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Assessing the Future of Physical Libraries in Higher Education: A Trend and Forecast Analysis of a College Library Usage Using ARIMA

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Abstract
This study explores the future of physical libraries in higher education by analyzing library usage trends of Tangub City Global College, Learning Resource Center from 2021 to 2025, with forecasts extending to 2035. The research aims to understand visitation and book borrowing patterns across 12 academic programs, using time-series analysis to predict their evolution amid growing digital resource adoption. Historical data on visitation and borrowing were collected from library records and analyzed using the Autoregressive Integrated Moving Average model in Gnu Regression, Econometrics, and Time-series Library software. Findings show an increase in utilization from 2021 to 2025, with a decline projected through 2028, leveling off at 2000–4000 visits and 300–400 borrowed books per program by 2035. While these trends indicate a move towards digital resources, these also underscore the importance of physical libraries as centers of academic activity. The conclusions support the need for allocating more digital resources alongside space reconfiguring, improving interaction, and enabling effective participation through library engagement policies to support sustainability in higher education.

Keywords: ARIMA forecasting, Academic libraries, Resource optimization

1. Introduction

The emergence of newer information and communication technologies has affected all education sectors, sparking discussions on the use of traditional college libraries in the face of e-books, online databases, and other digital resources [20,21]. While some argue that physical libraries are losing relevance, others highlight their critical role in promoting academic success, equitable access, and intellectual engagement [1,2,23].

The physical spaces within most traditional library settings-public libraries, academic libraries, and special libraries-have been important learning environments for the quiet study rooms; research assistance; print and electronic collections: Everything enables an academic atmosphere and boosts community activity [10,21,22].] Almost immediately, modern libraries have become hybrid hubs, combining a shelf with a computer workstation, collaborative tables, multimedia labs, maker spaces, and digital kiosks, thereby

fulfilling the different needs of users [22]. Librarians are information experts. They offer advice, conduct information literacy sessions, and implement outreach programs that exceed book lending [7,12].

Internationally, library utilization varies significantly by country. In China, the China Academic Library and Information System (CALIS)—initiated in 1998 and operational since 2001—has evolved into the country's largest academic library consortium, centrally funded and providing shared cataloging, cooperative acquisitions, interlibrary loan, document delivery, and cloud-based services across over 70 national and regional centers [23,24]. In India, consortia such as e-ShodhSindhu—established in 2015 by merging UGC-INFONET, N-LIST, and INDEST-AICTE—offer centralized access to more than 7,200 peer-reviewed e-journals, 164,300+ e-books via N-LIST, and document delivery services, while the National Digital Library of India provides a unified platform aggregating full-text academic content [1,25,26]. In the Philippines, the likes of UST, UP Los Baños, and Silliman have large Learning Resource Centers filled with a variety of print and digitized holdings, dedicated seating spaces, and branch-specific services, but rural and barangay libraries often suffer from staff shortages, limited hours of operation, and obsolete collection materials [6,8]. At the college's Learning Resource Center, comparable constraints exist: usage is concentrated in a limited number of academic programs, and several specialized sections remain underutilized due to inadequate promotion and restricted availability [7,14].

This study examines library usage trends at a college Learning Resource Center (LRC), focusing on visitation and book borrowing patterns across 12 academic programs from August 2021 to May 2025. By using Autoregressive Integrated Moving Average (ARIMA) model in Gnu Regression, Econometrics, and Time-series Library (GRETL) software, the research analyzes historical data and forecasts trends from 2026 to 2035.

2. Literature Review

Physical college libraries remain vital despite the digital shift, particularly for students with limited internet access [1]. Research from Adeleke University noted reduced library usage due to digital convenience and space constraints, yet emphasized their academic importance [1].

In the Philippines, the learning atmosphere of the library, including its available resources as well as staff attention, improves one's study skills and performance [2]. Libraries all over the world have gradually advanced and diversified into an open Internet zone and community gathering space [3].

In U.S. college libraries, circulation of physical materials experienced a dramatic fall of 50% between 1997 and 2011, suggesting a definite shift toward digital resources [4,5]. Locally, library use is related to academic achievement and resource awareness among senior high school students [6]. Students in Isabela Province frequently use physical books, though electronic database access is limited by connectivity issues [7,8].

Globally, younger generations are rediscovering libraries, driven by trends like #BookTok [9,10]. ARIMA forecasting has been used to predict library usage, aiding strategic planning [12]. In this study, the researcher uses ARIMA to forecast the the trends of library usage and evaluate the impact on resource management.

3. Methodology

3.1 Dataset

The research analyzes library attendance and usage data from Tangub City Global College (TCGC), Lear-

ning Resource Center (LRC) for the following periods: Academic Year 2021-2022, 2022-2023, and projected 2023-2024 as well as 2024-2025. These includes:

- **Visitation Records:** Annual visitation counts for 12 academic programs (e.g., AB English, BS Criminology), aggregated from monthly data (August–May).
- **Book Borrowing Records**: Annual borrowing counts for the same programs, similarly aggregated.
- **Enrollment Data**: Number of enrolled students per program per year, used to normalize visitation and borrowing counts.

