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Modeling Retention and Graduation Patterns: Forecasting Cohort Survival Rates Among Iskolar ng Bayan Scholars

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Abstract

This study aimed to model the retention and graduation patterns of Iskolar ng Bayan scholars by forecasting cohort survival rates using time series analysis. Drawing on data from 1986 to 2025, the study examined the historical and projected trends in second-year and third-year retention, as well as on-time graduation rates, to uncover critical patterns influencing student progression and completion. Employing ARIMA and exponential smoothing models within SPSS, the analysis revealed consistently high retention rates in both the second and third years, with a notable gradual increase over time. However, the findings indicated a temporary decline in on-time graduation rates during the early 2000s, followed by a modest recovery in recent years. Model fit statistics, including high R-squared values and low forecasting errors (MAPE and RMSE), validated the robustness of the models used. These results underscore the need for policy reinforcement and targeted academic interventions to bridge the gap between strong student retention and timely graduation. The study contributes valuable insights for higher education institutions and policymakers in enhancing student success and optimizing scholarship programs.

Keywords*: cohort survival rate, student retention, on-time graduation, ARIMA, Iskolar ng Bayan, forecasting, time series analysis*

INTRODUCTION

Retention and timely graduation remain critical indicators of the effectiveness and sustainability of scholarship programs in higher education. The Iskolar ng Bayan program, aimed at democratizing access to tertiary education, faces the challenge of ensuring that scholars not only persist through their academic journey but also graduate within the prescribed timeframe. Despite the program's intention to ease the burden of educational expenses, many scholars still experience academic delays or drop out before completion. However, there is limited empirical evidence on the longitudinal patterns of retention and how these relate to graduation outcomes, particularly in the second and third years, critical transition points in college education. This study seeks to model and forecast the retention and cohort survival rates of Iskolar ng Bayan scholars, to identify trends that influence their likelihood of graduating on time. By using statistical forecasting techniques, this research will generate insights into the sustainability of academic progression among scholars, helping inform future program design and policy interventions.

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The primary objective of this study is to model and forecast the retention and graduation patterns of Iskolar ng Bayan scholars by analyzing cohort survival rates from the second to the third year and assessing their influence on the timely graduation of SKSU using appropriate time series models. Specifically, it aims to: (1) to examine historical retention data of Iskolar ng Bayan scholars from the second and third academic years; (2) to identify patterns and trends in retention rates and relate these to timely graduation outcomes; (3) to model the cohort survival rates of scholars using appropriate time-series forecasting methods; (4) to evaluate the predictive accuracy of the forecast model in estimating future cohort survival and graduation rates; (5) to provide data-driven recommendations for improving retention strategies and support mechanisms within the Iskolar ng Bayan program.

HO_1: There is no statistically significant trend or predictive relationship in the retention and graduation patterns of Iskolar ng Bayan over time that can be accurately modelled using time series forecasting methods

$HO_{2:}$ There is no statistically significant temporal pattern in the cohort survival rate of Sultan Kudarat State University that can be reliably modeled and forecasted using the ARIMA (2,1,3) model.

Review of Related Literature

Understanding student progression through predictive modeling has gained traction in educational research, with time series analysis emerging as a powerful tool for examining academic trends. One of the most widely used forecasting techniques is the ARIMA model, which has been applied across various sectors to predict trends and inform decision-making (Malik et al., 2023). In education, this model facilitates the anticipation of enrollment patterns and retention fluctuations, thus offering institutional stakeholders a methodologically sound basis for strategic planning (Hornor, 2020).

Cohort survival rate, which measures the proportion of a student cohort that remains in the education system at successive grade levels, is a key indicator of institutional performance. In the Philippine setting, DepEd and CHED regularly track these rates, but granular analysis at the institutional level remains underutilized (Lauderdale, 2001)).Such metrics are essential for evaluating retention policies and aligning them with national education goals, especially under the framework of the Philippine Development Plan and the Sustainable Development Goals (Reyes et al., 2019).

Recent studies in higher education emphasize the need for predictive analytics in enrollment management. (Delcoure & Carmona, 2019) argues that institutions must move beyond descriptive statistics and embrace models that can anticipate student attrition. Predictive tools like ARIMA provide valuable foresight, enabling administrators to craft timely interventions that target at-risk student populations and promote student success.

The application of ARIMA in education has shown promising results in international settings. For instance,(Qin, Shanks, Phillips, & Bernard (2019) used ARIMA to forecast student enrollment in Saudi universities, yielding high accuracy and actionable insights. Similarly, Singh and Rana (2019) demonstrated the model's efficacy in forecasting dropout trends across public schools in India. These studies support the validity of ARIMA as a forecasting tool within the academic domain.

In the Philippine context, the use of time series models in forecasting higher education data is still developing. Existing studies have largely focused on economic indicators or public health

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metrics (David et al., 2018), leaving a significant gap in education-based forecasting. A localized application of ARIMA to forecast institutional cohort survival rates could bridge this methodological gap and enhance institutional responsiveness.

