SUPPLY CHAIN DESIGN OF LEAF WASTE BIOMASS PELLETS (NEW RENEWABLE ENERGY) BASED ON WASTE BANKS AS PRODUCERS (Case Study: CIAMIS WASTE BANK)

Adhiwana Mulya Irawan[1], Rachmawati Wangsaputra[2], Budi Nur Siswanto[3]

Department of Logistics Management, International Logistics and Business University, St. Sari Asih No.54, Sarijadi, Kec. Sukasari, Bandung City, West Java 40151

Department of Logistics, Institut Teknologi Bandung, St. Ganesha, No.10, Lb. Siliwangi, Kec. Coblong, Bandung City, West Java 40132

adhiwanamulya@gmail.com, rwangsap@itb.ac.id, info@ulbi.ac.id

ABSTRACT

Garbage is now a common problem that occurs in many places in Indonesia. Waste reduction activities are carried out with the aim that all levels of society, including the government, the business world, and the wider community, can carry out Reduce, Reuse, Recycle (3R) activities. The Ministry of Environment is developing a waste bank to carry out 3R activities by producing biomass pellet products from organic waste and biomass waste, namely leaf waste. Leaf waste biomass pellets for drive energy convection are able to support government programs to reduce coal consumption and become one of the solutions to replace coal in the future. Therefore, in this study there is a formulation of the problem, namely how much is needed for leaf waste biomass pellets to replace coal at PLTU Cirebon and how to design a supply chain for leaf waste biomass pellets to meet the need for new renewable energy to replace coal for PLTU Cirebon. Based on these needs problems, the objectives of this research are to find out how much leaf waste biomass pellets are needed and to design a supply chain for leaf waste biomass pellets to meet the demand for new renewable energy to replace coal for PLTU Cirebon. The research was conducted by researchers located at the Ciamis Main Garbage Bank and conducted at the Garbage Ecopreneur Training Center in Cimenyan, Bandung City. The data collection that was obtained started from the General Data of the Ciamis Main Garbage Bank to the method of making leaf waste biomass pellets. Furthermore, for data processing the method used is to use a supply chain design framework, namely the Framework for Network Design Decisions (Shunil Chopra-Peter Meindl), in which there are 4 stages, namely Stage 1 Supply Chain Strategy, Stage 2 Determining the Location of a Waste Bank as a Producer of Fuel Pellets , Stage 3 Data Allocation for 10 Waste Banks, and Stage 4 Meeting the Needs of the Cirebon PLTU, followed by the Strength, Weakness, Opportunities, and Threat (SWOT) method, 5W + 1H Method, Waste Management Method at the Source (TOSS), Pellet Calculation Biomass, Vehicle Operating Costs (BOK), Net Present Value (NPV), and Interest Rate of Return (IRR). The calculation results to meet the needs of the Association of Indonesian Private Electricity Producers (APLSI) which is almost 4.2 million tons per month, the Ciamis Garbage Bank can supply fuel pellets to meet the need for a substitute for coal for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for coalfired leaf waste pellets at PLTU Cirebon.

Keywords: *Garbage, Waste Bank, Supply Chain Design, Biomass Pellets, Biofuels*

1. INTRODUCTION

Waste is now a common problem that occurs in many places in Indonesia. There are many factors in the increase of waste generation in Indonesia, including economic growth and changes in people's consumption patterns, especially in urban areas. The composition of waste based on the source of the most waste comes from households, which is 40.9%, and the composition of waste based on the type of waste disposed of the most is food waste, which is 30.7%, in 2021.

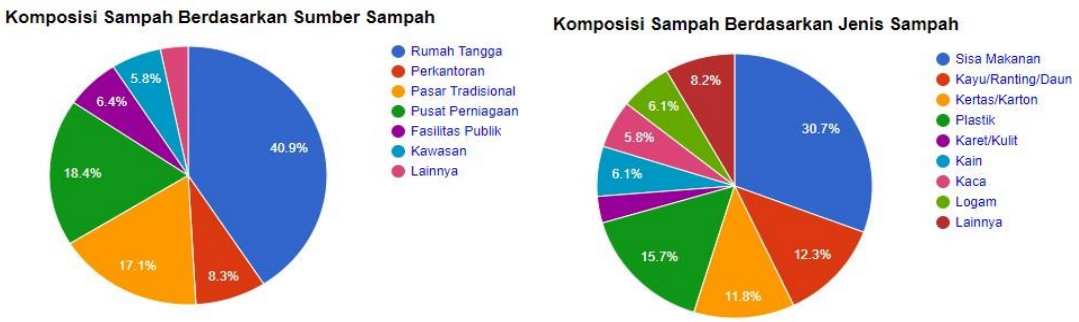


Image 1. Waste Composition

Waste reduction activities are carried out with the aim that all levels of society, both the government, the business world, and the wider community, carry out activities to limit waste generation, recycling and reuse of waste or better known as Reduce, Reuse and Recycle (3R) through smart, efficient and programmed efforts. The Ministry of Environment is making efforts to develop the Waste Bank.

The role of the Waste Bank is to carry out 3R activities by producing products that use packaging that is easily decomposed by natural processes, which creates as little waste as possible, using raw materials for production that can be recycled and reused, and/or withdrawing waste from products and product packaging for recycling and reuse such as making biomass pellets from organic waste and the biomass waste produced can become biofuel.

