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3. Melaksanakan perintah ini dengan penuh rasa tanggung jawab.

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Pada Tanggal : 2 Juni 2022

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Reducing market and household organic waste with the concept of an open-loop supply chain model

Reducing market and household organic waste with the concept of an open-loop supply chain model

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Abstract. Waste is a challenge for many countries in the world, including Indonesia. Based on data from the Ministry of Environment, the volume of waste in Indonesia reached 64 billion tons per year. Organic waste is the most significant type of waste produced, 60% of the total type of waste. This study analyzed the causes of organic waste originating from the household and market sectors, where organic waste is not handledcorrectly. Parts of fruit and vegetables that should still have added value are immediately disposed of and end up in landfills. This study used an open-loop supply chain method to analyze the potential for adding value to waste. This research produced a model for processing organic waste and suggestions for adding value to the organic waste. Such as being used as animal feed, as a medium for maggot growth, water fleas with high selling value, and compost or biogas. This research could directly impact the market's economic value, community environment, and housing.

1. Introduction

Waste was a problem that was a challenge for many countries in the world, including Indonesia. Based on the Ministry of Environment data, the volume of waste in Indonesia reaches 64 billion tons per year [1], where the type of organic waste becomes the largest waste produced with the amount of 60% of the total type of waste, then plastic, paper, rubber, factory, glass, and other waste with a volume of 40%. The volume of waste in Indonesia continues from 66 to 67 million tons of waste in one year in 2019. This condition can show in Figure 1. Indonesia has also regulated environmental management in law [2] to guarantee that all activities, industry, trade, and economy do not interfere with sustainability.

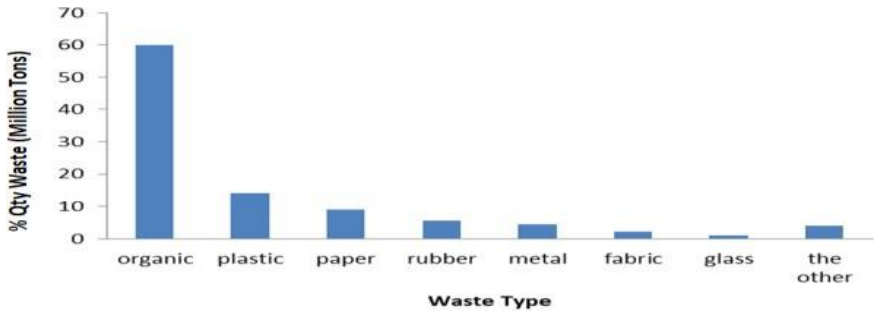

Figure 1. The condition of waste in Indonesia based on the type of waste in 2017.

Organic waste is the waste that comes from vegetables in the market or from households [3]. In the sales process, traders usually do the cleaning so that the products being sold look attractive and fresh so that traders remove parts that are not fresh or damaged. This condition causes waste which then piles up with other waste at the temporary dumpsite in the market. Organic waste comes from unused vegetable and fruit scraps and food scraps from the household sector. From Figure 2 below, it can show that in texture, organic waste originating from markets and households still has economic value if used and processed.

Figure 2. Market and household organic waste.

Based on Figure 2, it is found that the movement of organic waste and vegetables that traders cannot sell are just thrown away. They are collected in a temporary garbage collection place. The waste is then transported by truck to the final shelter. This proposal aims to build awareness of the added value of vegetable products starting from traders who do not dispose of their vegetable waste to be given added value that is still used for processed products for humans or animal feed. Research on the condition of this waste was carried out in the City and Regency of Bekasi, including the condition of waste in the Pasar Baru Market in Bekasi City, Pasar Baru Kranji Bekasi, Seroja Market, Wisma Asri Market, Bantar Gebang Market, Cibitung Center Market, Cikarang Market, Rawa Kalong Market, Tambun Market, Taruma Jaya Market, Harapan Indah Market, and Patra Tambun Market. In addition, market observations regarding waste management and distribution channels were also carried out in several residential locations and villages in the city and district of Bekasi.

Previous research on organic waste has been widely carried out [4], using waste as amedium for cultivating black soldier flies (BSF) larvae as animal feed. [5] manage fruit waste for fertilizers by using effective microorganisms. [5] researched making compost using vegetable waste materials. [6] also researched the use of vegetable waste as compost using the Takakura method. [7] use vegetable waste as feed to fatten cows. [7] Empowered groups of mothers in managing waste. Previous research has discussed using waste for something new, namely feed, compost, or biogas. This research will discuss using damaged vegetables with no selling value so that they do not become waste or garbage, damaging the environment. In this study, the utilization of vegetable waste will be carried out optimally based on the vegetables' physical condition, which can still be used properly as food ingredients. If they are damaged, they can be used as animal feed.