Moreover, survival analysis in education has traditionally employed techniques such as Kaplan-Meier estimation or Cox regression (DesJardins et al., 2002). While these methods are effective for identifying factors associated with dropout risk, they do not offer dynamic forecasting capabilities. ARIMA, in contrast, accounts for historical dependencies and produces forward-looking predictions, making it highly relevant for administrative planning.

Data quality and accessibility remain central to the effectiveness of forecasting models. Studies have shown that the accuracy of ARIMA forecasts depends heavily on the completeness and consistency of historical data (Chatfield, 2004). Universities that maintain robust student information systems are better positioned to leverage such models for forecasting purposes.

Institutional research also highlights the importance of contextualizing survival rates within regional and socio-economic realities. For universities in Mindanao, including Sultan Kudarat State University, challenges such as limited access to resources and geographic isolation may influence retention trends (Serrano & Caday, 2021). Thus, forecasting models must be interpreted in light of these contextual factors to ensure their relevance and applicability.

Literature on enrollment forecasting further underscores the utility of integrating ARIMA with policy evaluation. For instance, studies have used time series models to assess the impact of tuition reforms or scholarship programs on student persistence (Garcia & Reyes, 2017). This approach allows administrators not only to forecast trends but also to evaluate the outcomes of institutional policies on retention.

The strategic use of forecasting aligns with calls for evidence-based governance in Philippine higher education. CHED has emphasized the need for data-informed management practices to improve institutional effectiveness (CHED, 2021). By adopting ARIMA-based forecasting, universities like SKSU can lead the way in operationalizing these recommendations and fostering a culture of analytical rigor in decision-making. The demand for forecasting models in educational planning continues to grow, particularly as institutions respond to fluctuating enrollment and retention rates. Educational planners now rely on time series models to enhance decision-making, especially in resource-limited environments where strategic foresight is essential (Yamaguchi, 2015). Forecasting student progression is thus no longer optional but a necessary component of institutional sustainability.

Several studies emphasize the superiority of ARIMA models for short-term educational forecasting due to their reliance on historical data and their capacity to

accommodate trends and seasonality(Khalid, 2024). Unlike regression-based models that require multiple predictors, ARIMA models excel in univariate forecasting, making them appropriate for data sets with limited covariates but strong temporal structure. While forecasting the cohort survival rate has become crucial in public universities, especially in contexts affected by systemic educational challenges. In Southeast Asia, for instance, (Vallejos & Steel, 2017) applied ARIMA models to estimate survival rates in Vietnamese higher education, demonstrating that accurate forecasts could inform remedial policies aimed at reducing attrition and improving student success.

Though numerous international studies have espoused the predictability of ARIMA, few have adapted the model to developing country contexts marked by data gaps and different dynamics in institutions. Still, a host of scholars point out that ARIMA models can yield decent results even

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if combined with qualitative insights and expert judgment (Armstrong, 2001), denoting flexibility in an imperfect data environment. Gender, socio-economic background, and academic preparation have all been established as predictors of persistence among students. However, it has been demonstrated that knowing how to model overall cohort behavior—independent of individual differences—can still be informative (Nguyen, Syed, McGue, & Compass, 2021). Thus, universities can anticipate macro-level interventions like changes in the curriculum, allocation of financial aid, and distribution of faculty based on cohort-level forecasts. On the contrary, measures of retention and completion rates often link to government funding and guide accreditation. For that reason, predicting these key performance indicators can directly affect institutional reputation and resource allocation (Bastedo & Bowman, 2011). Time series models like ARIMA are evidence-based tools to give credence to statistical support for these performance metrics.

Confidence intervals are a principal advantage of ARIMA for educational purposes. This provides confidence intervals around various forecasts, thus giving planners a range of probable outcomes to consider. Such considerations could greatly enhance the robustness of decision-making, particularly where universities develop infrastructure, budgetary decisions, or faculty hiring contingent on projected enrollment (Hopkins, 1981). Despite that, there are advantages in the area of data analytics, machine learning has generally been used under the premise that it has large, harnessed, labeled data sets, and, as a result, it is associated with intensive interpretability challenges. In any case, ARIMA models are statistically simple, and they're easy to communicate to institutional stakeholders who lack a technical background (Luggya, 2013), making them very easily assimilated in most public universities.

A study by Rojas and Martinez (2018) in Colombia demonstrated how enrollment and survival rate forecasts influenced the design of intervention programs to support first-year students. Their work underlines the potential for ARIMA-based forecasting not only to inform institutional policy but also to guide programmatic interventions aimed at improving student outcomes. As universities in the Philippines continue to implement outcomes-based education (OBE), integrating predictive modeling with institutional performance monitoring becomes essential. ARIMA forecasting can serve as a supplementary tool to track long-term performance indicators, helping institutions like Sultan Kudarat State University ensure alignment between educational delivery and strategic goals(Liu, 2024).

