



MATERNAL MORTALITY FORECASTING FOR SOLOMON ISLANDS USING THE DOUBLE EXPONENTIAL SMOOTHING METHOD

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Abstract

This study uses annual time series data on MMR for Solomon Islands from 1985 to 2023 to predict future trends of MMR over the period 2024 to 2035. The study utilizes Holt's double exponential smoothing model. The optimal values of smoothing constants α and β are 0.6 and 0.1 respectively based on minimum MSE. The results of the study indicate that MMR will continue on a downward path to reach around 101 deaths per 100 000 live births by 2035. Therefore, we encourage authorities to tirelessly address local drivers of preventable maternal deaths and focus on quality improvement initiatives.

Keywords: Exponential smoothing, Forecasting, Maternal Mortality Ratio.

Introduction

Solomon Islands is a Pacific developing country with a population of approximately 700 000 inhabitants, spanning across 993 islands. The country encounters substantial geographical, socioeconomic and cultural barriers to achieving universal health coverage (De Silva et al. 2022). The Solomon Islands has poor perinatal outcomes, with recent data indicating a high rate of avoidable severe maternal morbidity (De Silva et al. 2021), maternal mortality (De Silva et al. 2020) and an estimated stillbirth rate of 17.6 per 1000 births in 2015 from WHO data (WHO, 2015). The aim of this paper is to model and forecast MMR for Solomon Islands using the double exponential smoothing model. The study findings will guide policy, planning and allocation of adequate resources to the



maternal and child health program so that preventable maternal deaths are further reduced.

Literature Review

Author(s)	Objective(s)	Methodology	Key finding(s)
Becerra et al. (2026)	to identify and analyze maternal complications associated with adolescent pregnancy, with a particular focus on the Latin American context	qualitative and descriptive approach	adolescent pregnancy in Latin America and the Caribbean entails significant medical risks and negatively affects the integral development of adolescents, a situation that is aggravated by the lack of access to health services, education and by factors such as poverty
Mackin et al. (2026)	to understand how levels of MNH care are organized in different country contexts	Scoping review	Three or four levels of MNH facility care were most commonly reported. Linking maternal and newborn facility care to community connections is an important consideration to ensure equitable access to routine and emergency care
Marks & Castro (2026)	To examine how MWHs have been implemented across Latin America, analyzing their evolution, the specific needs they address in different countries, and their impact on maternal and neonatal health outcomes throughout the region	Systematic review	The evolution of MWHs suggests that they address a spectrum of needs beyond their original purposes, such as providing culturally responsive maternal support and psychosocial and early childhood support
Tsushima et al. (2026)	To determine the long-term incidence of dysglycemia and dyslipidemia after	Prospective cohort study	postpartum weight change may help identify women at higher risk of subsequent metabolic abnormalities, particularly



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	GDM and evaluated whether postpartum changes in body mass index (BMI) independently predicted these outcomes		dysglycemia, in this high-risk population, although causal relationships cannot be inferred from this observational study
Yue et al. (2026)	to perform an umbrella review to summarize the current evidence to provide a reference for clinicians and future research	Systematic literature review	This review offers a thorough overview of the current evidence linking SLE, SS and APS to pregnancy and assisted reproductive outcomes. It identifies existing gaps and proposes future research directions
Cresswell et al. (2025)	To obtain updated evidence on causes of maternal death is needed to accelerate progress	Systematic review	Globally, the most common cause of maternal death was hemorrhage (27%; 80% uncertainty interval 22–32), followed by indirect obstetric deaths (23%, 18–30), and hypertensive disorders (16%, 14–19). The proportion of hemorrhage deaths varied substantially by region and was highest in sub-Saharan Africa and Western Asia and Northern Africa.
Quiroz-Acuña et al. (2025)	To assess maternal mortality trends in LAC women from 1997 to 2019, providing key insights to address this issue.	ecological observational time-series study	Despite overall progress, regional differences in maternal mortality persist across Latin America and the Caribbean. These variations highlight the importance of strengthening maternal health systems, improving access to skilled birth attendance, and ensuring quality prenatal and postnatal care



