An Application of Data Envelopment Analysis to Determine the Efficiency Level of the Fish Auction in Tangerang Indonesia

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Abstract. Tangerang Regional Regulation Number 8/2012 mentions that fish auction place is a place that specifically provided by the local government to undertake fish auctions including auction services and other facilities provided in the fish auction area. But implementation of the fish auction places in Tangerang was assumed not optimally. Efficiency level of fish auction support by the facilities. This research was conducted with purpose to identify the facilities, analyze the efficiency level and the utilization of fish auction in Tangerang. This research was conducted in three auction Places in Tangerang: Cituis, Kronjo, and Tanjung Pasir. The method used in this research was descriptive method. The sampling method used purposive sampling method. The method used for analyzing the conditions of facilities in fish auction using analysis qualitative descriptive, and method used for analyzing the efficiency of fish auction place is DEA analysis using Banxia Frontier Analyst 4.3. Fish auction place consider efficient if reach 100 %. The result after the fish auction place was analyzed using DEA Banxia Frontier Analyst 4.3 shows that two fish auction place were efficient (100 %) and one fish auction place was inefficient (82.61 %). For fish auction place that has not reached 100 % or inefficient, there need to manage the reduction or the increase input and output of the fish auction places.

1. Introduction
Tangerang regency is a regency located in Banten Province. It has an area of 1,337.01 km², consisting of 959.61 km² wide land area and 377.40 km² of bodies of water. Tangerang has a 51,2 km long coastline filled with marine potentials [1]. Consequently, fishery is one of the major incomes for the region and optimum utilization of marine potential in Tangerang regency is expected to encourage sustainable growth in the fishery sector and to improve general welfare of the fishermen.

Tangerang Regional Regulation Number 8/2012 [2] mentions that Fish Auction Place, is a place that specifically provided by the local government to undertake fish auction activities including auction services and other facilities provided in the fish auction area. The Government has regulated the requirements needed to be fulfilled by the fish auction place in the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number KEP.01/MEN/2007 on Requirements of Safety and Quality Assurance of Fishery Products in Production, Processing, and Distribution. The ministerial decree lists nine requirements ranging from the condition of the auction place building to
Numerous study have been carried out to examine efficiency aspects of fisheries [4,5,6,7,8,9,10,11]. However, only a few research have been done to look into efficiency aspects of fish auction place [12,13]. The efficiency level of fish auction place is based on the concept of technical efficiency, which measures production levels achieved at a given level of input. A fish auction place is deemed as more efficient than others when said auction place is measured using the same type and number of inputs obtains a higher physical output. The efficiency level of a fish auction place is inseparable from the facilities that support the performance of it and can be influenced by several factors such as its management, facilities, and the auctions happening in the auction place.

This research is done by assessing the fish auction places in Tangerang regency, which are Auction Place Cituis, Auction Place Kronjo, and Auction Place Tanjung Pasir, in order to find out their efficiency level.

The purposes of this research are:
1. To identify the facilities available in the fish auction places in Tangerang Regency;
2. To analyze the efficiency level of the fish auction places in Tangerang Regency; and
3. To analyze the utilization level of the fish auction places in Tangerang Regency.

2. Research Method
2.1 Research Method
Descriptive method is used in this research. Data used in this research are primary data and secondary data. Primary data was collected by documenting and observing the fish auction places in order to get a reality about their physical condition and their facilities (such as the area of the auction place and the number of baskets, weighing scales, and carts available on site). Then, the secondary data used in this research was obtained from Regional Technical Implementation Unit auction place, Marine and Fisheries Department of Tangerang Regency, and other related government agencies. Data in this research were collected by observations, literary researches, interviews, and documentations of the fish auction places in Tangerang regency. Descriptive qualitative analysis is used to analyze the condition of the auction places facilities.

