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Technical Article

Sustainability analysis of ornamental plants farming in Makassar

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Abstract

This study aims to analyze the sustainability index of each dimension of ecology, economy, social, and technology as well as identify sensitive attributes that determine the sustainability of ornamental plant farming in Makassar. The rapid appraisal for program modified from rapid appraisal for fisheries program using the multidimensional scaling (MDS) method was used as the analytical instrument. MDS ordination analysis results showed the sustainability index value of each dimension, namely ecology (37.30), economic (40.90), social (31.74), and technology (34.33) were categorized as less sustainable with an average index value of all dimensions was 36.07. The leverage analysis visualizes that 9 out of 17 attributes has shown to be sensitive attributes that affect the business sustainability of ornamental plant in Makassar, namely frequency of crop waste management, water sources, utilization of plant waste, market scale, profitability, business land status, company registration certificate, use of modern technology, and frequency of environmentally friendly technology usage. Government should provide special business zones for ornamental plant so that all ornamental plant farmer in Makassar can be grouped into one zone. Furthermore, it can increase gross regional domestic product, employment opportunities, and opening up opportunities of other industrial sectors growth.
Keywords: dimensions, gross regional domestic product, multidimensional scaling, ornamental plant farming, sensitive attributes, socioecology, sustainability.

Resumo

Análise de sustentabilidade do cultivo de plantas ornamentais em Makassar

Este estudo objetivou analisar o índice de sustentabilidade de cada dimensão da ecologia, economia, social e tecnologia, bem como identificar atributos sensíveis que determinam a sustentabilidade do cultivo de plantas ornamentais em Makassar. A avaliação rápida para programa modificado de avaliação rápida do programa de pesca usando o método de escalonamento multidimensional (MDS) foi usado como o instrumento analítico. Os resultados da análise de ordenação MDS mostraram que o valor do índice de sustentabilidade de cada dimensão, ou seja, ecologica (37,30), econômica (40,90), social (31,74) e tecnologica (34,33) foram categorizados como menos sustentáveis com valor de índice médio de todas as dimensões de 36,07. A análise de alavancagem visualiza que 9 de 17 atributos mostraram ser atributos sensíveis que afetam a sustentabilidade do negócio de plantas ornamentais em Makassar, ou seja, frequência de gestão de resíduos das culturas, fontes de água, utilização de resíduos de plantas, escala de mercado, lucratividade, situação do terreno comercial, certificado de registro da empresa, uso de tecnologia moderna e frequência de uso de tecnologias ambientalmente adequadas. O governo deve fornecer zonas comerciais especiais para plantas ornamentais, de modo que todos os produtores de plantas ornamentais em Makassar possam ser agrupados em uma única zona. Além disso, pode aumentar o produto interno bruto regional, oportunidades de emprego e abrir oportunidades de crescimento de outros setores industriais.
Palavras-chave: dimensões, produto interno bruto regional, escala multidimensional, produção de plantas ornamentais, atributos sensíveis, sócio ecologia, sustentabilidade.

Introduction

Ornamental plants are one of the agribusiness commodities that have excellent development prospects in Indonesia. The contribution of ornamental plants in the country's development continues to increase every year, for example, an increase in gross domestic product (GDP), the value of exports, employment, and farmer exchange rates (FER), as well as an improvement of environmental aesthetics. Data from the Ministry of Trade of the Republic of Indonesia shows that the increase in the export value of floriculture products occurred in 2018, amounting to USD

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18.6 million while the previous year was USD 17.6 million (Ministry of Trade of Indonesia Republic, 2019). This condition is an illustration of ornamental plant potentials in Indonesia. Thus, it is expected that the cultivation of ornamental plants can develop more broadly and evenly. Based on the data, the most exported ornamental plants were chrysanthemums, roses, and orchids.

