THE PERFORMANCE OF CONVENTIONAL SEWAGE TREATMENT PLANT IN KELANTAN

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Recently, a lot of domestic wastewater is being generated due to the rise in the population in most urban areas in Malaysia. This implies that more contaminations are being produced which are likely to affect human health. There for, it is obligatory for wastewater in urban areas and settlements to be treated before settled into surface waters. This study aims some results and discusses the appropriate design, workflow process of the system to handle Kota Bharu's wastewater treatment. There are four types of sewage treatment plants (STPs) including aerated lagoon (AL), extended aeration (EA), sequential batch reactor (SBR) and conventional activated sludge system (CAS) were analysed using secondary data set. The one-year data (2019) was prepared by Majaari Services Sdn Bhd (MSSB) including effluent data, electrical bill data and plant expenses. All the data set were analysed using statistical data analysis such as principle component analysis (PCA), discriminant analysis (DA) and analysis of variance (ANOVA). PCA used to identify the efficiency of the systems in the characteristics of BOD, COD, TSS in the effluent followed by DA to study the appropriate design, flaws and workflow process of the system and lastly ANOVA to determine the appropriate design, workflow process of the system to handle Kota Bharu's wastewater treatment. PCA resulted seven parameters which given high contributed to the STP efficiency. DA showed p- value (<0.05) for BOD, TSS and Ammoniacal Nitrogen and good in differentiate between STP types. ANOVA successfully presented AL was in a good performance followed by CAS, SBR and EL. Therefore, the efficiency of the sewage treatment systems should be identified necessary as it can be used as a guide for MSSB and others responsible teams to make a revolution in the management of domestic sewage in Kelantan in the future.

ABSTRAK

Kebelakangan ini, banyak air buangan domestik dihasilkan kerana pertambahan penduduk di kebanyakan kawasan bandar di Malaysia. Ini menunjukkan bahawa lebih banyak pencemaran sedang dihasilkan yang mungkin mempengaruhi kesihatan manusia. Oleh itu, pentingnya pembersihan air kumbahan di kawasan yang penduduknya padat sebelum air dilepaskan ke sungai. Kajian ini bertujuan menghasilkan keputusan dan membincangkan reka bentuk, system proses aliran kerja yang sesuai untuk menangani rawatan air sisa di Kota Bharu. Terdapat empat jenis loji rawatan kumbahan (STP) termasuk lagoon berudara (AL), aerasi lanjutan (EA), reaktor batch berurutan (SBR) dan sistem enapcemar aktif konvensional (CAS) akan dianalisis menggunakan set data sekunder. Data satu tahun (2019) disediakan oleh Majaari Services Sdn Bhd (MSSB) termasuk data efluen, data bil elektrik dan perbelanjaan loji. Semua kumpulan data dianalisis menggunakan analisis data statistik seperti analisis prinsip komponen (PCA), analisis diskriminan (DA) dan analisis varians (ANOVA). PCA digunakan untuk mengenal pasti kecekapan sistem berdasarkan ciri BOD, COD, TSS dalam efluen diikuti oleh DA untuk mengkaji reka bentuk, kelemahan dan proses aliran kerja sistem yang sesuai dan terakhir ANOVA untuk menentukan reka bentuk, proses aliran kerja yang sesuai sistem pengendalian air buangan di Kota Bharu. PCA menghasilkan tujuh parameter yang menyumbang kepada kecekapan STP. DA menunjukkan nilai p (<0,05) untuk BOD, TSS dan Ammoniacal Nitrogen dan baik dalam membezakan setiap jenis STP. ANOVA berjaya menunjukkan AL berada dalam prestasi yang baik diikuti oleh CAS, SBR dan EL. Oleh itu, kecekapan sistem rawatan kumbahan harus dikenal pasti kerana dapat dijadikan panduan bagi MSSB dan pasukan yang bertanggungjawab untuk membuat revolusi dalam pengurusan kumbahan domestik di Kelantan pada masa akan datang.

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LIST OF ABBREVIATIONS

IWK	-	Indah Water Konsortium
PE	-	Population Equivalent
O&G	-	Oil & Gas
STPs	-	Sewage Treatment Plants
MSSB	-	Majaari Services Sdn Bhd
EA	-	Extended Aeration
SBR	-	Sequential Batch Reactor
CAS	-	Conventional Activated Sludge System
AL	-	Aerated Lagoon
COD	-	Chemical Oxygen Demand
BOD	-	Biochemical Oxygen Demand
TSS	-	Total Suspended Solid
SPAN	-	Suruhanjaya Perkhidmatan Air Negara
IPA	-	Industri Perkhidmatan Air
STS	-	Sewage Treatment System
TOC	-	Total Organic Carbon
MLSS	-	Mixed Liquor Suspended Solids
PHA	-	Polyhydroxyalkanoates
TAG	-	Triacylglycerides
DS	-	Dry Solid
PCA	-	Principle Component Analysis
DA	-	Discriminant Analysis
ANOVA	-	Analysis of Variance
DO	-	Dissolved Oxygen

