



## Comparative Analysis of Chen and Singh's Fuzzy Time Series Method on Trend Revenue Forecasting Data

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**Abstract:** CV. Global Bali Expert, a tourism-related organization and the focus of this investigation, has applied revenue estimates from the preceding period as a benchmark for predicting future revenue. This method has resulted in marketing strategies that are less mature and ambiguous in terms of the company's development. One potential resolution to this problem is to implement revenue forecasting calculations. This study contrasts the Chen and Singh Fuzzy Time Series models to ascertain which forecasting model is more precise for this organization. The Chen model predicted Rp. 19,229,988 for the total revenue category, with a MAPE accuracy rate of 19.13%, and the Singh model predicted Rp. 20,074,992 for the same category, with a MAPE accuracy rate of 5.17%. The Singh Fuzzy Time Series model outperforms the Chen model, as can be inferred from this research.

**Keywords:** Forecasting, Fuzzy Time Series, Chen and Sing Model.

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## Introduction

The tourism industry is an economic sector that has an important role in the economic growth of a country. Bali Island is one of the main pillars in contributing to the tourism industry in Indonesia. The tourism industry refers to the economic sector related to travel, visitation, and recreational activities. In general, there are several services provided by tourism industry players such as travel and transportation services, accommodation, tourist attraction destinations, culinary and entertainment (Camilleri & Camilleri, 2018; Tribe, 2020). The tourism industry not only contributes significantly to a country's economy, but also has important social and cultural impacts. These include job creation, infrastructure development, and preservation of cultural and natural heritage. With the growth of technology and evolving travel trends, the tourism industry is constantly changing and evolving, which makes it possible to access a wider and more diverse range of destinations (Fauzi et al., 2023).

CV. Global Bali Expert, as one of the tourism companies in Bali, is experiencing problems in planning the company's revenue because it only relies on estimates based on previous period data without the application of more accurate analytical methods. This led to uncertainty in the company's marketing strategy and development direction, especially in the face of seasonal fluctuations and the impact of the COVID-19 pandemic. Despite a surge in revenue after the pandemic subsided in 2023, the company still struggled to plan its future revenue appropriately (Pradnyani et al., 2024; Suryadana & Sarasvananda, 2024; Suryawan et al., 2024). The

company only uses revenue estimates from the previous period as a benchmark to estimate revenue in the next period. This has led to a lack of mature marketing strategies, such as promotions on social media, and uncertainty about the direction of the company's development because there is no precise calculation of the next period's revenue.

With these problems, a careful planning is needed to be able to estimate the amount of revenue in the coming period so that the marketing strategy and company development are directed. Therefore, a scientific calculation is needed that can be used in processing revenue data in the future. One method that can be used is the calculation of revenue forecasting (Atmaja et al., 2022; Atmaja & Anandita, 2021; Sudiantara et al., 2024).

Forecasting is the science used to estimate future events by examining or analyzing events that have occurred in the past (Asana et al., 2022; Khaira et al., 2023; Ruhimat et al., 2023). Revenue forecasting is an activity to calculate the estimated revenue of a company in a certain period of time (Sandhiyasa et al., 2024; Sudipa et al., 2024). One of the benefits of revenue forecasting is that companies can estimate revenue in a certain period of time so that they can carry out good financial planning for the company. The forecasting method that will be used in this research is Fuzzy Time Series.

Fuzzy Time Series (FTS) is a forecasting method that uses Fuzzy principles as its basis. Forecasting with this method captures patterns from past data and is then used to project future data (Abhishekh & Kumar, 2020; Karasan et al., 2017; Putri et al.,

2024). This method was chosen because it can overcome the uncertainty and complexity of data such as random pattern changes and fluctuations. In the Fuzzy Time Series forecasting method, there are also several models in it, including the Chen and Singh models which will be used and compared for accuracy in this study. These two models were chosen because the Chen model can provide more accurate results on smaller data (Bose & Mali, 2019). This model can also handle uncertainty in time series data where this model can take into account the diversity of data on CV. Global Bali Expert. While Singh's model is suitable for use on seasonal data (Sari & Setiawan, 2024). Singh's model is directly proportional to the characteristics of the data on CV. Global Bali Expert which has a seasonal pattern. This model comparison is carried out because of the match with the characteristics of the data on CV. Global Bali Expert.