National ornamental plant production data in 2018 showed a large number of 935,791,268 trees while the ornamental plant production data in South Sulawesi province was only 17,873,513 trees (Indonesian Statistics, 2018). The third-largest contributing area of ornamental plant production in the South Sulawesi province is Makassar City, contributing to 614,166 ornamental plant production in 2018 (Makassar City Fisheries and Agriculture Service, 2018). Nowadays, some problems arose in the development of ornamental plant farming in Makassar City related to the sustainability of ornamental plant farming seen from the ecology, economic, social, and technological dimensions.

Most of the ornamental plant farmers who cultivate and establish their ornamental plant business in areas that are not under the growing capacity of plants and the carrying capacity of their land located along the shoreline. If this happens continuously without considering the ecology dimension, it might have an impact on the optimization of ornamental plant production and the degradation of the surrounding environment. Thus, the ecology dimension is one of the sustainability issues of ornamental plant farming in Makassar. Additionally, most of the ornamental plant farmers in Makassar did not know the profit points of their business. Some farmers admitted that they only run their business without calculating and considering how much profit they got. That was an example of the economic dimension that became the problem of the sustainability of ornamental plant farming in Makassar.

The number of ornamental plant businesses established and developed in Makassar did not guarantee the status of the occupied land was in legal status. Most of the ornamental plant farmers occupied illegal land. Hence, it is certainly against social rules and becomes one of the study problems in the social dimension of the sustainability of ornamental plant farming in Makassar. On the other hand, ornamental plant farmers in Makassar were generally still constrained by the use of modern technology. One of the uses of modern technology that was not relied upon yet by every ornamental plant farmer in Makassar is information and communication technology. Particularly in the field of services and marketing, every farmer naturally needs information and communication to increase the opportunity of ornamental plant purchases and to be easily accessible to the wider community. Based on this, the technological dimension is also one of the problems of ornamental plant farming sustainability in Makassar.

Considering the four problems elaborated above, it is necessary to conduct this study on the analysis of the sustainability of ornamental plant farming in Makassar to understand the concept of ideal farm sustainability. The purpose of this study was to analyze the sustainability index of each dimension of ecology, economy, social, and technology and to identify the sensitive attributes that determine the sustainability of ornamental plant farming in Makassar.

Materials and Methods

Research Design

This study was conducted in Makassar, South Sulawesi, from February to March 2020. The sampling technique used in this study was the simple random sampling technique, where this technique is enabling the entire population to have the same opportunity to be chosen (Nasution, 2009). The sample of this study was ornamental plant farmers in Makassar, with a total of 182 ornamental plant farmers. The sample was determined through the Taro Yamane's formula as follows (Riduwan, 2013):

$$n = \frac{N}{Nd^2+1} \quad (1)$$

Description:
n = number of samples
N = total population (number of ornamental plant farmers in Makassar)
d^2 = precision (set at 20% with a confidence level of 95 %)
n = 21.98 30 people

Based on the above formula, the sample of this study was 30 farmers spread in several districts in Makassar. Both primary and secondary data were analyzed in this study. Primary data sources were obtained through field observations and respondents' interviews. Meanwhile, the secondary data sources obtained through the results of previous studies, literature, and documents from various agencies related to this study. Data were collected in the form of attributes related to four dimensions of sustainability, namely ecology, economic, social, and technology.

Data Analysis

The analyze method for identifying the farming characteristics in Makassar city was descriptive analyses. Descriptive analysis aims to change the raw data set into a form that is easy to describe and understand, thus give the conclusion. An index assessment and business sustainability status can be assessed through multidimensional scaling (MDS) analysis. MDS analysis is a method used to build relationships with low-dimensional configurations to represent objects in high-dimensional space (Chiu and Pan, 2014; Ding and Kim, 2018). In this study, MDS technique was carried out through the rapid appraisal for floriculture (RAP-FCT) program. RAP-FCT is a modification of the rapid appraisal for fisheries (RAP-FISH) program developed by the University of British Columbia in measuring the sustainability of the fisheries sector, which consisted of MDS ordination analysis, Monte Carlo analysis, and Leverage analysis. The analysis technique utilized in the MDS method is a multivariate

statistical analysis by transforming each dimension and multidimensional sustainability (Suharno et al., 2019).

