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Research Article

Exploratory Factor Analysis (EFA) For Farming Business of Swamp Buffalo Development in South Kalimantan

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Abstract | Swamp buffalo is an endemic livestock that is widely found in South Kalimantan, including in North Hulu Sungai Regency. Swamp buffalo has high adaptability and is one of the good sources of animal food. The objectives of this study are 1) to find out the base area for the development of the swamp buffalo business in South Kalimantan, and 2) to identify the main factors for the development of the swamp buffalo business in South Kalimantan. The research method uses a combination method with the Concurrent Embedded Design research type. The type of data consists of primary data and secondary data. Primary data was obtained from the answers of 160 respondents who were swamp buffalo breeders in South Kalimantan and 7 respondents as experts, while secondary data was obtained from BPS, namely the number of buffalo populations in South Kalimantan. The data analysis method used was Location Quotient (LQ) analysis to determine the base area for swamp buffalo livestock development in South Kalimantan, and *Exploratory Factor Analysis* (EFA) analysis to determine the development factors of swamp buffalo livestock in South Kalimantan. The results of the study were obtained that there are 5 (five) districts that are the base areas for swamp buffalo development in South Kalimantan, namely (1) North Hulu Sungai Regency (HSU), (2) Barito Kuala Regency, (3) South Hulu Sungai Regency (HSS), (4) Hulu Sungai Tengah Regency (HST), and (5) Kotabaru Regency. North Hulu Sungai Regency (HSU) is the main base area in the development of swamp buffalo in South Kalimantan with an LQ = 11.30 value. The main factors in the development of swamp buffalo in South Kalimantan are: (1) institutional factors, (2) managerial factors, and (3) information system technology factors with institutional factors with a contribution rate to the model reaching 23.37%. It is hoped that the results of this research can be the basis for consideration of government policies, especially the Regional Government (South Kalimantan Province) to make North Hulu Sungai Regency, as a base area for the development of swamp buffalo livestock in South Kalimantan, as well as pay attention to the main factors, namely institutional, managerial and information system technology factors.

Keywords | Endemic, Habitat, Institutional, Managerial, Population

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INTRODUCTION

Swamp buffalo or mud buffalo, also known as "hadangan" or "kalang" buffalo (Hamdan and Sabran, 2005) is one of the endemic livestock in South Kalimantan that has great potential to be developed (Widaningsih *et al*., 2023a). The population of this type of buffalo is still classified as safe (not endangered) and its existence is widespread in

almost all districts in South Kalimantan (Widaningsih *et al*., 2025), as well as several areas in Central and East Kalimantan (Prihandini *et al*., 2023). The spread of swamp buffalo in South Kalimantan is very potential, considering that the swamp land area in South Kalimantan reaches 70,842.43 Ha. On the other hand, swamp buffalo have unique adaptations to swamp, river, and lake environments, making them a valuable regional biodiversity resource (Hegde, 2019), as well as easy to maintain (Talib *et al*., 2014), as swamp buffalo can convert low-quality fibrous feed into meat and milk and can utilize coarse feed, and are more efficient than cattle (Rostini *et al*., 2018). In addition, swamp buffalo also has high adaptability and disease resistance (Borghese *et al*., 2022).

Swamp buffalo contributes significantly to the livelihoods of smallholder farmers through the provision of meat and dairy, organic fertilizers, and labor (Prihandini *et al*., 2023). In addition, swamp buffalo also contributes to food diversification, with buffalo meat serving as an alternative or substitute for beef, while the milk provides higher essential nutrients than cow's milk, including lower cholesterol content and rich in iron, phosphorus, and vitamin A (Matondang and Talib, 2015). The meat and milk are a source of food and participate in realizing national meat self-sufficiency. Its contribution plays an important role in realizing a stable meat supply for the nation (Widaningsih *et al*., 2022). However, the consumption of raw buffalo milk is not as popular as cow's milk, thus limiting its potential use in the local market (Prihandini *et al*., 2023). In addition, the use of swamp buffalo also includes cultural roles, such as in the Kuda Gipang dance in South Kalimantan, which is an expression of gratitude to God Almighty (Putri and Syahrial, 2024).

The development of swamp buffalo in South Kalimantan, especially in North Hulu Sungai Regency, is very potential, considering that the swamp land area of North Hulu Sungai Regency is 46.01% of the existing swamp land area in South Kalimantan, which is 32,594.98 Ha. However, the productivity level of swamp buffalo in North Hulu Sungai Regency is still very low, which has decreased significantly in the last 10 years, both in terms of population and meat production. BPS South Kalimantan 2024 data shows that the number of swamp buffaloes in South Kalimantan has fallen to only 8,803, a decrease of 15,906 head or approximately 64.37%. A decrease also occurred for swamp buffalo meat production, from 680,350 kg in 2015, to 320,094 kg in 2024 or a decrease of around 52.95%. This is influenced by many factors that are very complex so that it is very difficult to overcome all existing problems (Atmoko *et al*., 2023). Some researchers report that the factor causing the decline in the population and production of swamp buffalo livestock is the change in land use (Widi *et al*., 2021). Climate change also negatively impacts forage provision (Yani *et al*., 2022). In terms of reproduction, the decline in the productivity of swamp buffalo is also caused by low productivity of female livestock (Reswati *et al*., 2021) as well as low access to information sources and lack of expertise in buffalo processing. In addition, the problems in the buffalo cattle business are quite varied for each region, so experts have developed various theoretical and practical steps in evaluating the factors that influence the development of the swamp buffalo farming business, but until now it has not been successful because the main determining factors are not known for sure. In addition, research on swamp buffalo livestock is still very minimal, when compared to other livestock research such as cattle and poultry.

