Identification of rice supply chain risk to DKI Jakarta through Cipinang primary rice market

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Abstract. This paper identifies several sources of risks in DKI Jakarta rice supply chain that through Cipinang Primary Rice Market (CPRM). Secondary data from several sources were collected and analysed using pareto chart and time series analysis. Based on the pareto analysis, it was known that there was a change in the order of suppliers whereas in 2011, 80% of the supply came only from Cirebon, Karawang and Bandung (West Java Province). While in 2015 the main source of supply changed to Cirebon, Central Java and Karawang. Linear trend equation using decomposition model for Cirebon and Karawang showed trend of decreasing monthly supply while Central Java had a positive trend. Harvest area of wetland paddy in Cirebon and Karawang showed a negative trend in the last 6 years. The data also showed that West Java Province was the province with the largest rice crop area affected by plant organism attack and drought disaster in 2015. DKI Jakarta had several potential supply chain risks from rice supply, drought risk and pests risk where the province of West Java, which previously could become a major supplier began to require supply assistance from other provinces, especially Central Java.

Keyword: pareto analysed, pest risk, rice market, rice supply, supply chain risk

1. Introduction

DKI Jakarta is the area of rice consumption due to the very limited amount of rice production in this city. So it requires supply from various producer areas. This big city needs about 876912 tons of rice to meet the food needs of its people in 2010 and it has been assured that DKI Jakarta can only fulfill about less than 1 percent [1]. The supply and distribution of rice in DKI Jakarta has been regulated by the Regional Government by assigning Cipinang Primary Rice Market (CPRM) managed by PT. Food Station Tjipinang Jaya as a regional-owned enterprise that maintains food security especially rice in DKI Jakarta. Rice entering through CPRM comes from three rice production centers namely Cirebon, Karawang and Bandung. The supply volume of Karawang and Cirebon tends to be high in March-April (first harvest season) and September-October (second harvest season) and low volume around December-February [2].

Rice supply chain as well as general supply chain face various risk factors. Several type of risks are supply risk, operational risk, demand risk, security risk, macro risk, policy risk, competitive risk and resource risk [3]. Another classification of risks are market related risks, logistical and infrastructure
related risk, political related risk, policy and institutional related risk, financial related risk and operational managerial related risks [4]. Specifically for agricultural supply chain, risk mainly comes from weather/natural disasters related as well as biological and environmental related [5], [6].

Global supply chain risk management and mitigation consists of five steps namely risk identification, risk assessment and evaluation, selection of appropriate risk management, implementation of supply chain risk management strategy and mitigation of supply chain risk [3]. This paper identifies risks related to market related risk (supply), natural disaster risk, and biology/environmental risk in DKI Jakarta supply chain that through CPRM using Pareto and time series analysis. Previous research related to the use of time series analysis for risk analysis was done by Leila to analyse risk and vulnerabilities in supply chain networks using ARIMA model [7].

2. Research Method
This study used secondary data coming from various institutions. Secondary data comes from various institutions namely PT. Food Station, statistical center bureau [8], [9] and Food Protection Directorate [10], [11]. The stage began with the collection of monthly rice supply data from various regions entering the rice Cipinang rice market for 5 years (2011 - 2015). The largest source of supply was analysed using a pareto diagram. Time series data are then analysed using decomposition method that can be used for trends and seasonal conditions [12], [13]. Time series could have trend, seasonal, or cyclical pattern. A trend is a gradual upward or downward movement of a time series over time and a seasonal effect is one that repeats at fixed intervals of time [14]. Decomposition computes time series decomposition in trend, seasonal, cycle and error components. The equations of this model is:

\[ Y_t = f (S_t; T_t; E_t) \]  

where \( Y_t \) = data at period \( t \)  
\( S_t \) = seasonal component at period \( t \)  
\( T_t \) = trend component at period \( t \)  
\( E_t \) = remainder (or irregular or error) component at period \( t \)

For additive decomposition : \( Y_t = S_t + T_t + E_t \) and for multiplicative decomposition : \( Y_t = S_t \times T_t \times E_t \). The additive model is most appropriate if the magnitude of the seasonal fluctuations or the variation around the trend-cycle does not vary with the level of the time series [12].

The analysis was then continued by looking at various factors that are likely to affect the pattern changes in the pare to diagram and time series analysis. The least squares regression method is used for wetland availability and paddy production trend analysis. Wetland area and paddy production data were from data Attack of plant pest organisms and drought disasters especially in West Java Province were analysed using bar chart.