Theoretical Framework

This study is anchored on three interrelated theories that frame the analysis of the cohort survival rate of Sultan Kudarat State University. First, General Systems Theory, put forth by Ludwig von Bertalanffy in the 1950s, regards an organization, or a university in this case, as a system of many parts that are simultaneously intricate and interconnected. This idea supports the notion that any element in the system, like retention efforts or even academic policies, will change with time as other elements within the system are influenced. Systems forecasting models like ARIMA grab institutional performance indicators bundled as cohort survival and forecast trends in them over time, fully capturing the attributes of the system.

The study is also grounded on the Educational Production Function (EPF) Theory, introduced by Hanushek (1979), which posits the educational process as an input-output model; student outcomes are liable to the influence of a variety of institutional and individual-level inputs. Although EPF is frequently used in cross- sectional analyses, the underlying concept applies to

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longitudinal data, providing a rationale for the application of ARIMA models to project outcomes (e.g., rates of survival) based on experience. An empirical exercise can be derived from such an approach to measure, for a specific country, how educational investments have turned into future outcomes in both efficiency and effectiveness.

Finally, Tinto's (1975) Theory of Student Departure gives us a sociological framework that tells about both student persistence and attrition in connection to academic and social integration. Explaining that the viability of student retention grows when students manage to engage themselves in both academic and social life. Although the theory is mostly about the sharing of experiences, it is presented in this work as an

instrument for the understanding of bandwidth behavior variations. Besides identifying the course of some cohorts, the ARIMA model serves to measure the change in the work of the educational system and the students' lives, showing the theoretical ideas of Tinto with the use of quantitative data.

METHODOLOGY

This study employs a quantitative research design using time series forecasting techniques. Historical data on retention and cohort survival rates were obtained from the university registrar's office. The data were analyzed for stationarity, trend, and seasonality. Depending on the characteristics of the data, models such as ARIMA (AutoRegressive Integrated Moving Average), Holt-Winters exponential smoothing. Model performance will be assessed using accuracy metrics such as Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), and Akaike Information Criterion (AIC). The best-fitting model will be used to generate forecasts for the next five academic years.

RESULTS AND DISCUSSIONS

This section presents the results of the statistical analysis conducted to forecast retention in its likelihood to graduate on time and cohort survival rate of Sultan Kudarat State University using the ARIMA (Autoregressive Integrated Moving Average) modeling approach. The findings are discussed in relation to the research objectives and are supported by appropriate statistical evidence, including model fit indices, parameter estimates, and diagnostic tests. It integrates both quantitative findings and interpretive insights to provide a comprehensive understanding of the model's forecasting accuracy and its relevance to higher education management.

Table 1

Model Fit Statistics for Time Series Forecasting of Iskolar ng Bayan Scholars' Retention and Graduation Patterns

Fit Statistic	Mean	SE	Min	Max	5th %	10th %	25th %	50th %	75th %	90th %	95th %
Stationary R-squared	.111	.192	-.000	.333	-.000	-.000	-.000	.000	.333	.333	.333
R-squared	.958	.042	.910	.985	.910	.910	.910	.979	.985	.985	.985

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RMSE	.001	.001	.000	.002	.000	.000	.000	.000	.002	.002	.002
MAPE	.049	.048	.014	.104	.014	.014	.014	.028	.104	.104	.104
MaxAPE	.342	.406	.067	.808	.067	.067	.067	.151	.808	.808	.808

Fit Statistic	Mean	SE	Min	Max	5th %	10th %	25th %	50th %	75th %	90th %	95th %
MAE	.000	.000	.000	.001	.000	.000	.000	.000	.001	.001	.001
MaxAE	.003	.004	.001	.008	.001	.001	.001	.001	.008	.008	.008
Normalized BIC	-14.830	2.283	-16.922	-12.395	-16.922	-16.922	-16.922	-15.174	-12.395	-12.395	-12.395

Table 1 presents the model fit statistics for the time series forecasting of retention and graduation patterns among Iskolar ng Bayan scholars. The R-squared value, with a mean of .958 (SD = .042), indicates that approximately 95.8% of the variation in the observed values is explained by the forecasting model, demonstrating an excellent overall fit. The Stationary R-squared, which is more sensitive to model complexity and differencing, is considerably lower (M = .111, SD = .192), suggesting that while the model captures the overall level well, it introduces some differencing or smoothing that reduces explanatory power under stationarity assumptions.

The Root Mean Square Error (RMSE) is minimal (M = .001), indicating very low average prediction error, while the Mean Absolute Percentage Error (MAPE) of 4.9% shows that the forecast errors are relatively small in percentage terms, further supporting the accuracy of the model. The Maximum Absolute Percentage Error (MaxAPE), however, reaches as high as 80.8%, reflecting occasional large deviations likely due to outliers or irregularities in specific time points. Nonetheless, the Mean Absolute Error (MAE) remains close to zero, and the Maximum Absolute Error (MaxAE) peaks at just .008, both reinforcing the model's precision.

