1. Introduction

Toward the end of 20th century, it has been widely accepted that sustainable economic growth requires not just accumulation of physical capital, technologies and labour or increasing Gross Domestic Product (GDP), but also the preservation of the natural resources, and the protection of our environment as well as our sustainable future. This message is especially becoming more and more important for the Asian region, which is a focal point for the world’s rapid growth, demonstrating a 120% increase in GDP in the region and accounting for 60% of the world’s population growth (WEPA-IGES, 2012). The rising Asian economies are incredibly successful when judged by their rapid economic growth, but less so when environmental damage is accounted for (Howes and Wyrwoll, 2012). As Asia’s population and economies continue to grow, the need to collectively deal with the increasing pollution caused by poor sanitation and wastewater discharges becomes one of the biggest challenges and urgent issue of many countries in the region.

Recently, global attention has focused on sanitation targets in the United Nations Millennium Development Goals (MDGs), aiming to increase proportion of population using improved toilet facilities including ventilated improved pit (VIP) latrine, pit latrine with slab, composting toilet, and flush or pour-flush to (i) piped sewer system; (ii) septic tank; or (iii) pit latrine, rather than paying appropriate attention to the consequences of its effluent. Corcoran et al. (2010) estimated that globally two million tons per day or more than 80% of sewage, agricultural and industrial waste in the world is discharged untreated into water bodies and at least 1.8 million children under 5 years-old die every year, or one every 20 seconds, because of water and sanitation related-diseases. The United Nations estimates that the total amount of global wastewater produced annually is about 1,500 km$^3$ per day for 1995. It is assumed that each litre of wastewater pollutes at least 8 litres of freshwater, and then an estimate of 12,000 km$^3$ of the globe’s water resources is not available for use. If the world population keeps growing to 9 billion by 2050, the world’s water resources would be reduced by some 18,000 km$^3$ (UNESCO-WWAP, 2003). Nelson and Murray (2008) and Baum et al. (2013) have stressed the necessity of defining sanitation more broadly to include treatment of all waste materials as “the entire community, as well as downstream populations, must be protected from discharge of untreated wastes”. Although conventional centralised wastewater management system has been utilized in densely populated areas for decades, mainly in urban centres of developed countries, to solve the problem of wastewater treatment, but unfortunately it has been proven unfeasible and unsustainable in many areas of Asian developing countries. Many drawbacks associated with the centralised approach for wastewater treatment have been pointed out in literatures, such as its huge investments as well as operation and maintenance cost requirements. In addition, restricted local budget allocations, lack of expertise for properly operation and maintenance, unfeasible technology selection under local contexts due to lack of stakeholder involvements in the decision making process, and often inappropriate management models have resulted in inadequate operation of wastewater treatment plants in many countries, and their effluents have caused many threats to our natural water resources and human health. It is estimated that about 85% - 89% of Asian’s wastewater is discharged untreated, polluting
both groundwater and surface water sources (Chiplunkar, 2011).

A new alternative approach has recently been introduced, namely decentralised wastewater treatment systems (DEWATS), which have several advantages compared to conventional approach. The system emphasizes on small-scale, onsite wastewater treatment and reuse, often at community level. Therefore, in many cases, long and large collection pipeline network may not be necessary. As a result, it significantly reduces the costs of sewerage system. Despite these facts, several limitations and obstacles are emerged while introducing and replicating these systems in Asian countries such as the issue related to energy efficiency of decentralised systems, requirements for operation and maintenance, required skilful and highly-qualified human resource, difficulties in effective sludge collection, treatment and disposal.

This policy brief investigates on a number of challenges, prospects as well as enabling environment and strategies to support for policymakers, local governments, water professionals and relevant stakeholders in Asia, especially member countries in the Water Environment Partnership in Asia (WEPA) network, in searching for efficient and reliable wastewater treatment systems, appropriate management models under their local context, and pursuing their long-term goal of community-wide sanitation improvements.