Data was retrieved from the LRC management system, converted into documents, and processed using GRETL for ARIMA modeling, data preprocessing, and visualization. The graphs show actual library usage trends from 2022 to 2025, along with projections for 2026 to 2035. To check how well the model performs, additional metrics like MAE and RMSE were also calculated.

Table 1: TCGC LRC Activity Statistics Report from A.Y. 2021-2022 to A.Y. 2022-2023

PROGRAM		INSITUTE	A.Y.2021-2022				A.Y.2022-2023			
			OPENING DAYS	Visit Count	Borrow Count	Enrolled Students Count	OPENING DAYS	Visit Count	Borrow Count	Enrolled Students Count
AB English	AB-Engl.	IAS	140	42	12	145	210	1627	490	151
AB Political Science	AB-PolSci	IAS		18	7	80		1606	507	99
Ab Communication	AB Com.	IAS		12	5	59		2132	446	81
BSBA-Human Resource Management	BSBA-HRM	IBFS		62	20	556		3619	403	592
BSBA-Marketing Management	BSBA-MM	IBFS		72	23	638		3412	556	732
Bachelor of Science in Office Administration	BSOA	IBFS		28	13	325		2839	433	329
Bachelor of Science in	BSCS	ICS		42	17	178		1849	181	153

Computer Science										
BEED-General Education	BEED-Gen. Ed.	ITE		31	20	113		3877	539	92
Bachelor in Secondary Education	BSED-Engl.	ITE		136	39	548		4414	391	545
BS Criminology	BSC	ICJE		111	21	1138		5427	291	1018
BS Industrial Security Management	BSISM	ICJE		87	17	764		4518	274	870
Diploma in Midwifery	Dip. in Mid.	IHS		30	14	201		2902	291	185

Table 2: TCGC LRC Activity Statistics Report from A.Y. 2023-2024 to A.Y. 2024-2025

PROGRAM		INSITUTE	A.Y.2023-2024				A.Y.2024-2025			
			OPENING DAYS	Visit Count	Borrow Count	Enrolled Students Count	OPENING DAYS	Visit Count	Borrow Count	Enrolled Students Count
AB English	AB-Engl.	IAS	215	3289	644	219	200	4312	695	265
AB Political Science	AB-PolSci	IAS		3093	608	142		3145	625	160
Ab Communication	AB Com.	IAS		4185	588	157		4861	629	253
BSBA-Human Resource Management	BSBA-HRM	IBFS		3511	630	698		3931	751	796

BSBA-Marketing Management	BSBA-MM	IBFS		3632	763	839		3971	853	949
Bachelor of Science in Office Administration	BSOA	IBFS		3102	707	386		3582	802	418
Bachelor of Science in Computer Science	BSCS	ICS		2002	392	169		2259	457	219
BEED-General Education	BEED-Gen. Ed.	ITE		2866	663	136		3141	741	170
Bachelor in Secondary Education	BSED-Engl.	ITE		3583	567	606		3214	682	572
BS Criminology	BSC	ICJE		4080	573	850		3501	579	641
BS Industrial Security Management	BSISM	ICJE		4220	497	1274		3751	560	1552
Diploma in Midwifery	Dip. in Mid.	IHS		2292	512	281		2586	727	333

Table.2 Aggregated Raw Data on TCGC LRC Visitation by Program

PROGRAM	YEAR			
	2022	2023	2024	2025
AB English	42	1627	3289	4312
AB Political Science	18	1606	3093	3145
Ab Communication	12	2132	4185	4861
BSBA-Human Resource Management	62	3619	3511	3931
BSBA-Marketing Management	72	3412	3632	3971

Bachelor of Science in Office Administration	28	2839	3102	3582
Bachelor of Science in Computer Science	42	1849	2002	2259
BEED-General Education	31	3877	2866	3141
Bachelor in Secondary Education	136	4414	3583	3214
BS Criminology	111	5427	4080	3501
BS Industrial Security Management	87	4518	4220	3751
Diploma in Midwifery	30	2902	2292	2586

Table 4: Aggregated Raw Data on TCGC LRC Books Borrowing by Program

PROGRAM	**YEAR**			
	2022	**2023**	**2024**	**2025**
AB English	12	490	644	695
AB Political Science	7	507	608	625
Ab Communication	5	446	588	629
BSBA-Human Resource Management	20	403	630	751
BSBA-Marketing Management	23	556	763	853
Bachelor of Science in Office Administration	13	433	707	802
Bachelor of Science in Computer Science	17	181	392	457
BEED-General Education	20	539	663	741
Bachelor in Secondary Education	39	391	567	682
BS Criminology	21	291	573	579
BS Industrial Security Management	17	274	497	560
Diploma in Midwifery	14	291	512	727

3.2 ARIMA Algorithm

-To understand and predict trends in library usage, this study used the Autoregressive Integrated Moving

Average (ARIMA) model. ARIMA (p, d, q) works well with time-series data that show patterns over time, making it a popular choice in information science for forecasting. The model can be described as follows:

$$x_t = \phi_1 x_{t-1} + \ldots + \phi_p x_{t-p} + a_t - \phi_1 a_{t-1} - \ldots - \theta_q a_{t-q}$$

Where:

- $\boldsymbol{\phi}$'s (Phis) represents the autoregressive (AR) parameters,
- $\boldsymbol{\phi}$'s (Thetas) denotes the moving average (MA) parameters,
- $\boldsymbol{x_t}$ is the time series at time *t*, $X_t = \Phi_1 X_{t-1} + \ldots + \Phi_p X_{t-p} + a_t - \Theta_1 a_{t-1} - \ldots - \Theta_q a_{t-q}$
- $\boldsymbol{a_t}$ is the random error term assumed to follow a normal distribution with zero mean.