In this study, the authors use an open-loop supply chain (OLSC) to solve the vegetable and fruit supply chain; OLSC is a traditional supply chain system. Unlike in a closed or reverse loop supply chain, the product does not return to the original manufacturer [8]. The product is taken back by another

party willing and able to reuse the material or product or dispose of it in a landfill. The material is returned and reused by the same originator [9][10]. Suppliers or manufacturers bring back the product and remake or update it before resale to the secondary market. The complexity of the traditional supply chain is defined by multiple echelons or cost centres, where the echelon is the place to store inventory. Most studies using OLSC have been carried out before, [11] making a network configuration model with integrated continuous supplier selection using an open-loop supply chain, [12] research to find out the hidden potential aspects in open-loop supply chains for remanufacturing, [13] research for open-loop supply chains to support the expansion of environmental sustainability coverage in reverse supply chains.

This study aims to implement proper and adequate waste management based on these conditions. This is because the potential for the added value obtained from wasted waste can still be obtained, especially for organic waste, whose management is easier to manage. The benefits can be directly felt in the short term. This research will focus on developing the potential added value of organic waste and taking steps to prevent unused vegetables from turning into waste. The state of the art of this research lies in the application of OLSC to overcome the problem of vegetable waste along the vegetable supply chain. Applying an open-loop supply chain model to map waste problems and provide solutions so that they do not need to be disposed of in landfills and meet the needs of farmers who require feed and other conditions.

2. Methodology

This research begins by analyzing the supply chain of vegetables and fruits from farmers to customers' hands, then analyzing the causes of vegetable waste. The analysis was carried out in several markets at the traders and the household sector level. The cause analysis results will be described in an open-loop supply chain flow, which is then a solution to utilize each type of waste based on research that several authors and previous researchers have carried out. This research aims to collect solutions that the community can do to maximize the added value of vegetable and fruit waste so that it does not become waste. The ultimate goal of this research is that people can manage organic vegetable waste into something useful and not damage the environment.

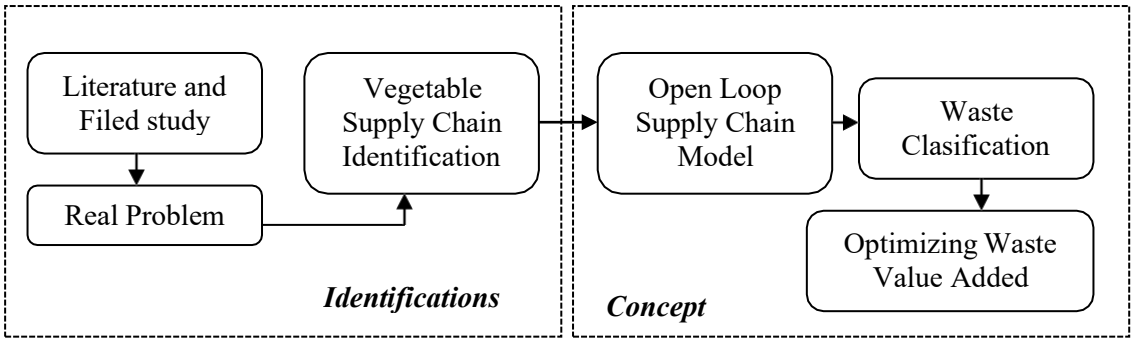

Figure 3. Framework study.

3. Result and Discussion

This study begins by describing the vegetable supply chain to analyze the chain of waste and decrease the added value of this vegetable product, from fresh vegetables to vegetables turning into waste. For more details, see Figure 4 below.

Based on Figure 4 below, the distribution chain of vegetables from farmers to the hands of customers shows that activities 2, 5, and 7 will cause vegetable waste due to vegetable cleaning activities; in Figure 2, the vegetables before being sent to the market will be cleaned first from the vegetable petals and stems, then in the activity in Figure 5, vegetable traders and distributors also clean vegetables by removing the damaged or wilted parts of the vegetables, so that the vegetables they sell look fresh. This

activity generates unused vegetable waste, which is immediately disposed of and becomes garbage. At levels 5 and 6, there are also other risks outside of garbage due to cleaning vegetables; another risk is vegetables that are damaged and not sold; this condition will cause a large amount of waste.

