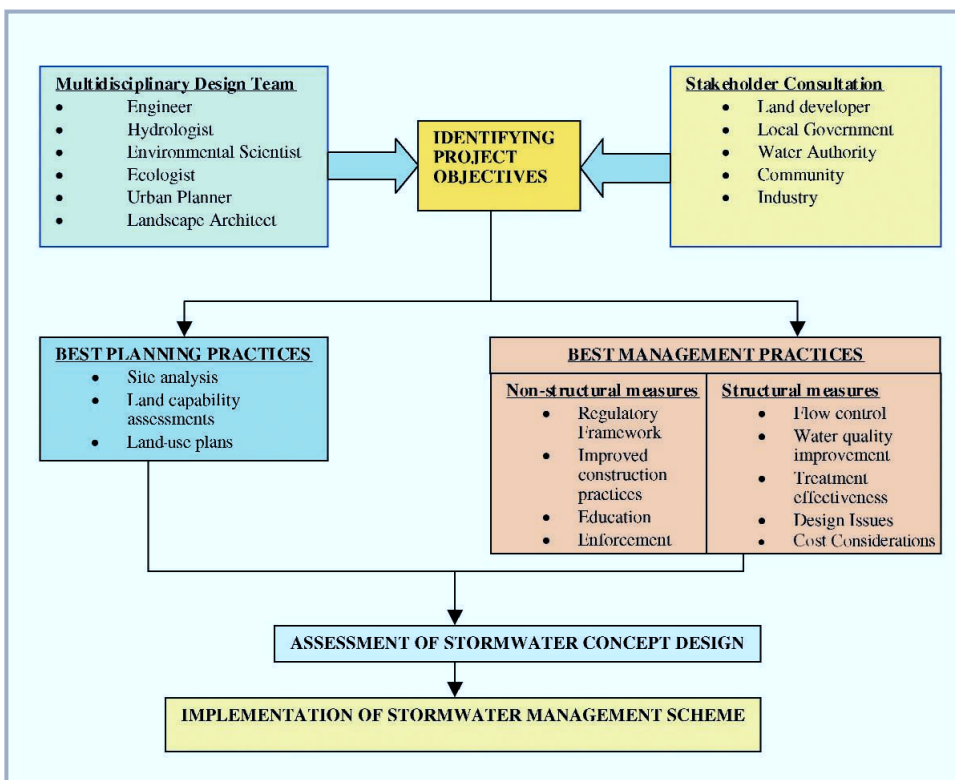


Figure 13: Key Considerations in the Planning, Design and Assessment of a Stormwater Management Scheme

tions, assisting stakeholders with developing their skills and “smart partnership” between local authorities and the industry to facilitate a widespread adoption of MSMA practices. Research should also be encouraged in the universities or research institutions to further scientific knowledge on urban stormwater management so as to implement stormwater management concepts from theory to practice. Once these issues are addressed, the development of sustainable drainage systems will be established to control the stormwater quantity and quality.

CONCLUSION

Perceptions of stormwater issues are almost uniform throughout Malaysia and there is not much difference in views between respondents with different backgrounds. The results of the surveys illustrate these findings, but also made it evident that urban

stormwater management presents a challenge in communities across Malaysia. In conclusion, the barriers hindering the wider adoption of MSMA have been identified from the study. Amongst the barriers are perception of increased costs, lack of design guidance, lack of design experience, lack of available modeling tools, operation and management uncertainty and issues on adoption and ownership. This information is very important in order to tackle the barriers so that the successful implementation of the new concept in MSMA can be ensured.

Effective use of the new concept of Stormwater Management Manual (MSMA) is not easy to achieve and requires an innovative approach. Innovation, by definition, involves risk taking, and risk can occasionally lead to failure. However, it can also lead to success. Both success and failure are important components of experience to

be shared in the updated version of MSMA in next five years. Now indeed is a fitting time for stormwater management concepts to be moved towards the stage of practical application and widespread adoption of the technology as suggested in MSMA throughout Malaysia. Overall, the outputs of the study give a useful insight into the status of stormwater management practices and effectiveness based on the MSMA manual in Malaysia.

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