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APPLICATION OF LAND USE APPROACHES IN CONTROLLING INDUSTRIAL WASTEWATER DISCHARGE INTO RIVERS

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Abstract

In Malaysia, water pollution is one of the major environmental problems facing the society at present, especially river water pollution. Despite their importance, especially as supply of water for consumption, rivers are continually being polluted by human. One of the main contributors to river water pollution in Malaysia is effluent (wastewater) discharge from industries. At present many of the measures exercised by various government agencies to control industry-related river water pollution centre on the use of non-land use approaches such as enforcement of legislation and use of technology. However, the use of non-land use approaches is not without its own shortcomings. Hence, this paper aims to provide some insights into the possibility of using land use approaches to achieve the same result, which is controlling industry-related river water pollution.

Keywords: Land use Approaches, Water Quality, River Pollution.

INTRODUCTION

Water is a precious environmental resource. To sustain life, living organism requires water. In fact, human would survive longer without food than without water. The major issues related to the use of water by humans are water quantity and quality. Water in quantities is necessary for the support of modern societies, but water of good quality is needed to allow for its consumption by the same societies. In Malaysia, water pollution is one of the major environmental problems, especially river water pollution. Rivers have always been the focus of growth and progress of societies in Malaysia, historically and presently. Rivers, like the Malacca River, Klang River, Muar River, had played a major role in the growth of important towns and cities in the past. Malacca River was the busiest trading zone during the Sultanate era, Klang River was the origin of Kuala Lumpur, the capitol city of Malaysia, and Muar River gave rise to Bandar Maharani (later Muar), former capitol of Johor. More recently, Putrajaya, the country fabulous federal administration centre, has also been developed with

river as its focus. Rivers are also the main source of water supply for consumption in Malaysia. Presently, there are close to 350 (Legal Research Board, 1992), if not more, potable water intakes all over the country, pumping in river water for processing and supplying clean water for consumption to more than 20 million of the population.

Malaysian River Water Quality

Despite their importance, rivers are continually being polluted by human. In Malaysia, Department of Environment (DOE) reports that prior to 1999, river water quality in the country is degrading steadily over the previous few years with the number of effluent-related pollution of river water remains high (DOE, 1999). However, monitoring results for the year 2001 have shown improvements in terms of Malaysian river water quality (DOE, 2001). DOE has conducted river water quality monitoring since 1978. The main objective of the exercise is to establish the status of water quality, to detect water quality changes and to identify sources of pollution (DOE, 2001). In 2001, out of the 120 river basins monitored, 60 basins (50%) have been identified as clean, 47 (39%) slightly polluted, and 13 (11%) polluted (refer Figure 1). Similar monitoring in the previous year indicates that 34 river basins were clean, 74 slightly polluted, and 12 polluted (DOE, 2001). Comparing the results of both years, it seems like there has been a marked improvement in water quality of those river basins, especially in terms of the increase in the number of clean river basins and the reduction in the number of slightly polluted river basins. However, one may argue that the improvement may not be that significant since the considerable increase in the number of clean river basins was largely attributed by '*...the fact that the 26 river basins that became clean (WQI > 81) were already* ***marginally*** *in the slightly polluted category (WQI 76-80) over the past several years.*'(DOE, 2001, p.33). By the same token, one may argue that the number of polluted river basins actually increased from 12 basins in year 2000 to 13 in year 2003.

Sources of Malaysian River Water Pollution

In terms of Malaysian river water pollution, the main sources are from sewage, industries, and earthworks and land clearing (DOE, 2001). Figure 2 below shows that 33% of the river basins were polluted by suspended solids resulting from land clearing and earthworks activities, 20% polluted by ammoniacal nitrogen from sewage that included livestock farming and domestic sewage, and 18% polluted by biochemical oxygen demand from sewage, and agro-based and manufacturing industries.