For this reason, it is important to conduct comprehensive research, including research for the development of swamp buffalo livestock business in South Kalimantan, with an Exploratory Factor Analysis (EFA) approach. EFA is a process for identifying the meanings, constructs, or dimensions that are evaluated by observed covariance (Panter *et al*., 1997). This method is well-suited for exploring complex linkages in new or under-researched domains, such as the specific ecological and socio-economic dynamics of swamp buffalo farming (Rohaeni *et al*., 2024). EFA is a useful method for understanding data structures and identifying latent factors underlying variables, so that it can reduce the data dimension by combining related variables and can understand the data structure and relationships between variables (Floriandi *et al*., 2020). In addition, the EFA serves as a basic step to uncover the basic constructs that might explain the observed correlations between various variables, allowing researchers to condense large data sets into factors that are easier to manage and interpret. This is especially valuable when researchers have limited prior hypotheses about the mechanisms underlying a phenomenon, allowing the identification of latent factors that reconstruct the complexity of the observed data in essential form (Sürücü *et al*., 2022). This analysis allows researchers to identify highly correlated variables and group them into more meaningful factors, often used to reduce and summarize the information contained in the observed variables (Ledesma *et al*., 2021). This method is particularly valuable in the early stages of research to distinguish the underlying linkages between a large set of variables (Shrestha, 2021).

With the increasing demand for meat and milk, which is in line with the increase in the population, including in South Kalimantan, various efforts continue to be made, including efforts to develop the swamp buffalo livestock business as an effort to meet the needs of meat sourced from animals. This study aims to find out the base area for the development of the swamp buffalo livestock business in South Kalimantan, as well as to find out the main factors for its development.

MATERIALS AND METHODS

Research approach

The research approach used is combination research, which is a combination of qualitative and quantitative approaches. The research approach is seen as quite appropriate (good) to answer the research objectives, which require both qualitative and quantitative approaches at the same time. The combination research approach allows researchers to take advantage of the advantages of both methods at once, so that they can better answer complex research questions (Oktariyani *et al*., 2025), and gain a more comprehensive understanding of a phenomenon, so that the data obtained becomes more valid, reliable, and objective (Nasruddin *et al*., 2019). The qualitative approach in the study is intended to determine the base area for the development of swamp buffalo livestock in South Kalimantan. Meanwhile, the quantitative approach is intended to find out the main factors that affect the development of swamp buffalo livestock in South Kalimantan.

The research design used is a Concurrent Embedded Design, which is the quantitative method that is the main method to determine the factors in the development of swamp buffalo livestock in South Kalimantan, and uses a qualitative method to determine the base area of swamp buffalo livestock development in South Kalimantan. In this design, quantitative and qualitative data are collected simultaneously, but one of the methods has a more dominant weight in achieving the research objectives (Rofiqoh *et al*., 2020). Furthermore, Nasruddin *et al*., (2019) stated that the concurrent embedded design method is a type of combination (mixed) research, which is a type of research that integrates qualitative and quantitative approaches simultaneously, where one method (primary) is assisted or supported by another method (secondary) within a larger design framework. In this study, the quantitative method served as the primary method with data sources from 160 respondents. Meanwhile, the qualitative research method as a secondary method is intended to obtain an overview of the importance of swamp buffalo development obtained from 7 expert respondents. It is further noted that this approach allows researchers to integrate the findings of both methods for a more comprehensive understanding, where qualitative data can provide context and in-depth explanation of the quantitative results.

Data types and sources

The types of data used in this combination study are primary data types, and secondary data. The primary data in this study are the results of filling out a questionnaire with a number of questions using a Likert scale (1-5), where 1= strongly disagree, 2= disagree, 3= hesitate, 4= agree, 5= strongly agree. The questionnaire consists of a number of variables and factors that are questions in the research, namely; the role of the government, maintenance system, knowledge of information system technology, zoning regulations, infrastructure facilities, livestock processing management, waste management, profits, extension institutions, seasons, distance of business locations, traditions, signal availability from providers, feed/forage technology, the existence of animal markets, community consumption patterns, internal conflicts, and environmental sanitation.

Meanwhile, the secondary data in this study is the data used to analyze the base area with the main data being the number of swamp buffalo populations in sub-district and district areas. The data was obtained from the district/city BPS in South Kalimantan.

Data collection methods

The data collection method used consisted of a survey method for filling out questionnaires which was carried out to 160 respondents who are swamp buffalo farmers spread across 13 districts/cities in South Kalimantan Province (North Hulu Sungai Regency 20 respondents, Barito Kuala 12 respondents, South Hulu Sungai 12 respondents, Hulu Sungai Tengah 12 respondents, Kotabaru 12 respondents, Banjarbaru 12 respondents, Tanah Bumbu 12 respondents, Tanah Laut 12 respondents, Tapin 12 respondents, Banjarmasin 12 respondents, Balangan 12 respondents, Banjarbaru 10 respondents, and Balangan Regency 10 respondents), and 7 respondents as experts in the field of swamp buffalo farming. The determination of respondents was carried out by the purposive sampling method, namely only swamp buffalo farmers and livestock experts were the target respondents. The expert respondents in this study are 7 people, namely; (1) Head of the North Hulu Sungai Regency Agriculture Office, (2) Head of the North Hulu Sungai Regency Environmental Service, (3) Head of the South Kalimantan Provincial Forestry Service, (4) Head of the North Hulu Sungai Regency Regional Research and Development Agency, (5) Head of the Panggang Lake BPP and Field Extension Coordinator of Paminggir District, (6) Head of Livestock and Animal Health of North Hulu Sungai Regency, and (7) Chairman of Gapoktan Paminggir District. The selected expert respondents have representativeness, namely representing various perspectives or interests that can improve the quality and balance of analysis results. The criteria of the experts are; (a) Have a commitment to the problem being studied, (b) Have a reputation, position/position in their competence with the field being studied, (c) Have abilities and competencies in the field being studied, and (d) Be neutral and open in receiving input/opinions from other respondents.

Meanwhile, the desk study method is used to obtain secondary data, namely the number of population (swamp buffalo) at the sub-district and district/city levels in South Kalimantan, through data tracing at BPS.

Data analysis methods

The data analysis method used is Location Quotient (LQ) analysis to determine the base area for the development of swamp buffalo livestock in South Kalimantan with the following formula:

$$LQ = \frac{x_i/x_t}{X_i/X_t}$$

Where; xi: Total livestock population i in the sub-district area, xt: The number of population of the livestock subsector in the sub-district area, Ni: Number of livestock population i in the district area, Nt: Number of population of livestock subsector t in the district area.