3. Result and Discussion
The results showed that CPRM get supplies from various rice production centers mainly Cirebon (including Indramayu), Karawang, and Bandung in 2011 (Figure 1). Total supply increased from 706308 tonnes in 2011 to 815402 tonnes in 2015. Based on the pareto analysis, it was known that there was a change in the order of suppliers, which about 85% supply previously in 2011 came from three regions namely Cirebon, Karawang and Bandung (part of West Java Province) has changed to Cirebon, Central Java and Karawang (Figure 2). Bandung regency has turned into the fourth largest region that supplies rice to Jakarta.
Time series analysis using Minitab software for rice supply from Cirebon can be seen in Figure 3. Linear trend model for Cirebon showed trend of decreasing supply amount with negative gradient. The negative slope coefficient indicates a potential risk factor on the supply side from Cirebon and surrounding areas (including Indramayu). Indramayu and Karawang are the two largest rice production centers in West Java [8]. R statistical programming software was used to visualize seasonal, trend and randomness separately (Figure 4). The trend patterns also show a declining pattern over the last 5 years. Seasonal patterns show a recurring pattern every year. Supply amount of rice will be large at the time of the first harvest (during March and April) and second harvest (during September and October) and will be very low at around the end and the beginning of the year.

**Figure 1.** Pareto chart of supply source area in 2011

**Figure 2.** Pareto chart of supply source area in 2015

**Figure 3.** Time Series Decomposition for supply from Cirebon (Additive Model).
Figure 4. Decomposition for supply from Cirebon (Additive Model) using R.

Fitted trend equation supply from Cirebon, Karawang and Bandung showed trend of decreasing supply amount with gradient coefficient respectively \(-44.6986\), \(-25.9552\) and \(-21.614\) (Table 1). The negative slope coefficient indicates a risk factor on the supply side from West Java Province. Unlike the supply from Cirebon, Karawang and Bandung, the supply from Central Java Province shows a positive trend (Table 1). Gradient coefficient was \(207\).

Table 1. Fitted trend equation for monthly rice supply to crpm 2011-2015 using decomposition method.

| Region of Supplier | Fitted Trend Equation |
|--------------------|-----------------------|
| Cirebon            | \(Y_t = 21557 - 44.6986* t\) |
| Karawang           | \(Y_t = 17005 - 25.9552* t\) |
| Bandung            | \(Y_t = 7916 - 21.6314* t\) |
| Central Java       | \(Y_t = 7274 + 207* t\) |

Harvest area of wetland paddy in Cirebon, Karawang and Indramayu Regency showed a negative trend in the last 6 years where based of gradient coefficient, the biggest decline occurred in Indramayu district (Table 2). The yearly data comes from [8]. Based on [15] for 13 years in the period 2000-2013, the decrease of rice fields in Karawang regency amounted to 12,402 ha or an average of 954 ha per year or 0.9% per year. In the year 2000 the area of rice field is 116,268 ha or 60.6% of the total area of Karawang regency, while in 2013 decreased the area to 103,866 ha (54.1%). Part of the area where rice fields are reduced is mainly near the urban and toll roads that are in the central part of Karawang regency [15].

Table 2. Linier trend model for wetland paddy harvested area and production 2010-2015 using least square regression method.

| Region                | Harvested Area (ha)            | Production (tons)  |
|-----------------------|--------------------------------|--------------------|
| Cirebon Regency       | \(Y_t=86771 – 1236.00* t\)    | \(Y_t=522247 – 6299.39* t\) |
| Karawang Regency      | \(Y_t=185194 – 106.914* t\)   | \(Y_t=1079174 + 12118* t\) |
| Indramayu Regency     | \(Y_t=230238 – 6113.54* t\)   | \(Y_t=1342109 – 13349.1* t\) |
| Bandung Regency       | \(Y_t=68408 + 1607* t\)       | \(Y_t=432542 + 9533* t\)  |
| West Java Province    | \(Y_t=1907441 – 18836.9* t\)  | \(Y_t=112716656 – 44959.7* t\) |

However, it is not always a decrease in the area of wetland rice is proportional to the level of rice production. Although the area of paddy field in Karawang regency decreased, the data sourced from
Central Statistics Agency of West Java showed that rice production still showed positive trend (Table 2). This is different from other rice supplier areas to Jakarta, namely Cirebon and Indramayu (areas adjacent to Cirebon). In both areas, rice production showed a negative trend. In total, this condition is similar to West Java province which originally became the main supplier of rice to DKI Jakarta. Rice production in West Java province shows a negative trend which indicates a supply risk (market related risk).

Figure 5. Wetland paddy area affected by pest (ha) in 2015.  
Figure 6. Wetland paddy area exposed to drought (ha) in 2015.

In addition to supply-side risk factors, this paper also reviews the risk factors in terms of natural disasters and environmental risks. The data also showed that West Java Province was the province with the largest rice crop area affected by plant organism attack and drought disaster in 2015 that is equal to respectively 48159 ha (Figure 5) and 80476 ha (Figure 6). Pest and disease attacks are a risk that must be faced by rice supply chain from West Java. This risk management is not always based on the use of chemical pesticides but can be done by utilizing various other control technologies. Such as the utilization of biological agents and vegetable pesticides [10]. The best practice on biological and environmental risk mitigation in Bandung Regency of West Java Province has been done by an exemplary farmer group named Sarinah Organik through the use of vegetable pesticides [16].

4. Conclusion
The results showed that DKI Jakarta rice supply chain had several potential risks from supply risk, drought risk and pests risk where the province of West Java, which previously could become a major supplier began to require supply assistance from other provinces, especially Central Java.

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