To replace coal in the future, New Renewable Energy (EBT) will continue to increase because there will be a New Renewable Energy-based Power Plant that will add electricity capacity around 2.07%. New Renewable Energy (EBT) is energy that comes from sustainable natural processes, such as energy from solar power, wind power, water currents, and biological processes or biomass.

Image 2. Leaf Waste Burning Pellets

Biomass pellets, when compared to other solid biomass pellets, have several things to compare, namely the physical shape of the pellets, both in terms of diameter and length, has met the standard. In addition, the moisture content of the pellets needs to be kept below 15%. The ash and tethered carbon content of biomass pellets need special attention, especially when they come from domestic waste. Pellets from husks and bamboo tend to have relatively high ash content. The heating value of biomass pellets can meet the class 1 standard which requires between 3000-4000 kcal/Kg. The calorific value is close to the standard and can replace coal. A price and calorific value comparison for coal and biomass pellets can be seen in Table 1.1.

Table 1. Comparison of Coal Price with Pellets Biomass

Fuel	Current Price (IDR/Kg)	Calories Produced (kcal)	Fuel	Current Price (IDR/Kg)	Calories Produced (kcal)
Coal	6000	5000	Biomass Pellets	1500	2000-4000

Biomass pellets for Energy Conversion can support the government program in reducing Coal consumption. With the current coal price of Rp.6,000/Kg, the cost of biomass pellets is Rp.1428.57 or rounded up to Rp.1,500/Kg, making biomass pellets one of the solutions to replace Coal in the future.

Waste management if utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Waste Bank as part of the supply chain for leaf waste fuel pellets or organic waste is that the TPS has begun to not be able to accommodate more waste and the concept of the Waste Bank is not maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy. So that the Waste Bank in each village will be the collection point of biomass waste in the city which will later be used as organic leaf waste fuel pellets, so in this study, the researcher wants to conduct research to design a supply chain so that the Waste Bank can meet the needs of leaf waste fuel pellets and how the Waste Bank contributes to the welfare of the community.

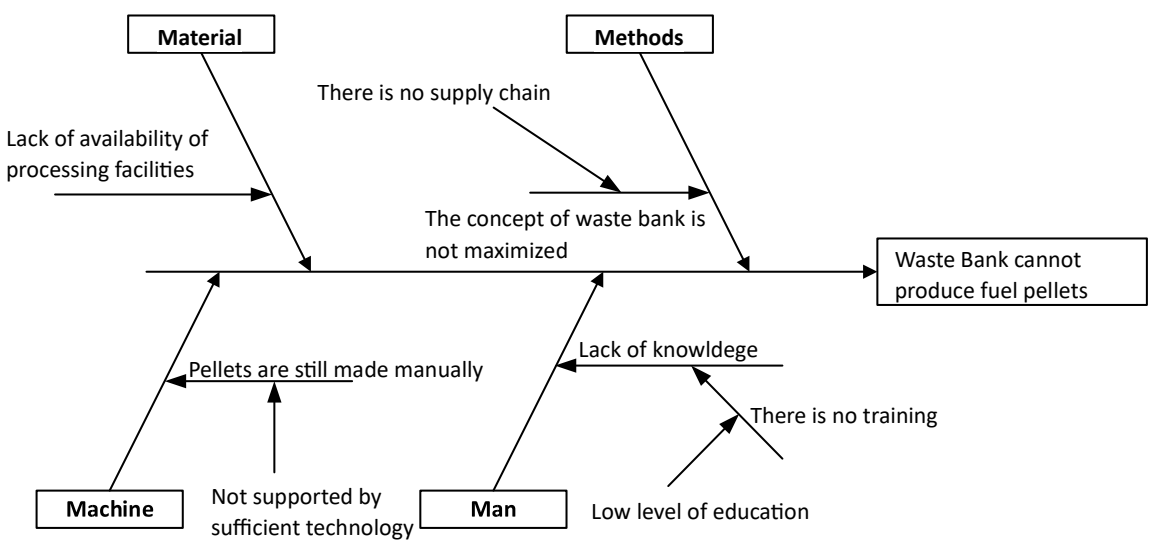


Figure 3. Cause and Effect Diagram

The touch of appropriate technology can be used as a source of new and renewable energy (EBT), namely community power plants or even for household energy needs. The initiation of converting organic waste into fuel pellets as an alternative raw material for power plants (populist electricity systems) and especially in growing ecopreneurs is a community service program of the Bandung Institute of Technology (ITB) in collaboration with the Indonesian College of Logistics Management (STIMLOG) and PT Comestoarra Bentara Noesantara (PT Comestoarra) using the organic waste and biomass processing method is Waste Management Technology at the Source (TOSS).

2. LITERATURE STUDY

Supply Chain Management

Supply chain management is an integrated and clear process. Its function is to help provide information to management regarding the procurement of goods. Not only that, this system also contains information about relationships with external parties such as vendors or suppliers. The goal is of course to maintain the supply of products that are needed by the company. Thus all businesses can run optimally. This management system also concerns all aspects. For example, from order delivery, raw material procurement, information dissemination to the latest product development.