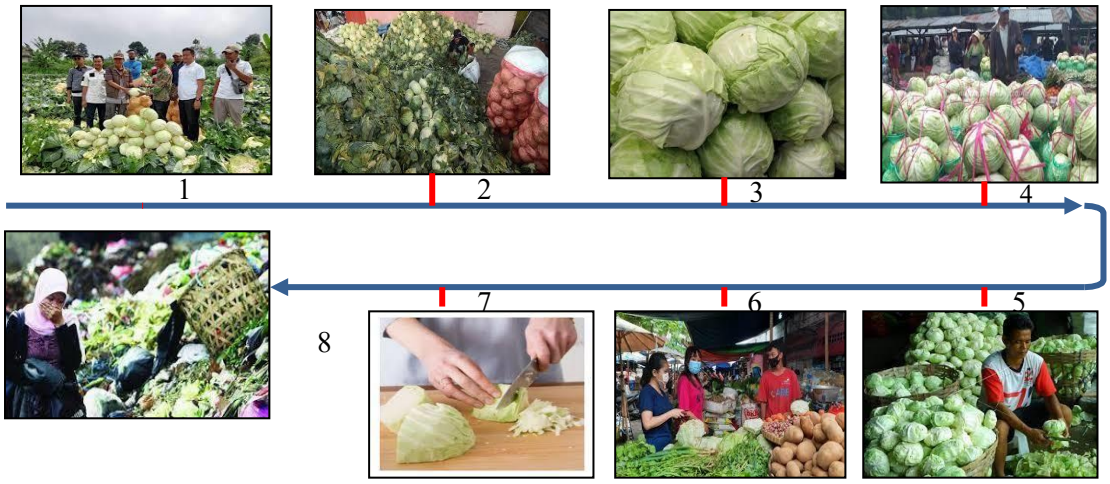

Figure 4. Vegetable supply chain from farmers to retailers

3.1. Open-Loop Supply Chain

All products are returned for various reasons in an open-loop supply chain (OLSC); the added value is maximized not to become waste and is disposed of [14]. Products that are returned or the rest of the process can be utilized as much as possible; the added value of the product can mean preventing the product from becoming more damaged, processing the product into a new product with longer shelf life, or being used as raw material for other products [10][15]. In the concept of an open-loop supply chain, returned products or the rest can be utilized or reprocessed by actors outside the organization. So, for the case of vegetable product waste, the concept of an open-loop supply chain model can be described in the Figure 5.

From Figure 5 below, it can see that the household sector contributes to the existence of organic waste; this organic waste can come from vegetable residue that is cleaned and cannot be consumed, then leftover food that is not spent after cooking. The utilization can be used as compost or biogas for this household waste. Still, collective management can be carried out because the amount is relatively small if calculated from each house. At a small level, it can be used as compost or liquid.

Based on Figure 5 below, there are four main actors in the vegetable supply chain: farmers, distributors, retailers, and households. At the farmer's level, vegetable waste occurs due to harvesting and cleaning vegetables before sending them to distributors or markets. Products with various levels are also produced at this level, namely products with good categories, low quality, and waste. The same thing also happens at the distributor level; the distributor referred to here is a collector who collects vegetables from farmers and then sends them to the main market; at this level, there are fewer checking and shortening activities because vegetable products have been sorted by farmers and are still in good condition. At the time of sale, sales are also carried out in bulk, which causes random inspections. Sorting and cleaning vegetables or refurbishment activities are mostly carried out at the retail level in the market or retailers. At this level, the vegetables sold are cleaned and re-examined so that the vegetables served for sale to level 2 retailers or consumers immediately look fresh. Many vegetable wastes will be generated at this level, in the form of vegetables that cannot sell because they are damaged, and parts of vegetables are cleaned to look fresh.

