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Analysis of Business Potential For Management of Faecal Sludge Using Black Soldier Flies Based on The Market-Driven Approach (Case Study: IPLT Duri Kosambi Jakarta City)

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Abstract
Faecal sludge management is crucial in supporting sustainable development in urban areas. Regional Regulation No. 10 of 1991 regulates the role of Faecal Sludge Treatment Plant managers in facing challenges related to increasingly limited dry sludge storage capacity. Therefore, this research explores the potential for utilizing faecal sludge processing products such as maggot and Kasgot organic fertilizer. This research includes identification of the product supply chain, analysis of market acceptance, and financial analysis using Net Present Value (NPV) and Benefit Cost Ratio (BCR). In the Duri Kosambi IPLT case study, the processed sludge produced and not yet managed could reach 100 m^3 per month. Through comprehensive management by IPLT managers, semi-dry processed sludge can be utilized and distributed via waste trucks to BSF farms in Jakarta City. Based on estimated calculations, the mud is used as animal feed (maggot) as much as 8 tons/month and Kasgot organic fertilizer (50 tons/month). Based on market acceptance, the market volume for faecal sludge management products reached IDR 169,091,699/ 100 m^3 with a growth rate of 7% every month. The factors influencing aspects of market acceptance consist of 9 factors, with the highest indicators influenced by market demand variables. Faecal sludge management using BSF is financially feasible based on an NPV analysis of 1.2 billion/year and a BCR of 1.2.
Keywords: *black soldier flies, faecal sludge, market driven approach, business potential*

Abstrak
Pengelolaan lumpur tinja memainkan peran krusial dalam mendukung pembangunan berkelanjutan di wilayah perkotaan. Peraturan Daerah No. 10 Tahun 1991 mengatur peran pengelola Instalasi Pengolahan Lumpur Tinja dalam menghadapi tantangan terkait kapasitas penyimpanan lumpur kering yang semakin terbatas. Oleh karena itu, penelitian ini mengeksplorasi potensi pemanfaatan hasil pengolahan lumpur tinja seperti maggot dan pupuk organik Kasgot. Penelitian ini mencakup identifikasi rantai pasok produk, analisis penerimaan pasar terhadap produk, serta analisis finansial menggunakan *Net Present Value* (NPV) dan *Benefit Cost Ratio* (BCR). Pada studi kasus IPLT Duri Kosambi, lumpur hasil olahan yang dihasilkan dan belum dikelola dapat mencapai 100 m^3 per bulan. Melalui manajemen menyeluruh oleh pengelola IPLT, lumpur olahan setengah kering dapat dimanfaatkan dan didistribusikan melalui truk tinja ke peternakan BSF di Kota Jakarta. Berdasarkan estimasi perhitungan, lumpur kemudian digunakan sebagai bahan pakan ternak (maggot) sebanyak 8 ton/bulan dan pupuk organik Kasgot (50 ton/bulan). Berdasarkan aspek penerimaan pasar, volume pasar untuk produk pengelolaan lumpur tinja mencapai Rp 169.091.699/ 100 m^3 dengan tingkat pertumbuhan 7% setiap bulan. Adapun faktor yang mempengaruhi aspek penerimaan pasar terdiri dari 9 faktor dengan indikator tertinggi dipengaruhi oleh variabel permintaan pasar. Pengelolaan lumpur tinja menggunakan BSF ini layak secara finansial berdasarkan analisis NPV sebesar 1,2 milliar/ tahun dan BCR senilai 1,2.
Kata Kunci: *black soldier flies, lumpur tinja, pendekatan pasar, potensi bisnis*

1. Introduction

IPLT Managers in Jakarta is aware that there will come a time when the dried sludge resulting from faecal sludge processing will no longer be able to be accommodated due to the lack of land to store the processed dried sludge. Therefore, it is necessary to utilize faecal sludge processing products to reduce dry sludge waste. IPLT Managers has researched using dry mud from processing feces into briquettes as an alternative to solid fuel. Most of the briquettes produced are not marketed to the public but are used by IPLT Managers, while some are thrown away.

