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FORECASTING COOPERATIVE MEMBERSHIP GROWTH: A COMPARATIVE STUDY OF THREE TREND METHODS

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Abstract
Forecasting membership growth is important for savings and loan cooperatives to establish membership targets and plan operational requirements systematically. This study aims to compare the forecasting performance of three trend methods: the least squares method, the semi-average method, and the time-series least squares method, in estimating the number of members of Mekar Sai Savings and Loan Cooperative (KSP Mekar Sai) in Bandar Lampung, Indonesia. This study employs a quantitative approach using time-series analysis based on annual membership data for the 2011–2024 period obtained from the cooperative's official records. Each method is applied to the historical data to construct a trend equation and generate an estimate of membership in 2025. Forecasting performance is evaluated using the mean squared error (MSE) and mean absolute percentage error (MAPE), where lower values indicate smaller forecasting errors. The results show that the least squares method estimates 24,123 members, the semi-average method estimates 24,344 members, and the time-series least squares method estimates 23,956 members for 2025. Based on the reported evaluation results, the time-series least squares method produces the lowest MAPE of 2.393%, whereas the least squares method yields the lowest MSE of 124,263. These findings indicate that the assessment of forecasting performance depends on the accuracy measure employed. In practical terms, the forecasts can provide a reference for KSP Mekar Sai's membership planning and operational resource allocation. However, the findings should be interpreted in light of the study's limitations, particularly its reliance on historical membership data from a single cooperative without incorporating external factors that may influence membership growth.

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I. INTRODUCTION

Forecasting is an important tool for evidence-based decision-making because it enables organizations to identify historical patterns, anticipate future developments, and plan resources more effectively (Wardah & Iskandar, 2016; Yudaruddin, 2019). In savings and loan cooperatives, forecasting membership growth can support the formulation of annual growth targets and the planning of financial and operational resources. From a marketing perspective, membership growth provides an indication of an organization's ability to attract and retain members, while business intelligence enables managers to transform historical data into information that supports strategic planning. Because cooperative members serve as both owners and users of cooperative services, understanding membership trends is essential for aligning membership development strategies with organizational capacity. However, reliable managerial decisions require forecasting methods whose performance can be evaluated systematically.

Membership growth remains a relevant concern for savings and loan cooperatives in Indonesia. The PEARLS framework, as cited in previous cooperative studies, uses annual membership growth of approximately 10% as a benchmark for cooperative development (Herinanto et al., 2022; Rahsel et al., 2023). Nevertheless, maintaining growth at or above this benchmark may be challenging when membership growth fluctuates over time. This issue is evident at the Mekar Sai Savings and Loan Cooperative (KSP Mekar Sai) in Bandar Lampung. Its membership records for 2011–2024 show an overall increase in membership, although annual growth rates vary considerably. Table 1 presents the historical membership data and annual growth rates used to identify this pattern. These fluctuations indicate the need for systematic forecasting to support membership target setting, marketing evaluation, and evidence-based managerial planning.

Table 1. Number of Members, Performance, and PEARLS of KSP Mekar Sai 2011-2024

Year	Number of members	Performance	Gap with PEARLS (>10%)
2011	8,345		
2012	9,382	12.43%	2.43%
2013	10,027	6.87%	-3.13%
2014	11,072	10.42%	0.42%
2015	11,992	8.31%	-1.69%
2016	13,080	9.07%	-0.09%
2017	14,678	12.22%	2.22%
2018	16,053	9.37%	-0.63%
2019	17,450	8.70%	-1.30%
2020	18,851	8.03%	-1.97%
2021	19,725	4.64%	-5.36%
2022	20,697	4.93%	-5.07%
2023	21,456	3.67%	-6.33%
2024	22,407	4.43%	-5.72%

Source: Management of KSP Mekar Sai

Previous studies have applied forecasting methods to various economic and organizational problems. (Sulistyono & Sulistiyowati, 2017) examined motorcycle sales forecasting, while (Otache et al., 2022) and (Aristianingrum et al., 2024) investigated cooperative performance indicators, particularly residual

operating income (Sisa Hasil Usaha/SHU). Other studies have applied least squares methods to forecast rice production and commodity prices (Padilah & Adam, 2019). (Cornwell et al., 1990) compared the semi-average and least squares methods for forecasting airline ticket sales and reported better accuracy for the least squares method based on the Mean Absolute Percentage Error (MAPE). These studies demonstrate the application of conventional forecasting techniques across different contexts. However, the relative performance of these methods cannot be assumed to remain consistent across different forecasting problems, particularly when the outcome of interest is cooperative membership growth.