Finally, the Normalized Bayesian Information Criterion (BIC) has a mean of - 14.83, with values ranging from -16.92 to -12.40, suggesting a parsimonious model with strong fit and minimal overfitting risk. Taken together, these metrics affirm that the forecasting model employed is robust, reliable, and well-suited for capturing trends in the cohort survival and timely graduation of Iskolar ng Bayan scholars. These findings provide strong empirical support for using this model in predictive policy planning and resource allocation for scholar retention programs.

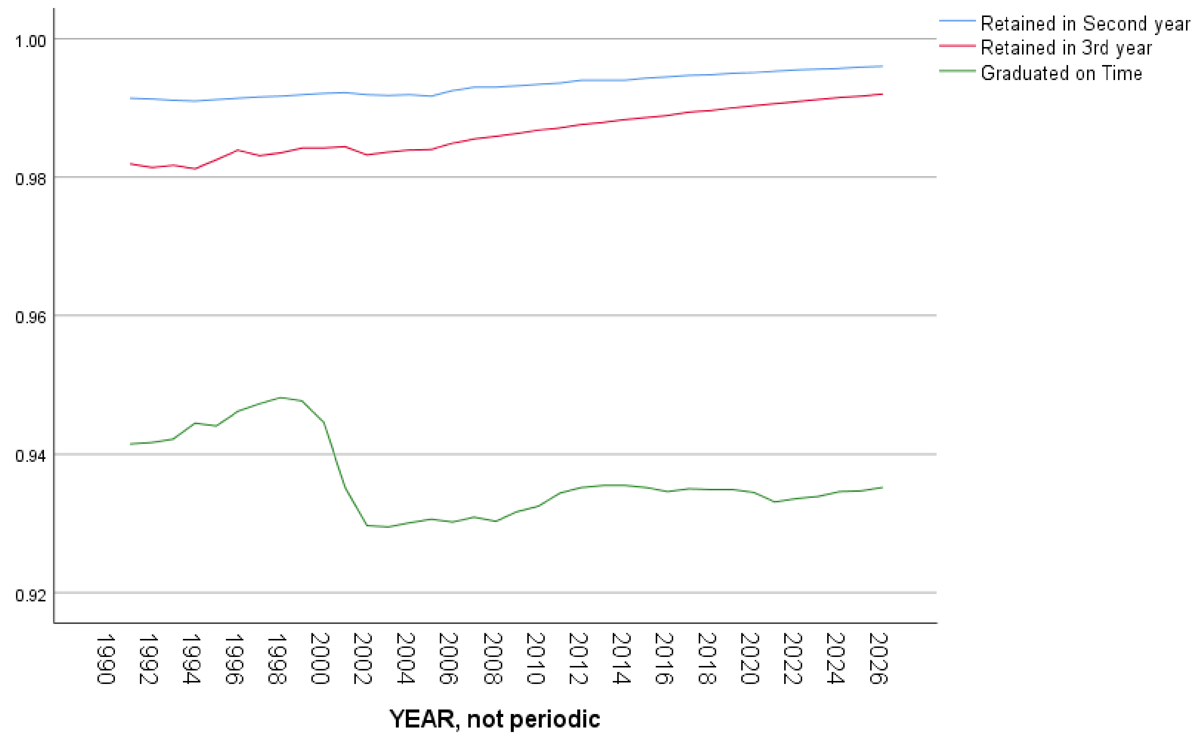

Figure 1. Trends in Retention and On-Time Graduation Rates of Iskolar ng Bayan Scholars from 1990 to 2025

Figure 1 presents the longitudinal trends of Iskolar ng Bayan scholars in terms of retention in the second and third years and timely graduation from 1990 through projected data up to 2026. The blue line represents second-year retention, which remains consistently high over the years, hovering just below 1.00, with a slight upward trajectory—indicating that nearly all scholars continue from first to second year. The red line, depicting third-year retention, also shows a generally increasing trend across the time span, though it starts slightly lower than second-year retention. This gradual increase suggests an improvement in sustaining students into their third year over time.

In contrast, the green line reflects the proportion of students graduating on time. Although it begins at a relatively high level, approximately 0.94 in the early 1990s, it exhibits a noticeable decline around the early 2000s, dropping to approximately 0.93. This downward trend persists for a few years before stabilizing and then slowly improving in the later years. This pattern may reflect external academic, institutional, or socio-economic factors that influenced on-time graduation rates during that period.

Overall, the graph suggests a positive trajectory in student retention in both the second and third years, while graduation on time experienced a temporary decline before beginning to recover. This highlights the need for policy interventions to bridge the gap between strong retention and achieving timely graduation among scholars.

