Dynamic model of beef availability for Rendang Industry in Payakumbuh City

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Abstract. The Payakumbuh City of Rendang is an icon that reflects one of the typical traditional foods with beef, coconut milk, and different kinds of spices as the basic ingredients. The availability of beef is very important for the rendang industry to ensure the production process. The roles of breeders, wholesalers, retailers, and their distribution need to be managed properly from upstream to downstream. This study aims to analyze the availability of beef for the rendang industry in Payakumbuh City using a dynamic model. Survey research methods and dynamic model data analysis method with Powersim software were utilized. The availability of beef to meet the demand for the rendang industry in Payakumbuh City is still very dependent on the results of slaughtered cattle in Payakumbuh City. Imported beef supply is currently used as an alternative option to fulfill the beef needs for the rendang industry in Payakumbuh City.

Keywords: Rendang, beef, dynamic model

1. Introduction

The raw material is the primary asset for industries. The availability of sustainable raw materials becomes the spearhead in the production process. Beef is one of the main raw materials in the Rendang industry in Payakumbuh city. Payakumbuh, the City of Rendang, is the icon of one of the cities in West Sumatera that is famous for the center of rendang with various flavors and raw materials. Beef rendang is the typical rendang of West Sumatera that has been popular worldwide. Rendang is a traditional cuisine of Minangkabau chosen by the CNN audiences in 2011 as one of the most delicious food in the world. The basic ingredients of rendang are beef, coconut milk, and herbs[1]. Rendang is from beef as the raw material and cut into cube size, and then adding coconut milk herbs into it. 43 small-medium industries (SMIs) of rendang exist in Payakumbuh city with different scales and variants of rendang type. The total rendang industry using beef as the raw material was 17 SMIs with a production scale of 20-50 kg (Dinasnakerin, 2019). The SMI of Rendang rapidly develops along with the popularity of rendang as the most delicious food in the world. The SMI of Rendang also keeps improving the business management by using the existing technology development. The digital technology development against the total demand of rendang is getting better after being affected by the COVID-19 pandemic condition. The increased number of demands for rendang should be balanced by the supply of high-quality beef as the raw material that is ready to be processed.

Beef in Payakumbuh city is from the people’s beef cattle farming business that is then slaughtered in a slaughterhouse (RPH), and the products are sold in the market. The beef demand in Payakumbuh...
city is not only from the SMI of Rendang but also from households, hotels, restaurants, and catering. The high demand for beef in Payakumbuh city makes the availability of beef in Payakumbuh city is decreasing and it even should be supplied from the outside of Payakumbuh city. The beef production in Payakumbuh city in 2019 was 1,377,577 kg from the slaughterhouse of beef cattle of 6,191 in total and the total beef cattle population was 5,830. The limited amount of available beef strongly affects the existing rendang industries; the problem faced by the SMI of Rendang against the beef supply occurs during the high demand for rendang (>200 kg) and the opportunity of exporting rendang that is continuously encouraged by the government of Payakumbuh city. Research on the availability of beef for the rendang industry in Payakumbuh has never been done before. Research that has been carried out on rendang products in West Sumatra includes [2]; [3]; [4]; [5]; [6]; and [1]. Based on the problems above, this study was conducted aiming at analyzing the availability of beef for rendang industries in Payakumbuh using a dynamic model. It is hoped that in the future the results of this study can be input for the local government in managing and accommodating the needs of beef in Payakumbuh, especially the Rendang Industry.