The results of the Location Quotient (LQ) analysis will be obtained from the base area for the development of swamp buffalo livestock in South Kalimantan. LQ with a value of more than >1.0 is categorized as a base/flagship sector and has export potential, LQ less than <1.0 is categorized as a non-base sector, or still depends on supply from outside the region.

Meanwhile, to find out the factors that influence the development of the swamp buffalo farming business in South Kalimantan, it was analyzed using the Exploratory Factor Analysis (EFA) method with the help of SPSS Statistics. Comprehensive statistical analysis, often involving software such as SPSS, is also essential for testing the validity of research instruments, such as questionnaires, in measuring the intended construct (Soma et al., 2025). The standard normal distribution is verified with a Kurtosis value (<7) and a skewness value (<2) are values that are within the acceptable range (Harerimana and Mtshali, 2020). This ensures that the data collected from the questionnaire accurately represents the variables being studied, which further supports the reliability of the study findings (Tambunan, 2024). The overall reliability is 0.950 with a minimum limit of 0.70 (Xi *et al.*, 2020). Furthermore, the Kaiser-Meyer-Olkin (KMO) Measure of sampling adequacy (>0.5) and Bartlett's test of Sphericity (<0.05) (Taherdoost *et al.*, 2014) were analyzed. This test is critical to determining the suitability of the data for factor analysis, ensuring that the intercorrelation between variables is sufficient to identify the underlying dimensions (Hidayat *et al.*, 2021). Specifically, the Kaiser-Meyer-Olkin statistics assess the proportion of variance in variables that may be caused by the underlying factors, with loading values above >0.5 generally indicating suitability for factor analysis or being categorized as significant (Sawiji *et al.*, 2023). The mathematical model for EFA is as follows:

$$X_i = a_{i1}F_1 + a_{i2}F_2 + a_{i3}F_3 + \cdots + a_{im}F_m + \epsilon_1$$

Where; Xi: Observed variable i-i (questionnaire item), aij: Factor loading correlation coefficient between variable and factor X_iF_j, Fj: The j latent (unobserved) factor, εi: The unique error term for variable Xi, m: The number of factors formed.

The rotation method used is Promax. The Promax method was chosen on the theoretical assumption that the measured factors are interconnected. In addition, the Promax method results in a simpler factor structure, especially if the factors are highly correlated (Ahmed and Maruod, 2025).

RESULTS AND DISCUSSION

Base region analysis

The determination of the base region for the development of the swamp buffalo business in South Kalimantan is carried out using the Location Quotient (LQ) analysis approach with a regional basis is all districts/cities within the territory of South Kalimantan Province. Location Quotient (LQ) is one of the regional economic analysis tools that is commonly used to measure the level of specialization or comparative advantage of a sector in a certain area compared to a wider reference area, such as a district within a province. Location Quotient (LQ) aims to find out whether a sector is a base sector that produces more than local needs, or a non-base sector that only serves the needs of the region itself. Based on the results of the Location Quotient (LQ) calculation, the base area for the development of swamp buffalo livestock in South Kalimantan Province is detailed in Table 1.

Table 1: Base region based on LQ value.

No	Region (Regency/City)	Value of location quotient
1	Hulu Sungai Utara (HSU)	11.30
2	Barito Kuala	1.70
3	Hulu Sungai Selatan (HSS)	1.58
4	Hulu Sungai Tengah (HST)	1.25
5	Kotabaru	1.10
6	Banjar	0.85
7	Tanah Bumbu	0.42
8	Tanah Laut	0.28
9	Tapin	0.17
10	Banjarmasin	0.09
11	Balangan	0.03
12	Banjarbaru	0.01
13	Tabalong	0.00

Source: Secondary data analysis (2025).

The results of the LQ analysis were obtained that there were 5 districts that had an LQ value of more than >1, namely; North Hulu Sungai Regency (HSU), Barito Kuala, South Hulu Sungai (HSS), Hulu Sungai Tengah (HST) and Kotabaru Regency. A district with an LQ value >1 indicates that the area has a relatively large population of swamp buffalo livestock compared to other areas. Thus, it can be declared as a base area for swamp buffalo farming and can be used as a leading livestock in South Kalimantan. The overview of the level of livestock population in a certain area is a measure to determine strategies for increasing livestock populations (Begna and Masho, 2024). This strategy is crucial to achieve meat self-sufficiency, considering that the low productivity of local livestock, both in terms of body weight and meat quality, is the main obstacle (Susanti *et al*., 2025). Increasing livestock populations and intensifying animal feed production need to be guaranteed to support the sustainability of the livestock industry (Daeng *et al*., 2023). The following is an overview of the development of the number of swamp buffalo livestock in South Kalimantan in the last 10 years (2015-2024) (Figure 1).

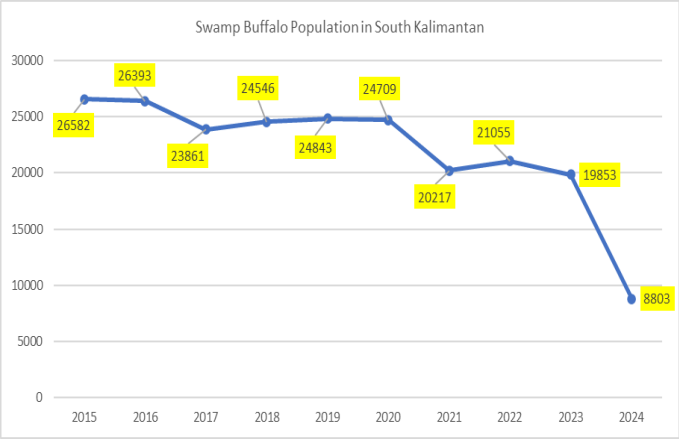

Figure 1: Trend of Swamp buffalo population in South Kalimantan (2015-2024).