Apart from processing dried faecal sludge into briquettes, the processed faecal sludge can be used as compost [1] . This has been widely implemented in various countries, cities, and districts in Indonesia, for example, in Kebumen Regency, which is organized by the Department of Housing, Settlement Areas & Environment or PKPLH [2]. Not only that, the use of faecal sludge using Black Soldier Flies (BSF), scientifically known as *Hermetia illucens* [3], can be an alternative in managing faecal sludge, which can reduce processed sludge [4], improve the quality of processed sludge and produce maggot larvae [5], which can be sold for animal feed [6]. BSF maggots can be a cheap and easy alternative feed in the cultivation process, so fish and poultry farmers can reduce production costs [7].

The application of faecal sludge processing using BSF is based on the existing conditions of the city of Jakarta and its surroundings, which have a significant target market for the use of BSF, such as poultry farms, fish farms, and BSF farms. The use of livestock maggots from faecal sludge management can support the 2021-2024 BSF Maggot Cultivation Green Financing program, which has been prepared by the DKI Jakarta Environmental Service [8].

Based on the description above, in this research, an analysis of the business potential of faecal sludge management using Black Soldier Flies will be carried out based on the market approach method by identifying the product supply chain, analyzing aspects of market acceptance of the product, as well as analyzing financing and financial feasibility using Net Present Value (NPV) and Benefit Cost Ratio (BCR) [9].

2. Material and Methods

Research Approach

Quantitative research analyzes the business potential of utilizing BSF faecal sludge. The process of identification and analysis of the product supply chain is determined based on the existing conditions of faecal sludge management at the ILPT Duri Kosambi, which PD PAL Jaya manages. The components of expenditure costs and the results of questionnaires regarding market interest are used to analyze the financing cycle and financial feasibility.

Research Population and Sample

The population in this study included BSF breeders, poultry breeders, and fish breeders in the city of Jakarta. The sampling technique used is the Cluster Random Sampling technique. According to Margono [10], this technique is used when the population does not consist of individuals but rather consists of groups of individuals or clusters.

Research Measurement Scale

Community acceptance of products resulting from faecal sludge management using BSF is measured using a Likert scale.

Data Processing

A. Technical analysis and potential income from faecal sludge products

Technical analysis was carried out based on the existing conditions of faecal sludge management so that the potential income generation of faecal sludge products at the ILPT Duri Kosambi could be mapped.

B. Product Supply Chain Analysis

Based on the income potential of faecal sludge products, the faecal sludge product supply chain was mapped, starting from the raw source capacity at the ILPT Duri Kosambi to product purchases by consumers.

C. Market Availability Analysis

Market availability or a market-driven approach is analyzed using the market-driven approach for selecting a faecal sludge treatment products toolbox kit [11] , which includes the following stages.

D. Financing and Financial Feasibility Analysis

The results of financing calculations, including investment, operational, and maintenance funds, as well as income from product sales and Black Soldier Flies, were analyzed financially using the Net Present Value (NPV) and Benefit Cost Ratio (BCR) methods.

Figure 1: Stages of market approach

General description of DKI Jakarta

IPLT Duri Kosambi receives faecal sludge from DKI Jakarta, especially in the West Jakarta, Central Jakarta, and South Jakarta areas. Geographically, DKI Jakarta Province is located at 6º12' South Latitude and 106º48' East Longitude with an area of 664.01 km^2. Jakarta is a lowland with an average height of +7 meters above sea level. The area of DKI Jakarta Province, based on Governor's Decree Number 171 of 2007, is 662.33 km^2 of land and 6,977.5 km^2 of sea [12]. Administratively, DKI Jakarta Province is divided into five administrative city areas and one administrative district. DKI Jakarta Province is a region with a relatively large number of reservoirs/situations, namely 17 rivers [13]. The territorial boundaries of DKI Jakarta Province are as follows:

a. Northern boundary : Java Sea
b. Eastern boundary : Bekasi Regency
c. Southern boundary : Bogor Regency
d. Western boundary : Tangerang Regency

Figure 2: Geographical area of DKI Jakarta
Source: DKI Jakarta Regional Government (2012)

3. Results and Discussion

Technical aspects of faecal sludge management

There are three types of processing systems at the ILPT Duri Kosambi: conventional, mechanical, and Andrich Technology Systems. Conventional processing capacity is 300 m^3/day, and mechanical processing capacity is 600 m^3/day. So, in 1 day, the ILPT Duri Kosambi can process 900 m^3 of faecal sludge. Thus, the ILPT Duri Kosambi has an idle capacity of 700 - 750 m^3/day.