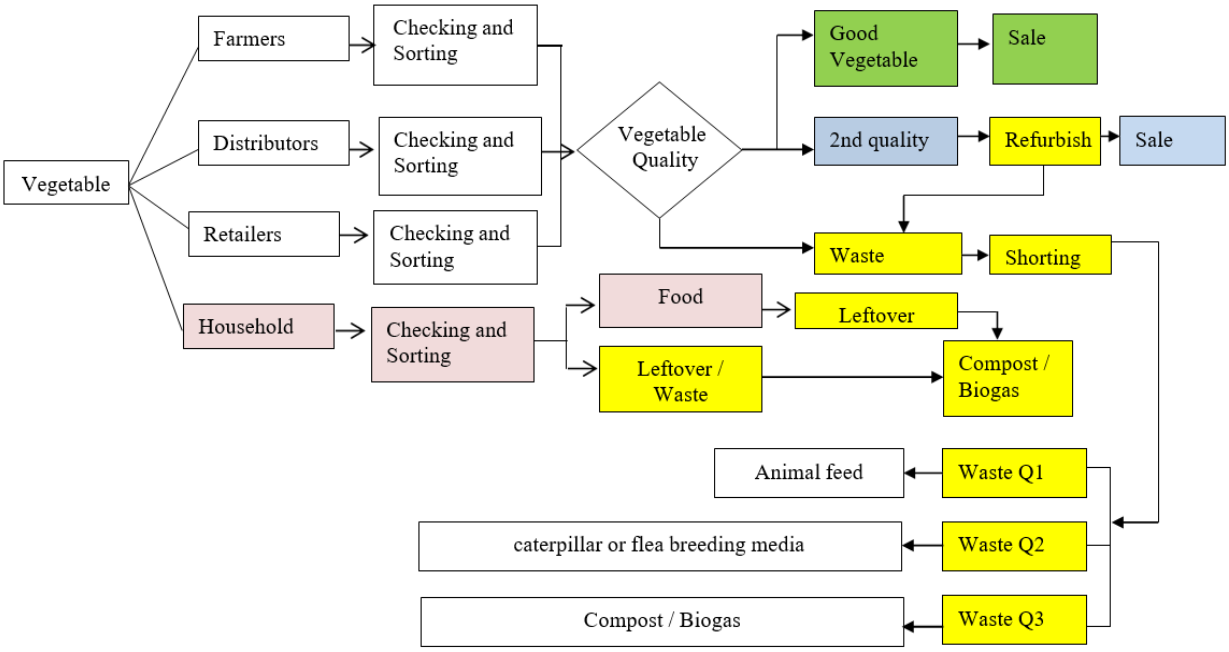

Figure 5. Vegetable open-loop supply chain flow chart.

3.2. Waste Classification

From Figure 5, the results of the sorting and inspection of products produce waste, which is vegetables in the category of unfit for sale. However, some parts of these vegetables are still edible in quality. Vegetable waste can be divided into three categories [17].

Waste Q1: is a category of vegetables sorted and cleaned that are still good; these vegetables can be directly used as animal feed, such as cricket feed, catfish feed, duck feed, et cetera.

Waste Q2: This is a category of sorted and cleaned vegetables that have been damaged but are still clean and have a complete form; these vegetables can be used as breeding media for larvae, water fleas, or other animal feed.

Waste Q3: is a category of sorted and cleaned vegetables whose quality is very damaged; the vegetables have changed shape, are slimy, and have a smell. Vegetables with this condition can still be used as raw materials for compost or biogas.

To see the detailed characteristics of vegetables, based on the Open-loop diagram in Figure 5 before, see the following table:

Table 1. Category Vegetable and the waste based on quality.

Category	Characteristics	Used for
Vegetable Grade 1	large size, looks fresh, no leaf and stem defects	Sale
Vegetable Grade 2	smaller size or imperfect shape, looks withered, there are defects in the leaves and stems	Sale
Waste Q1	vegetable scraps, still fresh, skin damaged or deformed, imperfect shape.	Animal feeds
Waste Q2	leftover pieces of vegetables, or whole vegetables that have withered, skin is damaged or deformed, imperfectly shaped.	breeding media for maggots, water fleas, or other animal feed
Waste Q3	quality is very damaged; the vegetables have changed shape, are slimy, and have a smell	Compost or biogas

By separating the characteristics of vegetables by level and condition, as shown in Table 1 above, business actors in the supply chain can control waste and reduce losses. Business actors can work together with the surrounding community to utilize the waste. It still has economic value, benefits the community, and does not become waste. By utilizing the economic value of waste based on the steps on the flow chart in Figure 5 and understanding the characteristics of vegetables, it can reduce losses, and the community can benefit from all parts of the vegetables. Then save the cost of transporting waste from the market to the final disposal site.

3.3. Optimizing Organic Waste Value Added

Optimizing the added value of organic waste produced by vegetable traders in the market and household sector can be done according to the flow chart in Figure 5. All waste and vegetables are sorted and placed according to categories and classifications in Table 1.