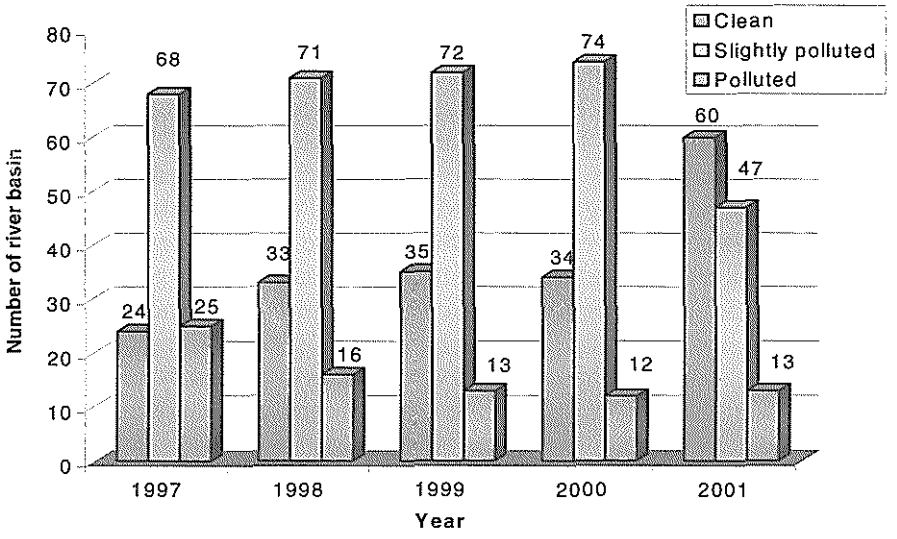

FIGURE 1: Water Quality of Malaysian River Basins, 1997-2001
Source: Adapted from DOE, 2001

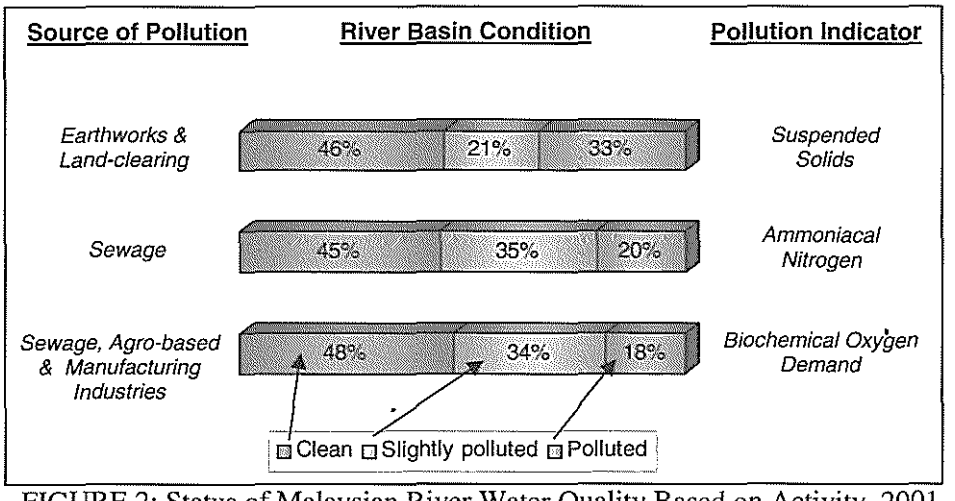

FIGURE 2: Status of Malaysian River Water Quality Based on Activity, 2001
Source: Adapted from DOE, 2001

SCOPE OF THE STUDY

Earlier discussion has identified several sources of river water pollution in Malaysia. Industrial activity has also been identified as among the biggest contributors to the problem. Figure 2 earlier indicates that in 2001, 52% of Malaysian river basins were polluted by biochemical oxygen demand from activities related to sewage, agro-based industries and manufacturing industries. The general consensus is prevention is better than cure. Thus, in order to control river water pollution resulting from industrial wastewater discharge, obviously, the best thing to do is to control the source of the pollution. Hence, this paper focuses its discussions on using land use approaches in controlling the problem of industrial wastewater discharge into rivers. It is also necessary to note here that all discussions within this paper are purely based on Malaysian context, unless specified otherwise.