## Method

### Chen's Fuzzy Time Series Model

Chen's Fuzzy Time Series model is one of the approaches used in Fuzzy Time Series to forecast values in time series data. Developed by Chen in 1996, this model is one of the techniques that uses the concept of fuzzy logic to overcome uncertainty in forecasting (Karasan et al., 2017). FTS forecasting using Chen's

model produces more accurate forecasts on smaller data samples than using larger data samples (Abhishekh & Kumar, 2020). However, Chen's model also has disadvantages, namely the lack of consideration in determining the universe and interval length, as well as ignoring patterns of change in the trend of previous data.

### Singh's Fuzzy Time Series Model

Singh's Fuzzy Time Series model was developed by Shiva Raj Singh in 2007. It was redeveloped to make it easier by minimizing the complexity in fuzzy relational matrix calculation and finding a suitable defuzzification process using a simple algorithm. Singh proposed a simple computational method for fuzzy time series forecasting using a simple algorithm and has linear order complexity. The obvious difference is that Chen's model uses FLRG results while Singh's model only uses FLR results to determine forecasting results (Bose & Mali, 2019; Singh, 2017). Singh's FTS model is suitable for use on data in the form of seasonal patterns, because based on several previous studies it produces a smaller level of accuracy than other methods.

### Research Stages

The description of the research method is carried out to find out the processes that run in the research.

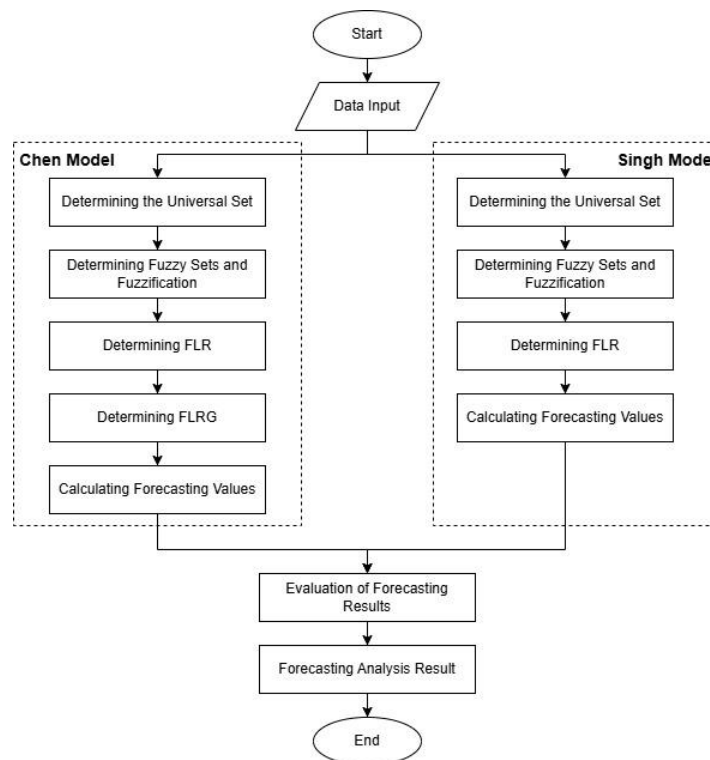


Figure 1. Stages of Chen and Singh Model Comparison

Based on Figure 1. It can be explained the research method of comparative analysis of Chen and Singh's Fuzzy Time Series method on trend revenue forecasting data starting from the data input stage in the forecasting counter application. Then the two models determine the universe set, which determines the highest and lowest values of the data used. Furthermore, to determine the fuzzy set and fuzzification, calculations need to be done to determine the number and length of intervals. After that, proceed to the process of determining FLR, which is determining the

attachment of each data to the data afterwards in the form of a fuzzy set. Furthermore, the FLRG stage is the process of grouping the results of FLR. The Singh model does not go through the process of determining FLRG, so it can directly perform the stage of calculating the forecasting value. Then the two models evaluate the forecasting results as a comparison of the accuracy levels of the two models, and finally determine the results of the forecasting analysis.

