Study on The Evaluation of The Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses in Indonesia

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Abstract. Physical infrastructure at urban in Indonesia ruminant slaughterhouse is typically old and in need of urgent rehabilitation. Infrastructure and equipment at ruminant slaughterhouses, in particular, are very poor and in many cases new facilities may be the only option for medium to long-term solutions. This study was carried out to evaluate the sustainability on physical conditions, and functional status of infrastructure of ruminant slaughterhouses. The survey data were collected the December 2017 until at April 2019 for this study. Twelve ruminant slaughterhouses situated at Bogor City, IPB, Depok, Jakarta, Bekasi, Yogyakarta, Denpasar, Yogyakarta, Semarang, Kudus, Surabaya, and Malang were selected for the study. Data were collected through interview as well as through observations. The data were coded, classified, tabulated and analysed using the software Statistical Package for the Social Science (SPSS) and Multidimensional Scaling (MDS). Furthermore, influential variables are processed through MDS analysis to find out the Ruminant Slaughterhouse infrastructure sustainability index. The research finding that the sustainability status value is 77.30 % (good sustainable), and leverage analysis showed that the attribute that has the highest Root Mean Square (RMS) value is Infrastructure of Water supply source (4.0119).

1. Introduction
All Slaughterhouse have unique infrastructure requirements, because of the best infrastructure design is the one that is tailored to suit existing operation. Range of standard designs as a benchmark for working capacity which are then fine-tuned to meet the needs, and to create a facility specific [1]. All of The slaughter houses which located in urban or rural areas were lacking infrastructure which are necessary for producing hygienic meat [2], including Indonesia. For Some farm systems, where for example animals have spent their entire life on one farm, slaughter would ideally be on the farm. A number of countries within the EU as well as Canada, New Zealand, America, Scotland currently have mobile abattoirs successfully operating within tight regulatory and infrastructure regimes [3,4]. Observational assessment of abattoir facilities such as lair age, evisceration section, guttery and tripper section, cold room, detained meat section and condemned meat section are present but non-functional [5]

1.1 Infrastructure of Ruminant-Slaughterhouse
Slaughterhouse is defined as any premises that is approved and registered by the controlling authority in which animals are slaughtered and dressed for human consumption. The purpose of a slaughterhouse is to produce hygienically prepared meat by the humane handling of the animal using hygienic techniques for slaughtering and dressing [6,7]. A suitable site in construction of conventional
slaughterhouse should have the following: main portable water and electricity, main sewage, contiguity with uncongested road and rail system, proximity with public transport, proximity to supply of varied labour, freedom from pollution from other industries, odours, dust, smoke, and ash.

2. Methodology
The survey data were collected the December 2017 until April 2019 for this study. Twelve ruminant slaughterhouses situated at Bogor City, IPB, Depok, Jakarta, Bekasi, Yogyakarta, Denpasar, Yogyakarta, Semarang, Kudus, Surabaya, and Malang were selected for the study. Evaluation of the Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses in Indonesia are identified from literature and inferable discussions with Ruminant-Slaughterhouses experts. Two different techniques namely, principal component analysis (PCA), and Multidimensional Scaling (MDS) are applied to The Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses [7,8,9,10]. PCA analysis has also been implemented in research which titled Identifying Industry 4.0 IoT enablers by integrated PCA-ISM-DEMATEL approach [11,12]

2.1 Principal Component Analysis
Principal component analysis (PCA) approaches is the foundation for multivariate data analysis. PCA technique is extensively analysed in the literature and in-depth details. PCA analyses data table representing observations described by several dependent variables, which are inter-correlated. Its aim is to extract the information from the data sets and then express it as a set of new orthogonal variables called principal components. Similar to PCA, factor analysis (FA) is another technique developed by group of psychologists in the year 1930. However, PCA and FA are closely related to each other and are used for clustering factors.

2.2 Multidimensional Scaling Analysis
Multidimensional scaling (MDS) analysis is one of techniques that can be used to determine the position of a different object based on its resemblance, as well as to know interdependent relationships or mutual dependence between attributes. This relationship is not known through the reduction or grouping of attributes, but rather by comparing the attributes in each object in question using the perceptual map. The MDS is also a technique that can help researchers to identify leverage attributes. MDS relates to the creation of maps to illustrate the position of an object with other objects based on the similarities of the objects. The MDS method helps identify double dimension scaling known as a perceptual map, which is a method that is to describe or map a perceived relative impression of a number of objects related to perception.