Reverse Logistics

Reverse Logistics is an often overlooked process that can help companies reduce waste and increase profits, as the name suggests, the opposite of what we have described so far in terms of planning and operations. It could be defined as the process of planning, executing, and controlling the efficient flow of recyclable and reusable materials, returns, and rework from the point of consumption for the purpose of repair, remanufacturing, redistribution, or disposal.

SWOT Analysis (Strenght, Weakness, Opportunities, and Threats)

SWOT stands for *Strengths, Weaknesses, Opportunities, and* Threats. A SWOT analysis organizes your key strengths, weaknesses, opportunities, and threats into an organized list and is usually presented in a simple grid bar. *Strengths* and *Weaknesses* are internal to your company. things that you can control and can change. Examples include who is on your team, your patents and intellectual property, and your location. *Opportunities* and *Threats* are external things that affect your business or things that happen outside your company in the larger market. You can take advantage of opportunities and protect against threats, but you cannot change them. Examples include competitors, raw material prices, and customer spending trends.

Net Present Value (NPV) Calculation Method

Net Present Value analysis is a method of assessing an investment that will be made by emphasizing the *net present* value *of* expenditures compared to the present value of revenue.

Internal Rate of Return (IRR) Calculation Method

The *Internal Rate of Return* (IRR) method is one method of finding interest rates when NPV = 0. The information generated in this IRR method is related to the level of *cash flow* ability to return investment capital which is explained in the form of percent (%) of the time period and how much obligation must be fulfilled.

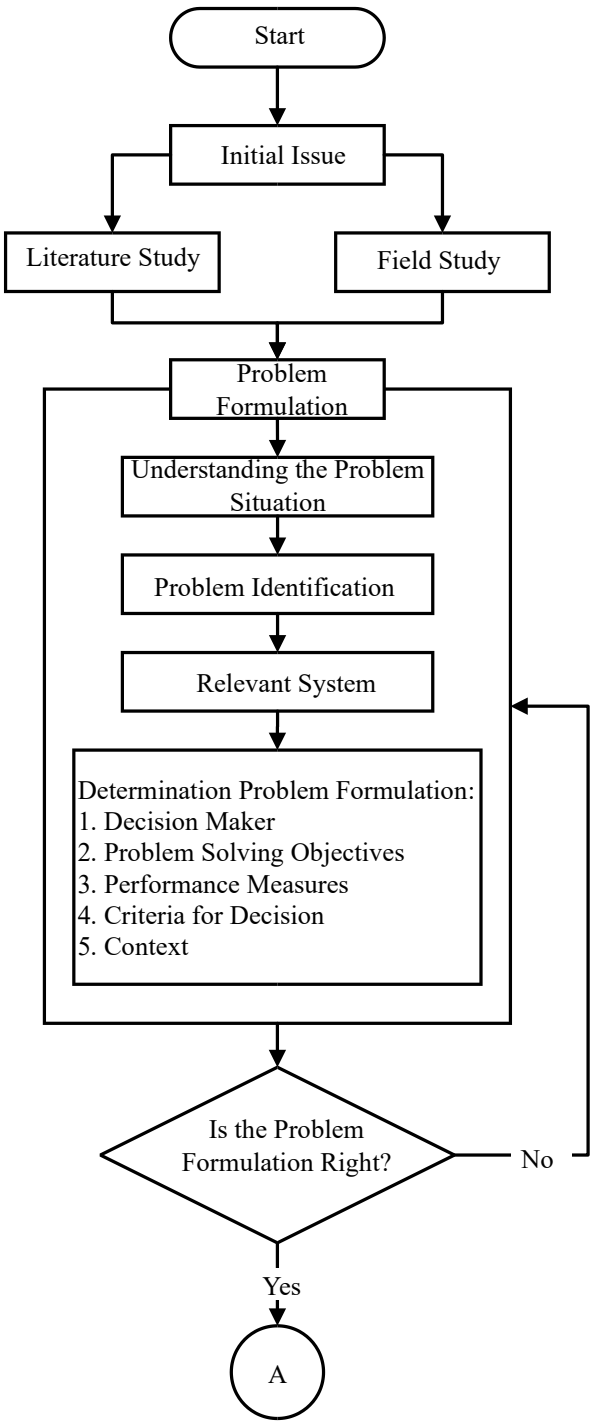
3. RESEARCH METHODOLOGY

Research Framework

For the research conducted by researchers, there are two supply chain actors. These actors are Waste Bank and PLTU. The two actors have a supply chain flow, starting from the Waste Bank which contracts with the PLTU to meet the PLTU's needs. After the PLTU contract occurs, the PLTU asks the Waste Bank to make fuel pellets as a substitute for coal. Waste Bank will start to collect organic waste which will become the basic ingredients of fuel pellets, after the availability of organic waste made from leaves, it is then ground until smooth and stirred with glue until it becomes flat and put into a mold. After molding the pellets, they are dried in the sun and oven for 2 days on a zinc base and drained, then when 50 leaf waste fuel pellets have been collected, they will be immediately *packed* to be sent to the PLTU.