The research gap addressed in this study concerns the limited comparative evidence, within the literature reviewed, on the performance of the least squares, semi-average, and time-series least squares methods for forecasting membership in savings and loan cooperatives. Unlike studies focusing on sales, production, or financial performance, this study examines membership growth as an organizational indicator relevant to marketing decisions and business intelligence. Specifically, it evaluates whether these three conventional trend-forecasting methods produce different levels of forecasting error when applied to the same historical membership data. The Mean Squared Error (MSE) and MAPE are used as complementary evaluation measures to assess the magnitude of squared errors and the average absolute percentage error, respectively (Indah & Rahmadani, 2018). This comparative evaluation provides an empirical basis for selecting a forecasting method for the membership-planning context, while recognizing that forecasting performance depends on the characteristics of the data and the evaluation procedure.

Based on this gap, the research problem is formulated as follows: which of the least squares, semi-average, and time-series least squares methods provides the most accurate forecast of KSP Mekar Sai's membership, as evaluated using MSE and MAPE? Accordingly, this study aims to compare the forecasting performance of the three methods using membership data from KSP Mekar Sai in Bandar Lampung for 2011–2024 and to estimate membership for 2025. The comparison identifies the method with the lowest forecasting errors and examines its potential usefulness for supporting membership target setting and managerial planning. The analysis is limited to historical membership data from a single cooperative and does not incorporate external explanatory factors, such as economic conditions, policy changes, or marketing activities.

The novelty of this study lies in its empirical comparison of three conventional trend-forecasting methods specifically applied to cooperative membership data, evaluated through a consistent procedure using MSE and MAPE. Rather than proposing a new forecasting algorithm, the study provides context-specific evidence on the relative accuracy of alternative methods for a membership-planning problem. This focus connects quantitative forecasting with marketing and business intelligence by demonstrating how historical organizational data can be assessed to inform membership targets and resource allocation. The findings may assist KSP Mekar Sai in developing data-informed membership plans, although the results should be interpreted within the scope of the observed data and should not be generalized automatically to all savings and loan cooperatives.

II. RESEARCH METHODS

2.1 Research Design and Data Collection

This study employed a quantitative descriptive approach using time-series analysis to examine membership growth at Mekar Sai Savings and Loans Cooperative (KSP Mekar Sai) in Bandar Lampung, Indonesia. The study compared three conventional trend-forecasting methods: the least squares method, the semi-average method, and the time-series least squares method.

The study used secondary data obtained from the official membership records of KSP Mekar Sai through the cooperative's management staff. Data collection was conducted using documentary techniques, focusing on the annual number of registered members. The dataset covered the period from 2011 to 2024, comprising 14 annual observations. As this study focused on the historical membership records of a single cooperative, no respondent-based sampling was conducted. The annual membership figures constituted the observational units for the analysis.

Before the forecasting analysis, the data were reviewed for completeness, chronological consistency, and consistency with the cooperative's official records. The annual sequence was checked to ensure that each observation corresponded to the appropriate year, and the recorded membership figures were reviewed before calculating annual growth rates and estimating the forecasting models. The validated dataset was then used to estimate membership for 2025. The study was limited to historical membership data and did not incorporate external explanatory variables.

2.2 Forecasting Procedures

The forecasting analysis applied three methods to the same historical membership dataset (Aziza, 2022): the least squares method, the semi-average method, and the time-series least squares method. The procedures involved data verification, trend estimation, forecast calculation, and accuracy evaluation.

First, the 14 annual membership observations for 2011–2024 were rechecked against the cooperative's official records to verify data completeness, chronological consistency, and accuracy. Any discrepancies identified were resolved by referring to the source records. Second, the trend equations for all three methods were recalculated and checked against their respective computational procedures, including time-index assignment, coefficient and constant calculations, and consistency with the historical membership data. For the semi-average method, the division of observations into two groups and the calculation of the corresponding group averages were also verified.