In the MDS the attribute be measured with be mapped within the distance of Euclidian where the perceived object has the same characteristics as the closest Euclidian distance. Conversely, objects with different characteristics are called dissimilarities so that the difference between them can be measured within the perceived perception distance in the perception index such as the Sustainability Index. Distance determination techniques are based on Euclidian Distance with the following formula:

\[ d_{1,2} = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2 + (Z_1 - Z_2)^2 + \ldots} \]

Description :
- \( d_{1,2} \) = euclidian distance
- \( X, Y, Z \) = Attribute
- \( 1,2 \) = Observation

The distance Euclidian between these two points \((D_{1,2})\) then inside the MDS is projected into the two-dimensional Euclidian distance \((\hat{D}_{1,2})\) based on the regression formula in the following equation:
\[ D_{1,2} = a + b D_{1,2} + c \]

Description:
- \( a \) = intercept
- \( b \) = slope
- \( c \) = error

In the MDS analysis (using the Rap-Infrastructure software which modified of Rap Fish software with MDS principle), two points or similar objects are mapped in one point adjacent to each other. The technique used is the ALSCAL algorithm and is easily available on almost every statistical software (SPSS and SAS). Rap-Infrastructure (modified Rap Fish) in principle makes iterations of the regression process so that the value of the smallest \( c \) is obtained and attempts to force the intercept on the equation equal to 0 (\( a = 0 \)). Iteration stops if the stress is < 0.25 \([11]\). For the attribute as much as \( M \) then stress can be formulated in the equation as follows:

\[
\text{stress} = \sqrt{\frac{1}{m} \sum_{k=1}^{m} \left( \frac{\sum_i \sum_j (D_{ij}^2 - d_{ijk}^2)}{\sum_i \sum_j d_{ijk}^2} \right)^2}
\]

Through the rotation method, the position of the sustainability point can be visualized through the horizontal and vertical axes with the value of sustainability indexes rated 0 percent (bad) and 100 percent (good). The output of the Rap-Infrastructure analysis is a sustainability index of 0-100 displayed in the ordination and leveraging indicators. Sustainability indices are grouped in 4 categories, namely: 0-25 (bad or unsustainable); 25, 01-50 (less sustainable); 50, 01-75 (fairly sustainable); 75, 01-100 (good or very sustainable) \([12]\).

2.3 Leverage Analysis
Leverage analysis is performed to determine the effect of stability if one of the attributes is omitted during ordination. The results of the Influence analysis (Leverage) shows the attributes that have the highest Root Mean Square are the most sensitive to sustainability attributes \([13]\).

2.4 Montecarlo Analysis
To evaluate the effect of errors on the estimation of ordination values used Montecarlo analysis, namely statistical simulation method to evaluate the effect of random error on the estimation process, as well as to evaluate the actual value \([13]\).

3. Result and Discussion
To evaluate the sustainability of the physical and functional condition infrastructure, started with the inventory of components the infrastructure. Based on interviews with government and private ruminant-slaughterhouse Managers, academics, it was agreed to evaluate 5 dimension and 55 components. Furthermore, the 5 dimension and 55 components are analysed with PCA to ensure representation in the physical and functional evaluation of infrastructure

3.1 Factorization Using Principle Component Analysis (PCA)
Fifty five factors identified for Evaluation of the Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses in Indonesia implementation are factorized using PCA. Following are the steps:

3.2 Data Validation and Reliability Analysis
The data 5 dimension and 55 components is collected from experts, private, government and academicians through online survey. The resulted is 200 returned questionnaires out of 245. Further data cleaning was done by applying case wise replacements. To apply PCA, the minimum sample size should be larger than five times the number of variables. Concretely, the sample size of 200 is considered for factorizing the fifty-five variables using PCA. Further, reliability test is conducted to assess the errors and overall consistency of the data sets using SPSS.
To find out accuracy of evaluation, then indicator validation is performed through bivariate correlation test and reliability test. The use of PCA analysis is also used in IT-related studies including 3.2.1 Data Validation:

For the instrument validity test used is a bivariate correlation test between each indicator and the total variable score. Pearson's correlation test results can be seen in Table 1.