Table 1. IPLT Duri Kosambi processing capacity

Processing Capacity	
Conventional	300 m^3/day
Mechanical	600 m^3/day
Total Estimation	900 m^3/day
Idle Capacity	700 – 750 m^3/day

Sources : [14]

A. Mechanical System Processing System

This system applies mechanical technology and aerobic processing types. The processing unit consists of a stone trap, sludge acceptance plant (SAP), SAP storage pond, dewatering machine, dewatering storage pond, aeration pond, sedimentation pond, maturation pond, and final pond. The effluent from this system is managed. Waste, cake disposal, and return to water bodies. Cake disposal includes stockpiling in empty land at the IPLT and piling in dry mud hangars.

B. Conventional Processing System

This system applies mechanical technology and aerobic processing types. The processing unit consists of an aeration pond, anaerobic pond, facultative pond, maturation pond, final pond, and sludge drying bed (SDB). The effluent from this system is waste management, cake disposal, and return to the water body. Cake disposal includes stockpiling in empty land at the IPLT and piling in dry mud hangars.

Utilization of faecal sludge products

The sludge produced by the ILPT Duri Kosambi has yet to be utilized optimally, where briquettes made from sludge processed by the IPLT are directly thrown into landfills, and only a few are used as briquettes. However, it is still on a research scale. Therefore, further research is needed to determine the potential and effective methods for utilizing sludge from the ILPT Duri Kosambi.

Existing conditions of the research population

Map the distribution of animal and BSF breeders in the Jakarta area shown in **Figure 3**.