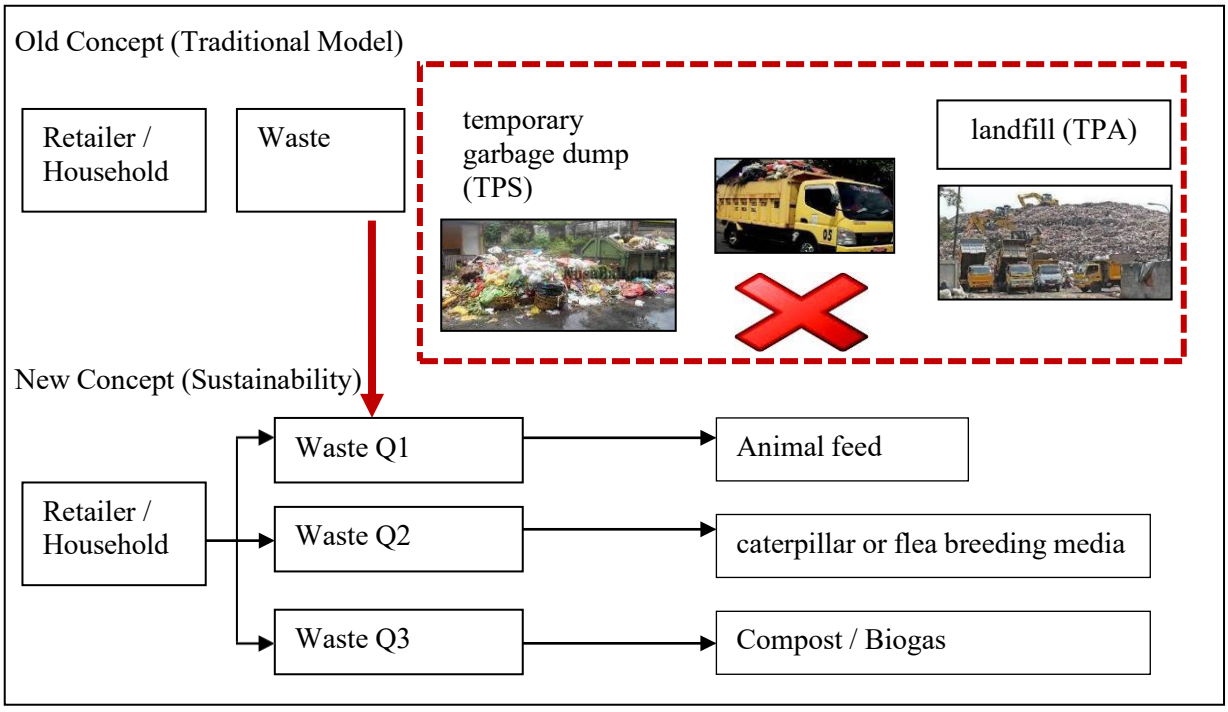

Figure 6. New concept handling base on value added and condition each garbage.

The optimization carried out in this study, as shown in Figure 6 above, is to cut the distribution of waste to temporary landfills and then transport it to final disposal sites. In the open-loop supply chain concept, the waste generated is separated by category, then processed as feed, development media, or if the waste has been badly damaged, it can be used as compost or biogas.

4. Conclusion

The results showed that the open-loop supply chain could map the condition of the vegetable supply chain. It is an improvement from the previous situation where vegetable waste was immediately dumped in a temporary landfill and then directly to the final waste collection point. In OLSC, waste can be directly collected for later use as raw material or animal feed. This solution can ultimately provide significant economic value and benefits for the community around the market. This research also offers opportunities for further more comprehensive analysis, such as creating models to calculate the maximum capacity for waste management, predicting the amount of waste using machine learning,controlling the level of damage to vegetables using IoT, and optimizing the use of market waste, forthe welfare of the community around the market.

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by P Paduloh , R I Rosihan M Widyantoro And I Zulkarnaen

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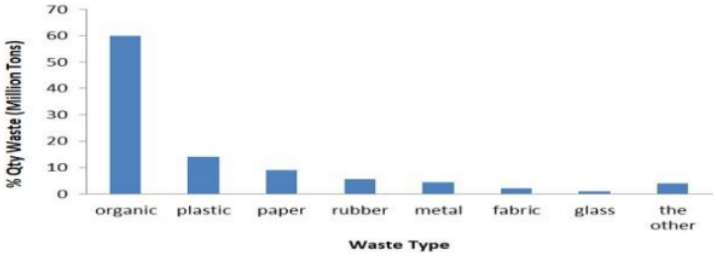

Figure 1. The condition of waste in Indonesia based on the type of waste in 2017.

Organic waste is the waste that comes from vegetables in the market or from households [3]. In the sales process, traders usually do the cleaning so that the products being sold look attractive and fresh so that traders remove parts that are not fresh or damaged. This condition causes waste which then piles up with other waste at the temporary dumpsite in the market. Organic waste comes from unused vegetable and fruit scraps and food scraps from the household sector. From Figure 2 below, it can show that in texture, organic waste originating from markets and households still has economic value if used and processed.

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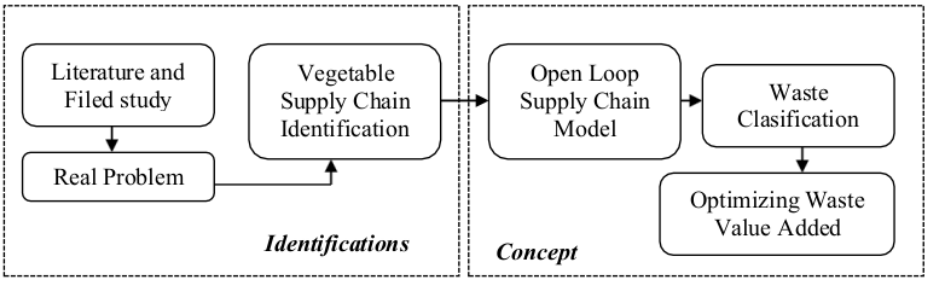

Figure 3. Framework study.

3. Result and Discussion

This study begins by describing the vegetable supply chain to analyze the chain of waste and decrease the added value of this vegetable product, from fresh vegetables to vegetables turning into waste. For more details, see Figure 4 below.