Table 1. Validation of The Sustainability Physical Facilities (Infrastructures) of Ruminant - Slaughterhouses in Indonesia

| No  | Dimension                                   | Invalid and significant indicators                                      |
|-----|---------------------------------------------|--------------------------------------------------------------------------|
| 1   | Main building requirements                  | All indicators have significant value                                     |
| 2   | Main building                              | All indicators have significant value                                     |
| 3   | Supplies                                   | All indicators have significant value                                     |
| 4   | Main building requirements and layout       | All indicators have significant value                                     |
| 5   | Facility requirements                       | All indicators have significant value                                     |

Based on the correlation test results (table 1), the correlation between each indicator is significant in value. So it can be concluded that the indicator is valid and can be continued with the Reliability Test process.

3.2.2 Reliability Test

Reliability test is demonstrated with Cronbach Alpha Coefficient, aiming to calculate empirical data of the results of the first and second trials. Reliability Test of five Dimensions is listed in Table 2.

Table 2. Five Dimensional Reliability Test Results of The Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses in Indonesia

| Dimension                                | Coefficient Reliabilities | Coefficient > Coefficient Cronbac Alpha | Description |
|------------------------------------------|----------------------------|----------------------------------------|--------------|
| Main building requirements               | 0.8979                    | 0.8979 > 0.7                         | Reliable     |
| Main building                            | 0.8525                    | 0.8525 > 0.7                         | Reliable     |
| Supplies                                 | 0.8636                    | 0.8636 > 0.7                         | Reliable     |
| Main building requirements and layout    | 0.9424                    | 0.9424 > 0.7                         | Reliable     |
| Facility requirements                    | 0.9080                    | 0.9080 > 0.7                         | Reliable     |
| Average                                  | 0.8994                    | 0.8924 > 0.7                         | Reliable     |

Table 2 shows that each dimension produces an average Cronbach's Alpha value or Alpha Reliability coefficient of 89.94% (0.8994). The next test using exploratory factor analysis by looking at the correlation values of each dimension.

3.2.3 Exploratory Factor Analysis

PCA using varimax rotation is applied to the datasets. Here, Kaiser-Meyer-Olkin (KMO) measures the sampling adequacy to provide the appropriateness of the data Bartlett’s Test of Sphericity verifies that obtained correlation matrix has an identity matrix and its associated p-value.

3.2.4 Exploration Factor Analysis:

To measure the adequacy of sampling (compatibility), the indicator used is kaiser-meyer-olkin (KMO) value. KMO values for the resulting 5 dimensions range (0.8600-0.9422) so that factors can be extracted (Table 3).
Table 3. List of KMO and Bartlett’s Test Value of Five-Dimensional Evaluation of The Sustainability Physical Facilities (Infrastructures) of Ruminant-Slaughterhouses in Indonesia

| No | Dimension                                  | KMO measure of sampling adequacy | KMO > coesisien (0.50) |
|----|--------------------------------------------|----------------------------------|------------------------|
| 1  | Main building requirements                 | 0.9292                           | Significant            |
| 2  | Main building                              | 0.8855                           | Significant            |
| 3  | Supplies                                   | 0.8600                           | Significant            |
| 4  | Main building requirements and layout      | 0.9422                           | Significant            |
| 5  | Facility requirements                      | 0.9272                           | Significant            |

Table 3 shows that the five-dimensional KMO Value Test meets the requirements (>0.50). If the result of the KMO Test < 0.5, then the variable is evaluated. From the results of the fifth KMO test Dimensions be obtained qualified results as seen in Table 4.