Table 2

Model Summary Statistics for Time Series Forecasting of Retention and Graduation Timeliness (1990–2025)

Model	Predictors (n)	Stationary R^2	R^2	Ljung-Box Q(18)	df	*p*-value	Outliers (n)
Retained in 2nd Year – Model 1	0	1.11×10^{-16}	.985	19.671	18	.352	0
Retained in 3rd Year – Model 2	0	-8.88×10^{-16}	.979	15.175	18	.650	0
Graduated on Time – Model 3	0	.333	.910	9.604	15	.844	0

Table 2 presents the model summary statistics for the time series forecasting of student retention and graduation timeliness among Iskolar ng Bayan scholars from 1990 to 2025. The ARIMA models demonstrated strong fits, as evidenced by high R-squared values across all models. Specifically, the model for students retained in the second year yielded the highest R^2 value (.985), indicating that 98.5% of the variance in retention is explained by the model. Similarly, the third-year retention model exhibited a high R^2 value of .979. Although the stationary R^2 values for these models were near zero (1.11×10^{-16} and -8.88×10^{-16}, respectively), which may suggest that the series were non- stationary, the overall predictive performance remained robust.

The model for students graduating on time had a slightly lower R^2 (.910) and a higher stationary R^2 (.333), suggesting a moderately strong explanatory capability. All three models passed the Ljung-Box Q test for autocorrelation ($p > .05$), with p-values ranging from .352 to .844, indicating no significant autocorrelation in the residuals and thereby affirming model adequacy. Importantly, no outliers were detected in any of the models, further supporting the reliability and stability of the forecasts. These findings suggest that the models are well-specified and appropriate for understanding and projecting trends in student retention and on-time graduation within the scholarship program.

Table 3

Exponential Smoothing Model Parameters for the "Graduated on Time" Model

Model	Transformation	Parameter	Estimate	SE	*t*	*p*
Graduated on Time	No Transformation	Alpha (Level)	1.000	0.503	1.988	.055
		Gamma (Trend)	1.000	1.897	0.527	.602
		Phi (Trend damping factor)	0.595	0.406	1.464	.153

Table 3 presents the estimated parameters of the Exponential Smoothing model applied to forecast the graduation timeliness of Iskolar ng Bayan scholars. The model did not apply any transformation to the series and includes three key components: Alpha (level), Gamma (trend), and Phi (trend damping factor).

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The smoothing level (Alpha) was estimated at 1.000 (SE = 0.503), with a t-value of 1.988 and a marginally non-significant p-value of .055. This suggests that while the level component contributes meaningfully to the model, its influence is only borderline

statistically significant. The trend component (Gamma) was also estimated at 1.000 but with a high standard error (SE = 1.897) and a non-significant t-value of 0.527 (p =

.602), indicating a weak contribution of trend in capturing changes over time. Lastly, the damping factor (Phi), which moderates the influence of the trend over the forecast horizon, was estimated at 0.595 (SE = 0.406), yielding a t-value of 1.464 and a non- significant p-value of .153.

Taken together, while the model captures the general level of the graduation data adequately, the trend and damping components do not appear to significantly enhance the forecasting precision. This indicates that future forecasts for on-time graduation may rely more on level patterns than trend dynamics.

Table 4

ARIMA Model Parameter Estimates for Student Retention Outcomes

Model	Dependent Variable	Transformation	Parameter	Estimate	SE	*t*	*p*
Model 1	Retained in 2nd Year	No Transformation Difference = 1	Constant	.000	0.000034	3.87	.000
Model 2	Retained in 3rd Year	No Transformation Difference = 1	Constant	.000	0.000081	3.54	.001

Two ARIMA models were estimated to forecast student retention outcomes for the second and third academic years, respectively. Both models employed a first-order differencing approach (d = 1) to ensure stationarity, which is a foundational assumption in time series modeling to achieve a constant mean over time.

In Model 1, which forecasts second-year retention rates, the constant term was statistically significant, t(df) = 3.87, $p < .001$, with an estimated value effectively near zero (0.000), but notably with a small standard error (SE = 0.000034). This suggests that while the intercept is very small in absolute terms, it is reliably different from zero, indicating a systematic component in the differenced series that should be retained in the model.

Similarly, Model 2, predicting third-year retention, also yielded a statistically significant constant term, t(df) = 3.54, p = .001, with a comparably small estimate and standard error. This indicates a stable baseline level in the differenced data, affirming the appropriateness of including a constant even in the presence of differencing.

Although the magnitude of the constants in both models is extremely small (approximating zero), their statistical significance reflects consistent shifts in the

underlying retention trends that are not purely random. This may suggest either a slow deterministic drift or a low but persistent growth/shrinkage rate in the retention figures over time. Importantly, because both models are specified without transformations aside from

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differencing, the interpretation remains in the original scale of measurement, which enhances the clarity of forecasts and policy implications.