2.2 Conceptual Framework
According to the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number KEP.01/MEN/2007 On Requirements of Safety and Quality Assurance of Fishery Products in Production, Processing, and Distribution [14], the requirements needed to be fulfilled in order a place is qualified as fish auction place were as follows: 1) It must have a closed structure with easy-to-clean walls; 2) It must have waterproof floorings that are easily cleaned and sanitized, equipped with drainage system and hygienic waste disposal system; 3) It must have sanitation facilities such as an adequate number of toilets and wash basins, which must be equipped with soap or other cleaning substances and disposable hand dryers; 4) It must have a sufficient lighting to ease the control of fishery products and auction activities; 5) Vehicles which produces heavy air pollution and animals that might affect the quality of fishery products must be banned from the premises; 6) It must be cleaned regularly at least once after each auction is done, and the containers must be washed with clean clear water or clean sea water; 7) It must be equipped with signs displaying the prohibition of smoking, spitting, eating, and drinking in the premises and they must be displayed in visible places; 8) It must have an adequate supply of clear water or sea water; and 9) It must have special rust and water proof containers to contain fishery products that are not eligible for human consumption.

In order to analyze the facilities of the fish auction places, this research observes the facilities available in each auction place location and compares them with the nine requirements stated in
Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number KEP.01/MEN/2007.

2.3 Data Envelopment Analysis
The non-parametric method Data Envelopment Analysis (DEA) technique is used to analyze the efficiency level of auction place management. DEA is one of the non-parametric approach with formulation from linear program [15,16,17]. In short, DEA determine the weight of each inputs and outputs of Economic Activity Units (EAU). Each EAU is assumed to be capable of determining the weight of each available input and output variables as long as they fulfill the two required conditions [18,19,20].

The research is done by analyzing the input factors that affects the output of fish auction place which is the amount of production in kilogram. The input factors are the length of the dock in meter, the number of boats available, the number of baskets available, the number of fish-catching devices, the number of carts, the number of auctioneers, the number of auction place officials, the number of fish collector participating, the number of fishermen, the number of weighing scales available, and the area of auction measured in meter square.

The data calculation is done using Banxia Frontier Analysis 4.3, and the efficiency level can be determined by looking at the scores of each EAU [21]. A fish auction place is classified as efficient if it can reach full one hundred percent score, and will be deemed inefficient if it fails to reach the full score. In order to make a fish auction place efficient, improvements should be done by changing input and/or output values to reflect the potential improvement value calculated by DEA [22,23].

3. Results and Discussions

3.1 Capture Fisheries Condition
Tangerang Regency originally has five fish auction places. However, out of five fish auction places only three remains functional, which are Auction Place Cituis in Pakuhaji district, Auction Place Kronjo in Kronjo district, and Auction Place Tanjung Pasir in Teluknaga district. These auction places are managed by the Fisheries Service of Tangerang Regency and they provide an influx of funds for Tangerang Regency Administration, which comes from 3.5% retribution imposed to the collectors in the auction places.

Wild fisheries products in Tangerang regency are pelagic fish, demersal fish, squids (Loligo sp.), and prawns (Peneaus sp.). Pelagic fish with notable economic value are anchovies (Stolephorus sp.), chub mackerels (Rastrelliger sp.), yellowstripe scads (Selaroides sp.), and round scads (Decapterus sp.). Then, the commonly caught demersal fish in Tangerang regency are threadfin bream (Nemipterus sp.), bearded croaker (Johnius sp.), and goldband goatfish (Upeneus moluccensis). Table 1 shows the wild fisheries production in Tangerang regency from year 2011 through 2015.

| No. | Year | Production (tonnes) | Auction Value (Rp) |
|-----|------|---------------------|-------------------|
| 1.  | 2011 | 19.040              | 297.133,700.000   |
| 2.  | 2012 | 19.691              | 300.614,500.000   |
| 3.  | 2013 | 20.781              | 402.580,000.000   |
| 4.  | 2014 | 20.070              | 235.450,301.000   |
| 5.  | 2015 | 19.597              | 512.894,461.000   |

Source: Tangerang Regency Central Bureau of Statistics, 2016.