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Silvana et al. (2025)	To describe the factors influencing the reduction of maternal mortality during the 2022–2024 management period at Tartagal Hospital (HT)	Participatory Action Research (PAR) with a qualitative-quantitative analysis. Twelve meetings and interviews were conducted with the healthcare team, along with 10 validated surveys administered to obstetric inpatients (10/12/24), and an analysis of hospital databases	intercultural, comprehensive, and territory-based management of pregnancy and childbirth led to a reduction in maternal mortality beginning in 2022. Teamwork and intersectoral collaboration optimized available resources, consolidating a sustainable and effective model for maternal health. However, the greatest challenge lies in maintaining and increasing funding to ensure the continuity of this policy
Nigenda and Serván-Mori (2024)	To discuss the relationship between the availability of human resources for health and the maternal mortality ratio for the period 1990–2021 in Latin America	used secondary data from a global source to show patterns in the relationship between these two aspects and identify gaps in the Latin American and Caribbean regions	Although variations in maternal mortality rate cannot be explained solely through the provision of health personnel, it is important to consider that it is critical to find new modalities on how human resources for health could integrate and create synergies with other resources to increase systems capacity to deliver care according to conditions in each country
Critto et al. (2022)	To examine the effects of a pandemic influenza virus on cause-specific maternal mortality time series, using Argentinian vital statistics	-conducted a population-based natural experiment from national vital records of maternal deaths between 1980 and 2017 -applied Join-point regression models	Over this 38-year study, the MMR decreased by 58.6% (69.5 to 28.8 deaths/100,000 live births), transitioning from direct obstetric causes (67.0 to 21.1/100,000 live births; 68.4% decrease) to indirect causes (2.6 to 7.7/ 100,000 live births; 196.2% increase)
De Silva et al. (2022)	to investigate the incidence and cause of stillbirth occurring at the National Referral	conducted a retrospective cohort study from January 2017 to December 2018	Stillbirth affects 31 in every 1000 births at the National Referral Hospital in the



	Hospital, Solomon Islands		Solomon Islands and many cases are preventable
Hill et al. (2009)	To assess the feasibility of measuring maternal mortality in countries lacking accurate birth and death registration through national population censuses by a detailed evaluation of such data for three Latin American countries	Applied established demographic techniques	The PRMRs for Honduras (2001), Nicaragua (2005) and Paraguay (2002) were 168, 95 and 178 per 100 000 live births, respectively. Surprisingly, evaluation of the data for Nicaragua and Paraguay showed overreporting of adult deaths, so a downward adjustment of 20% to 30% was required

Methodology

This study utilizes an exponential smoothing technique to model and forecast future trends of MMR for Solomon Islands. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

Holt's linear method is specified as follows:

Model equation

$$Z_t = \mu_t + \rho_t t + \varepsilon_t$$

Smoothing equation

$$S_t = \alpha Z_t + (1-\alpha) (S_{t-1} + b_{t-1})$$

$$0 < \alpha < 1$$

Trend estimation equation

$$b_t = \beta (S_t - S_{t-1}) + (1-\beta)b_{t-1}$$

$$0 < \beta < 1$$

Forecasting equation

$$f_{t+h} = S_t + hb_t$$

Z_t is the actual value of MMR at time t



ε_t is the time varying **error term**

μ_t is the time varying mean (**level**) term

ρ_t is the time varying **slope term**

t is the trend component of the time series

S_t is the exponentially smoothed value of MMR at time t

α is the exponential smoothing constant for the data

β is the smoothing constant for trend

f_{t+h} is the h step ahead forecast

b_t is the trend estimate (slope of the trend) at time t

b_{t-1} is the trend estimate at time $t-1$

Data Issues

This study is based on annual MMR in Solomon Islands for the period 1985–2023. The out-of-sample forecast covers the period 2024 – 2035. All the data employed in this research paper was gathered from the World Bank online database.