Method of Study

A questionnaire survey was conducted on selected sample consisting of built environment professionals who have experiences in town planning related works. These can be in the form of development plan study, physical plan preparation and environmental planning and management. Altogether, a total of 67 samples were selected for the purpose of this study. Out of the 67 respondents, 28 were those working in the field of town planning, 19 in environment, 12 in design and 8 in engineering. Those working in design are basically architects or landscape architects. Due to unavoidable constraints, sample selection has been limited to Klang Valley only. Data collected through the survey was later coded and keyed in into statistical computer software - SPSS 10.0 for Windows. Analyses on the data were also carried out using the same software.

NON-LANDUSE APPROACHES IN CONTROLLING INDUSTRIAL WASTEWATER DISCHARGE INTO RIVERS

Presently, non-land use approaches have found widespread application in efforts to mitigate the problem of industrial wastewater discharge into rivers. The main benefit of this type of approaches is that their implementation is direct, site-specific, and straightforward. This chapter will briefly look at three of the non-land use approaches commonly adopted – namely legislative approach, end-of-pipe approach, and pollution reduction approach.

Legislative Approach

Rules and regulations are possibly the most widely used measure in mitigating pollution resulting from industrial wastewater discharge. The amount and composition of pollutants in wastewater discharge is subjected to limits as stipulated by regulations. In Malaysia, the Third Schedule of the Environmental Quality (Sewage & Industrial Effluents) Regulations, 1979 (a subsidiary legislation to the Environmental Quality Act (Amendment), 1974) specifies the parameter limits of industrial wastewater discharge. The limits are categorised into two – Standard A and Standard B. Standard A is applicable to wastewater discharge upstream of potable water intake, while Standard B is for downstream discharge (Legal Research Board, 1992). The regulation is being widely imposed throughout the country and helps to reduce river water pollution resulting from industrial wastewater discharge.

End-of-pipe Approach

Apart from rules and regulations, end-of-pipe solution is also commonly adopted in controlling industrial wastewater discharge. End-of-pipe solution refers to the treatment of wastewater prior to discharge where wastewater is being treated using either physical processes, chemical processes, biological processes or combination of the three, in order to reduce the amount of pollutants in the wastewater. The use of suitable and proper treatment processes enable industries to achieve compliance with the regulation requirements in terms of wastewater discharge.

Pollution Reduction Approach

Pollution reduction refers to measures adopted in order to reduce pollution through several techniques as listed below.

i. Reduce the amount of pollutants resulting from the production processes such as by replacing hazardous input material with non-hazardous one, or changing the output composition. Replacing paint coating of the final product with longer lasting plastic coating is one of the many examples where changes in product composition can help to reduce pollution.
ii. Reduce the volume of wastewater through employing good management practices. For example, the practice of minimising the amount of water use for household tasks (such as cleaning of equipment and machinery) means less wastewater generated.

Reduce the volume of wastewater that need to be collected and treated through recycling and reuse of the wastewater. One of the common

iii. Practices among industries are to reuse wastewater in production process and also to use wastewater for other purposes in treatment process. For instance, acidic wastewater from one industry can be collected and transported to another industry with alkaline wastewater for neutralisation purposes.

Weaknesses of Non-Land use Approaches

There are several inherent weaknesses of the legislative approach which might affect its effectiveness in mitigating river water pollution resulting from industrial wastewater discharge. A case in point would be the comprehensiveness, or lack of it, of the Third Schedule of the Environmental Quality (Sewage& Industrial Effluents) Regulations, 1979. The list of parameter limits of the Third Schedule is not comprehensive and excludes parameters such as herbicides, pesticides, nitrate nitrogen, radioactive material, and total organic carbon.

Another main weakness of the legislative approach lies in its enforcement. Level of ground enforcement is questionable due to lack of manpower. The management and enforcement of the regulation fall under the responsibility of DOE. However, with a mere workforce of 586 for the whole of Peninsular Malaysia (DOE, 1998), it is arguable that DOE is capable to carry out effective enforcement of the regulations in order to curtail non-compliance discharges.

End-of-pipe approach relies heavily on technological capability to treat wastewater, and consequently, reduce its pollutants loading. The same can be said with regard to pollution reduction approach. The technology to treat wastewater, unfortunately, does not come cheap. Its installation, operation, and maintenance generally require hefty investments from the industries, and accordingly, a burden to small and medium scale industries. As a result, many of these industries opted not install wastewater treatment system and rather discharge their wastewater untreated.