2. Challenges and Prospects for Sustainable Domestic Wastewater Management Systems

a. Why sanitation systems fail in WEPA countries

Challenges in effective wastewater management are quite similar in WEPA countries. These include low percentage of improved sanitation ratio, especially in rural areas, inadequate sewerage network coverage, and lack of sewage treatment facilities. Most of WEPA countries, especially countries in Southeast Asia, still depend on septic tanks and other low-cost onsite sanitation facilities such as ventilated improved pit toilets, double-vault latrines, composting toilets, and pour-flush toilets with twin pits. However, approximately 90% of households have septic tanks in Sri Lanka, 77% in urban area of Vietnam, 85% in Metro Manila of Philippines and 62% in urban area of Indonesia having septic tanks (AECOM & SANDEC, 2010). Numbers of septic tanks are expected to grow rapidly in the future. Unfortunately, septic tanks are poorly designed and not properly constructed, operated and maintained in many cases. In addition, low contribution of septic tanks to water quality conservation is pointed out as a problem, because septic tanks in most areas treat only black water and grey water is directly discharged to the environment without any treatment. Low treatment performance efficiency, only 20-30% of BOD removal, has been observed in Vietnam (Anh et al., 2002). Although septic tanks are widely used in WEPA countries, but most of these countries do not have specific policies, legal and institutional frameworks for appropriate septage management. Consequently, septage treatment is almost ignored (Fig. 1). Only 4% in Indonesia, 5% in Metro Manila of Philippines, less than 4% in Vietnam, less than 1% in Nuwara Eliya of Sri Lanka, and 30% of generated septage has been treated in Thailand (AECOM & SANDEC, 2010).

Figure 1

Open discharge of septage to fishpond
Source: Author
Figure 2 presents the latest relationship between GDP per capita in 2012 and the coverage ratio of urban wastewater treatment in WEPA countries. From this figure, it can be seen that urban wastewater treatment ratio in many WEPA countries such as Lao PDR, Cambodia, Myanmar, Nepal, Vietnam, Sri Lanka, Indonesia is still low, less than 35%. Only in Malaysia and other developed countries such as Japan, Republic of Korea, Thailand, the ratio is higher than 60%. Ratios of urban wastewater treatment in these countries are 78%, 96%, 61% and 62%, respectively. Meanwhile, wastewater treatment ratio in rural areas is much lower in most of the countries, with an exception of Japan, Malaysia and Republic of Korea. Figure 2 also revealed that Asian countries with GDP per capita less than 5,000 US$ still have low coverage ratios, with less than 45%. Thus, GDP growth can be considered one of the key driving factors required to achieve target ratio of wastewater treatment in each country.

However, it may take such a long time for developing countries in Asia to gain a high level of GDP per capita like developed countries. Therefore, an alternative solution to conventional wastewater management approach is urgently needed.

GDP per Capita in 2012 (in US$)

Urban Wastewater Treatment Ratio (%)

It has been seen that construction of large-scale, conventional centralised wastewater treatment systems with advanced technologies imported from developed countries have been failed in many cases as it is not a cost-effective and feasible option for many developing countries in Asia. A new approach of decentralised wastewater management option, which has been recommended worldwide recently, would be a promising and viable alternative solution for WEPA countries with inadequate wastewater treatment facility, but at the same time having rapid urbanisation and population growth (Fig. 3).
Decentralised wastewater treatment systems (DEWATS) are becoming of special interest because of its possibility of reducing treatment costs in long term, minimizing environmental impacts and facilitating wastewater reuse (Daigger, 2009; Nhapi, 2004). It is estimated that costs for the sewers network of a centralised system can be up to five times higher than the sewage treatment plant itself. In contrast, DEWATS can reduce sewers network costs significantly. In addition, the cost of the treatment unit should also be lower, due to a less-sophisticated technical layout (BORDA, 2009). DEWATS have been proven in many countries in Asia, highest potential of DEWATS lies in new urban centres, peri-urban and rural areas. Good examples have been observed in case studies in Indonesia, Malaysia, and Manila city of Philippines. Successful cases of decentralisation are also recognised in Japan, where about 2,500 decentralised systems are associated with large blocks of building that treat and reuse their own wastewater (Yamagata et al., 2012). It is strongly believed that decentralised wastewater treatment systems or DEWATS could fill the gap between on-site system like septic tank and centralised treatment option, both in term of treatment performance, costs and reliability.