The ARIMA process involved:

- **Stationarity Testing**: Assessed via visual inspection and autocorrelation plots, with differencing applied to achieve stationarity.
- **Model Identification**: Selected (p,d,q) values using autocorrelation (ACF) and partial autocorrelation (PACF) plots, evaluated with Akaike Information Criterion (AIC) and residual analysis.
- **Model Estimation**: Validated through residual diagnostics to ensure no autocorrelation or heteroscedasticity.
- **Forecast Generation**: Produced 10-year forecasts (2026–2035) for each program's visitation and borrowing.

  Analysis was conducted in GRETL, which facilitated model fitting, diagnostics, and visualization.

4. Results and Discussions

ARIMA forecasting, conducted in GRETL, projects library usage trends from 2026 to 2035 based on data from 2021 to 2025. Results cover visitation and borrowing across 12 academic programs, visualized in Figures 1–24.

LRC Visitation Trends (2026–2035)

Figures 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 show visitation trends. Most programs start at 3000–4000 visits in 2026, decline until 2028, and stabilize by 2030. For example, AB English (Figure 1) decreases from 4000 to 2000 visits by 2035, while BSBA-Marketing Management (Figure 9) stabilizes at 4000. BS Computer Science (Figure 13) shows the lowest visitation, stabilizing at 1500. Confidence intervals (95%) narrow post-2030, indicating higher forecast reliability.

Book Borrowing Trends (2026–2035)

Figures 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, and 24 depict borrowing trends. Most programs start at 400–800 books in 2026, declining to 300–400 by 2035. AB English (Figure 2) drops from 600 to 400, while BS Criminology (Figure 20) stabilizes at 400. BS Computer Science (Figure 14) shows the lowest borrowing at 300. Confidence intervals narrow post-2030.

Historical Comparison (2022–2025)

Tables 3 and 4 show visitations for AB English increasing from 42 to 4312 visits and borrowing from 12 to 695 from 2022 to 2025. BS Criminology visitation grew from 111 to 3501, with borrowing from 21 to 579. Forecasts indicate a decline from these peaks.

Discussion

The forecast decrease in library use is consistent with worldwide trends, including the 50% decrease in U.S. library circulation between 1997 and 2011 [4,5]. This is a manifestation of greater dependence on electronic resources, spurred by post-COVID-19 digitalization [1]. Stabilization at 2000–4000 visits and 300–400 books per program by 2030, however, indicates resilience in line with libraries as complex

centers [3]. Program-specific trends, such as BS Criminology's consistent utilization (Figure 19), could be indicative of curriculum requirements [12], and BS Computer Science's minimal utilization (Figures 13, 14) is consistent with computer dependence [8]. The historical growth (2022–2025) contrasts with the forecasted decline, highlighting digital shifts, though trends like #BookTok already hints that users will swing by the library just to find what's hot there [9,10]. Projects such as the Augmented Library effort also add fun layers that could pull in curious visitor's confidence intervals for the ARIMA forecast are shrinking [19], yet the brief dataset keeps long-term predictions shaky [13].

5. Conclusions and Recommendations

Conclusion

The research was able to capture historical trends and project future patterns from 2021 to 2035 by using the ARIMA forecasting model on library visitation and book borrowing data for twelve academic programs. The results show a significant increase in usage from 2021 to 2025, with a subsequent gradual decline until 2028, visitation levels stabilizing around 2030 at 2,000 to 4,000 visits and 300 to 400 books borrowed per program annually.

This projected decline reflects the global shift in educational preferences, with more students and faculty turning toward digital resources for convenience, accessibility, and variety. The data, however, show that physical libraries still have an important function gatekeeping programs with high levels of enrollment like Criminology or Education, where reading materials and physical locations are important to learning and study behavior. This suggests that while the digital transition is inevitable and necessary, it should not fully replace the physical library model but rather enhance it through a hybrid strategy.

In addition, the decreasing intervals in the predictive models from 2030 onward reflect increasing rel iability of usage projections, supporting the thesis that physical libraries will plateau instead of becomi ng obsolete. This stability can be attributed to the evolving role of libraries—not only as repositories of books but also as academic sanctuaries for collaborative learning, focused study, and knowledge exchange. The consistent demand seen in several programs also supports the argument that physical spaces for intellectual exploration remain irreplaceable, especially in settings were resources are limited.

Briefly, the future of physical libraries in higher education is not demise but reinvention. They are adapting in response to technological progress and shifting user habits, and higher education institutions must do the same. Libraries that modernize—through amplified digital services, reconfigured physical environments, and community-centered initiatives—can continue to be vital in the academic landscape. The results of this research imply the necessity for smart investments, judicious policymaking, and visionary planning in order to see physical libraries contribute to academic achievement in the next decades.