Survey Findings

Based on the survey, it was found that all respondents agreed that river water pollution resulting from industrial wastewater discharge is a major problem. Additionally, many of them (80.6%) believe that the existing regulation is ineffective in controlling the problem. Only 13.4% said otherwise, but quoting

poor regulation enforcement as the reason for the problem. 6.0% of the respondents gave no answer since they were not aware that there is such regulation that control industrial wastewater discharge into rivers.

LAND USE APPROACHES IN CONTROLLING INDUSTRIAL WASTEWATER DISCHARGE INTO RIVERS

Earlier discussion has highlighted that, despite their ability to mitigate river water pollution resulting from industrial wastewater discharge, the non-land use approaches have their own shortcomings, and this was reflected in the high percentage of polluted and slightly polluted river basins by industrial effluent-related pollutant (refer Figure 2). Seemingly, more has to be done in order to mitigate river water pollution resulting from industrial wastewater discharge.

Due to the imperfection of the commonly adopted non-land use approaches, it is worth to consider how land use approaches can assist in mitigating river water pollution resulting from industrial wastewater discharge. The advantages of such strategy are that, besides being reactive and proactive in nature, it also represents a multi-pronged solution to the problem. The development of river reserve, for instance, does not only help to mitigate river water pollution, but also beautify the area and enable its use for other purposes such as recreational.

The following part of this paper will briefly discuss three of the many land use approaches that have the most potential in mitigating river water pollution resulting from industrial wastewater discharge. These approaches are development of river reserve, development of river corridor, and development of planned industrial area.

Development of River Reserve

From Malaysian context, river reserve can be defined as strips of land on both side of the river banks which have been gazetted by State Authority for the purpose of river reserve under the Section 62 of the National Land Code 1965 (Act 56). By being gazetted as reserve, understandably, the land belongs to the State and for public purposes. The minimum width of river reserve recommended by the Department of Irrigation and Drainage Malaysia (DID) is as in Table 1 below. Figure 3 provides a cross-section of a typical recommended river reserve.

TABLE 1:
Minimum Width Requirement of River Reserve

Width of water channel	**Minimum reserve requirement (m)**
> 40 metres	50 metres
20 – 40 metres	40 metres
10 – 20 metres	20 metres
5 – 10 metres	10 metres
< 5 metres	5 metres

Source: DID, undated.

Application

The designation of river reserve is multi-purpose, including serving as buffer for river erosion, acting as flood plain, providing access for river maintenance, and allowing for Future River widening and straightening works. However, the interest of this paper is solely on its use for river beautification and recreation. Presently, only a handful of river reserves have been developed by DID, State Authorities, or local authorities for such purposes. As a result, most river reserves are being left idle, unattended and unfriendly to any recreational use by the public. Without public attendance along river reserves, industries are relatively unfettered in discharging murky wastewater, which does not comply with regulation standards, into rivers. To the authorities, monitoring non-compliance industrial wastewater discharge is also difficult because the only way to monitor is through river patrol. However, dense shrubs and undergrowth, which covered the unattended river reserves, can easily conceal industries' discharge conduits.

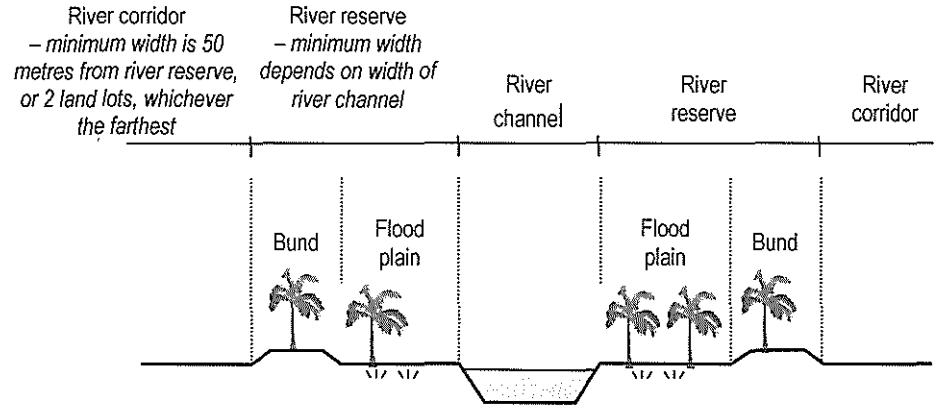

FIGURE 3: Cross Section of Typical DID Recommended River Reserve
Source: Adapted from DID, undated