**Figure 3**

Decentralised sanitation fills the gap between on-site and centralised sanitation options
Source: Modified from (WSP, 2013)

**Figure 4**

Cost estimate for different levels of sanitation technologies
Source: UNDP, 2006
In WEPA countries, a wide range of technical options for domestic wastewater collection and treatment have been currently utilised depending on their local socio-cultural, economic and environmental conditions. However, in term of collection systems, it can be divided into 3 main categories: (a) conventional combined gravity sewer system, (b) conventional separated gravity sewer system and (c) simplified gravity sewer system. For example, simplified sewer system has been offered as one of three choices for sanitation system improvement in a community-based sanitation program, namely SANIMAS, in Indonesia. For this option, the individual household has to provide its own toilet, usually septic tank, and connection to the sewer.

### Table 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Collection and Treatment Options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On-site or Cluster System (Decentralised)</td>
</tr>
<tr>
<td></td>
<td>Cluster (Community-based system)</td>
</tr>
<tr>
<td>No treatment</td>
<td>Direct discharge from household without treatment</td>
</tr>
<tr>
<td></td>
<td>With/without sewers network + no treatment</td>
</tr>
<tr>
<td>Blackwater treatment only</td>
<td>Individual septic tank with/without connected to sewers network</td>
</tr>
<tr>
<td></td>
<td>Individual or communal septic tank connected to sewers network + with/without sewage treatment plant</td>
</tr>
<tr>
<td></td>
<td>Individual night soil treatment tank (e.g. Johkasou system) without connected to sewers network</td>
</tr>
<tr>
<td>Treatment of both greywater and blackwater treatment</td>
<td>Individual septic tank + with/without connected to sewers network</td>
</tr>
<tr>
<td></td>
<td>Individual or communal septic tank connected to sewers network + with/without sewage treatment plant</td>
</tr>
<tr>
<td></td>
<td>Other dry sanitation systems (VIP, composting latrine, etc.)</td>
</tr>
<tr>
<td></td>
<td>Communal sewage treatment facility (e.g. SANIMAS) + with/without connected to sewers network</td>
</tr>
<tr>
<td></td>
<td>Sewer network + with/without centralised sewage treatment facility</td>
</tr>
</tbody>
</table>

**Domestic wastewater collection and treatment in WEPA countries**

#### b. Constraints and prospects for replication of DEWATS model

Although, DEWATS has offered a number of potential benefits compared to conventional centralised wastewater management approach. However, after many years of promoting DEWATS concept with many good pilot and demonstration projects, they still have not led to large or city wide-scale replications. It is believed that there are many reasons behind the lack of wide-scale implementation of DEWATS (Fladerer, 2010). One of the major problems for effective wastewater management in many developing countries is the poor coordination among the responsible and relevant ministries and departments of central government (Kamal et al., 2008). Besides, lack of long-term planning and enabling environment for effective wastewater management are also found in many WEPA countries. Decentralised wastewater management often requires political will, commitment and closely coordination between responsible local governments and relevant stakeholder groups in order to support the delivery of wastewater services. Although many countries recognized the need of having wastewater management supporting policies, but these policies are often designed for centralised infrastructure, and may not be appropriate for decentralised systems (Bernal and Restrepo, 2012). Thus, it is difficult to implement this approach because of lacking resources, especially human and financial resources from local governments, and management capacities (Parkinson and...
There are also several other factors behind the fact that why DEWATS has not yet been widely replicated in Asia, particularly in WEPA countries such as lack of knowledge of management and technical options; lack of suitable and transparent institutional arrangements, inadequate legal framework, policies and incentives measures, which encourage the application of decentralised approach; lack of involvement of relevant non-governmental stakeholders from the beginning of the decision making process. Although decentralised systems may offer some benefits in term of greater end-user involvement in operation and maintenance, but at the same time it often suffers from very limited access to skilled professionals (WHO, 2010).