Recommendations

1. Expand e-book and database access to complement physical collections.

As the usage of digital resources continues to increase, specifically enhancing access to e-books, online journals, and academic databases, can provide the students and faculty members a more convenient way to access information instead of borrowing physical materials. This is especially important for students and faculty members with little access to the library due to time, as in the case of online learning or for individuals living far from the library. Expanding access to digital collections will provide users with equitable access to library collections, and it will also assist the library in modernizing and remaining relevant and inclusive in a digital representation that supports differing preferences for learning.

2. **Redesign the library as a collaborative hub with Wi-Fi and engagement space.**

Libraries need to change the way they think, because they cannot only be a place where books are kept - they must also be a dynamic, technology-enhanced, location-independent space where students can meet and work together, engage with multimedia content, collaborate, and feel free to study alone. Taking on this more vibrant approach to libraries is a great way to increase foot traffic and engagement in the library. Libraries with comfortable seating, sufficient wireless technology, and a range of amenities can remain a place of academic purpose, while actively serving as spaces where a campus can be friendly and social.

3. **Use social media marketing (e.g., #BookTok) and programs like Library Hour to boost engagement.**

Bringing popular digital trends and social media into library promotions can help draw in younger audiences, especially Gen Z and Millennials. Engaging campaigns on platforms like TikTok — think #BookTok — along with programs like Library Hour, can spark new interest in physical books and build a stronger sense of community around reading and using library resources. These strategies also help reposition libraries as relevant, engaging, and responsive to student interests.

4. **Prioritize resources for high-usage programs like BS Criminology.**

Data from this study shows that there is a consistent higher usage of library resources. In order to optimize the library's transformation and provide enough support to increasing demands, there is a must to invest in additional resources and facilities. This differential strategy supports efficiency and helps maintain student academic achievement in programs that are highly dependent on libraries.

5. **Continuing data collection in order to enhance ARIMA forecast accuracy.**

Accurate and reliable forecasting through the use of ARIMA or comparable models requires consistent and ongoing data collection over the long term. Having detailed records of borrowing visitation trends. Libraries can evaluate the success of deployed strategies better, project shifts in usage, and make informed decisions. Monitoring on a continuous basis also enables planning and policy adjustments to be made reactively to the new trends that arise.

6. Appendix

Figure 1: Forecasted Bachelor of Arts in English Language LRC Visitation from 2026-2035

Figure 2. Forecasted Bachelor of Arts in English LRC Book Borrowed from 2026-2035

Figure 3. Forecasted Bachelor of Arts in Communication LRC Visitation from 2026-2035

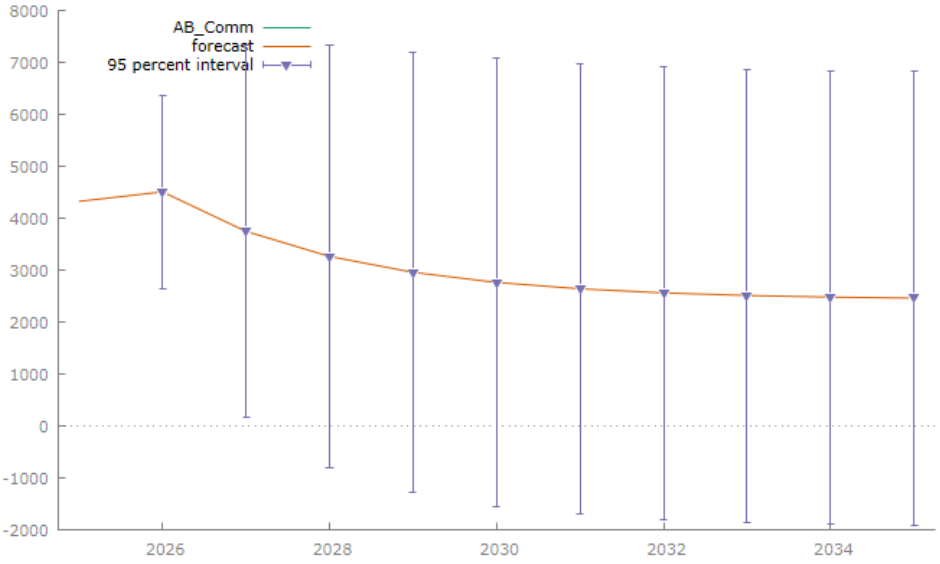


Figure 4. Forecasted Bachelor of Arts in Communication LRC Book Borrowed from 2026-2035