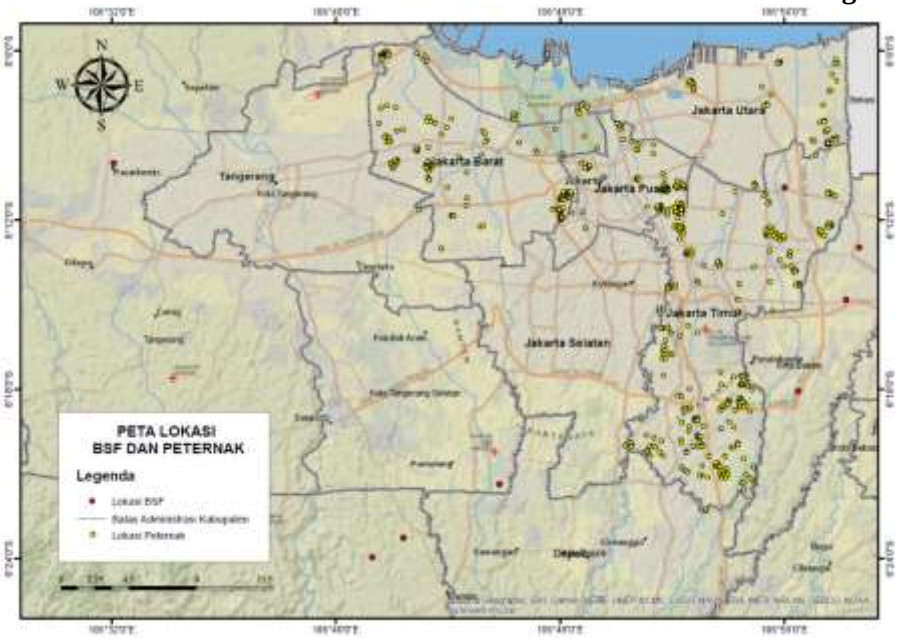

Figure 3: Map of study population distribution

Supply chain management for faecal sludge management products

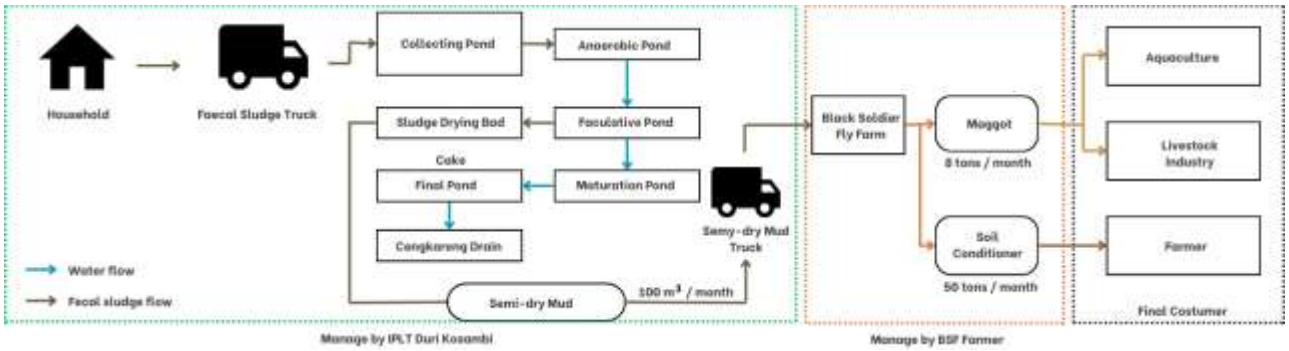

Figure 4: Chain management diagram for the supply of processed products at the ILPT Duri Kosambi

Based on the existing conditions of faecal sludge management at the ILPT Duri Kosambi, semi-dry sludge can be mixed with organic waste (50:50) or used as a whole food for BSF to breed. Furthermore, the 5-day-old larvae that grow can be traded as a source of animal protein and become the main ingredient for livestock food, such as poultry and fish. Additionally, the results of the reduction of faecal sludge by maggots can become an organic fertilizer known as Kasgot (Maggot Ex), which farmers can use. As for the ILPT Duri Kosambi, from 100 m^3 of semi-dry mud produced, it can produce 8 tons of maggot and 50 tons of Kasgot organic fertilizer every month.

Market attractiveness analysis

In aquaculture, faecal sludge management products in the form of maggots can replace green bean flour, corn flour, soybean meal, crab meal, shellfish meal, shrimp meal, and fish meal as the main composition for making fish feed. Meanwhile, market revenue for fish cultivation in Jakarta reached 113 million rupiah with a market growth of 7%.

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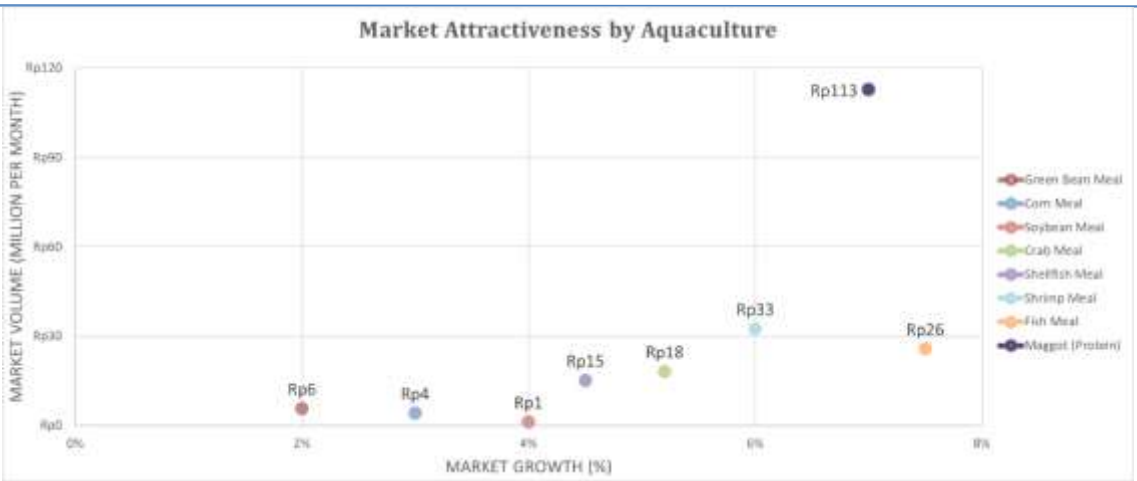