Limitations to decentralised management systems, according to many water authorities and engineers, are based on three arguments: (i) low performance- this argument is based on the fact that most of the decentralised technologies commonly used such as septic tanks often offer very low treatment performance, and the poor maintenance is usually receive; (ii) costs – construction and operating cost, mostly for energy consumption, of a large number of decentralised systems is assumed to be far more expensive than once large centralised system. Also, requirements for effective operation and maintenance of decentralised systems will be more than those of one centralised system; e.g. it must be operated and controlled by a number of skilful and highly-qualified people (Wilderer and Schreff, 2000; Bakir, 2001). Decentralised treatment approach can only be considered as a viable alternative if it is highly effective and provide advanced treatment, easy to operate and maintenance, and low cost (Wilderer and Schreff, 2000); (iii) difficulties in effective sludge management based on evidences mentioned earlier, it can be seen that effective sludge collection, treatment and disposal from decentralised wastewater treatment facilities such as septic tanks is much more complicated and costly than those of centralised treatment system.

3. Enabling environment and strategies for efficient and reliable decentralised wastewater management in WEPA countries

Identifying and promoting favourable environment such as strategic, long-term planning, supportive legal framework and institutional arrangements, pro-active participations of all relevant stakeholders including service end-users, appropriate technology selection, financial stability and sustainability, and appropriate management model are the key strategies for improving the situations of domestic wastewater management in WEPA countries.

As mentioned early, DEWATS has gradually become a promising solution for effective domestic wastewater management in many Asian countries, although it is not a universal solution for any local problem. However, in order to address the constraints and make use of all of its advantages as well as contribute to the efforts of replicating good practices of DEWATS in WEPA countries, the following strategies have been recommended:

Development of strategic plan for wastewater management

Development of strategic and long-term plan for domestic wastewater management is vital for each WEPA country. The plan is not only limited to national targets and strategies on how to achieve country’s sanitation targets, e.g. percentage of treated wastewater, within a given time frame, but also need to integrate other components related to wastewater management such as how to reduce the amount of wastewater generation, how to promote wastewater reuse and utilize it as a resource for some purposes, e.g. agricultural and aquaculture activities. Central or local governments should also express their strong, long-term commitments and political will for improvement of wastewater management system in the plan, including allocation of sufficient human and financial resources.
Decentralisation of decision making in wastewater management

In many countries in Asia, especially in South and Southeast Asia, wastewater management policies are often incorporated in national environmental protection law (Vietnam) or national policy (Bangladesh), national plan (Nepal, Thailand), national programs (Sri Lanka) or national strategy (Philippines). Central governments often provide assistance for policy formulation of wastewater management, while local authorities are responsible for sewerage services. However, problems of wastewater treatment and management are quite diversity under different local socio-economic contexts. Only local actors know well their challenges. Top-down decision making often make policies difficult to implement effectively (UNDP, 2008). Thus, effective policy formulation and successful implementation of such policies require the involvement of all relevant stakeholders, including local actors, in the early process of decision making. Decentralisation of decision making and active participation of multi-stakeholders are critical for sustainable wastewater management in WEPA countries.