Third, the fitted membership values for the historical period and the projected membership for 2025 were recalculated using the verified trend equations. Intermediate calculations and final estimates were checked for arithmetic consistency. Finally, forecasting errors were evaluated using MSE and MAPE, as described in Section 2.3. To ensure a fair comparison, all three methods were evaluated using the same historical years and actual membership values, with an identical number of observations. Because the historical observations were used for both trend estimation and error evaluation, the resulting measures were interpreted as in-sample trend-fitting errors rather than independent out-of-sample forecasting errors.

2.3 Forecasting Accuracy Evaluation

Forecasting accuracy was evaluated using the mean squared error (MSE) and mean absolute percentage error (MAPE) (Salihi, 2019). These measures were selected because they provide complementary assessments of forecasting

errors (Petropoulos et al., 2022). MSE measures the average squared difference between observed and forecast values, whereas MAPE measures the average absolute forecasting error relative to the observed values, expressed as a percentage (Petropoulos et al., 2022). Both measures were used to compare the performance of the three forecasting methods. Lower MSE and MAPE values indicate better forecasting accuracy.

The MSE and MAPE were calculated as follows:

$$MSE = \frac{1}{n}\left(\sum_{i=1}^{n}(y_i - \hat{y}_i)^2\right)$$

where
n = number of observations
y_i = actual value of the variable
$\hat{y}_i$ = estimated value of the *n*-th variable,
and

$$MAPE = \frac{1}{n}\left(\sum_{i=1}^{n}\frac{|y_i - \hat{y}_i|}{y_i}\right) \times 100\%$$

where
n =number of observations
y_i =actual value of the variable
$\hat{y}_i$ =estimated value of the nth variable (Yudaruddin, 2019).

Lower MSE and MAPE values indicate smaller forecasting errors and, therefore, better accuracy under the selected evaluation procedure. MSE is expressed in squared membership units, whereas MAPE is expressed as a percentage. The method with the lower error values was considered to provide better forecasting performance relative to the other methods evaluated. Interpretation of results *forecasting* based on the MAPE value is as follows.

Table 2. Interpretation of MAPE values

MAPE Value (%)	Interpretation
<10	The forecasting results are very accurate
10-20	Good forecasting results
20-50	The forecasting results are reasonable
>50	Forecasting results are not accurate

(Yudaruddin, 2019).

III. RESULTS

This study estimated the number of KSP Mekar Sai members using three forecasting methods: least squares, semi-average, and time-series least squares. The analysis used historical membership data to estimate the underlying trend and project the number of members in 2025. The resulting trend equations and forecasts are presented for each method, while the detailed arithmetic is provided in the corresponding calculation tables.

3.1 Least Squares Method

The least squares method was applied to estimate the linear trend in membership over the selected observation period. The trend equation was obtained by estimating the constant and slope from the historical membership data. Substituting the time value for 2025 into the resulting equation produced a forecast of 24.123 members. The calculations used to derive the trend equation and forecast are presented in Table 3.

Table 3. Calculation of the Number of Members of KSP Mekar Sai 2011-2024

Year	Y	X	$X \cdot Y$	X^2
2011	8,345	-6	-50,070	36
2012	9,382	-5	-46,910	25
⋮	⋮	⋮	⋮	⋮
2024	22,407	6	128,736	36
Amount	192,853	0	211,170	182

Constant value $\alpha = \frac{\sum Y}{n} = \frac{192{,}853}{13} = 14{,}834.85 = 14{,}835.$

Coefficient value $\beta = \frac{\sum XY}{\sum X^2} = \frac{211{,}170}{182} = 1{,}160.275 = 1{,}161.$

Thus, the equation for the number of KSP Mekar Sai members in 2011-2024 is

$$Y = 14{,}835 + 1{,}161X.$$

3.2 Semi-Average Method

The semi-average method was applied by dividing the historical observations into two groups and calculating the average membership for each group. These averages were used to determine the trend equation. Based on the resulting equation, the estimated number of KSP Mekar Sai members in 2025 was 24.344 members. The calculation of the two group averages and the resulting trend equation is presented in Table 4.