The stages of the analysis of the sustainability of ornamental plant farming in Makassar were as follows: 1) determining attributes in each dimension (ecology, economic, social, and technology), 2) assessing attributes on each dimension with an ordinal scale in the range of 1 to 4 interpreted from bad to good, 3) analyzing using MDS ordination to get the sustainability index value of ornamental plant farming before categorizing into one of the sustainability categories (status) (Table 1), 4) conducting leverage analysis to determine the sensitive attributes affecting the sustainability of ornamental plant farming in Makassar, 5) conducting Monte Carlo analysis to take into account aspects of uncertainty (Kavanagh, 2001; Pitcher and David, 2001), Monte Carlo analysis was used to evaluate the effect of errors on estimating MDS ordination values as well as in the analysis process conducted at 95% confidence intervals, and 6) doing the normalization test for the feasibility of the model (goodness of fit) using stress (S) and coefficient determination (R^2) (Achmad and Witiastuti, 2018).

The analysis results were considered quite accurate and can be accounted if the stress value was smaller than 0.25 or 25 percent and the coefficient of determination (R^2) was close to 1.00 or 100 percent (Kavanagh and Pitcher, 2004).

Results

Ornamental plant farming profile

The profile of ornamental farmer in Makassar (Table 2) showed that most of the farmer was male (73 %) ≥ 41 years old (53%) and had senior high school education level (80%).

In term of farming, the profile of ornamental farming (Table 3) showed that the highest number of farming location, framing area and type of ornamental flower was Tamalate district (43%), ≥ 15 m^2 wide (63%) and ornamental garden plant (67%).

Table 1. Index value and categories (status) for the sustainability of ornamental plant farming

Index Value	Category (Status)
0 – 25	Bad (not sustainable)
25 – 50	Quite bad (less sustainable)
50 – 75	Sufficient (moderately sustainable)
75 – 100	Good (very sustainable)

Source: Fauzi and Anna (2005)

Table 2. Ornamental plant farmer profile

Farmer Profile	Categories	Number of Farmer (person)	Percentage (%)
Gender	Male	22	73%
	Female	8	27%
	Total	**30**	**100%**
Age (years)	≤ 20	2	7%
	21 – 30	6	20%
	31 – 40	6	20%
	≥ 41	16	53%
	Total	**30**	**100%**
Education	Elementary school	0	0%
	Junior High school	4	13%
	Senior High school	24	80%
	Diploma	0	0%
	Undergraduate	2	7%
	Postgraduate	0	0%
	Total	**30**	**100%**

Table 3. Ornamental plant farming profile

Ornamental Plant Farming Profile	Categories	Number of Farmer (person)	Percentage (%)
Farming location	Tamalate	13	43%
	Rappocini	8	27%
	Biringkanaya	1	3%
	Panakukkang	7	23%
	Tamalanrea	1	3%
	Total	**30**	**100%**
Farming Area (m^2)	< 5	2	7%
	5 – 10	1	3%
	10 – 15	8	27%
	> 15	19	63%
	Total	**30**	**100%**
Type of ornamental plant	Cut flower	0	0%
	Ornamental pot plant (*indoor*)	10	33%
	Ornamental garden plant (*outdoor*)	20	67%
	Total	**30**	**100%**

Ecological sustainability of ornamental plant farming

The results of the RAP-FCT analysis indicate that the ecological sustainability index value of ornamental plant farming in Makassar was 37.30%, where it was categorized as less sustainable. Sensitive attributes that determined the ecological sustainability of ornamental plant farming were: 1) the frequency of crop waste management (RMS = 4.79), 2) water source (RMS = 4.62), and 3) utilization of plant waste (RMS = 3.60). Index values and sensitive attributes of the ecological sustainability of ornamental plant farming are visualized in Figure 1.