The capture fisheries production in Tangerang regency in the last five years tended to be consistent with little fluctuation. In 2011 the wild fisheries produced 19.040 tonnes of fish and it had 651 tonnes increase in 2012, which showed that the sector was still going to improve over time. While in 2013 the production reached 20.781 tonnes (which was the highest among other fishery sectors that year), it had 711 tonnes drop in 2014 and dropped even further to 19.597 tonnes in 2015 [24].

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3.2 General Condition of Fish Auction Places

3.2.1 Auction Place Cituis
Auction Place Cituis is located in Surya Bahari Village, Pakuhaji District, Tangerang Regency. In geographic coordinate, it is located at 6°153.33” S and 106°33’39.05” E. Auction Place Cituis is under the management of Tangerang Regency Fishery Service. It has a land area of 2000 m² with buildings and facilities including dock, breakwater, talud, mud ditch, parking lot, diesel generator, auction place management office, auction floor, fisherman meeting hall, stall room, ice depot, toilets and praying room. The auction area in Auction Place Cituis is 288 m² wide and located beside the auction place management office and stall room for the collectors. The number of personnel in Auction Place Cituis management is 14 persons strong, with 4 auctioneers available. The number of baskets used is 40 and all of them are owned by collectors. Fishermen in Auction Place Cituis are mostly traditional fishermen which use boats with 5 to 20 Gross Tonnage capacity and detachable engine. They use a variety of catching devices but the fishermen who take part in the auction only use cantrang (seine net) and bottom gillnet. Auction Place Cituis starts its operation from 09.00 WIT and ends at 16.00 WIT or depending how much fish available to be auctioned. There is a requirement for collectors who wish to join the auction. In order to be able to join the auction, they must pay a deposit of Rp 1,000,000 as a safety precaution in case the collectors run away or fail to fulfill their obligation. Table 2 shows the production output and auction value of Auction Place Cituis from 2013 to 2016.

Table 2. Data of Production Output and Auction Value of Auction Place Cituis Year 2013 - 2016

| No. | Year | Production (kg) | Auction Value (Rp) |
|-----|------|-----------------|-------------------|
| 1.  | 2013 | 470.448         | 5,073,254,000     |
| 2.  | 2014 | 449,840         | 5,324,802,000     |
| 3.  | 2015 | 481.113         | 5,687,691,000     |
| 4.  | 2016 | 428.213         | 5,700,022,000     |

Source: Auction Place Cituis, 2017.

The highest production output achieved in 2015 with 481.113 kg of fish being auctioned. In the year 2016 the Auction Place might only produce 428.213 kg of fish but the value of it was actually the highest in four years because of the high economic value of the fishes auctioned that year.

3.2.2 Auction Place Kronjo
Auction place Kronjo is located in Kronjo Village, Kronjo District, Tangerang Regency. In geographic coordinate, it is located at 6°31’17.49” S and 106°25’40.03” E. Auction Place Kronjo is under the management of Tangerang Regency Fishery Service. It has a land area of 2000 m² with buildings and facilities including dock, talud, parking lot, diesel generator, auction place management office, auction floor, fisherman meeting hall, stall room, ice depot, and toilets. The auction area in Auction Place Kronjo is 288 m² wide and located in front of the dock. The number of personnel in Auction Place Kronjo management is 10 persons strong, with 2 auctioneers available. The number of baskets used is 500 and all of them are owned by ship owners. Fishermen in Auction Place Kronjo use ship with 5 to 30 Gross Tonnage (GT) capacity and they also use a variety of catching devices but the fishermen who take part in the auction only use cantrang and fishing nets. Usually, cantrang is equipped to boats with 10 to 30 GT capacity while smaller boats only equipped with nets. Auction Place Kronjo starts its operation from 06.00 WIT and ends at 10.00 WIT. Fishes are sorted by type, put to baskets and then will be weighted accordingly. In December 2016 there were little activities happening there because of the issuance of Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number 02/PERMEN-KP/2015 [25]. Fishermen who used cantrang (seine net) were unable to put out because the permit for their ships (which were equipped with cantrang) were not issued by the administration as a result of said ministerial decree. But from January 2017 to June 2017, they are permitted to use
cantrang as the decree had been temporarily revoked with ministerial integrity pact. Table 3 shows the production output and auction value of Auction Place Kronjo from 2013 to 2016.

