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THE LIMITATIONS OF SUBSURFACE FLOW CONSTRUCTED WETLANDS APPLYING IN CITIES IN MALAYSIA

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ABSTRACT

The safety and adequacy of water resources are of vital importance to humanity. With economic and social development, urbanization has accelerated, and the population of townships has continued to rise, increasing the amount of domestic sewage discharged in towns. Although its discharge meets the Grade A standard of the Environmental Quality (Industrial Effluent) Regulations 2009, it is still lower than the Grade IV water in the National Water Quality Standards and belongs to the sewage category. In this study, a qualitative research method is used to investigate the limitations of the application of constructed wetlands in Malaysian cities. This study provides interview data on the views of the two water companies on the application of constructed wetlands to sewage treatment plants. This study finds that land and cost are significant factors restricting the application of constructed wetlands in cities. Therefore, the publication of relevant policies on the comprehensive utilization of water resources may encourage sewage treatment plants to apply tertiary sewage treatment technologies further to purify wastewater.

Keywords:
Constructed Wetlands; Interviews surveys; Sungai Selangor; Sewage treatment plant; tail water; Wastewater

INTRODUCTION

Recently, most rivers in Malaysia have polluted, and 53% classified as polluted (Naubi et al., 2016). The primary pollution sources of the river come from five aspects, namely manufacturing, agricultural industry, sewage treatment plant, pig farm and wet market. Among them, the sewage treatment plant discharges were the highest pollutants into the river on average; released 202 tonnes/day of Biochemical Oxygen Demand pollution load, 303 tonnes/day of Suspended Solids Load pollution load and 162 tonnes/day of Ammoniacal Nitrogen Load were released in 2018 (Goi., 2020). Due to the population of townships, increasing the amount of domestic sewage discharged in towns has continued to rise. The scale of sewage treatment plants is gradually rising (Hanum et al. 2019; Wong et al., 2019). However, its discharge meets the Grade A standard of the Environmental Quality (Industrial Effluent) Regulations 2009; it is still lower than the Grade IV water in the National Water Quality Standards and still belongs to the sewage category. The water quality index has been classified by the Department of Environment (DOE) according to a number of classes, for example, class I, II, III, IV and V. The higher the index value, the higher will be the quality of the water; the lower the index value, the lower the water quality (Mohiyaden et al., 2019). Consequently, it is significant to apply green technology to purify the tail water further (Abood et al., 2017). Corresponding, reclaimed water should be meet the national water quality standard Grade III that satisfy landscape purpose reuse, thereby saving water resources and protecting rivers (Division et al., 2004). Nowadays, treat sewage plant discharges by the subsurface flow constructed wetland become more and more in the world. Moreover, the treatment and recycling of tail water are effective means of mitigating water pollution problems; they can promote the sustainable and renewable development of water resources and is essential for treating effluent from sewage plants (Cheng et al., 2019).

Eutrophication of lakes and water quality deterioration have become a major environmental problem worldwide (Ayele and Atlabachew, 2021; Shaharom et al., 2019). Since the tail water of the sewage treatment plant is lower than the nitrogen and phosphorus discharge standards for surface

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water, the tail water is discharged into the river and the water body becomes eutrophication for a short time (Wang., 2020). Generally, the scale of rivers may determine their dilution capacity. Large rivers have a more substantial dilution capacity than small rivers.

Due to human activities, some rivers in Malaysia have been polluted. The quality of the water, which used to be classified as Class II and required only conventional treatment, has now deteriorated to Class III, which requires extensive treatment in the river's middle and lower basin (Huang et al. 2015; Baharudin et al. 2021). Due to the treatment of river pollution, massive investment in the workforce, time and economy. Therefore, it is economical to take measures to prevent river pollution.