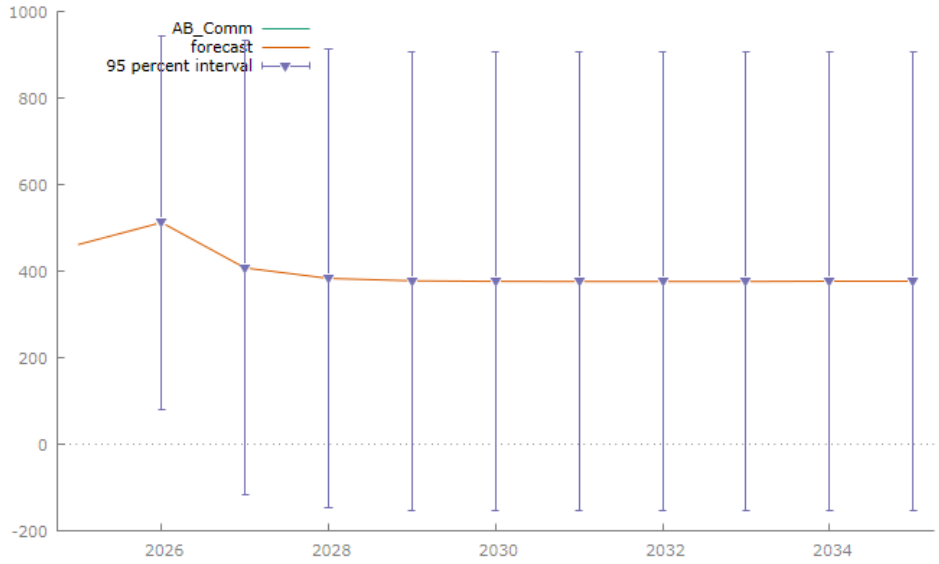


Figure 5. Forecasted Bachelor of Arts in Political Science LRC Visitation from 2026-2035

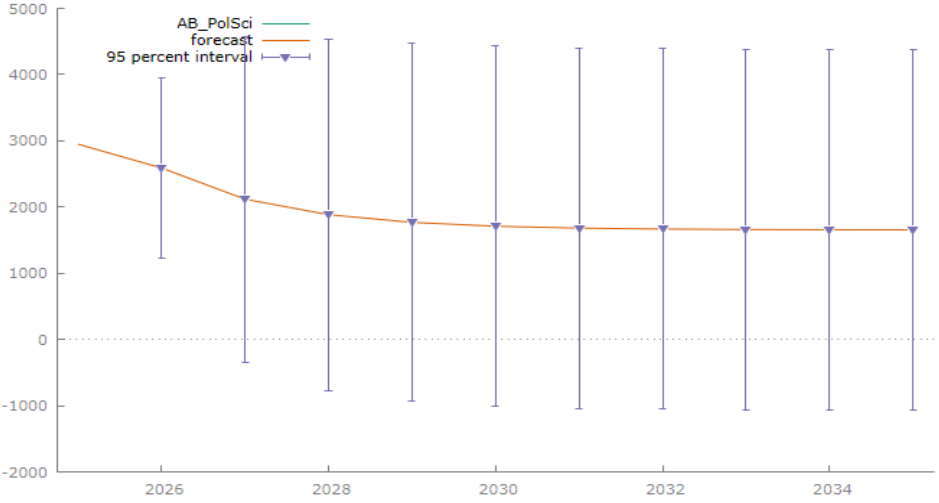


Figure 6. Forecasted Bachelor of Arts in Political Science LRC Book Borrowed from 2026-2035

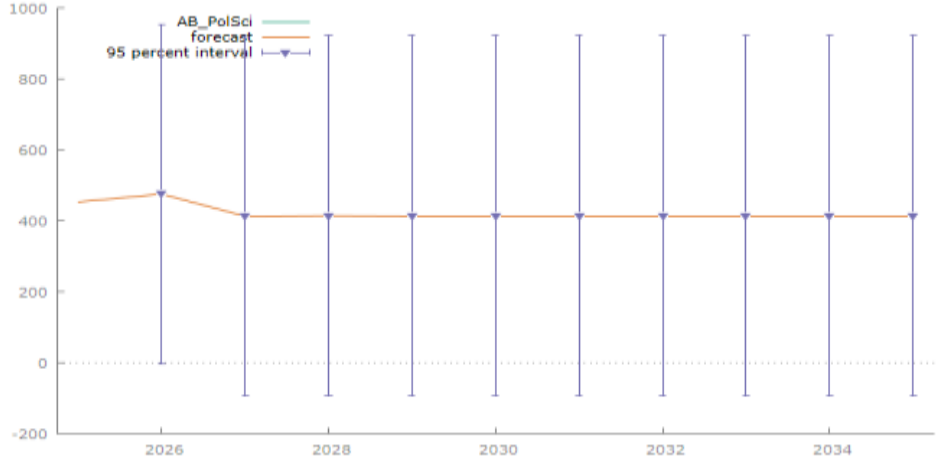


Figure 7. Forecasted Bachelor of Science in Business Administration Major in Human Resource Management LRC Visitation from 2026-2035