## Results and Discussion

### Data Analysis

The data used in this forecasting calculation is data on the total amount of revenue at CV. Global Bali Expert for the period January 2021 to October 2023, where the data is broken down into weekly data.

Table 1. Revenue Data for 2021

Month	Sunday	Total
January	1	Rp. 13,445,000
	2	Rp. 11,650,000
	3	Rp. 6,869,000
	4	Rp. 7,486,000
February	1	Rp. 15,454,000
	2	Rp. 11,594,000
	3	Rp. 9,285,000
	4	Rp. 8,767,000
...	...	...
December	1	Rp. 13,440,575
	2	Rp. 12,856,880
	3	Rp. 13,652,100
	4	Rp. 13,812,745
<b>Total</b>		<b>Rp. 596,934,000</b>

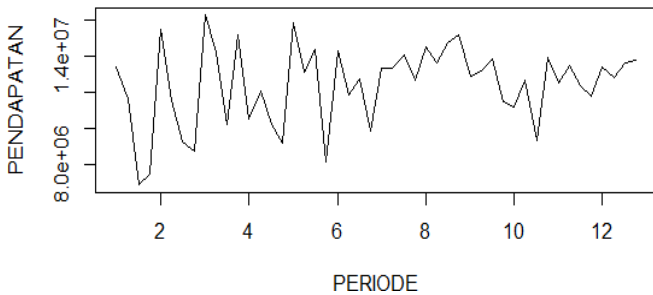


Figure 1. Actual Plot of 2021

Table 2. Revenue Data for 2022

Month	Sunday	Total
January	1	Rp. 14,230,000
	2	Rp. 12,500,000
	3	Rp. 16,100,000
	4	Rp. 14,093,200
February	1	Rp. 10,350,000
	2	Rp. 15,000,000
	3	IDR 16,245,500
	4	Rp. 11,906,000
...	...	...
December	1	Rp. 10,335,000
	2	Rp. 15,100,000
	3	IDR 15,460,000
	4	Rp. 11,836,050
<b>Total</b>		<b>Rp. 658,066,050</b>

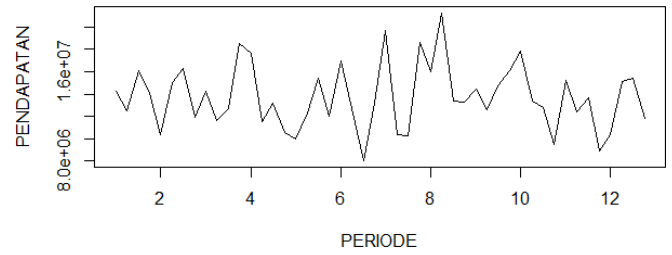


Figure 2. Plot of Actual Year 2022

Table 3. Revenue Data for 2023

Month	Sunday	Total
January	1	IDR 21,428,750
	2	Rp. 22,837,400
	3	IDR 20,110,390
	4	IDR 21,338,460
February	1	Rp. 20,375,250
	2	Rp. 19,237,500
	3	Rp. 21,944,000
	4	Rp. 19,944,250
October	1	Rp. 21,064,000
	2	Rp. 22,343,400
	3	Rp. 19,850,000
	4	Rp. 20,998,600
<b>Total</b>		<b>Rp. 972,646,300</b>

