# CHAPTER 3

# Materials and Methods

## 3.1 Data Source

District officer or Dinas sending data to ISIKHNAS via SMS or android application, this data is received by iSIKHNAS modem and if the code correct will be saved in Server, then the other modem will send an SMS containing identification number of animal health certificate, this SMS response received by the District officer.

The data of poultry and cattle movement were retrieved from the iSIKHNAS database, this database administered by the Directorate of Animal health, Ministry of Agriculture, Indonesia. iSIKHNAS containing of animal health certificate ID (SKKH), date of issued, type and number of animals, origin, destination. The geographic location of origin and destination livestock is provided at administration boundaries (Province, Districts, Sub districts and village), however the location of villages and sub districts level was incomplete, and therefore the location of districts was defined at districts level. The system recording of iSIKNAS in Java Island started in 2013, while on the Island of Sumatra initiate in October 2013 therefore data from November 2014 to October 2015 was used in this study, the location focused in three provinces (Lampung, West Java and Central Java) and link to another Province in Indonesia. Data from iSIKNAS database were retrieved through PostgreSQL Admin III or website and imported in Excel.



## 3.2 Data Analysis

### 3.2.1 Movement Description

For each movement, the following descriptive parameters were recorded and calculated: number of movements by species, number of livestock moved by species, distribution of movements and Euclidian distance which measured the distance between the geometric center (centroids) of the origin and destination district. Distribution of quantity of movement and distance was showed in boxplot and histogram and if the data does not meet the normality, then used Kruskal-Wallis test, this test was used to compare the mean quantity and distance per type of poultry. The geographical map used to visualize combined poultry and cattle movement from and into study locations.

### 3.2.2 Social Network Analysis

The unit of interest in this social network analysis (node) was the district and link (arc) was a movement of poultry or cattle connecting districts. A directed link (district A is connected to B but B may/may not be connected to A) was used in this study and each characteristic it had two values; one for the inside and one for the outside node. The network cattle and poultry movements were analyzed to investigate the main centrality parameters, seasonal pattern and network topology.

#### 1) Centrality Parameter of Network

The network was created based on combining poultry, species of poultry and cattle movements between the origin and destination district in 12 months. In contrast with poultry movements, the type of cattle is not available in iSIKHNAS, therefore, the analysis cannot be separated accordingly type of cattle.

The following centrality parameter was calculated for each node of poultry and cattle network and summarized for the entire network through descriptive statistics and displayed in plot means and error bar graphs: in-degree, out-degree and betweenness. The Kruskal-Wallis test was applied to compare centrality parameter between species of poultry. The nodes in each network with high centrality score were identified. We used correlation coefficient to measure the relationship between in-degree against ingoing contact chain, out-degree against outgoing contact chain and in-degree and out-degree. The similarity of in-degree, out-degree and betweenness in each network were measured using Moran’s I spatial analysis, for each district was used queen contiguity (polygons are adjacent. If they share a border or corner) and first spatial lag is districts neighbors which share a border or corner (first neighbor), second spatial lag is defined as sub-districts neighbors which share a border or corner with first spatial lag (neighbor-neighbor), and so on. Positive spatial auto-correlation occurs when Moran's I is close to +1. This means values cluster together, negative spatial auto-correlation occurs when Moran's I is near -1 and indicates dissimilar values are next to each other, value of 0 for Moran's I typically indicates no autocorrelation.

**2) Centrality Parameter of Monthly Network**

In this study, we used a monthly time scale by reason at this time windows have sufficient number for analysis and considered a plausibly period of time that allows disease infection could spread silently (Bajardi et al., 2011), furthermore Keeling and Eames (2005) argued large time windows may not necessarily problem when turn over slow relative to the time scale pathogen, the network will not change a lot during the epidemic phase.

A static network was created based on monthly time windows in 4 species of poultry, combined poultry and cattle network, resulting in 72 networks. In each network, the score of in-degree and out-degree of combined poultry and cattle network were also calculated

**3) Topology of the Network**

The structure of each network was explored for small world and scale free properties. Small-world networks are characterized by high clustering coefficients and short geodesic distances compared to random networks of equivalent size (Watts and Strogatz., 1998). Scale free properties was assessed characterized by an in-degree and out-degree skewed distribution with heavy tail, in which a majority of nodes have few contacts and a smaller of nodes have many contacts or double logarithmic axis (log-log plot), in which a power law follows a straight line approximated with $p\ (k) \sim k^{-\alpha}$

The exponent α is its degree exponent (Barabasi., 1999), α value between 2 and 3 implies a power law distribution (Clauset et al., 2009).

Network giant strong component (GSC) and weak component size (WCS) were calculated, a network is strongly connected if it is possible for every other node respecting the direction of the links and weakly connected if each pair of nodes is connected by a link disregarding the direction. The cut-points in each network was also computed, removing cut-points may assist in control and prevent disease.

**4) Topology of the Monthly Network.**

A static network in combined poultry and cattle network once again, each month was also observed to assessed small world properties, cluster coefficience and average geodesic distance were calculated to compared with random network, the cluster coefficient in the observed network should be greater than random network and average geodesic distance for observed and random network should be similar (Watts and Strogatz., 1998).

The geographical map of poultry and cattle movements was prepared by Quantum GIS (QGIS Development Team., 2015), Moran's I spatial analysis was conducted using GeoDa software (Anselin et al., 2006). Network analyses were carried out using the Igraph package (Csardi and Nepusz., 2006) for R software (R Development Core Team., 2016).