Stringent legal framework and transparent institutional arrangements

Legal framework for wastewater management of WEPA countries is normally inadequate and there is a lack of stringent enforcement of regulations, except in some countries like Japan, Malaysia and Republic of Korea. Meanwhile, institutional arrangements often characterized by separate and fragmentary management. Roles of different governmental departments or agencies are sometimes overlapped and not yet well-defined. For instance, in Vietnam; Ministry of Construction (MoC) takes responsibility for urban and industrial wastewater management. However, the provision of sewerage and solid waste collection services is the responsibility of municipalities. Ministry of Agricultural and Rural Development (MARD) is responsible for rural water supply and sanitation management. Ministry of Health takes responsibility for guiding medical wastewater collection and treatment as well as other sanitation matters relating to preventive health such as hand washing and general hygiene. Meanwhile, Ministry of Natural Resources and Environment (MoNRE) takes responsibility for overall environmental management. Thus, in order to overcome the shortcomings of wastewater management, strong legal framework and clarification of institutional roles and responsibilities is one of the key strategies. There are always inter-connections between wastewater and other relevant sectors such as water supply, solid wastes management, water resources management, etc. Therefore, a unified or integrated strategy for managing various components of water management, including wastewater treatment, under the coordination of a single governmental department or agency is vitally important.

Pro-active participations of all relevant stakeholders

Community wastewater management project must involve all relevant stakeholder groups, including both governmental and non-governmental stakeholders such as local actors or private sectors at the early stage of decision making process in order to ensure transparency in management and sustainability of the project. Examples of good practices have been observed in several countries such as Malaysia, Indonesia and Manila of Philippines. In Malaysia, for instance, privatization has been utilized as an effective tool to improve the management of water services by the State Government of Selangor (ADB & NUS, 2012). Another example is from Indonesia. The Government of Indonesia through Ministry of Public Works (MoPW) has committed to increase resources to support replication and scaling-up approach to community-based decentralised sanitation nationwide through a program entitled SANIMAS since 2006. The SANIMAS program is based on community-driven development principles. SANIMAS is a program to provide wastewater infrastructure for the people in the crowded urban slums (Fig. 6). After 2007 this approach is considered a success and the central government was adopting SANIMAS as national program to accelerate sanitation development by replicating it to other cities, in order to achieve the MDG targets. SANIMAS uses a demand responsive approach (DRA) principle. Local Government has to express their interest, indicated by budgeting on budget plan. Central government will select the participating city/
community by several criteria, such as join PPSP program (or Accelerated Sanitation Development in Human Settlements), already have city sanitation strategy and have a Mid-term Investment Planning for wastewater sector. Participating cities/communities were selected through a transparent and competitive process. Based on the standard criteria that included technical feasibility, willingness to contribute and experience with other self-help projects. SANIMAS was implemented in more than 569 locations in 31 provinces by Indonesia central government in 2012. The program goal is to encourage community initiatives in an open, participatory and self-reliance approach. Community involvement is also required in financing the facilities, both in construction and operational phase.

Appropriate technology choices

In many cases, application of advanced technologies for wastewater treatment are not feasible for local communities, mostly because of huge costs for investment, operation and maintenance, skilled workers requirements for proper operation of system. Depending on local physical and socio-economic conditions, sustainable wastewater treatment technologies should be selected. In order to be considered sustainable, selected technologies should be not only socially acceptable, economically viable, technically and institutionally appropriate, but it should also protect the environment and the natural resources (Langergraber, 2013). Although there is no single solution for all countries or cities, or even areas and the selection of technology choices is depended on various technical, socio-cultural, institutional and economic factors including consumer’s affordability and their willingness to pay, but appropriate low-cost, environmentally sound, socially and technically acceptable technologies with high reliability and simplicity in operation and maintenance should be given high priority, especially in developing countries, after taking into account their socio-economic conditions. For instance, in China, the constructed wetland system has been utilized for domestic wastewater treatment without the use of electricity. According to the Ministry of Environmental Protection in 2011, among 2,738 urban treatment plants, 86 operating domestic treatment plants applied the constructed wetland system. In Chongqing city, there are two domestic wastewater treatment plants constructed through a Japan-China cooperative project in 2008. These plants introduced a constructed wetland system after the contact aeration process and activated sludge process in order to reduce electricity consumption. These facilities achieved 43-98% and 62-97% of BOD removal rates respectively, based on monthly data for water quality monitoring conducted over a one-year period following construction (MoE, 2012)