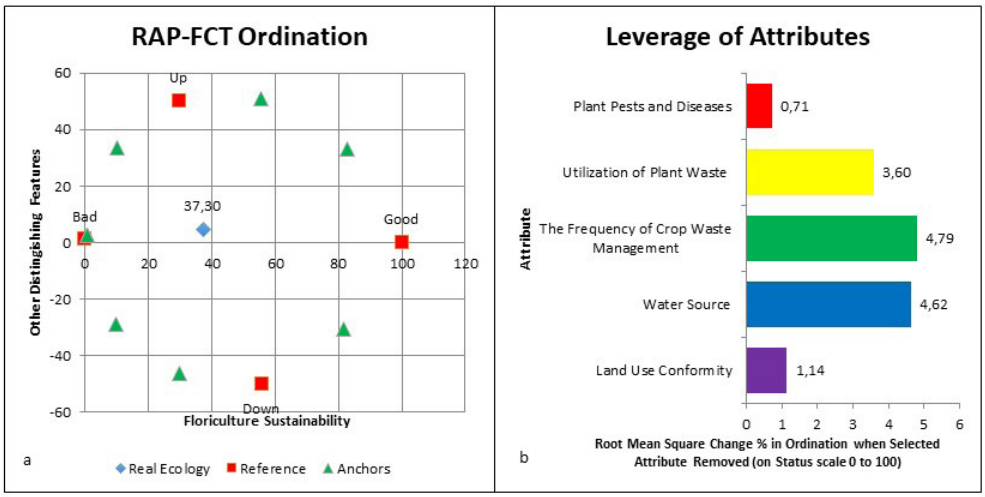

Figure 1. Index values and sensitive attributes of ecological sustainability of ornamental plant farming (a) RAP-FCT ordination (b) Leverage of attributes.

Economic sustainability of ornamental plant farming

The RAP-FCT analysis results present the economic sustainability index value of ornamental plant farming in Makassar was 40.90 (less sustainable). Sensitive attributes that affected the economic sustainability of ornamental plant farming were market scale (RMS = 4.72) and profitability (RMS = 2.59). Index values and sensitive attributes of the economic sustainability of ornamental plant farming are shown in Figure 2.

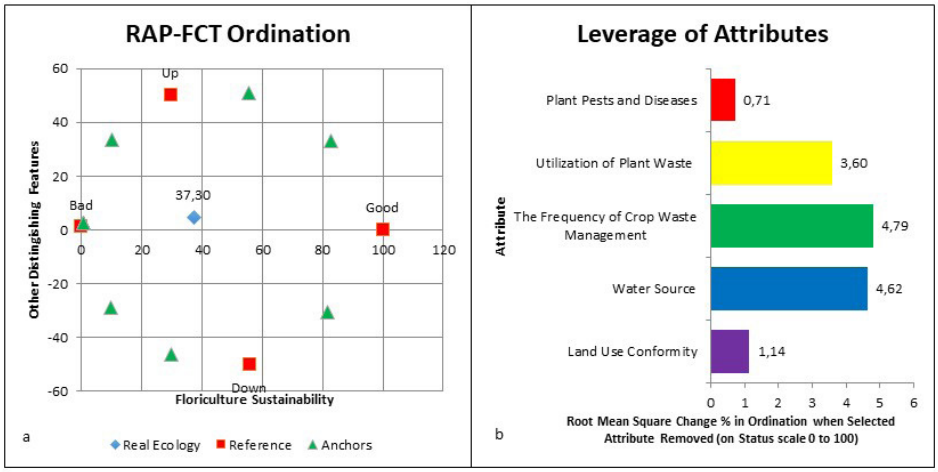

Figure 2. Index values and sensitive attributes of economic sustainability of ornamental plant farming (a) RAP-FCT ordination (b) Leverage of attributes.