The type of buffalo, which is generally found in South Kalimantan, is a swamp buffalo that is located in the same expanse of swamps and part of the watershed (Watershed) of the Barito River and its tributaries with almost the same characteristics of buffalo livestock because they come from a relatively similar genetic diversity. These buffalo populations are well-adapted to the region's unique hydrological conditions, characterized by extensive swamps and high rainfall, making them an integral component of the local agro-ecosystem (Nugroho *et al*., 2021).

The decline in the swamp buffalo population in South Kalimantan, especially in the last 4 years (2021-2024), is caused by various factors, both natural factors, as well as technological, institutional, and economic factors. This decline mirrors a broader national trend, where the Indonesian buffalo population experienced a substantial 39.35% reduction between 2002 and 2017, positioning it among the steepest declines globally after Sri Lanka and Thailand (Prihandini *et al*., 2023). This alarming decrease is attributed to factors such as low reproductive rates and suboptimal management systems. According to Haryanto (2015) there are 4 (four) main problems in swamp buffalo farming, namely 1) Natural or environmental factors, such as high mortality rates, and the development area is getting narrower due to land conversion, ecosystem disturbance and environmental damage. The decline in the population of swamp buffalo cattle is due to internal factors or the nature of buffalo livestock (silent heat and long gestational period). Additionally, the limited availability of quality feed, especially during the dry season, poses a significant challenge to improving livestock productivity in Indonesia, including buffaloes (Susanti *et al*., 2025).

Social factors, namely unclear territorial boundaries, ownership status and the occurrence of potential conflicts between communities, 3) Technological factors, namely traditional maintenance patterns, lack of technological inputs, limited field officers, lack of veterinary medical personnel, and lack of animal health facilities, and 4) Institutional and regulatory factors, including a lack of clear regulations, on grazing area boundaries, and low institutional levels of swamp buffalo farmers. According to Suhaimi *et al*. (2015) that the decline in the swamp buffalo population is due to limited capital factors and lack of expertise in processing livestock products. The decline in the population of swamp buffalo cattle is due to the relatively low reproductive ability of swamp buffaloes. The decline in the swamp buffalo population is also due to the existence of natural factors/traits of buffalo livestock, namely silent heat and long gestational periods. For this reason, it is very important to know and identify leverage factors in the development of swamp buffalo farming business in South Kalimantan.

Key factors analysis

The determination of the main factors in the development of the buffalo livestock business in South Kalimantan is carried out using the Exploratory Factor Analysis (EFA) analysis approach. The *EFA* technique is used to find the latent (hidden) structure of a complex set of variables, so that key factors can be determined that are easier to understand. The EFA technique was carried out using the main component analysis and the Kaiser-Meyer-Olkin and Bartlett test applied before evaluating the results of the EFA analysis with the KMO Index ranges from 0 to 1, with a value above 0.60 considered suitable for factor analysis (Ebneter and Latner, 2013). The results of the KMO and Bartlett's test of this research are presented in Table 2.

Table 2: Kaiser-Meyer-Olkin and Bartlett's test.

Kaiser-meyer-olkin measure of sampling adequacy		**0.817**
Bartlett's test of sphericity	Approx. Chi-Square	739.594
	Df	185
	Sig.	0.001

Source: Primary data analysis (2025).

Table 3: Total of variance explained.

Factor	**Initial eigenvalues**			**Extraction sums of squared loadings**			**Rotation sums of squared loadings**		
	Total	**% of variance**	**Cumulative %**	**Total**	**% of variance**	**Cumulative %**	**Total**	**% of variance**	**Cumulative %**
1	4.207	23.370	23.370	4.207	23.370	23.370	2.465	13.697	13.697
2	2.593	14.407	37.777	2.593	14.407	37.777	2.463	13.682	27.379
3	1.902	10.564	48.342	1.902	10.564	48.342	2.441	13.560	40.939
4	1.531	8.507	56.848	1.531	8.507	56.848	2.266	12.589	53.527
5	1.358	7.543	64.392	1.358	7.543	64.392	1.956	10.864	64.392
6	.911	6.728	71.120						
7	.908	6.155	77.274						
8	.860	5.334	82.609						
9	.728	4.045	86.654						
10	.601	3.341	89.995						
11	.450	2.501	92.496						
12	.367	2.041	94.537						
13	.329	1.830	96.367						
14	.259	1.439	97.806						
15	.153	.853	98.659						
16	.120	.664	99.323						
17	.063	.353	99.675						
18	.058	.325	100.000						

Extraction Method: Principal Component Analysis.

Source: Primary data analysis (2025).

The KMO results obtained a value of 0.817, which means that the samples taken were considered adequate (sufficient) and valid to perform factor analysis and Bartlett's test of Sphericity was significant. This shows that the relationships between variables are strong and the data are suitable for EFA. A probability value (sig.) of 0.001 or less than <0.05 can be interpreted that the sample size and normality have met to perform the analysis of the main components. This is in accordance with Ghozali (2011), that if the probability (sig.) is <0.05, then the research variable can be analyzed further, and vice versa. Further analysis was carried out was factor rotation by looking at the loading value of each manifest variable. The value of loading factors is detailed as in the table of total variation factors in Table 3.

Based on the results of the analysis as in Table 3 above, it is obtained that there are 5 factors that can be formed with an eigenvalue of more than >1. Eigenvalue is used to analyze the feasibility of a factor. A feasible condition is a factor when the eigenvalue is more than >1, while if it is less than <1, then the factor will be excluded from the model (not used) (Wood *et al*., 2015). The number of factors is determined based on the cumulative proportional value, which is 64.39%. This suggests that the factor can be chosen as the main factor because the cumulative proportional value is more than >60%. This factor extraction aligns with established practices for exploratory factor analysis, where eigenvalues exceeding one indicate robust underlying constructs (Sappaile et al., 2023). This method, often referred to as the Kaiser criterion, is widely applied in social science research to identify the optimal number of factors to retain (Costello and Osborne, 2005). Details of the loading factor values as shown in Table 4.