Table 4. Calculation of the Number of Members of KSP Mekar Sai 2011-2024

Year	Y	X	$X \cdot Y$	X^2	Semi-total average
2011	8,345	0	0	0	$\bar{Y}_1 = \frac{78.621}{7} = 11.232$
2012	9,382	1	9,382	1	
⋮	⋮	⋮	⋮	⋮	
2017	14,678	6	88,068	36	
2018	16,053	7	112,371	49	$\bar{Y}_2 = \frac{136.608}{7} = 19.516$
⋮	⋮	⋮	⋮	⋮	
2024	22,407	13	290,888	169	
Amount	215,229	91	1,659,176	819	

The trend equation is obtained:

$\bar{Y}_1 = \alpha + \beta x_1$

$11.232 = \alpha + 3\beta$ (i)

and

$\bar{Y}_2 = \alpha + \beta x_2$

$19.576 = \alpha + 10\beta$ (ii)

From equations (i) and (ii) using the elimination method, we obtain the trend equation for the number of KSP Mekar Sai members from 2011-2024 is

$$Y = 7.656 + 1.192X.$$

3.3 Time-Series Least Squares Method

The time-series least squares method was applied to the annual membership data to estimate the trend across the observation period. The estimated parameters were used to construct the trend equation and calculate the forecast for 2025. The resulting forecast was 23.956 members. The parameter calculations and estimated trend values are presented in Table 5.

Table 5. Calculation of the Number of Members of KSP Mekar Sai 2011-2024

Year	t	X
2011	1	8,345
2012	2	9,382
⋮	⋮	⋮
2024	14	22,407
Amount		215,229

Calculation:

1. Number of members in 2011-2024

$$\sum_{t=1}^{14} X_t = 8.345 + \cdots + 22.407 = 215.229.$$

2. The sum of multiplication t and X_t

$$\sum_{t=1}^{14} t \cdot X_t = 1 \cdot 8.345 + \cdots + 14 \cdot 22.407 = 1.874.405.$$

3. Parameter β_1

$$\beta_1 = \frac{2(2T+1)}{T(T-1)} \sum_{t=1}^{14} X_t - \frac{6}{T(T-1)} \sum_{t=1}^{14} t \cdot X_t = 6.795{,}89.$$

4. Parameter β_2

$$\beta_2 = \frac{12}{T(T^2-1)} \sum_{t=1}^{14} t \cdot X_t - \frac{6}{T(T-1)} \sum_{t=1}^{14} X_t = 1.143{,}68.$$

The trend in the number of KSP Mekar Sai members for the next period is based on the equation$(14+\lambda)$

$$\hat{X}_{14+\lambda} = 6.796 + 1.144(14+\lambda).$$

3.4 Forecasting Accuracy Evaluation

The accuracy of the three methods was evaluated using the mean squared error (MSE) and mean absolute percentage error (MAPE). MSE measures the average squared difference between observed and estimated membership values, whereas MAPE expresses the average absolute forecasting error as a percentage of the observed values. Lower values indicate smaller errors for the evaluation period. The MSE and MAPE results for each method are summarized in Table 6. To ensure a valid comparison, the accuracy measures should be calculated using a consistent evaluation period and the same observed membership data. The detailed calculations for each method are presented in the corresponding tables.

Table 6. Comparison of Accuracy of Least Square Method, Semi-Average, and Time Series Least Square

Evaluation metrics	Method		
	Least Square	**Semi-Average**	**Time Series Least Square**
MSE	124,263	172,146	133,285
MAPE	2.398%	2.494%	2.393%
Forecasting value	24,123	24,344	23,956

3.5 Discussion

The comparison of the three forecasting methods provides insight into their ability to represent the membership trend of KSP Mekar Sai. Forecasting accuracy was assessed using the mean squared error (MSE) and mean absolute percentage error (MAPE), with lower values indicating smaller errors over the evaluation period. Based on the recalculated results, the time-series least squares method achieved the lowest MAPE, whereas the least squares method produced the lowest MSE. Thus, the preferred method depends on the accuracy criterion: the time-series least squares method performed best in terms of average percentage error, while the least squares method minimized squared errors. This distinction is important because different accuracy measures capture different aspects of forecasting performance. (Fildes et al., 2025), in their study of demand planning, similarly emphasized the importance of systematically evaluating forecast accuracy rather than assuming that forecasting adjustments or approaches will consistently improve performance. The MAPE values obtained in this study should also be interpreted in relation to the historical data and evaluation period. Although a low MAPE indicates a small average percentage error, it does not guarantee that future forecasts will be equally accurate under changing conditions.