Social sustainability of ornamental plant farming

The results of the RAP-FCT analysis show that the social sustainability index value of ornamental plant farming in Makassar was less sustainable, with 31.74. Sensitive attributes that set the social sustainability of ornamental plant farming were business land status (RMS = 4.60) and company registration marks (RMS = 3.61). Index values and sensitive attributes of the social sustainability of ornamental plant farming are presented in Figure 3.

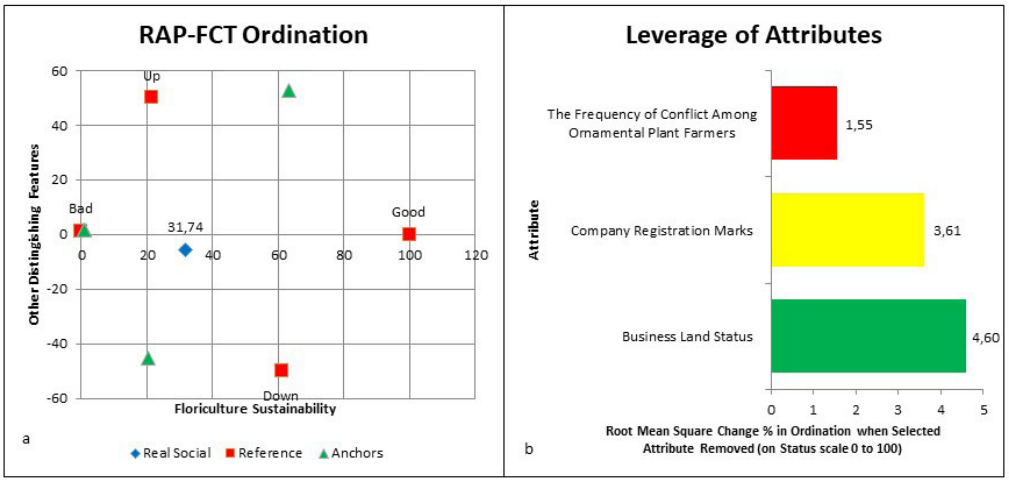

Figure 3. Index values and sensitive attributes of social sustainability of ornamental plant farming (a) RAP-FCT ordination (b) Leverage of attributes.

Technology sustainability of ornamental plant farming

The findings of the RAP-FCT show that the technological sustainability index value of ornamental plant farming analysis in Makassar was also categorized as less sustainable with 34.33. The sensitive attributes that determined the technology sustainability of ornamental plant farming were the use of modern technology (RMS = 2.85) and the frequency of use of environmentally friendly technology (RMS = 2.31). Index values and sensitive attributes of the technology sustainability of ornamental plant farming are visualized in Figure 4.

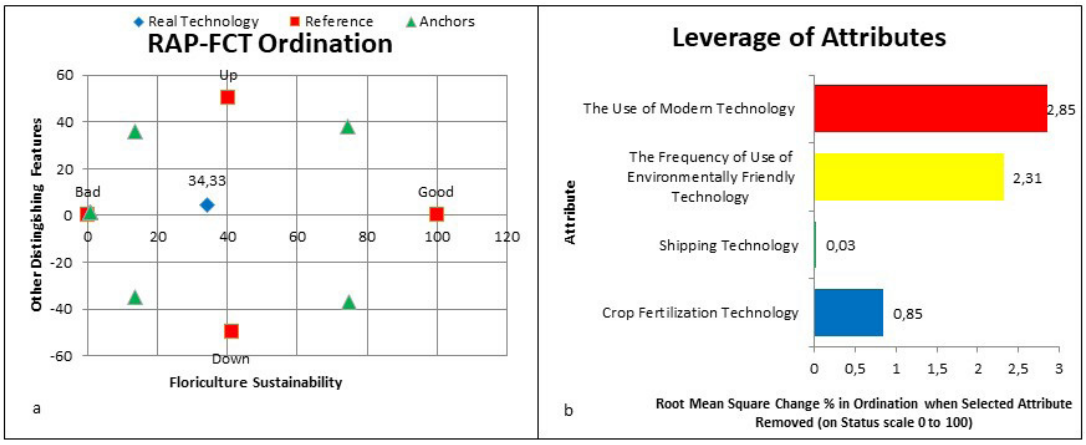

Figure 4. Index values and sensitive attributes of technological sustainability of ornamental plant farming (a) RAP-FCT ordination (b) Leverage of attributes.