| No. | Year | Production (kg) | Auction Value (Rp) |
|-----|------|----------------|-------------------|
| 1.  | 2013 | 457.413,5      | 3.517.000.000    |
| 2.  | 2014 | 490.221,8      | 3.862.664.000    |
| 3.  | 2015 | 440.142        | 3.879.050.000    |
| 4.  | 2016 | 349.015        | 4.041.950.000    |

Source: Auction Place Kronjo, 2017.

The highest production output achieved in 2014 with 490.221,8 kg of fish being auctioned. In the year 2016 the fish auction place only produced 349.015 kg of fish, but it is valued at Rp 4.041.950.000, the highest recorded value in the last four years.

3.2.3 Auction Place Tanjung Pasir

Auction Place Tanjung Pasir is located in Tanjung Pasir Village, Teluknaga District, Tangerang Regency. In geographic coordinate, it is located at 6°1'8.35" S and 106°40'16.26" E. auction place Tanjung Pasir is under the management of Tangerang Regency Fishery Service. It has a land area of 2000 m² with buildings and facilities including dock, retaining wall, parking lot, auction place management office, auction floor, ice depot, and toilets. The auction area in auction place Tanjung Pasir is 200 m² wide. The number of personnel in auction place Tanjung Pasir management is 5 persons strong, with an auctioneer available. The number of baskets used is 22 Fishermen in auction place Tanjung Pasir are mostly traditional fishermen which use boats with less than 5 Gross Tonnage capacity and detachable engine. They also use a variety of catching devices but the fishermen who take part in the auction only use bottom gillnet and long line. auction place Tanjung Pasir starts its operation from 09.00 WIT and ends at 11.30 WIT. auction place Tanjung Pasir there is no restriction regarding the auction participants as everyone is able to take part in the auction without any registration in advance. Furthermore, since auction place Tanjung Pasir is located in maritime tourism site, the auction participants usually grow larger during holidays. Table 4 shows the production output and auction value of auction place Tanjung Pasir from 2013 to 2016.

| No. | Year | Production (kg) | Auction Value (Rp) |
|-----|------|----------------|-------------------|
| 1.  | 2013 | 117.924        | 1.633.000.000    |
| 2.  | 2014 | 82.653         | 1.789.235.000    |
| 3.  | 2015 | 75.061         | 1.924.045.000    |
| 4.  | 2016 | 80.001         | 2.089.690.000    |

Source: Auction Place Tanjung Pasir, 2017.

The production in auction place Tanjung Pasir was on a decrease in volume while the value had been steadily increasing year by year. The highest production output achieved in 2013 with 117.924 kg of fish being auctioned. For the next two year it continues to drop to just 75.061 kg in 2015, but in 2016 there had been a small increase in output.