LITERATURE REVIEW

According to Liu, Zhang and Xu (2017), the constructed wetland system can serve as a sustainable landscape ecosystem and achieve the purpose of sewage treatment. Recently, the water resources shortage and pollution of the water environment in Malaysia have become increasingly prominent. The reuse of tail water from urban wastewater treatment plants is an effective measure to solve the urban water shortage. The advanced treatment and reuse of the tail water of urban sewage treatment plants for landscape purposes have comprehensive water conservation and environmental protection benefits (Zhu and Dou., 2018). While sewage treatment plants have wastewater treatment capabilities, they do not have ecological service functions. To improve the effluent quality of the sewage treatment plant and meet the Grade III water in the National Water Quality Standards, the sewage treatment plant needs to add advanced treatment processes. The subsurface flow constructed wetlands, as a treatment process with low cost and efficiency pollutants removal, are often used to treat sewage plant tail water (Liao., 2018). However, the current application of constructed wetlands is more widespread in rural areas than in cities. Therefore, it is necessary to discuss the limitations of the application of constructed wetlands in cities from economy, environment and technology.

Based on the research problem and literature review above, therefore this study is to identify and discuss the limitations of the application of subsurface flow constructed wetland in Malaysia.

METHODOLOGY

To measure comprehensible study outcomes, a qualitative study was conducted. The interview has certain advantages, it is relatively economical to implement, and it can obtain rich and detailed information to make it more in-depth to explore the problem. For this reason, the interviews surveys were conducted to investigate the perception about the possibility of subsurface flow constructed wetlands large-scale used in Malaysian cities. Therefore, e-mail interviews were conducted with two companies in March 2021. A corporate communications manager from Pembentungan MMC Langat Sdn Bhd was chosen as an interviewer for this study. The interviewer provided information on the management and operation of sewage treatment plants. A designer from Indah Water Konsortium Sdn Bhd in Malaysia was selected as an interviewee for this research because the interviewee has an in-depth understanding of sewage treatment systems. The purpose of this study is to collect and analyze different perspectives from various industries about the wastewater treatment system of sewage treatment plants and constructed wetland systems. The two sample sizes are considered to collect sufficient information because the two interviewees have extensive experience and participated in design projects. Due to they are involved in the design of wastewater treatment processes and constructed wetland systems, they have a deep understanding of municipal wastewater treatment processes, helping gather in-depth information on research topics.

In the qualitative phase, we analyzed the data through constant comparative method. The findings were linked to the available documents. There are two tables that summarize the key findings of the analysis.

Table 1. Summary of Interview Participants

Interviews	Profession	countries
Pembentungan MMC Langat Sdn Bhd	Corporate communications manager	Malaysia
Indah Water Konsortium Sdn Bhd in Malaysia	Designer	Malaysia

RESULTS AND DISCUSSION

Interview data collected by MMC Pembetungan Langat Sdn Bhd.

Table 2. Summary of Fundings

Respondents	Questions	Fundings
A corporate communications manager	Question 1: What are some of the current issues facing the Langat Centralized Sewage Treatment Plant?	Currently, the Solid Proving Test should be conducted and get Certificate of Completion and Compliance (CCC) from authorities.
	Question 2: What is the current method used in your sewage treatment? What I mean is the technology used. Do the nitrogen and phosphorus of the effluent from the treatment plant meet the Standard A effluent quality?	Typically, Advance Activated Sludge treatment process is used in the sewage treatment plants. Both nitrogen and phosphorus of the effluent from the treatment plant meet Standard A effluent quality.
	Question 3: Could you please tell me what disinfection method is employed in the sewage treatment at this plant?	Chlorination disinfection not have been used to treat effluent because not have planning to recycle for other usage currently.
	Question 4: Do you think constructed wetlands can be effectively used for the advanced treatment of reclaimed water before its discharge into the river?	Effectively constructed wetlands required a large area, which is not practical in at the highly populated areas.
	Question 5: Do you think the undeveloped land in the sewage treatment plant can be developed into an ecological wetland park with deep purification functions?	The application of the ecological wetland park with deep purification function may not be necessary as the sewage treatment plant's effluent is meet the Standard A Environment Quality (Sewage) Regulation 2009.