LIST OF SYMBOLS

z	-	component score
a	-	component loading
x	-	measured value of variable
i	-	component number
j	-	sample number
m	-	total number of variables
z	-	score on each predictor
di	-	discriminant function coefficient
i	-	denotes the number of groups (G)
ki		constant coherent to each group
n		number of parameters used
wij		weight coefficient assigned by discriminant factor (DF)
Yij		observation for treatment group
μj		observations
μ		grand mean of the observation
ti		treatment effect
€ij		effect of random error

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CHAPTER 1

INTRODUCTION

1.1 Overview of study

At the dawn of mankind, problems arising from acquiring fresh clean water is a one of the biggest concerns that could bring civilization to ruins in a matter of years. As human population flourish, so does the steady incline in wastewater generation. Untreated wastewater may lead to diseases and famine in the community. People begins to manage wastewater as early as 1500BC in the earliest known wastewater treatment in Mohenjo-Daro, near the Indus river, currently the state Pakistan (Wiesmann et all, 2007).

Wastewater is watering whose physical, synthetic or natural properties have been changed because of the presentation of specific substances which render it perilous for certain reasons, for example, drinking. The everyday exercises of man is basically water subordinate and hence release 'squander' into water. A portion of the substances incorporate body squanders (defecation and pee), hair cleanser, hair, food scraps, fat, clothing powder, texture conditioners, tissue, synthetic concoctions, cleanser, family cleaners, soil, miniature life forms (germs) which can make individuals sick and harm nature. It is realized that a lot of water provided winds up as wastewater which makes its treatment significant.

Wastewater treatment is the cycle and innovation that is utilized to eliminate a large portion of the contaminants that are found in wastewater to guarantee a sound situation and great general wellbeing. At the point when water is debased and purging gets vital, the best refinement approach ought to be picked to arrive at the refinement targets (as built up by guideline). A refinement cycle for the most part comprises of five progressive advances. There are starter treatment or pre-treatment on physical and mechanical, essential treatment including physicochemical and

concoction, optional treatment or refinement on synthetic and natural, tertiary or last treatment on physical and substance and treatment of the slime planned (administered tipping, reusing or cremation). With everything taken into account, the initial two phases are amassed under the possibility of pre-treatment or preliminary advance, dependent upon the condition (Anjaneyulu et al. 2005; Crini and Badot 2007, 2010).

Wastewater Management in this manner implies taking care of wastewater to secure the earth to guarantee general wellbeing, financial, social and political sufficiency (Metcalf and Eddy, 1991). For an extensive time, allotment wastewater, the board was not given a great deal, accepting any, thought. In numerous social orders, wastewater was disposed of in the lanes and near people focuses making veritable impacts on open prosperity and the earth. This is obvious by the different infections which happened all through Europe until the nineteenth century (Lucking, 1984; Brown, 2005; HDR, 2006; Aiello et al., 2008). Shockingly, when it came to waste the board and sanitization, countries, in reality, even those that suffered plagues, would by and large have short memories. From the earliest starting point of time wastewater, the board has presented people and governments with sweeping particular and political difficulties. The story of waste and wastewater the board is quickly a record of human innovativeness and human weakness (Sorcinelli, 1998; HDR, 2006).

Malaysia has a populace of 28.3 million reliant on the Report of Census 2010 by the Division of Statistics. The assessed volume of wastewater made by city and modern segments is 2.97 billion cubic meters for consistently. The degrees of populace identical (PE) served by the diverse sewerage structures are showed up in Figure 1.1. Indah Water Konsortium (IWK) and Majaari Services Sdn Bhd who's are the nation's principle sewerage capable, detailed the fundamental wastewater treatment types are starter including evacuation of clothes, junk, coarseness, oil, oil following by essential stage which are expulsion of settleable and floatable materials and optional treatment through by natural treatment to eliminate natural and suspended solids. Right now, there is no arrangement to construct tertiary treatment frameworks in Malaysia.

Present study research at Kelantan where is covered by Majaari Services Sdn Bhd (MSSB). MSSB responsible to manage sewerage management services in the State of Kelantan. There are four sewerage systems that were handle by MSSB including extended aeration (EA), sequential batch reactor (SBR), conventional activated sludge system (CAS) and aerated lagoon (AL) Therefore, the efficiency of the sewage treatment systems should be identified necessary as it can be used as a guide for MSSB and others responsible teams to make a revolution in the management of domestic sewage in Kelantan in the future.