Research Methodology

To launch the research, a research methodology is made, so that problem solving can be done properly and systematically. The following is the research methodology shown in the figure


Start
Initial Issue
Literature Study
Field Study
Problem Formulation
Understanding the Problem Situation
Problem Identification
Relevant System
Determination Problem Formulation:
1. Decision Maker
2. Problem Solving Objectives
3. Performance Measures
4. Criteria for Decision
5. Context
Is the Problem Formulation Right?
No
Yes
A

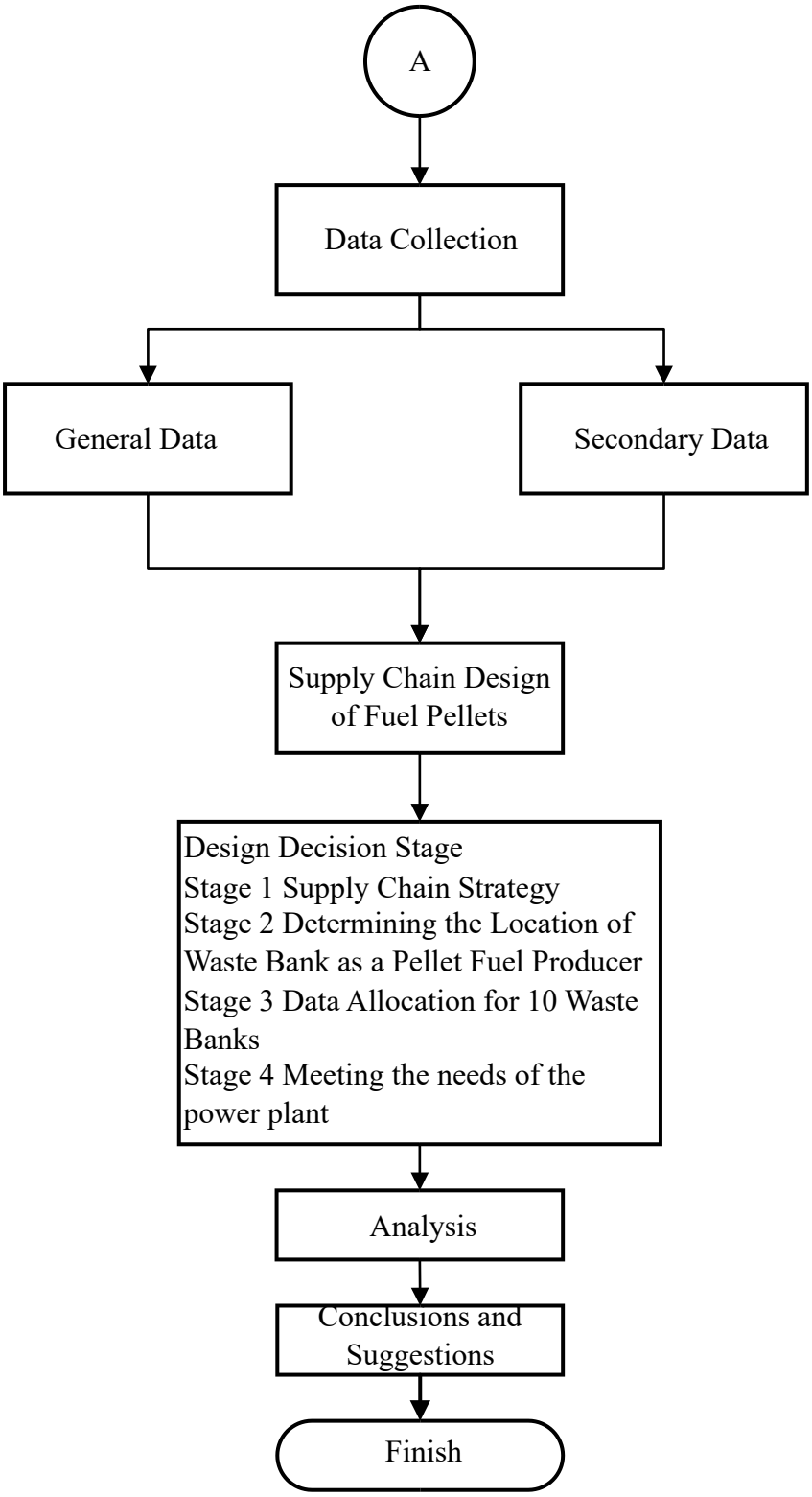


Figure 4. Research Methodology

Initial Issue

Waste is now a common problem that occurs in many places in Indonesia. There are many factors in the increase of waste generation in Indonesia, including economic growth and changes in people's consumption patterns, especially in urban areas. In urban areas, economic growth will go hand in hand with changes in people's consumption patterns. Where people's consumption patterns will show an increase.

Against the backdrop of this problem, waste management converts waste if it is utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Waste Bank as part of the leaf waste or organic waste fuel pellet supply chain is that the TPS has begun to be unable to accommodate more waste and the concept of the Waste Bank is not maximized, so the absence of supply chain management results in the accumulation of waste and the activity of converting leaf waste into organic leaf waste fuel pellets into vegetable coal which is used to replace coal and is included in New Renewable Energy.