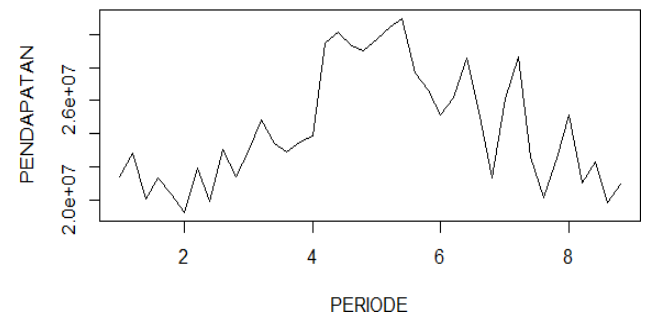


Figure 3. Plot of Actual Year 2023

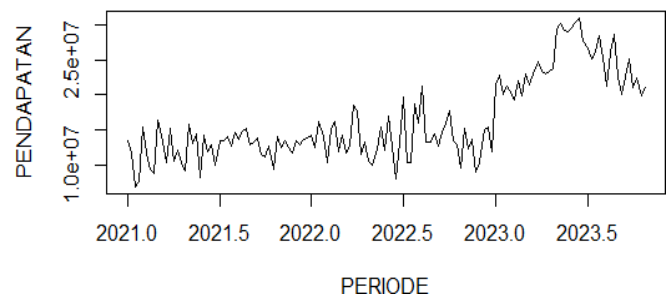


Figure 4. Actual Plot for 2021-2023

### Fuzzy Time Series Calculation Results

In this forecasting calculation, the data used is the total revenue from immigration and tour and travel starting in the period January 2021 to October 2023. Revenue data is broken down into weeks to increase accuracy in each period. Chen and Singh's Fuzzy Time Series forecasting results are described in the following table.

Table 4. Fuzzy Time Series Calculation Results

Period			Actual (Rp)	Chen (Rp)	Singh (Rp)
Year	Month	Sunday			
2021	January	1	13445000	N/A	N/A
2021		2	11650000	14406188	N/A
2021		3	6869000	14406188	N/A
2021		4	7486000	12898750	8315121
2021	February	1	15454000	12898750	15110094
2021		2	11594000	14406188	11584906
2021		3	9285000	14406188	8467479
2021		4	8767000	12898750	8822848
...	...	...	...	...	...
2023	September	1	22612500	26465688	23699394
2023		2	20139300	24958250	20522847
2023		3	22546000	19229988	23558769
2023		4	25152200	24958250	26465688
2023	October	1	21064000	25460729	20435938
2023		2	22343400	19229988	23341604
2023		3	19850000	24958250	20885201
2023		4	20998600	19229988	20074992

Chen 8 fuzzy set

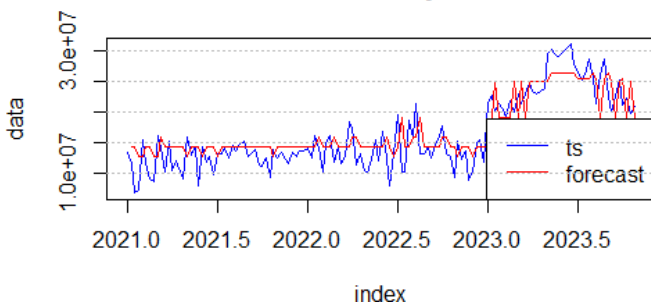


Figure 5. Chen Model result graph

Singh 8 fuzzy set

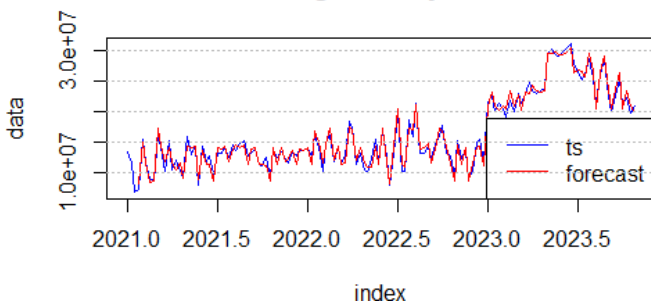


Figure 6. Singh Model result graph

Based on the results of the graphs and tables in the total income category above, it can be seen that the results of the Singh model's Fuzzy time series forecasting are better than the Singh model. By showing the forecasting results for the next period on the Chen model, namely Rp.19,229,988, and on the Singh model, namely Rp.20,074,992.