1.3 Research Question

Based on the statement problems on comparative performance of four type of sewage treatment plant (STP) in Kelantan, Malaysia there are a few questions to guide the researcher for fulfill this study. The questions as per following;

i) What is the efficiency of the systems in the characteristics of BOD, COD, TSS in the effluent?
ii) Is it system successfully demonstrates appropriate design, workflow process of the system?
iii) Which one sewage plant system successfully demonstrates appropriate design, workflow process of the system?

1.4 Research Objective

The main objective and the specific objectives as per below:

1 To identify the efficiency of the systems in the characteristics of BOD, COD, TSS in the effluent.
2 To study the appropriate design, flaws and workflow process of the system.
3 To determine the appropriate design, workflow process of the system to handle Kota Bharu's wastewater treatment.

1.5 Research Significant

The main focus of this study is to compared the performance of four types of sewage treatment systems in Kelantan. The advantage of this study for MSSB and the company were collaborated (Suruhanjaya Perkhidmatan Air Negara (SPAN) dan Industri Perkhidmatan Air (IPA)) to maintain which one of sewage treatment systems needs to make a revolution in the management of domestic sewage in Kelantan.

In addition, to assess the four types of sewage treatment system (STS) base on different category station, further analysis needs, by searching the variances between quality of sewage, electricity cost and plants expenses. The significant of distinguishing result claim either the STSs in good performance or not. In other words, there is a something wrong with the plants if the same pattern of the contaminant exposes that is mean their pattern before water treat and after the water was treated stable so that, there is a problem with that plant. So, the precaution should be taken and consistent on the monitoring plants. Therefore, the high quality of discharge water will produce and safe before release to the river (upstream or downstream).

At last, the analyzation will be selected which one of STS will save money usage, time management and sapling task management. The reducing maintenance costs will make it easier for MSSB to select the sewerage system which is needed to replace the existing sewage treatment plant with a more effective one.

1.6 Research Limitation

Present study depends on a few of limitation as per following;

1. The sewage treatment, electricity and plants expenses data were collected from MSSB.
2. All the procedures and protocols used are referenced and it is adaptations used by the previous researcher where validity and consistency have been proven.

1.7 Research Outline

Chapter 1 identifies the introduction of the research which are included background study, problem statement, research questions, aims and objectives, research significant, research limitations and thesis outline. The whole of this section was used for further section.

Chapter 2 presents the literature review, focuses upon the role of sewage characteristics which are including temperature, pH, color and ordor, solids, nitrogen phosphorus, chlorides, organic materials (BOD, COD) and toxic metals and compound. Besides that, sewage treatment systems such as sewage treatment systems for urban areas, sewage systems for small communities and sewage systems used in Kelantan. Then sewage treatment process, sludge treatment and disposal, effluent standard and Statistical analysis such as DA, PCA and ANOVA.

Chapter 3 discusses on the methodology of comparative of four STP performance in Kota Bahru, Kelantan in detail. Start from study area followed by laboratory sampling (BOD, BOD, TSS), in- situ test sampling, Electricity Consumption, Operation and Maintenance cost, Data Collection, Data Pre-Treatment, Data Analysis (Principle Component Analysis, Discriminant Analysis, Analysis of Variance and Efficiency Calculation.

Chapter 4 is the result and discussion that provides a qualitative and quantitative analysis for the four systems of STPs performance. In this chapter, each group parameter was discussed personally based on the target objectives. Sub- topic 4.1 elaborate The identification of efficiency of the systems in the characteristics of BOD, COD, TSS in the effluent, followed by sub topic 4.2 tell about the appropriate design, flaws and workflow process of the system and lastly sub topic 4.3 represent determination of the appropriate design, workflow process of the system to handle Kota Bharu's wastewater treatment.

Chapter 5 provides an overall conclusion of the thesis.

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APPENDICES

Appendix A Contribution of the variables (%) after Varimax rotation

Contribution of the variables (%) after Varimax rotation:

Parameters	D1	D2	D3	D4	D5
pH	0.030	0.341	61.586	0.244	0.011
Temperature	0.003	39.003	9.801	2.338	1.394
BOD	15.095	8.409	0.298	2.232	1.167
COD	20.845	0.120	0.046	1.149	3.785
TSS	20.933	0.893	0.124	5.128	1.296
Oil & Grease	0.231	0.002	0.061	0.178	80.606
Ammoniacal Nitrogen as N	20.743	0.099	3.885	2.626	4.398
Nitrate Nitrogen (NO_2 + NO_3)	0.118	0.011	0.637	71.850	0.245
Total Phosphorus as P	17.531	0.352	1.609	2.872	3.984
electricity cost	4.447	17.371	19.906	2.032	0.419
plant expenses	0.024	33.398	2.047	9.352	2.695