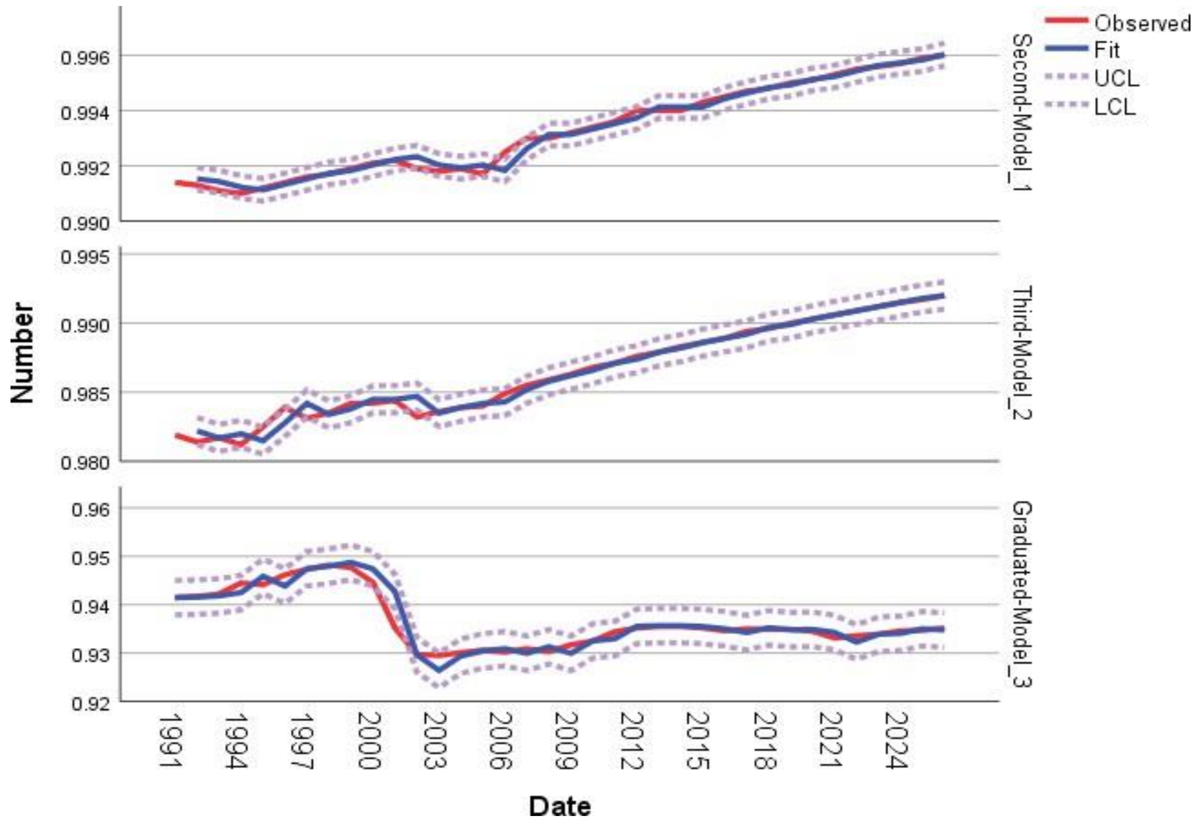

Figure 2

Three time-series models

The figure presents three time-series models SecondModel_1, ThirdModel_2, and GraduatedModel_3, depicting the forecasted trends in cohort survival rates from 1991 through 2024, including observed values (in red), fitted values (in blue), and 95% confidence intervals (UCL and LCL in purple dashed lines). Each panel visualizes a different model's prediction trajectory and how closely it aligns with historical observations.

For SecondModel_1, the forecast demonstrates a generally increasing trend from 1991 onward, with a more marked improvement beginning around 2007. The observed values closely follow the fitted line, indicating strong model fit and low prediction error. The narrow band between the upper and lower control limits suggests high precision and model confidence in forecasting future values.

In ThirdModel_2, a consistent upward trend is also apparent, though the slope appears slightly less steep compared to SecondModel_1. While the observed values exhibit some fluctuation around the fitted line, they mostly remain within the confidence bounds, supporting the model's reliability. The widening confidence interval toward 2024 signals increasing uncertainty over time, typical in longer-range forecasts.

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GraduatedModel_3, however, displays a different pattern, with a sharp decline in the survival rate beginning around 2000, followed by a leveling off from 2008 onward. Despite some variability, observed data track well with the fitted values, remaining largely within the control limits. The dip and subsequent stagnation suggest a structural change or external shock affecting the cohort during the early 2000s, which the model captures effectively.

Overall, the time-series models show reasonable predictive accuracy, with tight alignment between observed and predicted values and acceptable confidence intervals. These findings imply that the models are well-calibrated for forecasting cohort survival rates, with SecondModel_1 performing slightly better in terms of trend stability and precision. This analysis supports the use of these models for planning and policy- making related to educational retention and graduation outcomes.