Development of river reserves for recreational activities can attract the public into the area. While no permanent building is allowed, recreational facilities such as sports fields and courts, children playgrounds, jogging paths, and cycling paths, can be developed within river reserves for public use. This approach, apart from beautifies rivers and provides recreational areas for the public, also exposes any activity of industries illegally discharging non-compliance wastewater into rivers. Since more people are using river reserves, any murky and polluted industrial wastewater discharge can be easily spotted by the users, who, in turn, would complain to the authorities or the media. Acting on complaints by the public and reports by the media, the authorities could then easily locate the source of the pollution and enforce appropriate penalty on the polluters.

Weaknesses

As aforementioned, development of river reserves not only beautify rivers and provide recreational areas for the public, but it also help to control river pollution resulting from industrial wastewater discharge. This measure relies on the public to notify authorities or media upon spotting industrial discharges that they think may not comply with the regulation standards. This is easy enough if the pollutants loading of the discharge are represented by the colour of the discharge. For example, wastewater with high oil and grease loading would produce a blackish discharge, and therefore easily identified. However, many other pollutants loading in wastewater is not represented by the colour of the discharge. Wastewater which is highly polluted with certain heavy metals, for instance, can still have a clear discharge. The same goes to wastewater with

high temperature. Although toxic or hazardous, this wastewater is still clear in appearance and, to the public, it might not be a cause of concern.

Survey Findings

In terms of application, 77.6% of respondents replied that they have used river reserve development approach in their previous work, and out of this, 75% of the respondents have experience using the approach specifically to control the problem of industrial wastewater discharge into rivers. A high number (76.1%) of respondents also perceived this approach as being effective in controlling the problem, with only 22.4% of respondents replied otherwise. 1.5% did not answer. Despite its perceived effectiveness and widespread used among the respondents, more than half (55.2%) of the respondents replied that the approach is difficult to implement. 38.8% replied that it is quite difficult to implement the approach, 11.9% very difficult, and 4.5% impossible to implement. Nevertheless, 70.1% respondents expressed their interest to use, or continue using, the approach in the future for the purpose of controlling the problem of industrial wastewater discharge into rivers.

Development of River Corridor

DID identifies river corridor as areas outside river reserves, but within fifty metres or two land lots, whichever the farthest, from river reserve (Figure 3). In utilising the concept of river corridor to control industrial wastewater discharge into rivers, there are two approaches that can be adopted by local planning authorities – to restrict or prohibit industrial activities within river corridor, or to provide incentives to attract non-industrial development within river corridor. Although both approaches lead to the same result, the implementation of one is markedly different from the other. The former is stick and the latter is carrot.

Application

Development of river corridor in controlling industrial wastewater discharge into rivers relies on the exploitation of planning approval mechanism in the planning system. To illustrate, say, a local authority, in efforts to protect a river from being polluted by industrial wastewater discharges, embarks on a policy of industry-free river corridor. Implementing this policy would mean no planning permission would be granted by the local authority to any application for industrial development within the river corridor. At the same time, existing industries operating within the river corridor would also be denied to renew

their operating licence, and therefore, have to operate somewhere else, outside of the river corridor.

On the other hand, instead of applying outright prohibition on industrial activities within the river corridor, the local authority could instead opted for a softer approach. The local authority may decide to provide incentives to attract development, other than industrial, into the river corridor. For example, a higher plot ratio or a bigger plinth area will be allowed for non-industrial development within the river corridor, or planning application for such development will be subjected to a fast approval process at discounted planning fees. Apart from the incentives, the local authority may also decide to increase the fees for licence renewal for existing industries operating within the river corridor. The incentives provided by the local authority, coupled with the increase in licence renewal fees, would make it more profitable to developers/land owners to develop their land within the river corridor, including existing industrial premises, with non-industrial development.