3.2.4 Analysis of Fish Auction Place Facilities in Tangerang Regency

Nine requirements stated in the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number KEP.01/MEN/2007 serve as indicators on how the state of facilities in the Fish Auction Place in Tangerang Regency be defined. Table 5 below is used to describe them in detail.
Table 5. Analysis of Fish Auction Place Facilities in Tangerang Regency.

| Indicator                                      | Observed Condition |
|------------------------------------------------|--------------------|
| Fish Auction Place has closed structure        | √      √      √    |
| The condition of floorings and drainage system | +      +      +    |
| Sanitation facilities                         | +      +      +    |
| Lighting condition                            | √      √      √    |
| Vehicular pollution control                   | √      +      +    |
| The frequency of Fish Auction Place being     | √      +      √    |
| cleaned                                       |        |                   |
| Prohibition signs                             | +      +      +    |
| Clean water supply                            | √      √      √    |
| Special containers for fishes unfit for       | -      -      -    |
| consumption                                    |        |                   |

Information:
√: Facilities exist in good condition and in accordance with the indicator
+: Facilities exist but not in good condition and not in accordance with the indicator
-: Facilities unavailable

According to Table 5, it can be inferred that the facilities in three observed Fish Auction Places in Tangerang Regency are still not up to the standards set by the Minister of Marine Affairs and Fisheries. Explanations regarding the observed Fish Auction Places facilities condition are stated below:

1. Fish auction place must have a closed structure with easy-to-clean walls. All three observed fish auction place buildings were in good conditions. They all had closed-structure buildings with no signs of leak from the roof. Air circulation in every Fish auction place were excellent since they had high ceilings, so there was no problem regarding unpleasant smell and odors.

2. Fish auction place must have waterproof floorings that are easily cleaned and sanitized, equipped with drainage system and hygienic waste disposal system. Both fish auction place Cituis and fish auction place Tanjung Pasir had waterproof ceramic floorings so they could easily be cleaned and sanitized. Moreover, the floorings in fish auction place Tanjung Pasir was slanted in hope that any water puddles would flow to the drain. But in reality, there were some broken floors with holes spotted in fish auction place Tanjung Pasir floorings that sometimes create puddle if there was a water spill. Different situation was observed in fish auction place Kronjo. Its building did not have any flooring at all, so during auction processes the fishes are put in baskets, not directly above the floor. Broken floors in auction place, especially in the auction area, caused mud and grime from the auction activities to accumulate in those holes, making it harder to clean [26,27]. Aside from the flooring conditions, all three observed fish auction places were equipped with their own drainage system to flow water during cleaning process. The drainage system in fish auction place Kronjo and fish auction place Tanjung Pasir were in good conditions, water flowed freely without any clogging. While in fish auction place Cituis the drainage system was clogged in several spots.

3. According to the indicator, a fish auction place must have sanitation facilities such as an adequate number of toilets and wash basins, which must be equipped with soap or other cleaning substances and disposable hand dryers [28]. But in reality, all three observed fish auction places did not have adequate sanitation facility. Only one toilet was available in each fish auction place...
and while there was a wash basin in fish auction place, they were not equipped with disposable hand dryers.

4. Fish auction place must have a sufficient lighting to ease the control of fishery products and auction activities. All three observed fish auction places only operate during daytime, so natural source of lighting from the sun was sufficient enough. There were lamps observed in every fish auction place buildings, but they were mainly used for nighttime security purposes, not used during auction activities.

5. Vehicles which produces heavy air pollution and animals that might affect the quality of fishery products must be banned from the premises [29,30]. Out of the three observed fish auction places, only auction place Cituis that enforced this prohibition, since fish auction place Cituis premises were surrounded by fences and equipped with guard booths while the other fish auction places are not. Fish auction place Kronjo’s fences did not encircle the whole premises while auction place Tanjung Pasir did not have any fences at all. As a result, traffic and animal control in auction place Cituis could be possibly done, while it was hard to enforce the prohibition in the other two fish auction places.

6. Fish auction place must be cleaned regularly at least once after each auction is done, and the containers must be washed with clean clear water or clean sea water [31]. Both fish auction place Cituis and auction place Tanjung Pasir were cleaned daily with artesian water after auction activities are done, while auction place Kronjo were only cleaned every two days.