Based on the results of the analysis, it was obtained that the smallest loading factor was 0.510 and the highest was 0.850. The value of the loading factor can be used to explain the components that make up the factor, where the value is above the threshold of >0.4. This is in accordance with

the opinion of Osborne *et al*. (2014), that factor loading is above the minimum threshold of 0.40, which suggests that the structure of the factors resulting from this EFA can be accounted for statistically and theoretically. Thus, all factor items in this study are included in the model, namely as many as 18 factors that affect the development of the swamp buffalo farming business in South Kalimantan. The grouping of variables into factors is presented in Table 5.

Table 4: Loading factor.

Variabel manifest	Factors				
	1	2	3	4	5
F1.1	0.754				
F1.2	0.710				
F1.3	0.709				
F1.4	0.638				
F2.1		0.802			
F2.2		0.790			
F2.3		0.580			
F2.4		0.751			
F3.1			0.850		
F3.2			0.789		
F3.3			0.590		
F3.4			0.513		
F4.1				0.818	
F4.2				0.703	
F4.3				0.608	
F5.1					0.755
F5.2					0.706
F5.3					0.510
Contribution	23.37%	14.41%	10.56%	8.51%	7.54%

Source: Primary data analysis (2025).

Based on the grouping results, Factor 1 (Government institutions, business managerial, and information technology) was able to explain the development model of the swamp buffalo livestock business by 23.37%. Factor 2 (Infrastructure, business management, business revenue, environmental management) was able to explain the development model of the swamp buffalo livestock business by 14.41%. Factor 3 (Institutional, ecological, socio-cultural) was able to explain the development model of the swamp buffalo livestock business by 10.56%. Factor 4 (Information technology, business technology, economic infrastructure), and factor 5 (Socio-cultural, environmental health) have a contribution of less than <10%. Thus, the main factor in the development of the swamp buffalo farming business in South Kalimantan is institutional, managerial, and information system technology factors whose position is in the factor 1 cluster. These three factors are the main factors in the development of the swamp buffalo livestock business in South Kalimantan.

Government institutions, business managerial, and information technology factors are elements in the development of the buffalo livestock business in South Kalimantan. These elements are essential to promote a sustainable swamp buffalo business by increasing productivity, standardizing quality, and increasing farmers' incomes, ultimately reducing dependence on imported meat and promoting regional economic development (Rusdiana and Talib, 2019; Sumarsono *et al*., 2016). Effective communication channels between breeders nd extension workers, coupled with advances in cage technology and disease management, further contribute a to the sustainability of these farming businesses

Table 5: Grouping variables into factors.

No	Manifest variabels	Loading factor	Factors name	% of Variance
1	The Role of Government Livestock rearing system Information technology knowledge Zoning regulations	0.754 0.710 0.709 0.638	**Factor 1** (Government institutions, business managerial, and information technology)	23.37
2	Infrastructure Livestock processing management Waste management Profit of the business	0.802 0.790 0.580 0.751	**Factor 2** (Infrastructure, business management, business revenue, environmental management)	14.41
3	Counseling institutions Climatic season Distance of business location Community traditions	0.850 0.789 0.590 0.513	**Factor 3** (Institutional, ecological, socio-cultural)	10.56
4	Signal from the provider Feed technology Animal markets	0.818 0.703 0.608	**Factor 4** (Information technology, business technology, economic infrastructure)	8.51
5	Public consumption patterns Internal conflicts Environmental Sanitation	0.755 0.706 0.510	**Factor 5** (Socio-cultural, environmental health)	7.54

Source: Primary data analysis (2025).

(Rohaeni *et al*., 2024). In addition, government intervention through well-structured programs and significant allocation of budgetary resources, especially for livestock, has a noticeable impact on the expansion of livestock populations and the socio-economic improvement of farmers (Romadhon *et al*., 2022). Strengthening the government's institutional aspects through 1) The establishment of a District-Based "Swamp Buffalo Service Unit" that functions for integrated vaccination, superior insemination/mating, population data collection, and consulting services. This is based on research findings from farmer interviews that the level of coordination between agencies is weak, so that the existence of a single unit will minimize service fragmentation, and 2) the Market Partnership Scheme with Slaughterhouses (RPH) and Processed Meat MSMEs to ensure more stable prices and continuous demand. This is based on research findings where farmers complain of price fluctuations and market uncertainty.

Institutional factors are very important, especially including farmer institutions, cooperatives, livestock groups, marketing associations, financial institutions, and local government regulations. This institutional strengthening is essential to facilitate access to better quality feed, capital, and marketing, in order to overcome the productivity challenges of ruminant livestock in Indonesia (Susanti *et al*., 2025; Rohaeni *et al*., 2024). The development of partnerships between farmer groups and CPO and PKO processing companies can be used as an alternative feed source in the form of solid waste, which has great potential as a raw material for complete feed (Qomariah *et al*., 2023). This approach not only reduces dependence on conventional feeds but also promotes a circular economy through the utilization of industrial waste. With the existence of institutions, it ensures coordination and collaboration between actors (farmers, extension workers, government, markets, financial institutions). Without a strong institution, farmers will run alone and have no bargaining power. Institutions strengthen access to capital, inputs, and markets, where through institutions (cooperatives, BUMDes, gapoktan), farmers can obtain collective financing, subsidized feed, and wider access to marketing. In addition, institutions are also the basis for the implementation of community-based regional policies, where the Government can more easily channel assistance programs or interventions in the development of the swamp buffalo livestock business as part of the food self-sufficiency program, especially the fulfillment of meat consumption needs.

Business managerial factors are also the main factor in the development of the swamp buffalo farming business in South Kalimantan. This includes important aspects such as feeding strategies, animal health management, as well as the efficient application of reproductive technology to increase productivity. In addition, effective human and financial resource management also contributes significantly to the operational success of livestock businesses. The application of modern technologies such as automated monitoring systems and the use of innovative feeds can substantially improve the efficiency and production yield of buffalo farms (Longgy and Widianingrum, 2024). Farmers, both individually and in groups, are in dire need of business managerial skills, including in the swamp buffalo farming business. Managerial ability provides the ability to farmers and business managers in planning, organizing, directing, and controlling livestock resources. This is in line with the view that an organization's competitive success is highly dependent on innovation that is influenced by employee motivation and work ethic. Managerial aspects can be strengthened through 1) Business bookkeeping/recording training programs, for example; amount of feed, labor costs, body weight gain, and reproductive cycles. This is based on research findings that show that business management is still intuitive, where by improving the recording system, it will increase the efficiency and effectiveness of the business which leads to an increase in profits, 2) Technical training on maintenance using local swamp feed, management of fertility and pregnancy, and how to reduce calving intervals.