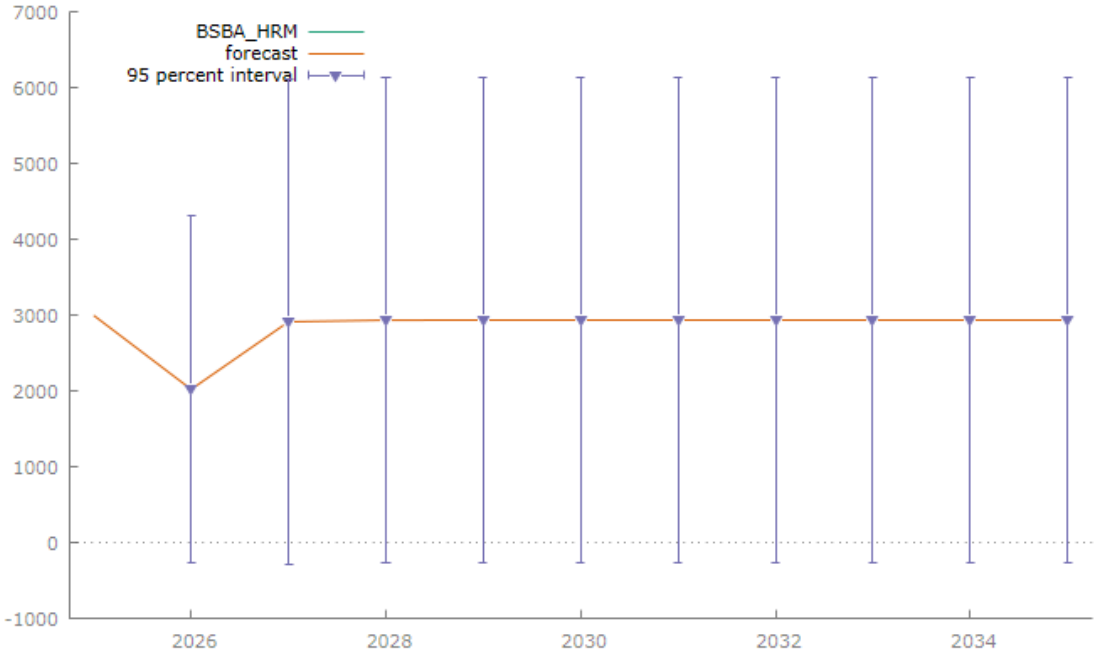


Figure 8. Forecasted Bachelor of Science in Business Administration Major in Human Resource Management LRC Book Borrowed from 2026-2035

Figure 9. Forecasted Bachelor of Science in Business Administration Major in Marketing Management LRC Visitation from 2026-2035

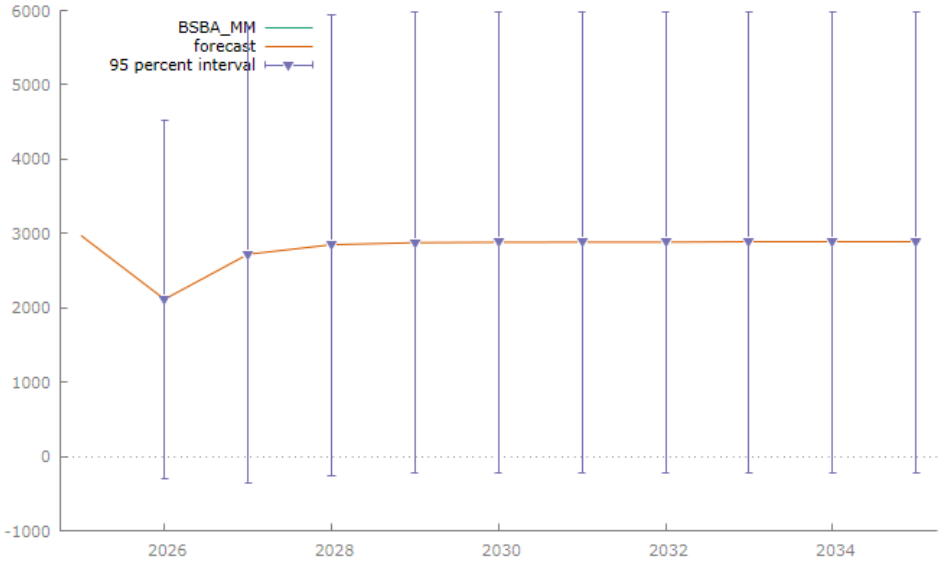


Figure 10. Forecasted Bachelor of Science in Business Administration Major in Marketing Management LRC Book Borrowed from 2026-2035

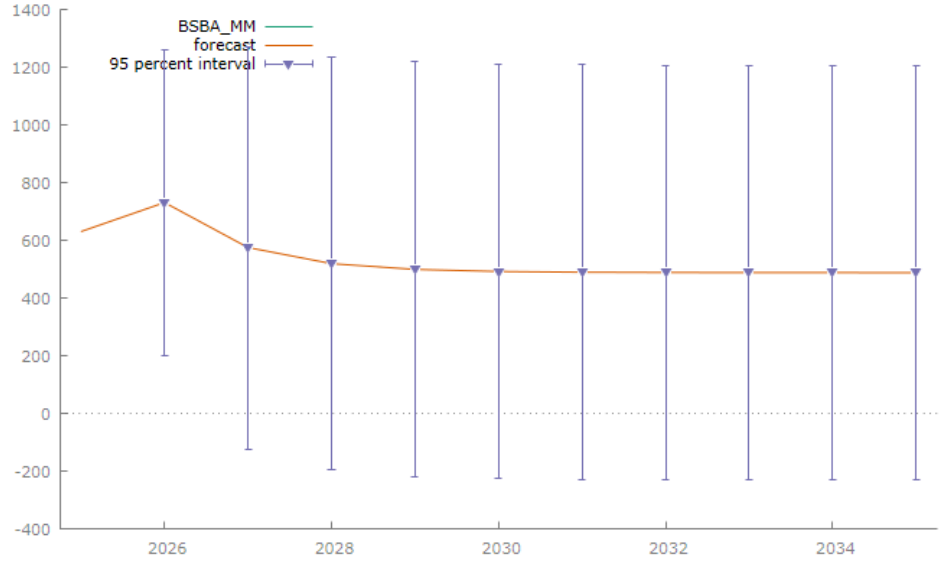


Figure 11. Forecasted Bachelor of Science in Business Administration Major in Office Administration LRC Visitation from 2026-2035