Interview data collected by Indah Water Konsortium Sdn Bhd

Table 2. Summary of Fundings

Respondents	Questions	Fundings
A designer	Question 1: What are some of the current issues facing the Sewage Treatment Plant?	Some of the older treatment plants are also not designed to meet the latest DOE standards.
	Question 2: What is the current method used in your sewage treatment? What I mean is the technology used.	Currently, the Activated Sludge treatment process is used, namely Extended Aeration and Sequential Batch Reactor.
	Question 3: Do you think constructed wetlands can be effectively used for the advanced treatment of reclaimed water before its discharge into the river?	Although the constructed wetland may help to further polish the effluent to better quality, the overall life cycle cost of the system would need to be evaluated to ascertain if it is effective.
	Question 4: Could you give some of your views on the current status and future development of the sewage treatment process?	Currently, most sewage plants not have fitted with constructed wetlands. However, it would be a welcome move if the government or developer who constructs the sewage plant consider this option that will benefit all in terms of addressing the effluent quality and recreational value.
	Question 5: Do you think the undeveloped land in the sewage treatment plant can be developed into an ecological wetland park with deep purification functions?	Generally, most sewage plants' land areas are given based on the stipulated land requirement in Malaysia Sewerage Industrial Guidelines (MSIG) Volume 4 which is based on sizing needs of sewage treatment processes and hence, may not be sufficient for additional space (undeveloped land) for the constructed wetlands.

Both Respondents from interview data were collected by Indah Water Konsortium Sdn Bhd (Respondent A) and MMC Pembetungan Langat Sdn Bhd (Respondent B) were felt that more research and development are needed before the application of constructed wetlands in cities.

Indah Water Konsortium Sdn Bhd served more than 25 million population equivalent, operate and maintain more than 7,000 sewage treatment plants and around 20,000 km underground sewage pipelines. Respondent B believed that a modern and efficient sewage treatment system is essential to ensure that wastewater is treated before it is discharged into the river to help protect the country's water resources, protect public health and provide a cleaner and safer environment. The respondent reports that most sewage treatment plants use Activated Sludge treatment process, named Extended

Aeration and Sequential Batch Reactor. Generally, the sewage treatment stage is divided into primary treatment and secondary treatment. Currently, there is no tertiary treatment in the sewage treatment plant. The tertiary treatment is to purify the wastewater further to achieve high water quality standards and reuse reclaimed water. Therefore, most sewage treatment plants have not realized comprehensive utilization of water resources.

Several considerations may limit the application of constructed wetlands in cities, including cost, land, and policies. Respondent B felt that constructed wetland is an effective advanced sewage treatment technology. Both respondents believe that should evaluate the entire life cycle cost of the constructed wetland to determine whether it is effective. The life cycle cost of constructed wetland is a method to evaluate the total cost of an asset during its life cycle, including construction cost, maintenance cost, and operating cost. Although constructed wetland is an environmentally friendly sewage treatment technology, it has some limitations for its application in cities. Therefore, when the large-scale application of constructed wetlands in cities, it should be planned to a suitable place to make it play the most effectively. In the background of global warming, green wastewater treatment technology will be one of the significant developments, so it is important to improve the restrictions on the application of constructed wetlands in cities.

The constructed wetlands can meet both the value of sewage purification and landscape aesthetics at the same time. Therefore, the landscape -type constructed wetlands method is recommended to be used instead and included in the green space plan to solve the contradiction between constructed wetlands and urban land. It can be used as a central point connecting the city's sewage treatment plant and the river as an important natural filtration system before the discharge flows into the river. After the sewage is deeply purified by the landscape-type constructed wetlands, the treated water can be raised in standard or quality to fulfill the Class I or Class II of the national water quality standards for Malaysia.

CONCLUSION

The research results show that the application of constructed wetland in sewage treatment plants has limitations because it is uneconomical to use constructed wetland in densely populated cities. In addition, the discharge standards of some sewage treatment plants do not meet the recycled water reuse standards, limiting the use of recycled water. Furthermore, most sewage treatment plants do not have tertiary sewage treatment because they have no purpose for reclaimed water reuse. However, land, cost and policy may affect the application of constructed wetlands in cities. Therefore, the publication of relevant policies on the comprehensive utilization of water resources may encourage sewage treatment plants to apply tertiary sewage treatment technologies further to purify wastewater.

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