2. Research method
The research was conducted in Payakumbuh City used a survey method. Data analysis was carried out using dynamic models with Powersim software. System dynamics several stages that should be done were as follows: a). The making of Causal Loop Diagram; b). The making of flow diagram; c). Model Verification and validation and d). The making of scenario from the initial model [7]. The structure of the system dynamics model contained stock (condition), flow (rate), and increase/variable constant. By using the causal loop diagram, the stock diagram and the flow diagram showed the relationship between the variables [8]. Mathematically, the stock at a time of t is expressed in the following integral equation:

\[ Stock(t) = \int_{to}^{t} [Inflow(s) - Outflow(s)]ds + Stock(to) \]

Whereby, Inflow(s) is a total Inflow (increase in Stock), Outflow(s) is a total decrease in the stock during a period of s between the initial time (t_o) and the current time (t) [9]. After making a model, the next stage was testing the model. The model testing included two important stages, namely, validation and verification. In the model verification, the checking process was performed to know whether the model that had been made reflected the conceptual model clearly and was free from error. The model verification should be done, especially for preventing the logical fallacy that might occur, so that ensuring the model could give a reasonable solution. The model verification also prevented the general error to occur, such as an unimportant range of variables while other significant variables were ignored. To compare the model behavior against the actual condition (quantitative behavior pattern comparison), use the MAPE (Mean Absolute Percentage Error) test in Microsoft Excel [10]:

\[ MAPE = \frac{1}{n} \sum \left( \frac{X_m - X_d}{X_d} \right) + \times 100\% \]

The formula can make the explanation if X_m is the data of simulation result; X_d is actual data, and n is period or the total data. The criteria of model accuracy using the MAPE test are as follows: MAPE < 5 % is strongly accurate; 5% < MAPE < 10% is accurate and MAPE > 10% is inaccurate.

In the system dynamics modeling, the final goal that would be achieved was related to understanding, while the target was improving the understanding of the relationships that happened between the structure of feedback and the dynamic behavior of a system so that it could be developed as several policies for improving the behavior of the occurring problems.

3. Result and discussion
Rendang should be produced hygienically, including the preparation method and the management based on the regulation on the Guideline of Good Manufacturing Practices for Processed Food (CPPOB)[11].
The National Standardization Agency [12] explained that high-quality beef would produce high-quality products, both farmers and the people running the rendang industry should understand the beef quality both physically and microbiologically according to the National Standard of Indonesia (SNI) number 3932: 2008 on the carcass and beef quality. The supply of high-quality beef as the rendang raw material started from the upstream to the downstream that was finally processed into rendang should be performed well and accurately.

In the rendang industries, beef was collected or purchased from the retail seller. Beef that had been cut in the slaughterhouse was directly delivered to the processing industries (rendang) for the further process. The amount of beef that was purchased for producing some units per period was 30kg depending on the existing rendang demand. Most of the rendang industries in Payakumbuh still used fresh beef as the industrial raw material even though frozen beef has started to be marketed; it is related to the beliefs of the people operating the industry in the halal status of the beef that they will use. (Figure 1) shows the causal loop of beef cattle farming in Payakumbuh city started from the beef population in 2019 and a large number of qualified beef cattle to be slaughtered up to the carcass products from the slaughtering. The total beef population strongly affected the total beef cattle that could be slaughtered and the total beef products. The average weight of beef cattle in Payakumbuh city was 400 kg – 500 kg with the carcass weight of approximately 250-300 kg/beef cattle.

Figure 1. The causal loop diagram for the beef stock in Payakumbuh City.

The mortality rate of beef cattle is still relevant to the minimum standard of mortality (<5% of the total population), indicating that the management of beef cattle in Payakumbuh city was categorized as very good. The total beef collected after the livestock slaughter in 2019 was 1,377,577 kg from the total livestock slaughter of 6,191 beef cattle. The beef stock in Payakumbuh city was not only used for IKM rendang but also for hotel business, catering, restaurant, and the household among the people in Payakumbuh. The changes in beef demand could be affected by four factors, namely (1) consumer income, (2) taste and preference, (3) the price of complementary/substitute goods, and (4) total consumers in the market [13].
Figure 2. The simulation of beef cattle farming development in Payakumbuh City.