Weaknesses

The softer, or carrot, approach of providing incentives to non-industrial development within river corridor does not guarantee an industrial-free river corridor, especially when it involves existing industries. This approach is more effective in attracting non-industrial development into the river corridor but might not be able to influence existing industries to relocate their operations to other areas outside of the corridor. In reality, the decision for an industry to relocate its operation is not solely governed by the amount of licence renewal fees or profitability of developing the premise with non-industrial development. Various other factors, like availability of workers, easy accessibility for material and product transportation, and economies of scale, also play an important role in any relocation decision.

The stick approach, on the other hand, seems to be able to guarantee an industrial-free river corridor. However, the rigid nature of the approach is usually not favoured by the local politicians since it will reduce their popularity. Fierce lobbying by industry owners might also help to influence local politicians to not adopt such an approach.

Another aspect, which has to be looked into, is the minimum width requirement for river corridor. The existing minimum width requirement of fifty metres or two land lots from river reserve is rather small. It is still possible for an industry operating, say, one hundred metre (width of river corridor plus maximum width

of river reserve) away from river to channel its wastewater direct into the river via underground pipe or even open conduit. The minimum distance of river corridor should ensure that it is impossible or very costly for industry operating immediately outside of river corridor to discharge wastewater direct into the river. Additionally, the minimum river corridor width must also ensure that any seepage from industry does not reach the river before it being diluted or neutralised.

Survey Findings

Most of the respondents (68.7%) agreed that it is difficult to implement river corridor development approach in controlling the problem of industrial wastewater discharge into rivers. This is reflected in the low number (52.2%) of those who replied that they had used the approach in their previous work. Nevertheless, whenever this approach was used, most of them (82%) have been for the purpose of controlling problem of industrial discharge into rivers. The low number of its use may also be because of this approach is relatively new in the field of environmental management as compared to, say, development of river reserve approach. In fact, many of the respondents requested further elaboration on what this approach is all about and how it works. Despite being relatively new, a high number (73.1%) of respondents (after provided with brief explanation on how the approach works) perceived this approach as effective in controlling the problem of industrial wastewater discharge into rivers. Only 25.4% of respondents replied otherwise, and 1.5% did not answer. A chi-square analysis also indicates that there is no significance between the variables of having experience in using this approach in previous work and the perceived effectiveness of the approach. This is reflected in the high number (68.7%) of respondents whom expressed their interest to use, or continue using, the approach in controlling the problem in the future.

Development of Planned Industrial Area

Development of planned industrial area revolves around locating industrial activities in purposely-planned locations, and favourably away from high-density areas (such as urban and residential areas). In Malaysia, apart from providing premises for new industries, development of planned industrial area is also used by local authorities as a mean to provide premises in industry relocation exercise. It has been a popular solution to problems like urban congestion caused by heavy vehicle transporting input material to, and product from, industrial premises; noise and air pollution within residential and

commercial area as a result of industrial activities; and water pollution as a result of industrial wastewater discharges.

Application

Locating industrial activities away from rivers can significantly help to reduce river pollution resulting from industrial wastewater discharge. In implementing this approach, a site, away from rivers and high-density areas would be designated as a planned industrial area by the local authority. Basic infrastructure such as road, drainage, water supply, and electricity supply would be provided in the area. To ensure economy of scale, the type of industries to be developed in a planned industrial area may be restricted, but the scale of the industries varies. To illustrate, say, a planned industrial area is restricted to automotive industries. In such industrial areas, there would normally be a few anchor industries developed, with the rest acting as supporting industries. The anchor industries would be involved in the production of engine, chassis moulding, and vehicle assembly. The supporting industries, on the other hand, would be involved in making components to be supplied to the anchor industries.