Monte Carlo analysis and normalization test (Goodness of Fit)

Statistical parameters of the MDS ordination, Monte Carlo, the difference in values between the MDS and Monte Carlo ordination, the stress value (S), and the coefficient of determination (R^2) on each dimension of ornamental plant farming sustainability is presented in Table 4.

Multidimensional sustainability of ornamental plant farming in Makassar

The value of the sustainability index of each dimension: ecology, economic, social, and technology of ornamental plant farming was positioned in the form of a floating diagram presented in Figure 5.

Table 4. Statistical parameters in the sustainability of ornamental plan farming in Makassar

Dimension	MDS	Monte Carlo	The difference in Value (between MDS and Monte Carlo)	Stress (S)	Coefficient of Determination (R^2)
Ecology	37.30	36.89	0.41	0.15	0.95
Economic	40.90	40.69	0.21	0.14	0.95
Social	31.74	31.41	0.33	0.16	0.96
Technology	34.33	33.65	0.68	0.16	0.95

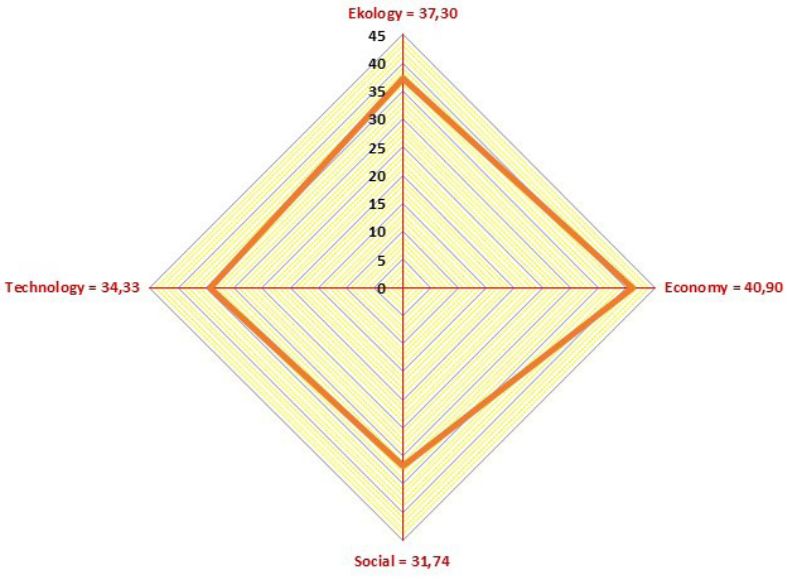

Figure 5. Diagram of sustainability index of ornamental plant farming in Makassar

Discussion

Based on the findings of the ecological sustainability, ornamental plant farming in Makassar was categorized as less sustainable, where the sensitive attributes that set the ecological sustainability were the frequency of management of plant waste, water sources, and utilization of plant waste.

Generally, ornamental plant farmers in Makassar was not interested in managing crop waste from their agricultural products. There were some reasons for farmers not to manage crop waste from their agricultural products: 1) Farmers could not manage agricultural waste; 2) Farmers did not have complete tools and materials to manage agricultural waste; 3) Farmers did not have much time to manage agricultural waste. The utilization of agricultural waste is more focused for purposes that are directly related to agricultural activities, bioenergy, or restoration of fertility and soil health.

The sustainability of Indonesian agriculture is highly dependent on the organic material components in the soil. Without recycling the plant residues, soil infertility progression will increase rapidly and can leads to very serious disaster for farmers in the future (Krause and Rotter, 2018).