Literature Study

To find information and theoretical basis, the first thing to do is literature study. The information the author gets comes from books and journals. The purpose of the literature study is to support the problems that will be raised in the research. On the other hand, the knowledge that the author has can be developed even better. Literature study is carried out to find a theoretical basis related to Supply Chain Management, Waste Supply Chain, Types of Waste, Burning Pellets.

Field Study

The next step is to conduct a field study or observation. Field studies can see directly the situation that is happening. Interviews with Mr. Ervan as the Waste Bank Manager, collecting information and data, and observing how Mr. Ervan makes fuel pellets. The author conducts field studies to find out the problems faced in designing the fuel pellet supply chain at the Ciamis Garbage Bank.

Problem Formulation

The formulation of the problem is to raise the topic that will be researched by the author in this research. The formulation of the problem can refer to the results of the field study conducted by the previous compiler and complemented by references read in the literature study. Based on that, then the author determines the problem formulation of this research. The formulation of the problem in this study, namely:

a. Problem Situation Understanding

The existing problems must be understood so that the reader understands the problem in this study is to understand the situation of the problem to be studied by designing the fuel pellet supply chain in order to meet the needs of new renewable energy to replace coal for PLTU.

b. Problem Identification

Waste Bank as part of the supply chain of leaf waste fuel pellets or organic waste is that the TPS has begun to be unable to accommodate more waste and the concept of Waste Bank is not maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy.

c. Relevant System

By using the relevant system, the supply chain design method is used.

d. Determination of Problem Formulation

The determination of the problem formulation must be done by answering the following problem formulation:

1. *Decision Maker*: Mr. Ervan and the Garbage Bank
2. Problem Solving Objective: to find out that the Waste Bank can fulfill the need for leaf waste fuel pellets to replace coal in the PLTU.
3. Performance measures: Design a supply chain for leaf waste pellets to meet the need for renewable energy to replace coal for power plants.
4. Decision Criteria: by designing a new renewable energy supply chain: organic waste biomass fuel pellets.

e. Context: Mr. Ervan and Bank Sampah Induk Ciamis as the context in this final project.

Data Collection

Information collection is used by researchers to obtain and collect data needed to act on findings about a problem. The data obtained from the object under study is then identified to obtain the appropriate data. The data collection process in this research is shown in Figure 5.

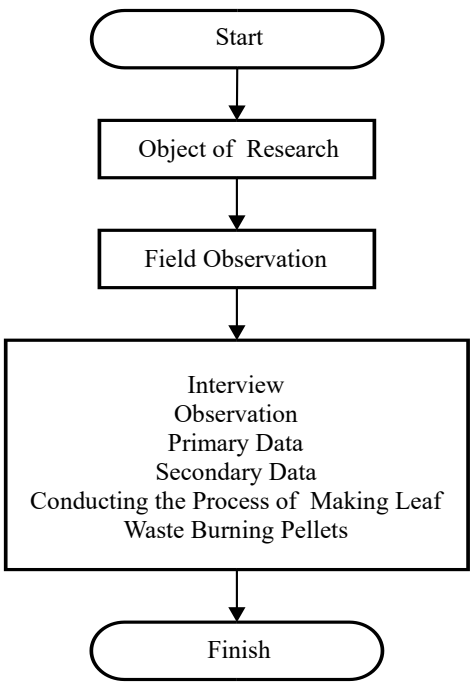


Figure 5. Data Collection

1. Interview
   Collect data by asking directly to Mr. Ervan as the source.
2. Observation
   Observation is a data collection technique carried out by researchers who see directly and review directly the existing conditions in the field. In this study, observation activities were carried out by looking directly at the Waste Bank.
3. Conducting the process of making leaf waste fuel pellets Watching and following the directions as taught by Mr. Ervan.

Supply Chain Design

The model development in this study uses the decision stage of supply chain design. The first stage is to create a supply chain strategy, by creating a competitive strategy and internal constraints that exist in Bank Sampah Ciamis. The second stage determines the location of the waste bank as a producer of fuel pellets and makes 10 Waste Bank Units as Waste Banks that have shredding machines. The third stage makes data allocation for 10 Waste Banks ranging from waste estimation to waste production. The fourth stage fulfills the needs of the PLTU by using fuel pellets as a substitute for coal.

Design Decision Stage

Designing the supply chain for leaf waste fuel pellets at Bank Sampah Ciamis so that the product can successfully replace new coal, four stages must be carried out in designing the leaf waste fuel pellet supply chain.

a. Stage 1 Supply Chain Strategy
   The first stage determines the supply chain strategy for leaf waste pellets to meet the needs of new renewable energy, then determines the ability to support competitive strategies with the SWOT method and Cause and Effect Table.
b. Stage 2 Determining the Location of Waste Bank as a Pellet Fuel Producer
   The second stage determines 10 waste bank units that are the center of the chopping machine to chop leaf waste into fuel pellets by knowing the types of plants in Ciamis City, green land in Ciamis City, the method of Waste Management Technology at the Source (TOSS), and the process of making leaf waste fuel pellets.
c. Stage 3 Data Allocation for 10 Waste Banks
   The third stage selects locations based on the availability of infrastructure to support the design of the leaf waste pellet fuel supply chain so that it can be implemented, the location selection is selected based on the availability of 10 waste bank units that cover each village, one waste bank unit covers 20 villages and knows the distance from 260 villages to each waste bank and calculates leaf waste based on the area and green open space in each subdistrict.
d. Stage 4 Meeting the needs of the power plant
   Stage four determines decisions based on the stages that have been carried out by knowing the calculation of leaf waste and knowing how much fuel pellets are needed to replace coal in the Cirebon PLTU.