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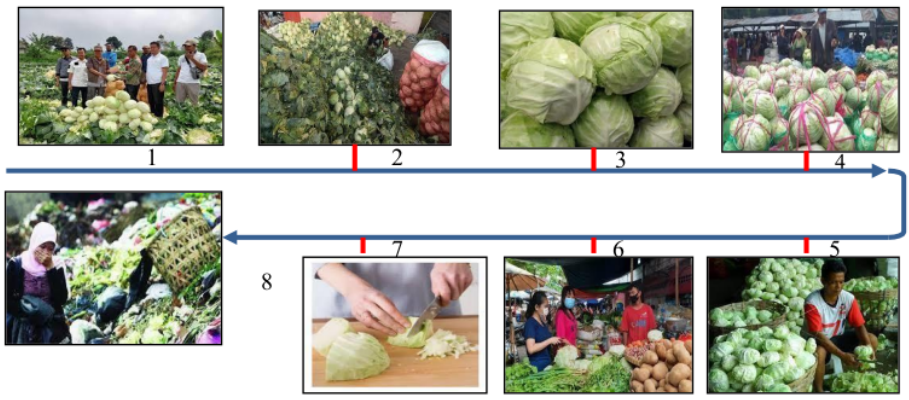

Figure 4. Vegetable supply chain from farmers to retailers

3.1. Open-Loop Supply Chain

All products are returned for various reasons in an open-loop supply chain (OLSC); the added value is maximized not to become waste and is disposed of [14]. Products that are returned or the rest of the process can be utilized as much as possible; the added value of the product can mean preventing the product from becoming more damaged, processing the product into a new product with longer shelf life, or being used as raw material for other products [10][15]. In the concept of an open-loop supply chain, returned products or the rest can be utilized or reprocessed by actors outside the organization. So, for the case of vegetable product waste, the concept of an open-loop supply chain model can be described in the Figure 5.

From Figure 5 below, it can see that the household sector contributes to the existence of organic waste; this organic waste can come from vegetable residue that is cleaned and cannot be consumed, then leftover food that is not spent after cooking. The utilization can be used as compost or biogas for this household waste. Still, collective management can be carried out because the amount is relatively small if calculated from each house. At a small level, it can be used as compost or liquid.

Based on Figure 5 below, there are four main actors in the vegetable supply chain: farmers, distributors, retailers, and households. At the farmer's level, vegetable waste occurs due to harvesting and cleaning vegetables before sending them to distributors or markets. Products with various levels are also produced at this level, namely products with good categories, low quality, and waste. The same thing also happens at the distributor level; the distributor referred to here is a collector who collects vegetables from farmers and then sends them to the main market; at this level, there are fewer checking and shortening activities because vegetable products have been sorted by farmers and are still in good condition. At the time of sale, sales are also carried out in bulk, which causes random inspections. Sorting and cleaning vegetables or refurbishment activities are mostly carried out at the retail level in the market or retailers. At this level, the vegetables sold are cleaned and re-examined so that the vegetables served for sale to level 2 retailers or consumers immediately look fresh. Many vegetable wastes will be generated at this level, in the form of vegetables that cannot sell because they are damaged, and parts of vegetables are cleaned to look fresh.

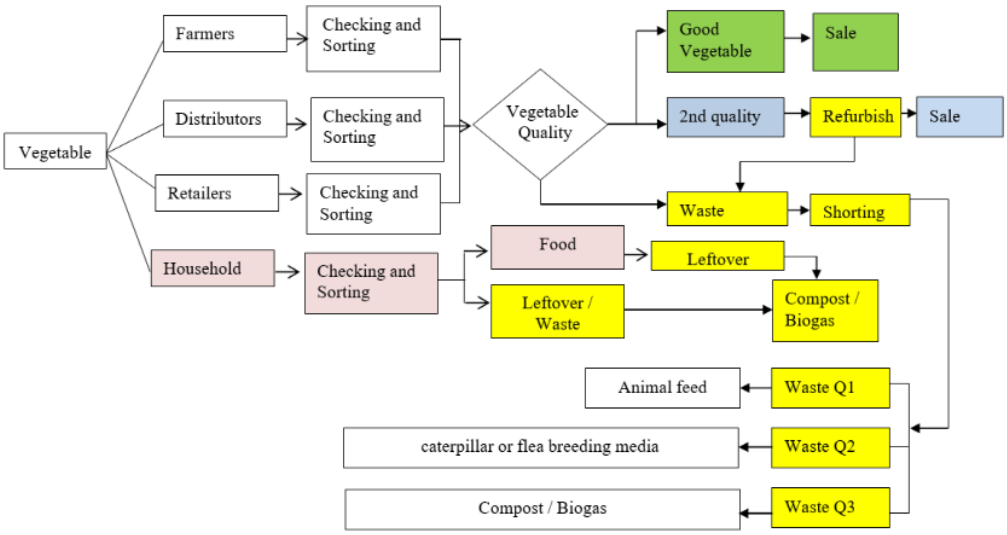

Figure 5. Vegetable open-loop supply chain flow chart.