**Evaluation Calculation**

The method used for calculating the evaluation in this study uses the Mean Absolute Percentage Error (MAPE) calculation method.

Testing in this study aims to determine and compare the level of accuracy produced in implementing the revenue forecasting method of the Fuzzy time series model of Chen and Singh at CV. Global Bali Expert.

Table 5. Calculation Results of Chen Model Evaluation

Actual (Rp)	Chen (Rp)	MAPE
13.445.000	N/A	N/A
11.650.000	14.406.188	23,65%
6.869.000	14.406.188	109,72%
7.486.000	12.898.750	72,30%
15.454.000	12.898.750	16,53%
11.594.000	14.406.188	24,25%
9.285.000	14.406.188	55,15%
...	...	...
22.612.500	26.465.688	17,04%
20.139.300	24.958.250	23,92%
22.546.000	19.229.988	14,70%
25.152.200	24.958.250	0,77%
21.064.000	25.460.729	20,87%
22.343.400	19.229.988	13,93%
19.850.000	24.958.250	25,73%
20.998.600	19.229.988	8,42%
<b>Average MAPE</b>		<b>19,13%</b>

Table 6: Calculation Results of Model Evaluation Singh

Actual (Rp)	Singh (Rp)	MAPE
13.445.000	N/A	N/A
11.650.000	N/A	N/A
6.869.000	N/A	N/A
7.486.000	8.315.121	11,07%
15.454.000	15.110.094	2,22%
11.594.000	11.584.906	0,07%
9.285.000	8.467.479	8,80%
...	...	...
22.612.500	23.699.394	4,80%
20.139.300	20.522.847	1,90%
22.546.000	23.558.769	4,49%
25.152.200	26.465.688	5,22%
21.064.000	20.435.938	2,98%
22.343.400	23.341.604	4,46%
19.850.000	20.885.201	5,21%
20.998.600	20.074.992	4,39%
<b>Average MAPE</b>		<b>5,17%</b>

Tables 5 and 6 above present the MAPE calculation data for each period in the total revenue category. After obtaining the MAPE results for each period, an average calculation is then performed to find the final result. In the calculation of MAPE in the total revenue category, the average MAPE result in the Chen model is 19.13% and in the Singh model is 5.17%. Based on these results, the Singh model is superior to the Chen model in the total revenue category.

Singh's fuzzy time series model is superior when compared to Chen's model. This may be due to data characteristics. The Chen model can handle data uncertainty but will provide more accurate results on smaller data. While the Singh model is suitable for seasonal data, but this model requires more historical data to be able to perform calculations.

## Conclusion and Suggestions

Based on the results of the implementation and discussion of the research entitled "Comparative Analysis of Chen and Singh's Fuzzy Time Series Method on Trend Revenue Forecasting Data", several conclusions can be drawn as follows: 1) Based on revenue data obtained from CV. Global Bali Expert, comparative analysis of Chen and Singh's Fuzzy time series forecasting models provides significant differences in results. 2) The results of forecasting calculations in the total revenue category using the Chen model are Rp.19,229,988 with a MAPE accuracy rate of 19.13% which is classified as good. While the Singh model shows results of Rp.20,074,992 with a MAPE accuracy rate of 5.17% which is classified as excellent results. Based on these results, it can be concluded that the suitable model used in the total income category is the Singh model. 3) Based on the results of the analysis in this study, Singh's fuzzy time series model gets better results than the Chen model. 4) Singh's fuzzy time series model is superior to the Chen model due to data characteristics, where the Chen model can handle data uncertainty but will provide accurate results on smaller

data. While the Singh model is suitable for seasonal data, but this model requires more historical data to be able to perform calculations.

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