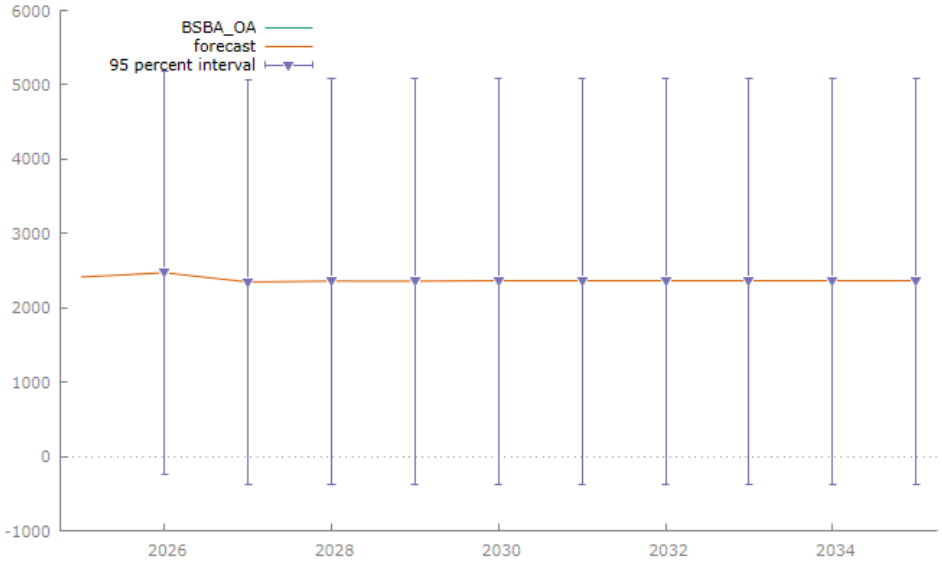


Figure 12. Forecasted Bachelor of Science in Business Administration Major in Office Administration LRC Book Borrowed from 2026-2035

Figure 13. Forecasted Bachelor of Science in Computer Science LRC Visitation from 2026-2035

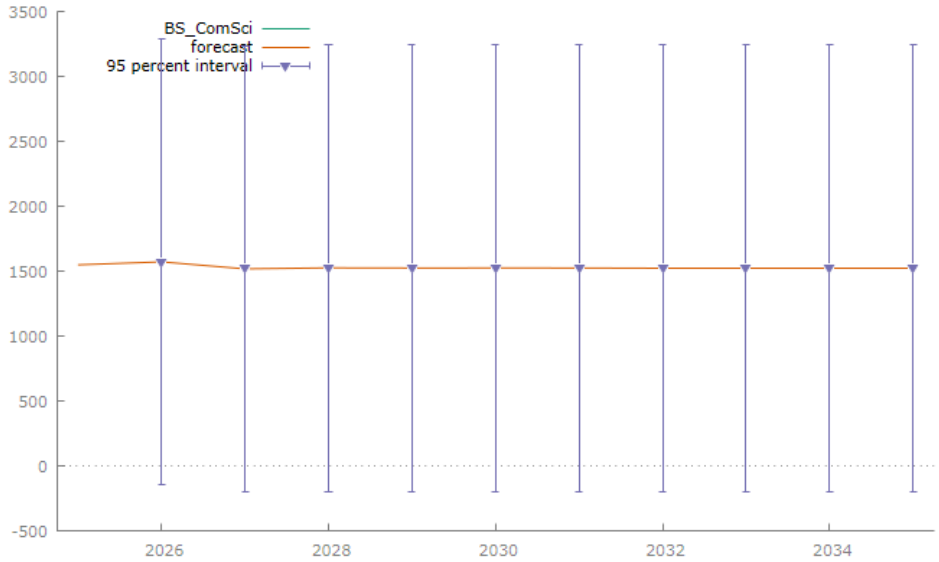


Figure 14. Forecasted Bachelor of Science in Computer Science LRC Book Borrowed from 2026-2035