Information system and technology factors are also the main factors in the development of the swamp buffalo farming business in South Kalimantan. This is in line with Widaningsih (2023b) that the development of swamp buffalo livestock in South Kalimantan is also influenced by information system technology factors that are developing today. The use of integrated digital technology allows for significant improvements in operational efficiency and productivity in the agriculture and livestock sectors (Longgy and Widianingrum, 2024). The use of digital technology and information systems will support livestock management, marketing, and livestock population data integration systems. The use of good information technology will increase data-based monitoring and production control, where the use of IoT (Internet of Things) applications or systems allows real-time monitoring of livestock conditions, health, and feed (Widaningsih *et al*., 2022b). This allows for faster and more precise decision-making, minimizes the risk of loss, and optimizes production yields (Nugraha *et al*., 2024). The use of information technology, carried out through 1) information systems that are current and current, such as SMS/WhatsApp groups for Price Information, Diseases, and Service Schedules will greatly help ease of business. There is no need for complex applications, just a WA group then information can be received equally and quickly. Research findings show limited digital literacy among farmers, suggesting simple platforms would be

adopted more quickly, 2) The use of IoT/AI such as the Water Level and Weather Alert pilot project which aims to monitor inundation, potential disease outbreaks, and buffalo safety during extreme rainy seasons. This is based on the findings of research in the field that swamp buffalo are very sensitive to changes in swamp conditions, so simple IoT technology can prevent large losses that can occur.

CONCLUSION

The study found that there are 5 (five) districts that are the base areas for swamp buffalo development in South Kalimantan, namely 1) North Hulu Sungai Regency (HSU), 2) Barito Kuala Regency, 3) South Hulu Sungai Regency (HSS), 4) Hulu Sungai Tengah Regency (HST), and 5) Kotabaru Regency. North Hulu Sungai Regency (HSU) is the main base area in the development of swamp buffalo in South Kalimantan with an LQ = 11.30 value. In addition, the main factors for the development of swamp buffalo in South Kalimantan were also obtained based on the results of the EFA analysis with the main factors, namely; 1) institutional factors, 2) managerial factors, and 3) information system technology factors with institutional factors with a contribution rate to the model reaching 23.37%.

Thus, it is hoped that the results of this study can be the basis for consideration of government policies, especially the Regional Government (South Kalimantan Province) to make North Hulu Sungai Regency, as a base area for the development of swamp buffalo livestock business in South Kalimantan, and pay attention to the main factors, namely institutional, managerial and information system technology factors.

Therefore, population conservation and carrying capacity recovery must form as the foundation for business development. In other words, the business is not a standalone goal, but the result of investment in biophysical improvements: grazing pasture rehabilitation, nutritional improvement, reproductive management, inbreeding control, and protection of supporting ecosystems. Without this integration, the title and content of the study would appear contradictory.

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NOVELTY STATEMENT

The main finding of this study is that the main development center for swamp buffaloes is in Hulu Sungai Utara Regency, with the main factors for its development being institutional, managerial, and information system technology factors

AUTHORS CONTRIBUTION

NW designed research, analyzed data, and wrote the manuscript. AZ designed research and prepared the manuscript. SE validation and revised the manuscript. MY tabulation and data analysis, as well as an in-depth discussion of the study of research results. All authors reviewed the final version and approved the manuscript before submission.

Generative AI and AI-assisted technology statement

Generative AI is used as a tool to find various related research for in-depth discussion and to help find the latest related literature.

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Ahmed A, Maruod W (2025). Comparative analysis of varimax and *Promax rotation* methods in exploratory factor analysis. Edelweiss Appl. Sci. Technol., 9(5): 501-513. https://doi.org/10.55214/25768484.v9i5.6929

Atmoko BA, Prabowo BW, Sumantri I, Prastowo S, Widyas N, Widi TSM (2023). A conceptual framework for assessing the sustainability of swamp buffalo production systems. J. Buffalo Sci. 8(12): 44-54. https://doi.org/10.6000/1927-520X.2023.12.06

Begna R, Masho W (2024). Valuation of livestock population and national feed security to enhance livestock productivity in Ethiopia. Vet. Med. Sci., 10(3). https://doi.org/10.1002/vms3.1415

Borghese A, Chiariotti A, Barile VL (2022). Buffalo in the world: Situation and perspectives. In: Chauhan MS, Selokar N, editors. Biotechnological applications in buffalo research. Singapore: Springer, pp. 3-32. https://doi.org/10.1007/978-981-16-7531-7_1

Costello, A.B., Osborne, J.W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment, Research, and Evaluation, 10(7), 1–9. https://doi.org/10.7275/jyj1-4868

Daeng B, Iyai D, Bajari M, Runtuboi YY, Parera E, Saragih EW,

Laatung S, Mamboai H (2023). Calculation of livestock production and animal feed susceptibility, case study of the agro-ecological area of the Yapen Islands. Agrinimal J. Ilmu Ternak dan Tanaman, 11(2): 51-60. https://doi.org/10.30598/ajitt.2023.11.2.51-58

Ebneter DS, Latner JD (2013). Stigmatizing attitudes differ across mental health disorders: A comparison of stigma across eating disorders, obesity, and major depressive disorder. J. Nervous Mental Dis., 201(4): 281–285. https://doi.org/10.1097/NMD.0b013e318288e23f

Floriandi A, Nurcholis N, Muchlis D, Salamony SM, Andari G (2020). Factors affecting the response of livestock farmers in buffalo farming as a permanent business. Musamus J. Agribus., 2(2): 48-56. https://doi.org/10.35724/mujagri.v0i0.2977

Ghozali I (2011). Application of multivariate analysis with SPSS program. Badan Penerbit Universitas Diponegoro.