Another approach to development of a planned industrial area would be to restrict the scale of industries within the area. A popular approach in Malaysia is to develop a planned industrial area which is restricted to small and medium scale industries. The argument for such an approach is that the small and medium scale industries are among the main contributors to water pollution. Operating at the lower end of the scale, it is argued that these industries could not afford to install the hi-tech and expensive wastewater treatment system. As a result, many of these industries discharge their wastewater untreated. The economy of scale achieved by locating them all in one place would enable a centrally operated treatment system to be installed in the area to treat the industries wastewater. The cost of installing and maintaining the central wastewater treatment system could be shared among them.

Weaknesses

As mentioned previously, the development of a planned industrial area can be used in relocating existing industries away from the riverside in order to protect the river from industrial wastewater discharge. Nevertheless, this approach is not free from problems. Perhaps the most prevalent one is the unwillingness of existing industries to relocate their operations into the planned industrial area.

In a highly urbanised area, the local authority might also face with the problem of finding suitable site to be developed as planned industrial area. Locating such development close to urban area would usually invite strong protest from the surrounding population, while remote location would reduce its attractiveness to the industries.

Survey Findings

A high number (73.1%) of respondents replied that they have experience using the development of planned industrial area approach in their previous work. Out of this, 98.0% have been for the purpose of controlling the problem of industrial wastewater discharge into rivers. In terms of effectiveness, 94.0% of respondents perceived the approach as being effective in controlling the problem. Only 4.5% of respondents replied otherwise, and 1.5% did not answer. In terms of implementation, the general perception is that the approach is relatively difficult to implement, with only 46.3% of respondents replied otherwise. 34.3% perceived the approach as quite difficult to implement, 17.9% very difficult, and 1.5% impossible to implement, with many quoted that finding suitable location as one of the main difficulties in implementing this approach. Despite the perceived difficulties of its implementation, still 92.5% of the respondents expressed their interest to use, or continue using the approach in the future.

CONCLUSION

This study has been helpful in understanding the perception among the built environment professionals involved in the survey on the application of non-land use, as well as land use, approaches in controlling river water pollution resulting from industrial wastewater discharge. The main findings of the study can be summarised as below.

i. All of the surveyed professionals agreed that river water pollution resulting from industrial wastewater discharge is a major problem.
ii. A high number of the surveyed professionals perceived that the regulation is not effective in controlling the problem of industrial wastewater discharge into rivers.
iii. A high number of the surveyed professionals perceived that the land use approaches identified in this study as effective measures in controlling the problem of industrial wastewater discharge into rivers.
iv. A high number of the surveyed professionals perceived that these land use approaches are difficult to implement.

v. A high number of the surveyed professionals are interested in using, or will continue using, these land use approaches in controlling the problem of industrial wastewater discharge into rivers.

In conclusion, it has to be noted here that the aim of this study is not to determine which approach (land use or non-land use) is the best in controlling the problem of industrial wastewater discharge into rivers. Instead, it is to introduce several of the approaches that can be, and have been, used in controlling the problem, and to suggest that there may be a need for employing these various approaches in a more strategic way in controlling the problem. As can be seen from earlier discussion, no one approach is not without its weakness, but all of them posses different strengths that can help in controlling the problem. Therefore, the way forward would be to exploit the strength of the approaches and at the same time to overcome their weakness. With all the approaches being employed strategically, their impacts in controlling the problem would be monumental. Among the various approaches that can be applied in controlling the problem of industrial wastewater discharge into rivers are the land use approaches. As can be seen from the findings of this study, incorporating land use approaches in controlling the problem of industrial wastewater discharge into rivers can be beneficial. The perceived effectiveness of the approaches makes them popular among the professionals surveyed. Furthermore, the need to incorporate these approaches in controlling the problem is even more pressing with the regulation being perceived as ineffective. In addition, a high number of respondents also expressed interest to use, or continue using, the land use approaches in the future despite the general perception that implementation of the approaches is difficult. In the case of river corridor development approach, apart from being perceived to be difficult to implement, it is also relatively new to many of the respondents. Nevertheless, many of them perceived it as being effective and many are interested to use, or continue using, the approach in the future. This may be due to the increase in awareness among the respondents that a more strategic approach is required in controlling the problem of industrial wastewater discharge into rivers. Relying on one approach may not be effective in controlling the problem. But strategic combination of various approaches might be able to bring about better results.

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