Figure 5: Market acceptance graph for aquaculture

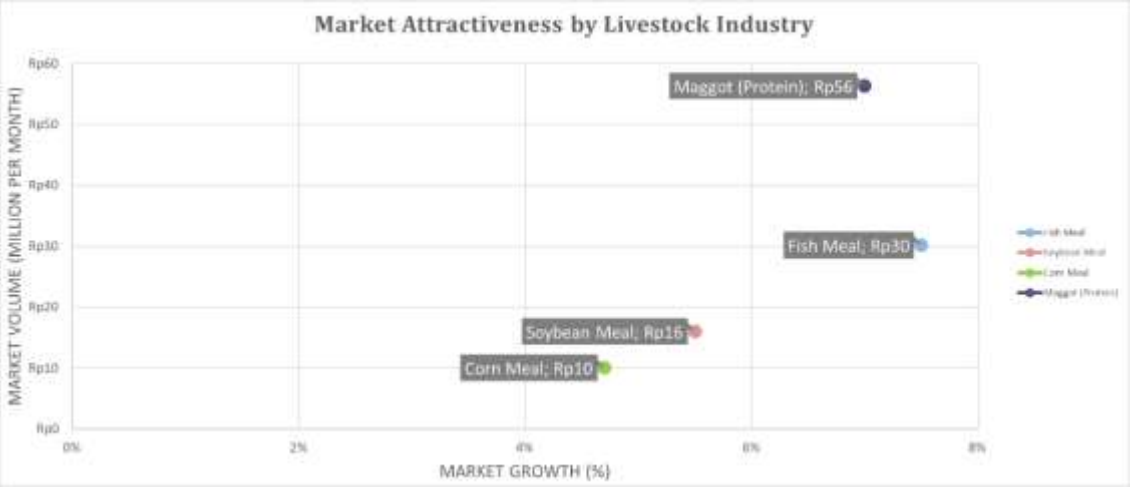

Figure 6. Market acceptance graph for the livestock industry

Meanwhile, in the livestock industry, faecal sludge management products like maggots can replace fish meal, soybean meal, and corn flour as the main composition for animal feed. Meanwhile, market revenue for fish cultivation in Jakarta reached 56 million rupiah with a market growth of 7%.

Based on an analysis of livestock cultivation and the livestock industry, it is known that the total market volume reached 169 million rupiahs with a market growth of 7%.

Market acceptance indicators

Based on questionnaire analysis, it is known that the indicators that influence the management of faecal sludge products reach up to 9 adjustment factors. A higher score means the factor is increasingly relevant to the transition of products that already exist in society towards faecal sludge products [15].

Table 2. Indicators of faecal sludge product management on a Likert scale

Adjusment Factor	Aquaculture	Livestock Industry
Switching Costs	323	210
Investment Costs	300	280
Efficacy/ Quality	350	337
Geographical	338	353
Distribution	300	323
Entry point	313	317
Demand Variability	363	397
Price Sensitivity	292	317
Social Stigma	297	99

Financing aspects

A. Net Present Value (NPV)

The results of the NPV analysis for faecal sludge management using BSF reached 1,2 billion rupiahs, with income obtained from sales of maggots and Kasgot organic fertilizer, which, if managed effectively and efficiently, could reach an income of up to 9 billion per year.

B. Benefit Cost Ratio (BCR)

Based on BCR analysis, a value of 1.2 is obtained. So, faecal sludge management using BSF is economically feasible.

4. Conclusion

IPLT Duri Kosambi has three processing systems: conventional (300 m^3/day), mechanical (600 m^3/day), and Andrich Technology System. It produces 100 m^3 of processed sludge every month but has not been able to utilize the processed faecal sludge properly.

Semi-wet faecal sludge processed at the Duri Kosambi IPLT (100 m^3/month) can be utilized and distributed via faecal trucks to BSF farms in Jakarta City, which will then be used as 8 tons/month of animal feed (maggot) and fertilizer. Organic Kasgot (50 tons/month) through comprehensive management by IPLT Duri Kosambi.

Based on market acceptance, the market volume for faecal sludge management products reached IDR 169,091,699/ 100 m^3, growing 7% monthly. Nine factors influence market acceptance, with the highest factor being the market demand variable, worth 380 out of 500.

Faecal sludge management using BSF is financially feasible based on an NPV analysis of 1.2 billion/year and a BCR of 1.2.

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