3.2. Waste Classification

From Figure 5, the results of the sorting and inspection of products produce waste, which is vegetables in the category of unfit for sale. However, some parts of these vegetables are still edible in quality. Vegetable waste can be divided into three categories [17].

Waste Q1: is a category of vegetables sorted and cleaned that are still good; these vegetables can be directly used as animal feed, such as cricket feed, catfish feed, duck feed, et cetera.

Waste Q2: This is a category of sorted and cleaned vegetables that have been damaged but are still clean and have a complete form; these vegetables can be used as breeding media for larvae, water fleas, or other animal feed.

Waste Q3: is a category of sorted and cleaned vegetables whose quality is very damaged; the vegetables have changed shape, are slimy, and have a smell. Vegetables with this condition can still be used as raw materials for compost or biogas.

To see the detailed characteristics of vegetables, based on the Open-loop diagram in Figure 5 before, see the following table:

Table 1. Category Vegetable and the waste based on quality.

Category	Characteristics	Used for
Vegetable Grade 1	large size, looks fresh, no leaf and stem defects	Sale
Vegetable Grade 2	smaller size or imperfect shape, looks withered, there are defects in the leaves and stems	Sale
Waste Q1	vegetable scraps, still fresh, skin damaged or deformed, imperfect shape.	Animal feeds
Waste Q2	leftover pieces of vegetables, or whole vegetables that have withered, skin is damaged or deformed, imperfectly shaped.	breeding media for maggots, water fleas, or other animal feed
Waste Q3	quality is very damaged; the vegetables have changed shape, are slimy, and have a smell	Compost or biogas

By separating the characteristics of vegetables by level and condition, as shown in Table 1 above, business actors in the supply chain can control waste and reduce losses. Business actors can work together with the surrounding community to utilize the waste. It still has economic value, benefits the community, and does not become waste. By utilizing the economic value of waste based on the steps on the flow chart in Figure 5 and understanding the characteristics of vegetables, it can reduce losses, and the community can benefit from all parts of the vegetables. Then save the cost of transporting waste from the market to the final disposal site.

3.3. Optimizing Organic Waste Value Added

Optimizing the added value of organic waste produced by vegetable traders in the market and household sector can be done according to the flow chart in Figure 5. All waste and vegetables are sorted and placed according to categories and classifications in Table 1.

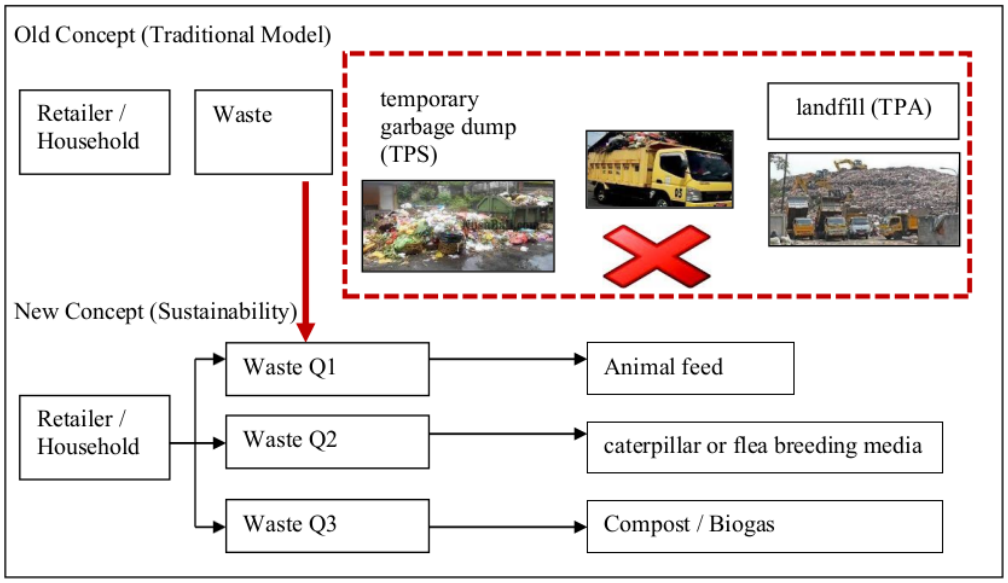

Figure 6. New concept handling base on value added and condition each garbage.

The optimization carried out in this study, as shown in Figure 6 above, is to cut the distribution of waste to temporary landfills and then transport it to final disposal sites. In the open-loop supply chain concept, the waste generated is separated by category, then processed as feed, development media, or if the waste has been badly damaged, it can be used as compost or biogas.