The source of water used by every ornamental plant farmer in Makassar was quite diverse, for example, from lakes, wells, and Regional Drinking Water Company. The source of water used by each farmer directly affects the growth of plants and the expenses incurred by every ornamental plant farmer in Makassar.

Therefore, it might have an impact on the sustainability of ornamental plant farming in Makassar. Most of the ornamental plant farmers in Makassar did not utilize their agricultural waste. Where in fact, these crop wastes can be traded and reused for their farming needs to reduce the impact of pollution and environmental damage due to the accumulation of plant waste.

Related to the economic sustainability of ornamental plant farming in Makassar that was categorized as less sustainable, two sensitive attributes determined the economic sustainability of ornamental plant farming in Makassar were market scale and profitability. In general, ornamental plant farmers in Makassar only marketed and sold their ornamental plant products on a local market scale. The local market is a market where the marketing area covers only certain areas and generally only offers goods needed by the surrounding community (Illiyyun, 2012).

Some things that caused the ornamental plant farmers in Makassar were only able to market and sell their ornamental plant products at the local market scale was due to farmer limitations in capital, human, and information resources. A successful business is certainly marked by the level of benefits obtained. However, a small number of ornamental plant farmers in Makassar admitted that the level of benefits obtained was very low and even unprofitable (break-even). The performance of a business can be seen from the level of sales, profit, and return on capital, turnover, and market share achieved (Liu et al., 2021). Elkington (1999) also added that business sustainability has to pay attention to Profit, People, and Planet (3P).

Furthermore, the social sustainability of ornamental plant farming in Makassar that was categorized as less sustainable had two sensitive attributes, namely the status of business land and company registration marks.

Most of the ornamental plant farmers in Makassar occupied illegal business land according to the existing law or illegal status. Some farmers had acknowledged that the status of their business land is illegal or unlicensed from landowners. This condition is certainly far from the concept of farming sustainability. Based on the Government Regulation in Law No. 51 of 1960 on the illegal use of land by others, buildings built illegally on state-owned land do not have to be compensated, the land/building must be vacated, and even can be convicted if it is not properly managed. Meanwhile, not all farmers had company registration marks. They assumed that it could burden their finances due to high corporate tax payments while the profits are still low.

The technology sustainability of ornamental plant farming in Makassar was categorized as less sustainable and had two sensitive attributes, namely the use of modern technology and the frequency of using environmentally friendly technology. In general, ornamental plant farmers in Makassar were still lacking in modern technology usages, such as the lack of android mobile phone usage that facilitates their information and communication. According to Yanti et al. (2018), the role of information and communication technology (ICT) is quite important to support the excellence of competitiveness and business sustainability. Meanwhile, the frequency of the use of environmentally friendly technology by most farmers was only done as much as once a month such as organic fertilizer technology usage.

One of the anticipatory measures needed in sustainable agricultural development is to apply environmental management in all agricultural production activities, especially in the field of agricultural product processing and non-agricultural production activities (Fatemi and Rezaei-Moghaddam, 2019).

The results of the Monte Carlo analysis and the normalization test (goodness of fit) (Table 4) indicate that the low difference in value (<1) between the MDS ordination and the Monte Carlo on each dimension. The difference means that 1) errors in each attribute score were relatively small, 2) the variety of scoring due to difference in opinion was relatively small, 3) the analysis process carried out repeatedly was stable, and 4) data entry errors and lost data could be avoided. This difference also shows that the system studied has a high level of trust (Nurmalina, 2008).

If the results of the Monte Carlo analysis do not change significantly or have a small difference in value between the results of the MDS ordination and the Monte Carlo analysis, then it can be concluded that the results of the MDS ordination have overcome the random error (Rosyani et al., 2019). The results of this statistical test also show that the RAP-FCT method was good enough to be used as

an evaluation tool for the sustainability of ornamental plant farming.