Financial stability and sustainability

One of the key issues in any wastewater management project is how to ensure financial stability and sustainability. Traditionally, costs for investment, operation and maintenance of wastewater projects are often covered by central or local governments. However, budget allocations from local governments for wastewater

Figure 6

SANIMAS system using MCK Plus+ facility in Bekasi City, Indonesia
(Enhanced communal bathing, washing and toilet block, often referred to as “MCK Plus+” facility)
Source: Author, 2013
treatment projects are usually very limited. Therefore, in order to sustain wastewater services delivery, innovative and effective financial management mechanisms and economic instruments or tools have to be considered, e.g. privatization, public-private partnerships, micro-financing or revolving funds, which have been successfully applied in some WEPA countries such as Malaysia, Philippines and Vietnam, respectively.

**Public-Private partnerships**

Nowadays, many countries are searching for viable models to improve and provide better infrastructure services including sanitation and sewerage services because of the current public backlash and depressed investor outlook. Privatization is one of these viable options. Good practices have been observed in Philippines and Malaysia. However, this model is still new to most of countries in Southeast Asia, thus it is important to keep in mind that the governments should not rush into privatization if they may not find many good and well-qualified candidates for making privatization become success.

In the Philippines, a public company namely the Metropolitan Waterworks and Sewerage System (MWSS), the largest sanitation and sewerage service provider, took an important positive step of signing 25-year concession contracts in 1997 with two private water utilities for providing water supply and sanitation services to Metro Manila. About 10 years later in 2007, 15 years term extension was given to these two private water companies. The decision of privatization was aimed at transferring financial burden to private sector, improving service standards and operational efficiency, as well as minimizing tariff impact. However, assets are still belonged to MWSS. The service area of MWSS was divided into East and West Zones, and two separate concession contracts were signed with Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI), respectively. They provide sewerage and septage management to their customers in the Metro Manila Region and adjoining provinces, serving approximately 15 million people and covering an area of 1,940km². It is expected that by the end of the concession period in 2037, each concession area will be fully covered by sewerage system with complete sewage treatment. Outside of Metro Manila, a number of Local Government Units (LGUs) and Water Districts (WD) are responsible for planning, implementation and monitoring of sanitation programs through the provincial, city of municipal health offices. Besides, there are a number of private companies in major cities providing septic tank desludging services.

Experience with privatization of sanitation and sewerage services in Philippines has been mixed. Although both concessionaires suffered pressures of currency devaluation since the start of concession contracts, but after the first five years of operation, Maynilad experienced considerable difficulty in obtaining loans to finance capital expenditures, while Manila Water was making profits. This is just because they adopted different financing models and approaches in addressing the problem. Manila Water used the cooperative approach, which recognized that people wanted to pay as little as possible for their water services. Therefore, they focused more on the urban poor and low-income communities, where pipelines were shared by several households. By doing this, the fixed installation cost can be reduced. As a result, the problem of illegal connections can be controlled and the network has been protected. On the other hand, Maynilad took a threatening strategy. People who were caught for water theft were penalized. Unfortunately, this monitoring and enforcement approach was not very effective (Chia, et al., 2007). Therefore, it can be seen that before determining to go with privatization, governments may need to consider many other important factors as well such as proposed financing models as well as approaches to address the problem.

Another good example has been observed in Malaysia, one of the few countries in Southeast Asian region that achieved great success in both wastewater and septage management through privatization of sewerage services. Until 1994, many local governments still controlled sewerage services covering the entire country. Unfortunately, these services were not consistent and in many areas, standards were not met. Understanding the need of improving the sanitation level of the
country, the federal government passed the Sewerage Service Act (SSA) in 1993 and signed a concession agreement with Indah Water Konsortium (IWK), a private contractor, to deliver the management of sewerage services. The contract included operation, maintenance, and development of sewerage infrastructure over a 28-year concession period. However, the government of Malaysia, under the Ministry of Finance, controlled capital expenditure and similar to Philippines case, assets still belong to the government.