Analysis

After processing the data, the author will analyze how much fuel pellets are needed to replace coal in the PLTU, and how to design the fuel pellet supply chain so that the need to replace coal can be met, and the results on the data processing. This is so that the author can describe all logical possibilities and provide an understanding that can be drawn from the results of data processing and summarize the overall results of the research that has been done in order to get a solution to solve existing problems.

Conclusions and Suggestions

Drawing conclusions is the final stage of the research. The conclusions drawn are based on the results of data processing and analysis carried out in the previous chapter, and are also equipped with suggestions that might be useful for joint business farmer groups, so that they can apply what has been suggested by researchers. In addition, it is also equipped with suggestions for further researchers.

4. Results and Discussion

Problem Situation

Knowing the amount of leaf waste in each community environment, waste management changes if it is utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Ciamis Garbage Bank as part of the leaf waste or organic waste fuel pellet supply chain is that the local landfill has begun to not be able to accommodate more waste and the concept of the Garbage Bank has not been maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy. So that the Waste Bank in each village will be the collection point of biomass waste in the city which will later be turned into organic leaf waste fuel pellets.

Supply Chain Design Decision Stage

The decision stage carried out in the design of the leaf waste fuel pellet supply chain at the Ciamis Garbage Bank, to do something the decision is made in 4 (four) stages, including the first stage, namely the supply chain strategy, the second stage, namely determining the location of the Garbage Bank as a producer of leaf waste fuel pellets, the third stage, namely data allocation for 10 Garbage Banks that produce and estimate leaf waste fuel pellets, and in the fourth stage, namely meeting the needs of the power plant.

Stage 1 (Supply Chain Strategy)

The first stage of determining supply *chain* strategies for supply chain design oriented to fuel pellets can meet the needs of new renewable energy to replace coal in PLTU, namely by determining the company's competitive strategies for leaf waste fuel pellets. The following matrix analysis for each strategy:

SWOT Matrix for SO Strategy

To see the strengths used to take advantage of the opportunities owned by Bank Sampah Ciamis which can form a competitive strategy in the waste bank by improving the quality of human resources, expanding the marketing area of fuel pellets, maintaining good relations between waste banks, and increasing the production capacity of leaf waste fuel pellets in waste banks.

SWOT Matrix for WO Strategy

From the weaknesses and opportunities owned by Bank Sampah Ciamis, strategies can be developed to minimize existing weaknesses so that waste banks can take advantage of opportunities and find competitive strategies by improving the supply chain management system, optimizing pellet fuel promotion efforts, conducting supply chain design, increasing leaf waste fuel pellet production planning at Bank Sampah Ciamis.

SWOT Matrix for ST Strategy

Judging from the strengths and threats of Bank Sampah Ciamis, it uses its strengths to overcome threats that can come at any time, namely by developing products by improving the quality of fuel pellet products, participating in seminars or activities related to EBT in order to get new strategies, and increasing promotional activities on social media to expand the marketing of leaf waste fuel pellets at Bank Sampah Ciamis.

SWOT Matrix for WT Strategy

On the weaknesses and threats that exist in Bank Sampah Ciamis, internal weaknesses can be minimized to avoid external threats, namely by improving the production site, management system and supply chain management system, completing facilities such as shredding and pelletizing machines, and learning about New Renewable Energy.

Phase 2 (Determination of Waste Bank as a Center for Burning Pellets Production)

Knowing that Ciamis Regency has 258 waste bank units spread across sub-districts in Ciamis Regency. Of the many waste bank units scattered, there are only 10 waste bank units that are the center of the shredder to shred leaf waste. It is known that there are 37 types of plants in Ciamis City and there are 32 uses of green plant spaces in Ciamis Regency which are managed by the Ciamis Regency Public Housing, Settlement Area and Environment Office. After knowing the types of plants and green open spaces that exist, the appropriate method used is Tenologi Olahan Sampah di Sumbernya or (TOSS) which utilizes organic waste and biomass waste into biofuels in the form of biomass pellets. These biomass pellets can be an alternative material as a substitute for coal. The concept of processing with TOSS consists of several main steps such as the process of biodrying, shredding, pelletization, and handling of final products.

Stage 3 (Data Allocation for 10 Waste Banks)

Site selection is based on the availability of *hard infrastructure requirements,* and *soft infrastructure requirements*. *Hard infrastructure* requirements include: availability of suppliers, transportation services, communications, utilities, and machinery and warehousing facilities. *Soft infrastructure* requirements include availability of skilled labor, labor turnover, and community acceptance of the waste bank. The waste bank unit that is the center of the shredding machine to shred waste represents 20 village coverage or its closest area with the allocation of mileage data from 260 villages in Ciamis Regency to each of the 10 waste banks that have become producers to make leaf waste fuel pellets.