7. Fish auction place must be equipped with signs displaying the prohibition of smoking, spitting, eating, and drinking in the premises and they must be displayed in visible places. The regulatory signs were observed in every fish auction places, but the enforcement was so weak that personnels, collectors, and fishers did not pay attention to them.

8. Fish auction place must have an adequate supply of clear water or sea water. All three observed fish auction places had artesian water supplies that were used for cleaning the auction floors, fishes, baskets, and toilets.

9. Fish auction place must have special rust and water proof containers to contain fishery products that are not eligible for human consumption. None out of the three observed fish auction places had any special containers for fishery products that are not fit for human consumption.

Qualitative approach was used to observe the condition of existing fish auction place facilities in Tangerang District. Based on the analysis of facilities with indicators from Minister of Marine Affairs and Fisheries of the Republic of Indonesia Decree Number KEP.01/MEN/2007, auction place Cituis had the most adequate facilities when compared with the other two fish auction places. Auction place Cituis fulfilled five out of nine indicators, auction place Tanjung Pasir fulfilled four out of nine indicators, while auction place Kronjo only fulfilled three out of nine indicators. Physical size of existing facilities was converted into input variables that will be analyzed to determine the fish auction place efficiency by using DEA.

3.2.5 Result of Fish Auction Places Efficiency Analysis in Tangerang Regency
The efficiency analysis of fish auction places in Tangerang Regency was done using Banxia Frontier Analyst 4.3. There were eleven input variables with one output variable which was included in the analysis. Table 6 displays the variables.
Table 6. Input and Output Variables of fish auction places in Tangerang Regency

| Variabel Input / Output | TPI Cituis | TPI Kronjo | TPI Tanjung Pasir |
|-------------------------|------------|------------|------------------|
| Input                   |            |            |                  |
| Length of dock (m)      | 41         | 20         | 52               |
| Number of ships         | 367        | 332        | 83               |
| Number of baskets       | 40         | 500        | 22               |
| Number of catching devices | 367   | 332        | 83               |
| Number of carts         | 1          | 2          | 1                |
| Number of auctioneers   | 4          | 2          | 1                |
| Number of personnels    | 14         | 10         | 5                |
| Number of fish collectors | 82     | 18         | 50               |
| Number of fishermen     | 1278       | 1632       | 1526             |
| Number of weighing scales | 1        | 4          | 1                |
| Auction floor area (m2) | 288        | 120        | 200              |
| Output                  |            |            |                  |
| Production output       | 428213     | 349015     | 80001           |

Data served at Table 7 are the efficiency rates of each fish auction place according the calculations done in Banxia Frontier Analyst 4.3.

Table 7. Efficiency Rates of Fish Auction Place in Tangerang Regency

| No  | fish Auction Place Name | Efficiency Rate (%) | Predicate |
|-----|-------------------------|---------------------|-----------|
| 1.  | Cituis                  | 100.00              | Efficient |
| 2.  | Kronjo                  | 100.00              | Efficient |
| 3.  | Tanjung Pasir           | 82.60               | Inefficient |

From the analysis results, it can be inferred that auction place Cituis and auction place Kronjo are operated efficiently. Both of them reach the full 100% mark, meaning that theoretically they do not need any physical improvement in order to be qualified efficient. But in reality, auction place Cituis and auction place Kronjo can still be further improved, especially their facilities, in order to improve their operational income and the general welfare of the fishermen. The result also shows that auction place Tanjung Pasir fail to reach the 100% efficiency rate, with only 82.6% rate. It was caused by the actual inputs that surpassed the theoretical target input capacity of the auction place. This was further backed by [32,33,34] who stated that the efficiency score calculated by DEA was relative to each Decision-Making Unit (DMU). According to DEA approach, a DMU is deemed efficient if it can score 100% and deemed inefficient if it scores less than 100% [35,36], which means there is extravagance in using the inputs.