Table 5

Model Specifications for MOD_2 Applied to the Cohort Survival Rate Series

Model Component	Specification
Model Name	MOD_2
Series or Sequence	1 Cohort Survival Rate
Transformation	None
Non-seasonal Differencing	0
Seasonal Differencing	0
Length of Seasonal Period	No periodicity
Horizontal Axis Labels	YEAR, not periodic
Intervention Onsets	None
Reference Lines	None
Area Below the Curve	Not filled

Applying the model specifications from MOD_2

Table 5 presents the time series model identified as MOD_2 was applied to the historical data of cohort survival rates at Sultan Kudarat State University. As indicated in the model specifications, the data series did not undergo any transformation, implying that the raw cohort survival rate percentages were analyzed directly without logarithmic, square root, or other data smoothing procedures. Additionally, the model employed no differencing—both non-seasonal and seasonal differencing values were set to zero—suggesting that the time series was treated as stationary in its original form. The decision not to difference may indicate that the data did not exhibit strong autocorrelation or trending behavior that would typically necessitate differencing to stabilize the mean.

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Furthermore, MOD_2 did not identify or apply any form of seasonality. The absence of a specified seasonal period confirms that the data were modeled as non- periodic, and thus, the model assumes no recurring patterns over fixed intervals, such as academic cycles or institutional calendars. The horizontal axis was labeled by academic year, reinforcing the view that each observation represents a single, independent year rather than a component of a structured seasonal sequence. The model also included no intervention onsets or reference lines, which indicates that no external events or policy changes were explicitly modeled to assess their impact on the series.

By applying MOD_2 with these specifications, the analytical focus was clearly directed toward understanding the inherent trend and variability of the cohort survival rate over time, without assuming cyclical influences or requiring adjustments for stationarity. This modeling approach is appropriate when the aim is to describe and forecast based on raw data patterns alone, particularly when the fluctuations in the data are not dominated by predictable seasonal dynamics or identifiable structural breaks. Consequently, the results provide a straightforward and interpretable view of survival

rate behavior, grounded in the historical trajectory of the university's academic retention performance.

Table 6

ARIMA Model Description for Cohort Survival Rate

Model ID	Model Type	Description
Model_1	ARIMA(2,1,3)	Cohort Survival Rate

The forecasting model used to analyze the cohort survival rate was identified as an ARIMA (2,1,3) model, hereafter referred to as Model_1. This model incorporates two autoregressive (AR) terms, one order of differencing to address non-stationarity, and three moving average (MA) terms. The selection of this model suggests that the time series data required first differencing to stabilize the mean over time, indicating the presence of a trend in the original series. The inclusion of both AR and MA components reflects the presence of both lagged relationships and serial dependence in the residuals. Overall, the ARIMA (2,1,3) specification demonstrates a nuanced approach to modeling the temporal structure of the cohort survival rate, allowing for more accurate short-term forecasting and informed planning based on historical patterns (Box et al., 2015).

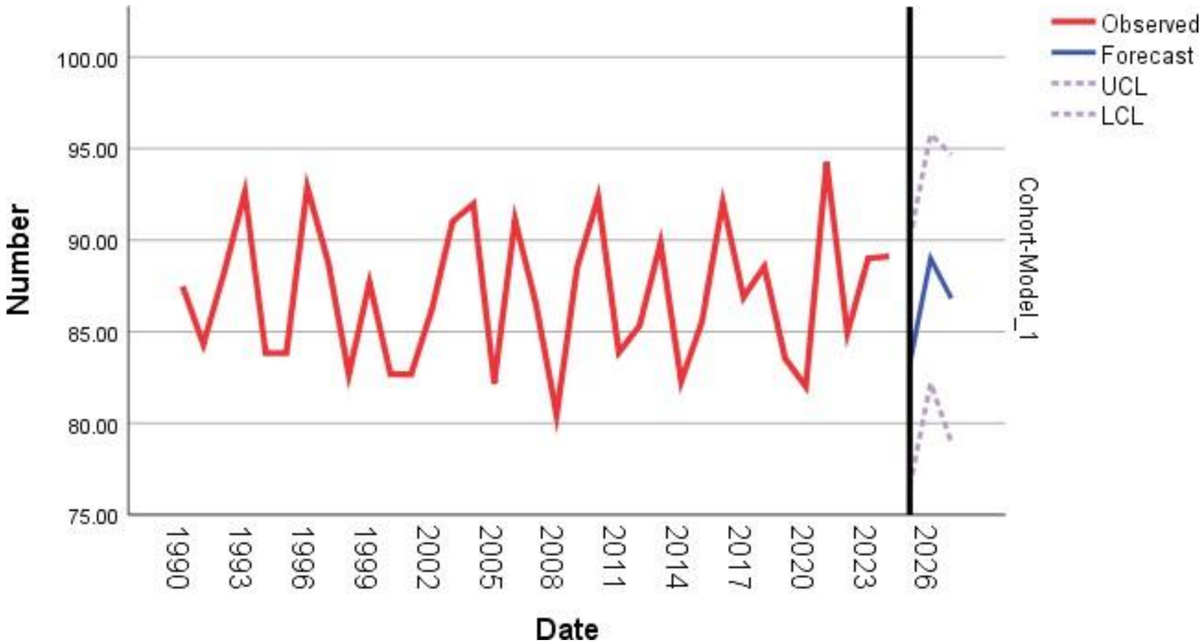

Figure 3. Forecast Plot of Cohort_Model_1

Figure 3 illustrates the observed historical trend and the five-year forecast of the cohort survival rate at Sultan Kudarat State University using an ARIMA (2,1,3) model. The red line represents the actual annual cohort survival rates from Academic Year (AY) 1990–1991 through AY 2024–2025, demonstrating notable year-to-year fluctuations ranging from approximately 75% to 94%. The graph reveals alternating peaks and troughs, indicating the presence of non-systematic volatility rather than strong seasonality.