Hamdan A, Sabran (2005). Karakteristik Kerbau Rawa Kalimantan Selatan. Lokakarya Nasional pengolahan Sumbern Daya Genetika di Indinesia. Balai Pengkajian dan pengembangan Teknologi Pertanian, Kalimantan Selatan.

Harerimana A, Mtshali NG (2020). Using exploratory and confirmatory factor analysis to understand the role of technology in nursing education. Nurse Educ. Today, 92: 104490. https://doi.org/10.1016/j.nedt.2020.104490

Haryanto A (2015). Cultivation systems, problems and strategies in supporting the development of swamp buffalo in Central Kalimantan. Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner.

Hegde NG (2019). Livestock development for sustainable livelihood of small farmers. Asian J. Res. Anim. Vet. Sci., 3(2): 1-17. https://doi.org/10.9734/ajravs/2019/v2i152

Hidayat R, Idris WIW, Qudratuddarsi H, Rahman MNA (2021). Validation of the mathematical modeling attitude scale for Malaysian mathematics teachers. Eurasia J. Mathemat. Sci. Technol. Educ., 17(12). https://doi.org/10.29333/ejmste/11375

Ledesma RD, Ferrando PJ, Trógolo M, Poó FM, Tosi JD, Castro C (2021). Exploratory factor analysis in transportation research: Current practices and recommendations. Transport. Res. F Traffic Psychol. Behav., 78: 340. https://doi.org/10.1016/j.trf.2021.02.021

Longgy DHA, Widianingrum DC (2024). Application of modern livestock technology and innovative marketing strategies to increase the added value of livestock products. J. Ilmiah Petern. Halu Oleo, 6(4): 304-312. https://doi.org/10.56625/jipho.v6i4.151

Matondang RH, Talib C (2015). Utilization of buffalo livestock to support increased milk production. J. Penelitian dan Pengembangan Pertanian, 34(1): 41-49. https://doi.org/10.21082/jp3.v34n1.2015.p41-49

Nasruddin N, Umiyati H, Fadil KR (2019). The Optimization management of combination research methods in improving the quality of writing research reports. Aptisi Trans. Manage., 3(1): 36. https://doi.org/10.33050/atm.v3i1.823

Nugraha R, Varlitya CR, Judijanto L, Adiwijaya S, Suryahani I, Murwani IA, Sopiana Y, Munawar A, Boari Y, Kartika T, Fatmah F, Rusmiatmoko D, Meilin A, Nasirly R, Rusliyadi M, Basbeth F, Sepriano S, Efitra E, Gustiani W, Agusdi Y (2024). Green economy (theories, concepts, ideas for the implementation of the green economy in various fields in the future).

Nugroho A, Maharani DM, Legowo AC, Purba F (2021). Competitiveness enhancement of the small enterprises of dried three-spot gourami (*Trichogaster trichopterus*) in Banjar Regency, South Kalimantan Province through improvement of the process technology, managerial, and business Culture. Engagement Jurnal Pengabdian Kepada Masyarakat, 5(1): 146-155. https://doi.org/10.29062/engagement.v5i1.277

Oktariyani Y, Safitri S, Fitriani Y (2025). Qualitative and quantitative research design in the context of education. Indones. Res. J. Educ., 5(4). https://doi.org/10.31004/irje.v5i4.3004

Osborne JW, Costello AB, Kellow JT (2014). Best practices in exploratoryfactor analysis. CreateSpace Independent Publishing Platform. pp. 86-99. https://doi.org/10.4135/9781412995627.d8

Panter AT, Swygert KA, Dahlstrom WG, Tanaka JS (1997). Factor analytic approaches to personality item-level data. J. Person. Assess., 68(3): 561–589. https://doi.org/10.1207/s15327752jpa6803_6

Prihandini PW, Tribudi YA, Hariyono DNH, Sari APZNL, Praharani L, Handiwirawan E, Tiesnamurti B, Romjali E, Matitaputty PR, Wiyono A (2023). Biodiversity of Indonesian indigenous buffalo: First review of the status, challenges, and development opportunities. Vet. World, pp. 2217-2229. https://doi.org/10.14202/vetworld.2023.2217-2229

Putri DA, Syahrial S (2024). Function of the gipang horse dance pandawa children's studio, Panggung Village, Haruyan District, South Kalimantan. Cendekia Jurnal Ilmu Pengetahuan, 4(1): 34. https://doi.org/10.51878/cendekia.v4i1.2751

Qomariah R, Ilham N, Rahayu HSP, Rina Y, Lesmayati S (2023). The Potential for Cattle-Palm Integration Business Development in South Kalimantan, Indonesia. E3S Web Conf., 444: 2013. https://doi.org/10.1051/e3sconf/202344402013

Reswati, Purwanto BP, Priyanto R, Manalu W, Arifiantini RI (2021). Reproductive performance of female swamp buffalo in West Sumatra. IOP Conf Ser. Earth Environ. Sci., 748: 012025. https://doi.org/10.1088/1755-1315/748/1/012025

Rofiqoh I, Zulhawati, Wisnu, Indriani R, Ivan A (2020). Quantitative, qualitative, and mixed research methods. Penerbit Andi. Yokyakarta.