Figure 2, explains the flow diagram of the beef stock in Payakumbuh city. The flow diagram started from the development of the beef cattle population based on the birth rate and mortality rate so that it could be obtained the total beef cattle from 2019 to 2025. The Directorate General of Livestock and Animal Health targeted the development of the beef cattle population could increase by 7% in 2021-2025 in all areas of Indonesia. This target can be made as a motivation for the farmers and the relevant departments in all areas of Indonesia, especially Payakumbuh city, to increase the total beef cattle and products. The Department of Livestock in West Sumatera Province also issued the parameter of slaughtering, inflow, and the outflow of beef cattle in 2019 with the details in Table 1.

| Parameter of Beef Cattle | Percentage (%) |
|--------------------------|----------------|
| Birth                    | 23.48          |
| Mortality                | 0.87           |
| Slaughtered              | 29.82          |
| Livestock Inflow         | 9.43           |

Source: Livestock Statistics of West Sumatera, 2020

In 2019, this relatively high total of livestock slaughter in Payakumbuh city was performed to fulfill the need for beef cattle in Payakumbuh city. The beef cattle population in 2019 was 5,830 while the total slaughtered beef cattle was 6,191; the discrepancy between the total population and the total slaughtered beef cattle since the inflow of beef cattle from outside the Payakumbuh city for fulfilling the needs of beef. The Department of Livestock in West Sumatera Province explained that, in 2019, there was an inflow of beef cattle of 9.43% to the West Sumatera.
The need for beef in Payakumbuh city as the raw material of rendang industries for producing some units per period for each SMI of Rendang was around 30kg and the total need for beef for all SMIs was around more than 1 ton for producing some units per period. This high demand for beef will increase significantly approaching Eid-al Fitr day and Eid-al Adha day. One of the people running the rendang industry stated that when the rendang demand increased, beef as the raw material was often difficult to be fulfilled; this becomes the main problem in rendang production.

The beef price in Payakumbuh city is IDR 120,000/kg, and this is a big number in the production cost of rendang if the total demand is more than 100kg. The scarcity of beef can trigger the increase in the beef price and it will eventually affect the rendang industries that existed in Payakumbuh city. [14] the vertical capacity of the market structure identified that the increase and the decrease in price from the distribution system was the reflection of market performance. The proof for the downturn of the price drop in the agriculture-food supply chain can be considered as the inefficiency indicator; hence, it should be a concern for the economists and policyholders.

Based on figure 4, the availability of beef in Payakumbuh city can fulfill the consumption need of households, hotels, catering, restaurants, and SMIs with a normal production scale of 30 kg/SMI. If the demand from the SMI of rendang increases and the export opportunity is opened, the availability of beef should be a priority so the opportunity of high rendang demand can be fulfilled based on the consumer demand. The import of frozen beef has entered West Sumatra. The information related to the use of
import beef as the raw material of rendang industries allows the local beef stock to not be able to fulfill the needs of rendang industries.

The import beef price of IDR 85,000 – 100,000/kg that is considered cheaper than the fresh beef price of IDR 120,000 – 130,000/kg becomes a consideration for the rendang industries to start using import beef as one of the alternatives for fulfilling the need for beef as the raw material for rendang industries in West Sumatera, specifically in Payakumbuh city. Figure 4 shows the illustration of import beef as an alternative raw material of rendang industries compared to the total local beef that is available to be consumed by all sectors.

The technology development also facilitates the people who run the industry to access high-quality beef for the raw material via online media. Along with the high export opportunity of rendang and the increased rendang demand, the people involved in running the rendang industry continue to improve business management by using online media. The process of making from fresh beef to be ready-to-eat rendang requiring around 6-8 hours makes the beef rendang price more special. The rendang product in a refrigerated condition will be packed with a weight of 300 gram/pack and a price of IDR 75,000/300 gram and IDR 300,000/kg.

4. Conclusion
The beef stock in Payakumbuh city should be improved starting from the upstream to the downstream and well-managed so the IKM rendang can fulfill the demand of rendang industries according to the market target that will be achieved. The beef import has an opportunity to be an alternative for fulfilling the need for beef in Payakumbuh city, especially rendang industries.

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