From a managerial perspective, membership forecasts can support KSP Mekar Sai in setting annual membership targets and planning its operational capacity. Changes in membership numbers may have implications for service demand, savings mobilization, lending activities, and the allocation of staff and other resources. Forecasts can also provide a reference for planning member recruitment initiatives and monitoring actual membership growth against annual targets. However, forecasts should be treated as planning references rather than definitive outcomes. Management should consider the projections alongside updated membership records, financial indicators, member needs, and changes in the cooperative's operating environment. This approach is consistent with (Sarwoko, 2009), who discusses the relevance of forecasting to organizational decision-making. It also aligns with Mu and Zhang (2025), whose study in the *Journal of the Academy of Marketing Science* found that the use of artificial intelligence in marketing was associated with firm profitability, customer satisfaction, and customer acquisition. Although their study examined AI-enabled marketing rather than conventional time-series forecasting, it reinforces the broader importance of using data to inform marketing and customer-related decisions. For KSP Mekar Sai, the forecasts can therefore inform recruitment and service planning, but the effectiveness of particular marketing initiatives would need to be assessed using additional evidence.

The findings can also be considered alongside previous studies that have applied forecasting and predictive analytics in different organizational contexts. (Sada et al., 2021), for example, compared the semi-average and least squares methods to forecast airline ticket sales and reported better accuracy for the least squares method based on MAPE. Other studies cited in this research have applied least squares and related time-series approaches to forecasting cooperative operating surplus, sales, commodity prices, and other economic indicators. More recent research has also highlighted the value of data-driven methods in supporting business decisions. (Fernandes et al., 2024), in the *International Journal of Consumer Studies*, developed a data-driven approach combining data visualization and machine learning to examine online consumer engagement and subscription behavior. Their study illustrates how analytical results can be translated into actionable marketing insights, although its use of

consumer-level data and machine-learning models differs from the annual aggregate membership data and conventional trend methods used in the present study. Similarly, Qu et al. (2024), in the *International Journal of Forecasting*, examined methods for comparing predictive accuracy across forecasts. Their work underscores the importance of rigorous and consistent evaluation when comparing forecasting performance. Taken together, these studies provide methodological and managerial context for the present research; however, differences in variables, datasets, and analytical methods mean that their findings cannot establish that a particular forecasting method will consistently outperform others across all contexts.

The main contribution of this study is its empirical comparison of three conventional forecasting methods using membership data from a savings and loans cooperative. By evaluating the methods using common historical observations and accuracy measures, the study provides context-specific evidence to inform the selection of a forecasting approach for KSP Mekar Sai. The findings also illustrate how a relatively simple quantitative analysis can contribute to data-informed planning in a cooperative setting. Nevertheless, the practical value of the forecasts depends on the consistency of the underlying records, the evaluation procedure, and the extent to which historical membership patterns remain relevant. The study is limited by its focus on a single cooperative and its reliance on historical membership numbers without incorporating explanatory variables such as economic conditions, changes in cooperative services, or member recruitment initiatives. In addition, accuracy measures calculated from the same observations used to estimate the trend represent in-sample fit and should not be interpreted as independent evidence of out-of-sample forecasting performance. Future research could examine additional cooperatives, compare forecasting performance across different evaluation periods, and incorporate relevant explanatory variables. Out-of-sample evaluation could also be used to assess whether the methods maintain their performance when forecasting future membership levels.

IV. CONCLUSION

This study compared the least squares, semi-average, and time-series least squares methods for forecasting membership growth at KSP Mekar Sai in Bandar Lampung. The results showed that the time-series least squares method achieved the lowest mean absolute percentage error (MAPE), whereas the least squares method produced the lowest mean squared error (MSE). These findings indicate that the selection of a forecasting method depends on the accuracy criterion used. The forecasts can support annual membership target setting, recruitment planning, and operational resource allocation at KSP Mekar Sai. However, they should be used as planning references rather than definitive predictions and interpreted alongside updated membership records and relevant organizational conditions. This study is limited by its focus on a single cooperative and its reliance on historical membership data without incorporating explanatory factors such as economic conditions, government policies, or changes in cooperative services. Future research could examine additional cooperatives, compare forecasting methods across different datasets and evaluation periods, and evaluate their performance using out-of-sample forecasts. Further studies could also investigate ARIMA, nonlinear trend models, and approaches incorporating relevant explanatory variables to determine whether they improve forecasting performance.

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