Rohaeni ES, Ilham N, Saptati RA, Rahayu HSP, Priyono P, Anggraeny YN, Qomariah R, Pamungkas D, Ermuna SS, Mahendri IGAP, Mariyono M, Darsani YR, Hutahaean L, Praptana RH, Lesmayati S, Ahmad SN, Bahar S, Suhartini SH, Santoso AD, Rakhmani SIW (2024). Developing a sustainable beef cattle business model for smallholder farms in South Kalimantan's Drylands. Int. J. Sustain. Dev. Plann., 19(2): 481. https://doi.org/10.18280/ijsdp.190207

Romadhon R, Amam A, Romadhona S, Rusdiana S (2022). The effect of human resources for beef cattle farmers on sustainable livestock development. Majalah Ilmiah Peternakan, 25(3): 147. https://doi.org/10.24843/MIP.2022.V25.i03.p05

Rostini T, Zakir I, Biyatmoko D (2018). Different in the quantity of microbial rumen fluid of river buffalo and swamp buffalo. In: In'am A, Usada B, Kriswianti T, Susanto HA, editors. Proceedings of the International Conference on Applied Science and Engineering (ICASE 2018); 2018 Oct 6-7; Sukoharjo, Indonesia. Atlantis Press. 118-129. https://doi.org/10.2991/icase-18.2018.32

Rusdiana S, Talib C (2019). Kebijakan pemerintah mendukung

peningkatan usaha sapi potong di peternak. Soca Jurnal Sosial Ekonomi Pertanian, 13(3): 380. https://doi.org/10.24843/SOCA.2019.v13.i03.p08

Sappaile, B.N., Halim, M.Y., Taba, M.I. (2023). Construct Validation of Student Learning Motivation Scale Using Exploratory Factor Analysis. Jurnal Psikologi Pendidikan & Konseling: 9(1), 85-94. https://doi.org/10.26858/jpkk.v9i1.47214

Sawiji H, Rusmana D, Permansah S, Prameswara YT, Rapih S, Irfan M, Akbarini NR, Winarko D (2023). Self-assessment instrument online opportunity skills and online risk survival skills for e-learning students of economics and education programs. In: Advances in economics, business and management research/Advances in Economics, Business and Management Research (p. 184). Atlantis Press. https://doi.org/10.2991/978-94-6463-302-3_22

Shrestha N (2021). Factor analysis as a tool for survey analysis. Am. J. Appl. Mathemat. Stat., 9(1): 4. https://doi.org/10.12691/ajams-9-1-2

Suhaimi A, Royensyah RV, Heldawati (2015). Swamp buffalo development strategy in North Hulu Sungai Regency, South Kalimantan. J. Rawa Sains., 5(2): 376-382. https://doi.org/10.36589/rs.v5i2.53

Sumarsono S, Tan F, Febriamansyah R (2016). Analisis elemen pengembangan industri peternakan sapi potong di provinsi jambi. MIMBAR J. Sos. Dan Pembangunan, 32(1): 74. https://doi.org/10.29313/mimbar.v32i1.1758

Sürücü L, Yıkılmaz İ, Maslakçi A (2022). Exploratory factor analysis (EFA) in Quantitative researches and practical considerations. https://doi.org/10.31219/osf.io/fgd4e

Soma, A., Wijaya, B., Pratiwi, C. D. (2025). A step-by-step guide to construct validity testing using SPSS for social science research. Metode: Jurnal Metodologi Penelitian Kuantitatif, 12(3), 112-125. https://doi.org/10.1234/metode.v12i3.5678

Susanti R, Shamad Z, Sathalica C (2025). Increase in the productivity value of high-nutrient feed with rice straw fermentation technology using modified livestock rumen for goat weight gain. J. Pengabdian Kepada Masyarakat, 5(1): 203-211. https://doi.org/10.51878/community.v5i1.6514

Taherdoost H, Sahibuddin S, Jalaliyoon N (2014). Exploratory factor analysis; concepts and theory. Adv. Appl. Pure Mathemat., 27: 375–382.

Talib C, Herawati T, Hastono (2014). Strategies to increase buffalo productivity through feed and genetic improvement. Wartazoa, 24(2): 83-96. https://doi.org/10.14334/wartazoa.v24i2.1052

Tambunan WP (2024). Analisis pengaruh parents orientation, learning outcome, safe environment, dan good teachers terhadap parents' loyalty melalui parents' satisfaction pada orangtua siswa sd plus ark sidikalang. Learn. J. Inovasi Penelitian Pendidikan Dan Pembelajaran, 4(2): 262. https://doi.org/10.51878/learning.v4i2.2861

Widaningsih N, Hartono B, Utami HD, Rohaeni ES (2022a). Swamp buffalo marketing transformation (*Bubalus bubalis carabauesis*) digital based marketing: Cases in Hulu Sungai Utara Regency, South Kalimantan Province. Adv. Anim. Vet. Sci., 10(12): 46–54. https://doi.org/10.17582/journal.aavs/2022/10.12.2546.2554

Widaningsih N, Hartono B, Utami HD, Rohaeni ES (2023a). Profile of South Kalimantan's Endemic Swamp Buffalo. CV. Widina Media Utama. Bandung

Widaningsih N, Hartono B, Utami HD, Rohaeni ES (2022b). Implementation of technology and information systems (IOT) to support sustainable livestock development: Future challenges and perspectives. Caspian J. Environ. Sci.,

Widaningsih N, Hartono B, Utami HD, Rohaeni ES (2025). Developing Swamp Buffalo Business Potential. CV. Widina Media Utama. Bandung

Widaningsih N, Hartono B, Utami HD, Rohaeni ES, Gunawan E (2023b). Indicators of swamp buffalo business sustainability using partial least squares structural equation modelling. Open Agric., 8(1): 1-15. https://doi.org/10.1515/opag-2022-0216

Widi TMS, Pratowo S, Sulaiman A, Hulfa R, Sumantri I (2021). Reproductive characteristics of female swamp buffalo reared under the kalang production system in South Kalimantan. IOP Conf. Ser. Earth Environ. Sci., 902: 012041. https://doi.org/10.1088/1755-1315/902/1/012041

Wood ND, Akloubou GDC, Bowling JW (2015). Combining parallel and exploratory factor analysis in identifying relationship scales in secondary data. Marriage Family Rev., 51(5): 385–395. https://doi.org/10.1080/01494929.2015.1059785

Xi Z, Beatrice KS, Lu Q (2020). Exploratory factor analysis of institutional environment: An evidence from gender perspective in China's Microebusiness. E3S Web of Conf., 218: 3022. https://doi.org/10.1051/e3sconf/202021803022

Yani W, Hamdani, Fajeri H (2022). Analysis of the adoption level of swamp buffalo farming and its relationship with social economic factors in Paminggir Sub-district of Hulu Sungai Utara Regency, Indonesia. Russ. J. Agric. Socio-Econ. Sci., 6: 128-134.