Table 4. PCA Results Factor Grouping

| No | Dimension                                  | Component                      |
|----|--------------------------------------------|-------------------------------|
| 1  | Main building requirements                 | IL01, IL02, IL03, IL04        |
|    |                                            | IL05, IL06, IL07, IL08, IL09, IL10, IL11 |
| 2  | Main building                              | CL01, CL02, CL03, CL04, CL05, CL06, CL07, CL08 |
|    |                                            | CL09, CL10                    |
| 3  | Supplies                                   | GL01, GL02, GL03, GL04, GL05, GL06 |
|    | main building                              | SL01, SL02, SL03, SL04, SL05, SL06, SL07, SL08, SL09, SL10, SL11 |
| 4  | Requirements and layout                    | SL12, SL13, SL14, SL15, SL16, SL17 |
|    |                                            | OL01, OL02, OL03, OL04, OL05, OL06 |
| 5  | Facility requirements                      | OL07, OL08, OL09, OL10, OL11   |

Hence, 55 components are factorized into five principal components. The 5 components are: (i) Main Building Requirements, (ii) Main Building, (iii) Supplies, (iv) Main Building requirements and layout, (v) Facility requirements. Based on face validity with Head of Livestock Field of Bogor, for sustainability evaluation agreed as many as 15 attributes

3.2.5 Sustainable Analysis

The Rap-Infrastructure analysis shows that the sustainability status value is 77.30 % (very sustainable) (Figure 1). Validation of simulation results shows that determination coefficient (R2) of 0.950. It means that the 15 attributes included have a considerable role in explaining the diversity of infrastructure sustainability evaluations. Stress value is 0.1315 (< 0.25) which means the accuracy of the goodness of fit of the built model is a good. The sustainability of Slaughterhouse Infrastructure be achieved, then the leverage attribute must be intervened
Based on the MDS analysis and leverage analysis showed that the attribute that has the highest Root Mean Square (RMS) value is Infrastructure of Water supply source (4.0119) (Table 5).

Table 5. Attributes of Leverage Produced by Rap-Infrastructure

| No | Attributes                                                                 | Root Mean Square |
|----|---------------------------------------------------------------------------|------------------|
| 1  | Construction of main building have be to have ventilation and sunlight, prevents the entry of rodent, insects, birds | 3.4638           |
| 2  | Walls (waterproof, not easily corrosive, not slippery, not toxic, resistant to impact) | 3.2947           |
| 3  | Electric light and power                                                  | 3.9091           |
| 4  | Meeting angle between walls                                               | 3.6599           |
| 5  | Floor (waterproof, not easily corrosive, not slippery, not toxic)         | 3.8725           |
| 6  | Post-mortem and ante mortem checkpoint                                    | 3.1398           |
| 7  | Production modules of meat cutting & processing                           | 2.8731           |
| 8  | Amenities and office for planting to effluent trenches                    | 2.8653           |
| 9  | Production modules of tripe room or dirty area                            | 2.9541           |
| 10 | Production modules of chiller                                             | 3.1734           |
| 11 | Service modules of skin processing                                        | 3.3039           |
| 12 | Production modules of slaughter floor                                     | 3.4627           |
| 13 | Modules of lairage                                                        | 3.3770           |
| 14 | Infrastructure of water supply source                                    | 4.0119           |
| 15 | Service modules of solid waste & blood disposal                           | 3.3774           |

Infrastructure of water supply source (4.0119) is a key attribute that needs to be maintained. Because for sustainability on physical and functional status of infrastructure of ruminant slaughterhouses depend on infrastructure of water supply. In some Slaughterhouses (Bogor City), the infrastructure is built with recycle (reverse osmosis) techniques year 2014 [14, 15]. Construction of Main Building have be to have ventilation and sunlight [16], prevents the entry of rodent, insects, birds (3.4638). Enough ventilation and sunlight could be prevents virus-containing droplets from infected individuals [17]. The difference
in MDS values with the relatively small Monte Carlo analysis is 0.320 or < 1. It indicates that the results of the MDS calculation can reflect a high degree of precision (Kavanagh and Pitcher 2004).

4. Conclusions
The resulting of evaluate of the sustainability on physical functional status of infrastructure of ruminant-slaughterhouses is very sustainable. Most of RPH’s infrastructure is Dutch heritage buildings. Physically RPH infrastructure is still functioning properly, only maintenance of infrastructure is very low. We would like to advise the local government to pay attention to the infrastructure of the availability of clean water. Because of the function of Slaughterhouse as a food provider of animal origin (meat) safe-healthy-whole-halal (ASUH).

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