4. Conclusion

The results showed that the open-loop supply chain could map the condition of the vegetable supply chain. It is an improvement from the previous situation where vegetable waste was immediately dumped in a temporary landfill and then directly to the final waste collection point. In OLSC, waste can be directly collected for later use as raw material or animal feed. This solution can ultimately provide significant economic value and benefits for the community around the market. This research also offers opportunities for further more comprehensive analysis, such as creating models to calculate the maximum capacity for waste management, predicting the amount of waste using machine learning,controlling the level of damage to vegetables using IoT, and optimizing the use of market waste, forthe welfare of the community around the market.

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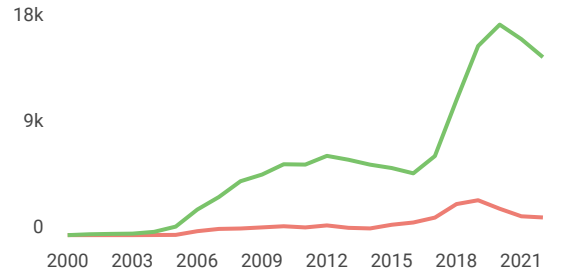

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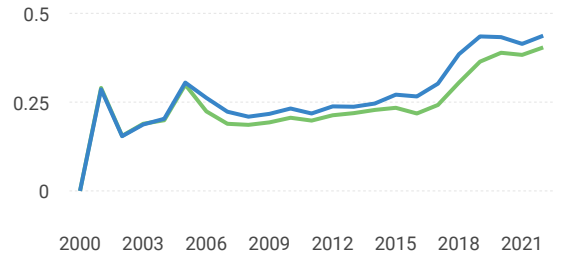

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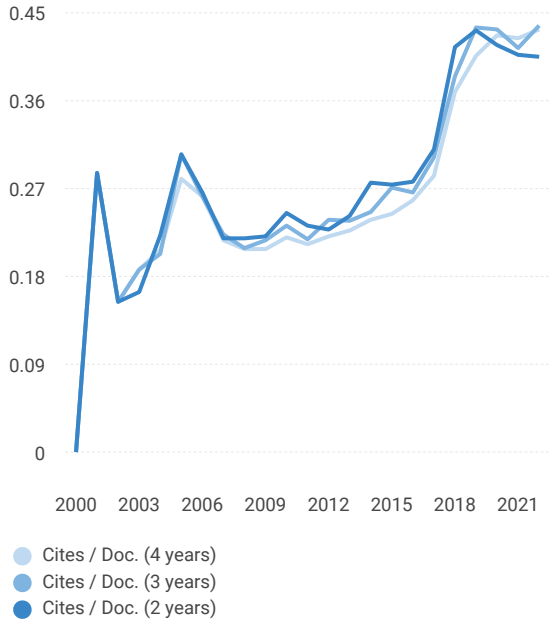

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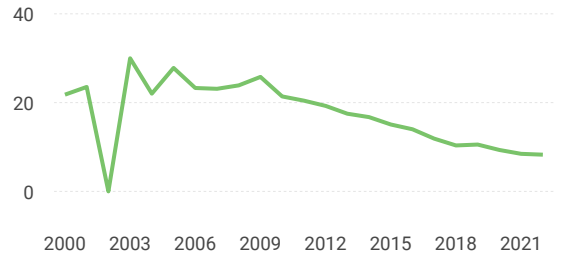

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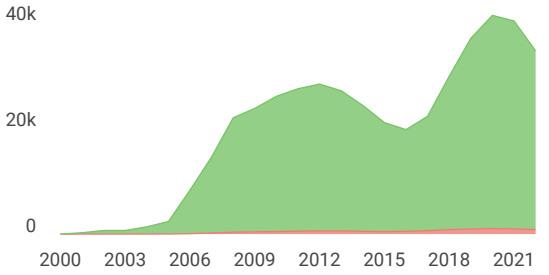

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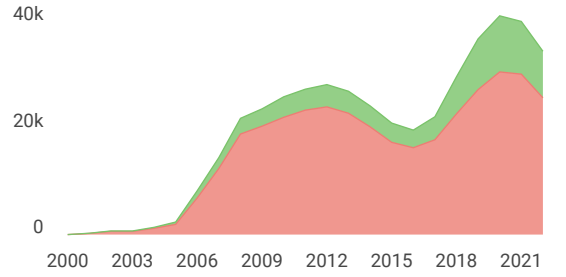

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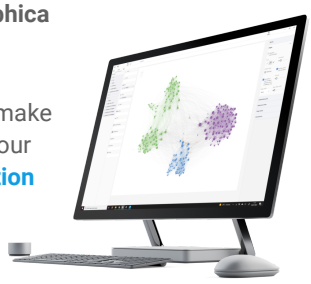

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