The results of the normalization test for the feasibility of the model (goodness of fit) using the stress value (S) and the coefficient of determination (R^2) obtained stress value (S) on each dimension smaller than 0.25 percent (< 25%) and the coefficient of determination (R^2) on each dimension approaching the value of 1. It can be concluded that the data were normally distributed. This is reinforced by Kavanagh and Pitcher (2004) who argued that the results of the analysis are considered quite accurate and can be accounted for if the stress value is less than 0.25 or 25% and the coefficient of determination (R^2) approaches the value of 1.0 or 100 percent.

The sustainability index values of each dimension, ecology (37.30), economic (40.90), social (31.74), and technology (34.33) were categorized as less sustainable with the overall dimension index value of 36.07. This lack of sustainability required efforts to prioritize sensitive attributes that can determine the multidimensional sustainability of ornamental plant farming in Makassar. Therefore, from the previous category that was less sustainable, could increase into a sustainable category.

Efforts need to be made in improving the ecological sustainability status of ornamental plant farming in Makassar. They need to 1) increase the frequency of crop waste management every month. Agricultural waste treatment results in addition to improving soil properties and as a source of soil nutrients, also useful in controlling plant diseases; 2) using a good water source to optimize the growth and development of ornamental plants; 3) utilizing crop waste from their farming to be traded and reused for their farming needs to reduce the impact of pollution and environmental damage due to the accumulation of crop waste (Aryantha, 2002; Hossain, et al., 2017).

Furthermore, efforts that need to be made in improving the economic sustainability status of ornamental plant farming in Makassar are to increase and expand the market scale from the local market scale to the national market as well as the international market scale. Later on, business profits have to be increased by managing finances appropriately also monitoring and evaluating capital resources at any time.

Meanwhile, the way to improve the social sustainability status of ornamental plant farming in Makassar is to have a legal permit to occupy business land. Thus, the land used must be in legal status and has a company registration to prevent and avoid dishonest business practices. Obligatory to register this company based on law number 3 of 1982 concerning mandatory register of companies mentioned that by registering a company can prevent and avoid the emergence of companies and business entities that are not responsible that might harm honest companies. Moreover, it is also to protect consumers from unsolvable company so their business can be guaranteed.

The way to improve the sustainability status of ornamental plant farming technology in Makassar is by increasing the use of modern technology in helping all types of work carried out by farmers to be more effective and efficient. Adopting new technologies that lead to sustainable is based on the results (Santiteerakul et al.,2020). If the results are sustainable, then the technology can be used continuously, or discontinued when the technology no longer meets the expectations or upgraded version is available (Adenle et al., 2019).

Another way to improve the sustainability status of ornamental plant farming technology is by increasing the frequency of use of environmentally friendly technology (Saiz-Rubio and Rovira-Más, 2020).

According to Sulewski et al. (2018) and Purvis et al. (2019) to support sustainable agricultural development, they need to balance between equity and environmental aspects in the production, processing, and marketing of agricultural products. Thus, it is emphasized that the use of environmentally friendly technology is highly recommended in agricultural activities from input to output.

Conclusions

The sustainability index values of ornamental plants farming in Makassar in each dimension (ecology, economic, social, and technology) were categorized as less sustainable. Leverage analysis describes nine sensitive attributes involved in determining the sustainability of ornamental plant farming in Makassar, namely the frequency of crop waste management, water sources, utilization of plant waste, market scale, profitability, business land status, signs company list, use of modern technology, and frequency of environmentally friendly technology usage. Therefore, Government support is needed to provide special business zones for ornamental plants in Makassar, so all farmers can be grouped into one zone (area) following the concept of ecological, economic, social, and technological sustainability. More advanced cultivation of ornamental plants in Makassar in the future can contribute an important role for increasing gross regional domestic product (GRDP), employment sources, and increases opportunities for growth in other industrial sectors.

Author Contribution

RT: conducting and evaluating the experiment and writing of the manuscript**; DR, MM:** developing the idea and correcting the manuscript**; RDA:** conducting the experiment.

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