Findings of the study

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	Z
Included Observations	39
Smoothing constants	
Alpha (α) for data	0.600
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	5.314767
Sum Square Error (SSE)	2491.553328
Mean Square Error (MSE)	63.885983
Mean Percentage Error (MPE)	-0.244203
Mean Absolute Percentage Error (MAPE)	3.185782



Residual Analysis for the Applied Model

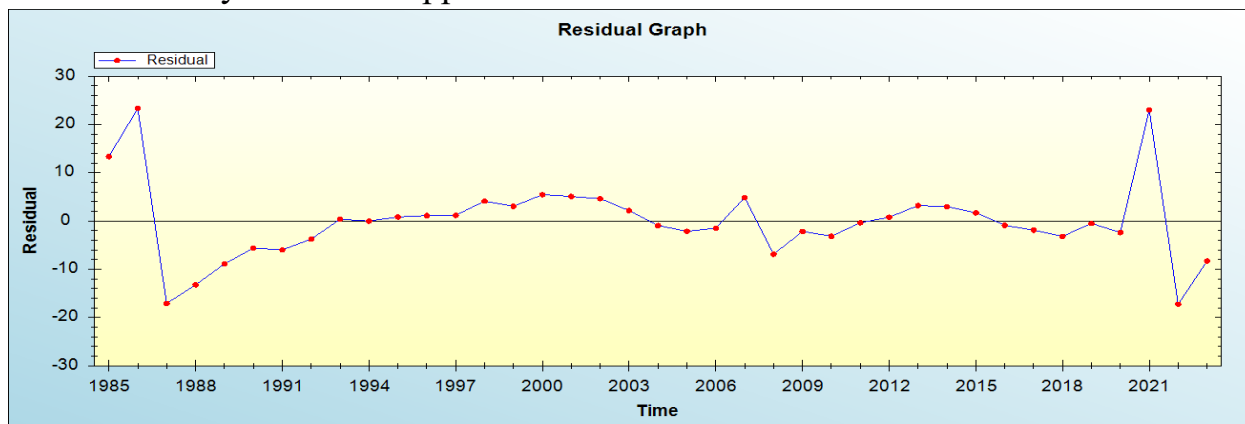


Figure 1: Residual analysis

In-sample Forecast for Z

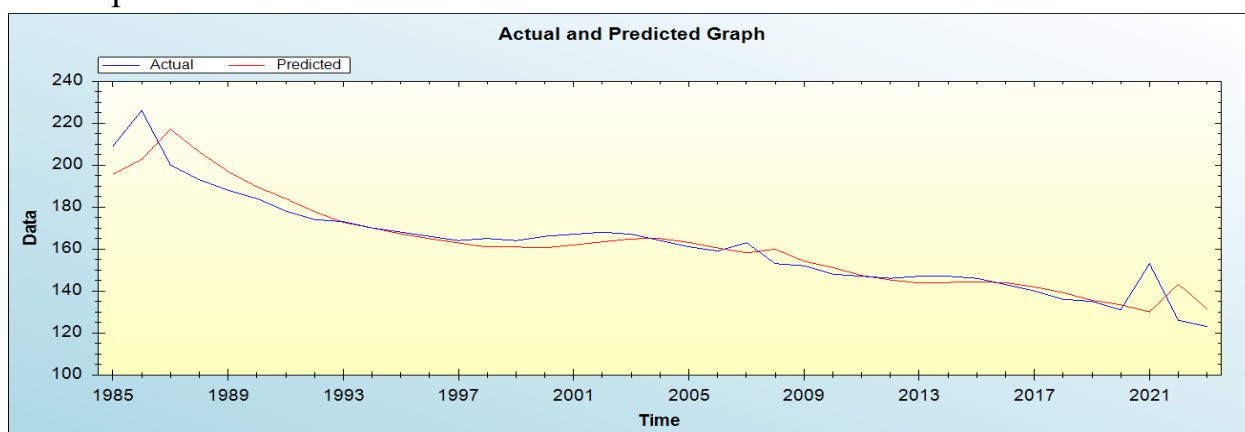


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for Z series

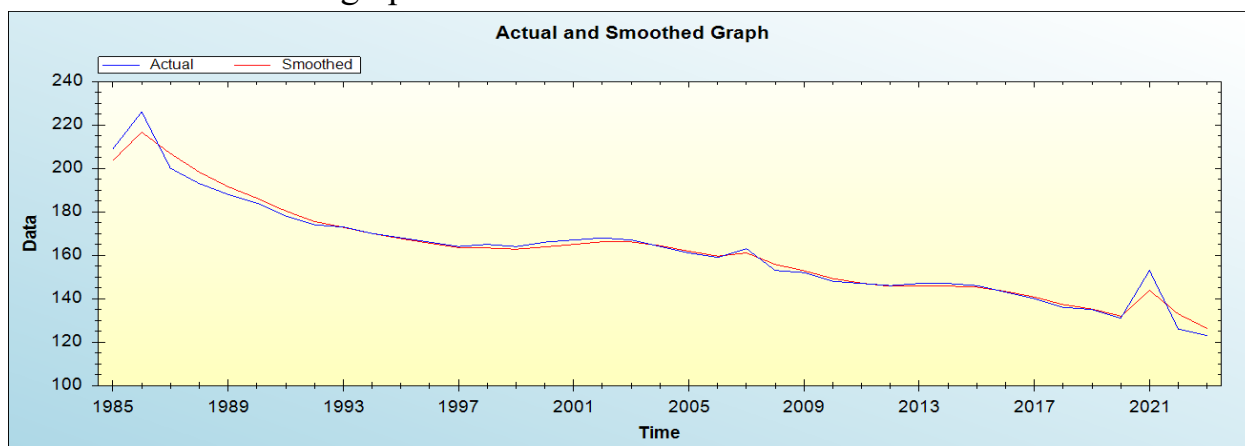


Figure 3: Actual and smoothed graph for Z series

Out-of-Sample Forecast for Z: Actual and Forecasted Graph

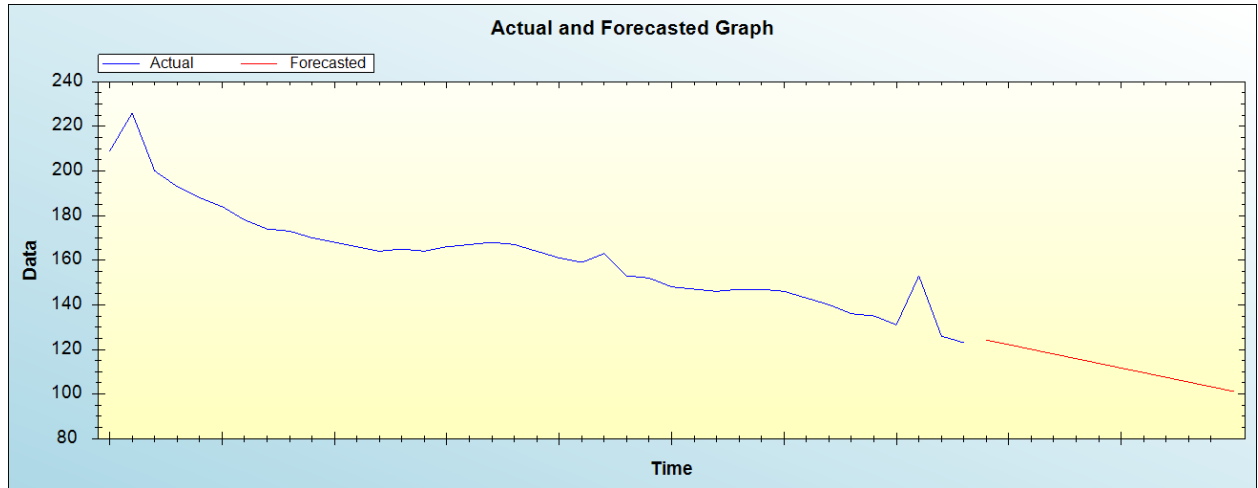


Figure 4: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted MMR
2024	124.2256
2025	122.1305
2026	120.0354
2027	117.9403
2028	115.8452
2029	113.7501
2030	111.6550
2031	109.5599
2032	107.4648
2033	105.3697
2034	103.2746
2035	101.1795

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual MMR will continue on a downward path to reach around 101 deaths per 100 000 live births by 2035.



Conclusion

In this paper, the double exponential smoothing technique is used to model and forecast MMR for Solomon Island, and results indicate that MMR will continue on a downward path to reach around 101 deaths per 100 000 live births by 2035. Hence, authorities should direct resources towards activities designed to improve the quality of maternal healthcare services.

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