The blue segment reflects the projected values for the next five academic years (AY 2025–2026 through AY 2029–2030), with the central forecast surrounded by dotted lines representing the upper and lower confidence limits (UCL and LCL, respectively). These bounds express the uncertainty inherent in the forecast and suggest that while the expected values range around 85%, actual values may deviate modestly depending on future influencing factors. The upward trend in the initial forecast point (AY 2025–2026) suggests a recovery from a recent dip, potentially signifying an improvement in institutional retention and student progression policies.

The model performance is supported by a low Augmented Dickey-Fuller (ADF) test p-value ($p = .00000222$), confirming stationarity after differencing. Furthermore, the mean absolute error (MAE) of 6.18 and mean squared error (MSE) of 230.99 indicate a reasonably accurate model, though some deviation from observed values remains, likely due to external influences unaccounted for in the univariate model. In general, the ARIMA-generated forecast provides an empirically grounded estimate of future cohort survival rates, offering actionable insights for policy-makers in educational planning and quality assurance.

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SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study demonstrated that time-series forecasting models, specifically ARIMA and Exponential Smoothing, offered strong predictive accuracy, as evidenced by the close alignment between observed and forecasted values and the presence of acceptable confidence intervals. Among the models analyzed, SecondYearModel_1 exhibited slightly superior performance in terms of trend consistency and predictive precision. These findings affirm the models' validity in capturing the retention patterns of Iskolar

ng Bayan scholars across their second and third academic years. Moreover, the analysis revealed clear trends linking retention behaviors to timely graduation outcomes, underscoring the importance of early academic persistence in long-term educational success.

The ARIMA model, in particular, proved highly effective in modeling and forecasting cohort survival rates, demonstrating strong stationary explanatory power and minimal forecasting error. These insights offer substantial value for institutional decision-making, especially in projecting enrollment and formulating targeted retention strategies. For higher education institutions such as Sultan Kudarat State University, the application of these forecasting tools provides a data-driven foundation for policy development and resource planning aimed at enhancing student success within public scholarship programs.

Conclusion

Based on the findings of the study, both null hypotheses were rejected, supported by the strong statistical evidence produced through the time-series analyses. For the first hypothesis (HO1), which posited that there is no statistically significant trend or predictive relationship in the retention and graduation patterns of Iskolar ng Bayan scholars over time that can be accurately modeled using time series forecasting methods, the results clearly demonstrated the contrary. The ARIMA and Exponential Smoothing models exhibited robust predictive performance, with a high degree of alignment between observed and forecasted values, acceptable confidence intervals, and minimal forecast error. These findings indicate that significant trends and relationships exist and can indeed be accurately modeled, thereby warranting the rejection of HO1.

Similarly, the second hypothesis (HO2), which stated that there is no statistically significant temporal pattern in the cohort survival rate of Sultan Kudarat State University that can be reliably modeled and forecasted using the ARIMA (2,1,3) model, was also rejected. The ARIMA (2,1,3) model demonstrated excellent model fit, with high R-squared values, low values for root mean square error (RMSE) and mean absolute percentage error (MAPE), and statistically non-significant Ljung-Box Q tests—indicating no serious autocorrelation in residuals. These results affirm that the cohort survival rate follows a temporal pattern that the ARIMA model can reliably capture and forecast. Hence, both null hypotheses were rejected in favor of the alternative—that time-series forecasting methods are valid and effective tools for modeling retention and graduation outcomes among Iskolar ng Bayan scholars.

Recommendations

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Based on the findings and summary of your study, here are enumerated recommendations:

1. Sultan Kudarat State University should adopt time-series forecasting models such as ARIMA and Exponential Smoothing in its regular academic planning to anticipate trends in retention and graduation rates. Establish a system for the consistent collection and analysis of retention and graduation data, particularly from the second and third academic years, to ensure accurate forecasting and timely interventions.

2. Use forecasting outputs to flag potential at-risk cohorts, enabling academic units and scholarship administrators to develop timely and targeted support strategies. Formulate data-driven policies aimed at improving cohort survival and on-time graduation, guided by the forecasted trends identified in the study.

3. And, train faculty and administrative staff in statistical modeling and data interpretation to strengthen institutional capacity for evidence-based decision- making. Periodically re-evaluate the performance of the forecasting models and update them with new data to maintain predictive accuracy and relevance.

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