According to JSC (2011), since the start of concession agreement, the ratio of connected households to the sewerage system has significantly increased to about 70% in 2010, compared to 5% in 1993. Number of wastewater treatment plants that comply with the standards for discharged effluent has also increased from year to year. In 2006, up to 69% of wastewater treatment plants met the BOD standard and 88% of them complied with the total suspended solid (TSS) standard. IWK operates and maintains about 5,800 wastewater treatment facilities across the country, which covers a population equivalent of 19,500,000 people by 2010. Meanwhile, by the year 2010, total population in Malaysia is estimated at 28,400,000 people. In the past, a communal septic tank used for an apartment was considered a wastewater treatment plant, but it now regarded as an individual household septic tank. In term of septage management, IWK started the scheduled desludging program; consequently, the percentage of desludged septic tanks has drastically increased from 2% in 1993 to 58% in 2001. Recently, an increasing number of septic tank owners showed unwillingness to pay the desludging fee and contacted a sludge extractor only when their tanks had trouble. To tackle this issue, the government of Malaysia has adopted a new policy for desludging which requested that sludge must be collected once every 3 years either by IWK or a private contractor holding a permit from SPAN. If septic tanks are not desludged within 3 years, owners can be fined up to 50,000 Ringgit (about US$16,500). Under Water Service Industrial Act (WSIA), the fines for non-compliance have significantly been increased to oblige owners to comply with their desludging duty and pay for sewerage services in covered areas (JSC, 2011).

4. Conclusion and Recommendations

Most of WEPA member countries have made significant progress to improve proportion of people access to improved sanitation facilities in the last decade. However, challenges of effective domestic wastewater management in WEPA countries should not merely place on efforts to increase proportion of population using improved toilet facilities to meet sanitation targets of MDGs set by each member country, but appropriate attention should be given to the performance of these toilet facilities as well as the consequences of its effluent.

Decentralised wastewater treatment system are becoming a promising solution for effective domestic wastewater management in WEPA countries for the time being, even they also have some limitations compared to centralized systems. Therefore, in order to take the full advantages and replicate appropriate DEWATS models in WEPA countries, the following points should be considered:

- A strategic and long-term plan for domestic wastewater management is essential, where strong commitments and political will from both central and local governments should be emphasized, including allocation of sufficient human and financial resources. At the same time, septage management especially in urban areas should be considered a critical aspect of sanitation planning.

- Decentralisation of decision making and active participation of multi-stakeholders are proven to be critical for sustainable wastewater management, especially in WEPA countries. Although, theoretically, decentralised system still has some disadvantages, especially in term of energy efficiency as mentioned earlier, however, by utilizing decentralised energy sources, e.g. distributed solar photovoltaics (PV), this problem can solved. The experience of Japan in effective decentralised sanitation management with Johkasou might be useful and applicable to other countries as a prevalent measure of sanitation.
- Stringent legal framework and transparent institutional arrangements are needed. Roles and responsibilities of different governmental departments or agencies should be clearly defined.

- Pro-active participations of all relevant stakeholders, especially private sector involvement and investments in sanitation sector should be considered in the sanitation planning process.

- Selection of technological choices should depend on local socio-cultural, institutional, technical and economic conditions. However, appropriate low-cost, environmentally sound and socially acceptable technologies with high reliability and simplicity in operation and maintenance should be given a high priority.

- Ensure financial stability and sustainability of the project by utilizing innovative and effective financial management mechanisms and economic instruments.

5. References


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Figure 1: Picture was taken in Haiphong city of Vietnam

Figure 2.: Data for the relationship between urban wastewater treatment ratio and GDP per capita in WEPA countries

Figure 4: Data for cost estimate for different levels of sanitation technologies

Figure 6: Pictures were taken during the field visit in Indonesia (2013)

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