3.2.6 Level of Fish Auction Place Utilization in Tangerang Regency

According to the DEA calculation, two out of three fish auction places in Tangerang Regency were operated efficiently, while the other one, auction place Tanjung Pasir, was operated inefficiently with only 82.6% efficiency rate. The inefficiency in auction place Tanjung Pasir can be further improved with the application of technical efficiency. Technical efficiency is a scale that shows the comparison between actual production and maximum production. Technical efficiency requires a production process to utilize fewer inputs while still producing the same amount of output. More related data are shown in Table 8.
Tabel 8. Result of Fish Auction Places Tanjung Pasir Analysis

| Input/Output | Actual | Target | Potential Improvement (%) |
|--------------|--------|--------|---------------------------|
| **Input**    |        |        |                           |
| Length of dock (m) | 52.00  | 7.66   | -85.27                    |
| Number of ships | 83.00  | 68.56  | -17.39                    |
| Number of baskets | 22.00  | 7.47   | -66.03                    |
| Number of catching devices | 83.00  | 68.56  | -17.39                    |
| Number of carts | 1.00   | 0.19   | -81.32                    |
| Number of auctioneers | 1.00   | 0.75   | -25.27                    |
| Number of personnels | 5.00   | 2.62   | -47.69                    |
| Number of fish collectors | 50.00  | 15.32  | -69.36                    |
| Number of fishermen | 1526.00 | 238.76 | -84.35                    |
| Number of weighing Scales | 1.0    | 0.19   | -81.32                    |
| Auction floor area (m²) | 200.00 | 53.81  | -73.10                    |
| **Output**   |        |        |                           |
| Production output | 80001.00 | 80001.00 | 0                          |

Based on existing input variables, substantial reductions can not be made to all input variables. The operational variables of the input value that can be reduced are the number of ships, catching devices, and baskets. The excess number of ships with their catching devices can be diverted to the other fish auction place in Tangerang regency, or it can be accommodated by building another fish auction place in a new place in the regency. Eight baskets are enough to accommodate the activities in auction place Tanjung Pasir, while currently there are 22 baskets. There was no need to reduce the number of fish auction place officer in place. Since in practice, five personnels are not enough to ensure the fish auction place operates maximally. The same goes for the number of auctioneers, weighing scales, and carts. The possible improvement that can be made in the output variable is by increasing the amount of production. The amount of production that should be achieved can be calculated as follows:

\[
\text{Amount of production} = \text{Production amount} + (\text{Production amount} \times \text{the highest potential improvement})
\]

\[
= 80001 + (80001 \times 85.27\%)
\]

\[
= 80001 + 68216.8527
\]

\[
= 148217.85
\]

If auction place Tanjung Pasir can increase the production amount from 80,001 kg to 148,217.85 kg, then it can achieve optimum efficiency.

4. Conclusions
The facilities in the three auction places in Kabupaten Tangerang still have room for improvements. Out of the three observed fish auction places, only auction place Cituis that has adequate supporting facilities, while auction place Tanjung Pasir’s facilities are almost adequate and auction place Kronjo’s facilities are not adequate. Further improvement that can be made to all three observed fish auction places are the addition of special rust and water proof containers to contain fishery products that are not eligible for human consumption.

According to the calculation done on Banxia Frontier Analysis 4.3, two out of three observed fish auction places are efficient with scores of 100% for both auction place Cituis and auction place Kronjo while auction place Tanjung Pasir is inefficient with scores of only 82.61%.

There are two options to further increase the efficiency of auction place Tanjung Pasir. The first option is to decrease input variables such as the number of ships and catching devices which can be reduced by 17.39%, the number of baskets which can be reduced by 66.03%, the number of officials working in place can be reduced by 47.69%, the number of fish collectors which can be reduced by
69.36%, and the number of fishermen can be reduced by 84.35%. The second option is to increase the amount of production from 80,001 kg to 148,217.85 kg in order to reach optimum efficiency.

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