Stage 4 (Meeting the needs of the power plant)

As explained in the previous chapter, the results of the calculation of leaf waste from table 4.31 are 10 Ciamis Waste Banks produce leaf waste for one day as much as 96,438 Kg, one week as much as 674,471 Kg, one month 2,890,590 Kg, and in one year as much as 35,070,435 Kg to calculate the total production of organic waste into organic waste fuel pellets then knowing each waste bank can produce fuel pellets in one month is:

1. Waste Bank Unit Waluya produces leaf waste fuel pellets generated from the total leaf waste production of 590,460 Kg is 295,230 Kg of fuel pellets.
2. The Sayangkaak Unit Waste Bank produces leaf waste fuel pellets resulting from the total leaf waste production of 146,610 Kg is 73,305 Kg of fuel pellets.
3. The Compass Unit Waste Bank produces leaf waste fuel pellets generated from the total leaf waste production of 341,370 Kg is 170,685 Kg of fuel pellets.
4. Bank Sampah Unit Al-Huda produces leaf waste fuel pellets resulting from a total leaf waste production of 366,000 Kg is 183,000 Kg of fuel pellets.
5. Bank Sampah Induk Ciamis produces leaf waste fuel pellets resulting from a total leaf waste production of 211,830 Kg is 105,915 Kg of fuel pellets.
6. Unit Masagi Waste Bank produces leaf waste fuel pellets resulting from the total leaf waste production of 176,370 Kg is 88,185 Kg of fuel pellets.
7. Waste Bank Unit ABC produces leaf waste fuel pellets generated from the total leaf waste production of 363,330 Kg is 181,665 Kg of fuel pellets.
8. Bank Sampah Unit Mulung Untung produces leaf waste fuel pellets resulting from the total leaf waste production of 331,230 Kg is 165,615 Kg of fuel pellets.
9. Tumras Unit Waste Bank produces leaf waste fuel pellets resulting from a total leaf waste production of 200,280 Kg is 100,140 Kg of fuel pellets.
10. The Mawar Unit Waste Bank produces leaf waste fuel pellets generated from the total leaf waste production of 163,110 Kg is 81,555 Kg of fuel pellets.

The total leaf waste produced by 10 Waste Banks in 1 month to meet the need for coal to be used as fuel pellets is 2,890,590 Kg per month, and the fuel pellets that can be supplied by Waste Banks as producers are around 1,445,295 Kg per month. In one year the Waste Bank can produce 35,070,435 Kg of leaf waste, and the fuel pellets that will meet the needs of coal are 17,535,217 Kg per year.

So to meet the needs of the Indonesian Private Electricity Producers Association (APLSI) which is almost 4.2 million tons per month, Bank Sampah Ciamis can supply fuel pellets to meet the needs of coal substitutes for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for leaf waste fuel pellets to replace coal in PLTU.

Vehicle Operating Costs

After all are calculated from *fixed* costs to non-fixed costs, the *total fixed cost* and *total variable cost* are obtained.

Table 1. Vehicle Operating Costs

BOK / Unit / Year	BOK / Unit / Rit	BOK / Unit / Trip	BOK/Unit/Km
IDR156,854,000	IDR326,870	IDR156,178	Rp3,226

NPV (*Net Present Value*) Calculation

So the Net Present Value (NPV) can be said to be feasible if NVP> 0. And it has been calculated from the calculations above showing the NPV results of Rp.267,685,650. from these results, the investment to be made for 4 years is feasible.

Internal Rate of Return (IRR) Calculation

IRR calculates the rate of return from the investment in a chopping machine for biomass pellets, the calculation of IRR is a continuation of NPV, where NPV = 0 where IRR> *cost of capital* then the investment is feasible and if IRR < *cost of capital* then the investment is not feasible. So in the above calculation, the IRR is 82.1197%, so the investment for 4 years is feasible.

5. Conclusion

Leaf waste generated and processed by 10 Ciamis Waste Banks in one day is 96,438 Kg, one week is 674,471 Kg, one month is 2,890,590 Kg, and in one year is 35,070,435 Kg. to meet the needs of coal in the PLTU, the leaf waste will be processed into leaf waste fuel pellets, knowing that the need for coal for steam power plants, aka PLTU in the country continues to increase by almost 4.2 million tons per month, then Bank Sampah Ciamis meets the needs and distributes these fuel pellets and the fuel pellets that can be supplied by Bank Sampah as a producer are around 1,445,295 Kg per month. In one year, Waste Bank can produce 35,070,435 Kg of leaf waste, and the fuel pellets that will meet the needs of coal are 17,535,217 Kg per year.

So to meet the needs of the Indonesian Private Electricity Producers Association (APLSI) which is almost 4.2 million tons per month, Bank Sampah Ciamis can supply fuel pellets to meet the needs of coal substitutes for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for leaf waste fuel pellets to replace coal in PLTU.

Designing the supply chain starts from sampling leaf waste and measuring and weighing leaf waste, then sending it to the Ciamis Unit Waste Bank as a producer of leaf waste fuel pellets, the Ciamis Unit Waste Bank will send leaf waste fuel pellets to the Ciamis Main Waste Bank for Finalization The product will be stored, the storage place must be protected from rain and humidity because otherwise the biomass fuel pellets will get wet and damaged. The supply chain route from the Ciamis Unit Waste Bank which has a shredding machine and sends it to the Ciamis Main Waste Bank for data collection which will later become leaf waste fuel pellets produced by Ciamis Regency which are then sent to meet the needs of replacing coal in the PLTU.

LITERATURE

Abigail. (2018). "Core Business." *E-Journal Atma Jaya University Yogyakarta*: 18. Https://EJournal.Uajy.Ac.Id/17045/2/Hk115731.Pdf.

Anantara, Pt. Gagas Edukasi. (2023). "Business Model Canvas." *Great Nusa*: 1. Https://Greatnusa.Com/Artikel/Apa-Itu-Business-Model-Canvas/.

Anih Sri Suryani. (2014). "The Role of Waste Bank in the Effectiveness of Waste Management (Case Study of Waste Bank Malang)." *Center for Assessment, Data and Information Processing*: 7184.

Arief Noerhidayat. (2021). *Outcome Report on the Development of Waste Technology at the Source into Renewable Fuel to Support the Renewable Energy Program*. Ed. Pt Comestoarra Bentarra Noesantarra. Bandung: Pt Comestoarra Bentarra Noesantarra.

Central Bureau of Statistics. (2020). *Indonesia Standard Business Field Classification 2020*.

Central Bureau of Statistics. (2022). *Ciamis Regency in Figures*. Ed. Bps Ciamis Regency. Ciamis Regency: Cv. Rikma Karya.

Budi Nur Siswanto. (2018). "Measurement of Malabar Indonesia Coffee Supply Chain Performance." *Journal of Logistics Management*: 1-13.

Budi Nur Siswanto. (2020). "Efforts to Improve the Performance of Bank Sampah Induk Cimahi (Samici)." *Journal of Logistics and Transportation Management* 6(3): 1-8.

Budi Nur Siswanto, Dudi Hendra Fachrudin, Tazkia Salsabila Putri. (2022). "Analysis of the Efficiency Level of Distribution Costs and Comparison of Costs and Benefits for the Selection of Production Site Location at Cvnawasena Pangan Kreatif." *Journal of Logistics and Transportation Management* 8 (3): 1-13.

Chopra, Sunil. (2013). *Supply Chain Management: Strategy, Planning, And Operation.* 5th Ed. Ed. Peter Meindl. India: Kindersley, Dorling.

Population and Civil Registration Office of Ciamis Regency. (2021). *Population Aggregate Data of Ciamis Regency*.

Hendy Suryana. (2019). "Development of Plastic Waste Recycling Model in Reverse Logistics System Network." *Journal of Industrial Engineering & Systems Media*: 90-94.

I Made Indradjaja, M. Brunner, Arief Norhidayat, Satria M. Brunner. (2021). "Processing Organic Waste and Biomass Waste with Waste Management Technology at the Source." *Journal of Serambi Engineering*: 2085-95.

Monice, Perinov. (2016). "Analysis of Waste Potential as Raw Material for Waste Power Plant in Pekanbaru." *Journal of Science, Energy, Technology & Industry*: 9-16.

Muhammad Fadli, Dianta Mustofa Kamal, Pribadi Mumpuni Adhi. (2019). "Swot Analysis for Direct Co-Firing of Coal with Waste Pellets in Cfbc Type Boilers." *Journal of the Electric Power Generation Study Program*: 272-79.

Nur Chairat, Arief Suardi. (2019). "Socialization of the Application of Popular Electricity to Overcome the Problem of Electric Energy Needs in Rural Areas." *Terang* 1(1): 69-77.

Paul A. Myerson. (2015). 1 *Supply Chain And Logistics Management*. 1st Ed. Ed. Amy Neidlinger. United States Of America: Paul Boger.

Remmy Setiawan Tjumardi. (2015). "Analysis of the Distribution and Sufficiency of Green Open Space to Support the Green City Development Program in Ciamis Regency." *Journal of Algiculture*: 1115.

Rian Alfian, Arlina Phelia. (2021). "Evaluation of the Effectiveness of the Waste Transportation and Management System at Tpa Sarimukti Bandung City." *Journal of Infrastructural in Civil Engineering (Jice)*: 16-23.

Roni Sahroji, Ade Sri Mariawati, Ani Umyati. (2020). "Identification of Causes of Work Accidents with the 5w + H Method in the Continous Casting Area of the Ssp Division." *Journal of the Department of Industrial Engineering, Sultan Ageng Tirtayasa University*: 25-30.

Rummler, Geary. (2021). "Value Creation Hierachy." Https://Ccg.Co.Id/Blog/2021/05/21/Establishment-of-Value-Hierarchy--Value-CreationHierachy-Vch/.

Decree of the Regent of Ciamis. (2020). *Establishment of the Ciamis Regency Parent Waste Bank "Bank Sampah Ciamis" at the Public Housing, Settlement Area and Environment Office of Ciamis Regency*. Ciamis.

Tanti Trinita Dewi. (2016). "The Function of the Public Works Office of Spatial Planning and Land in the Management of Public Open Space in Ciamis Regency." *Journal of Social and Political Sciences*: 1-7.

Wijaya, Dicko. (2017). "Value Chain Analysis." *Binus University Journal*: 1. Https://Sis.Binus.Ac.Id/2017/04/20/Value-Chain-Analysis/.