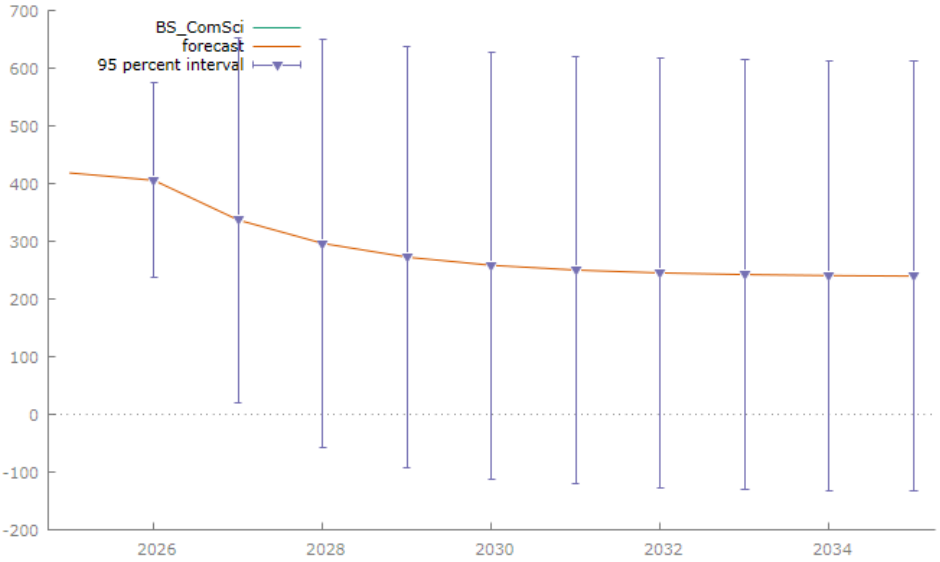


Figure 15. Forecasted Bachelor in Elementary Education LRC Visitation from 2026-2035

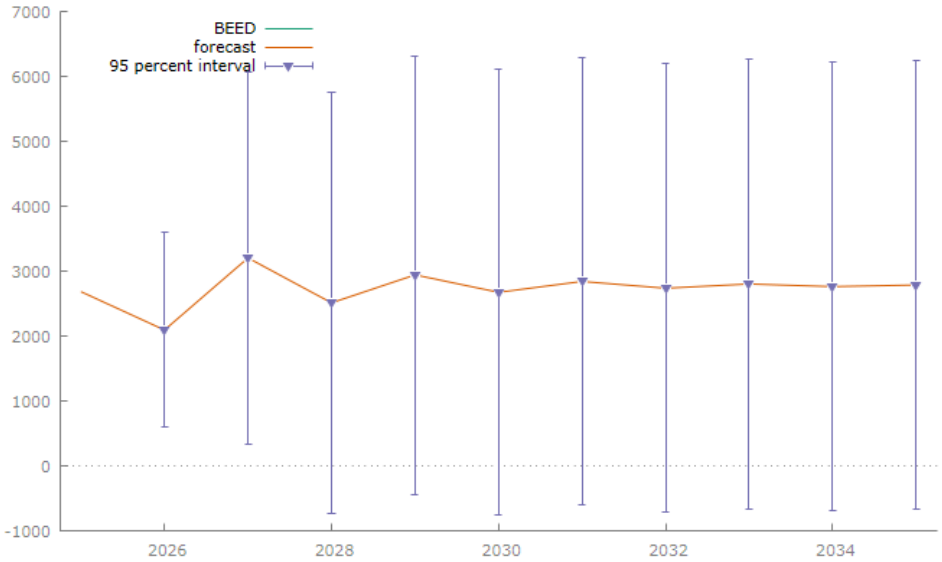


Figure 16. Forecasted Bachelor in Elementary Education LRC Book Borrowed from 2026-2035

Figure 17. Forecasted Bachelor in Secondary Education LRC Visitation from 2026-2035

Figure 18. Forecasted Bachelor in Secondary Education LRC Book Borrowed from 2026-2035

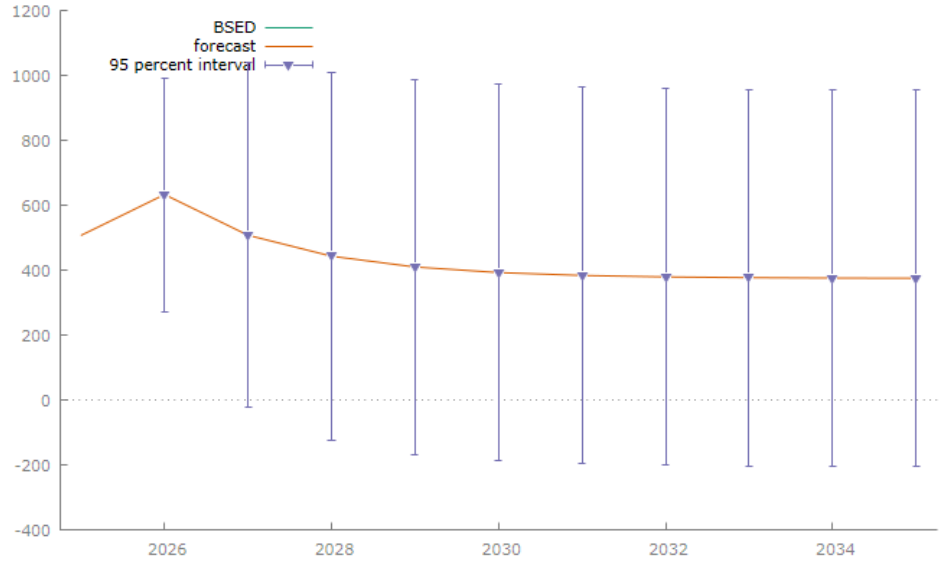


Figure 19. Forecasted Bachelor of Science in Criminology LRC Visitation from 2026-2035

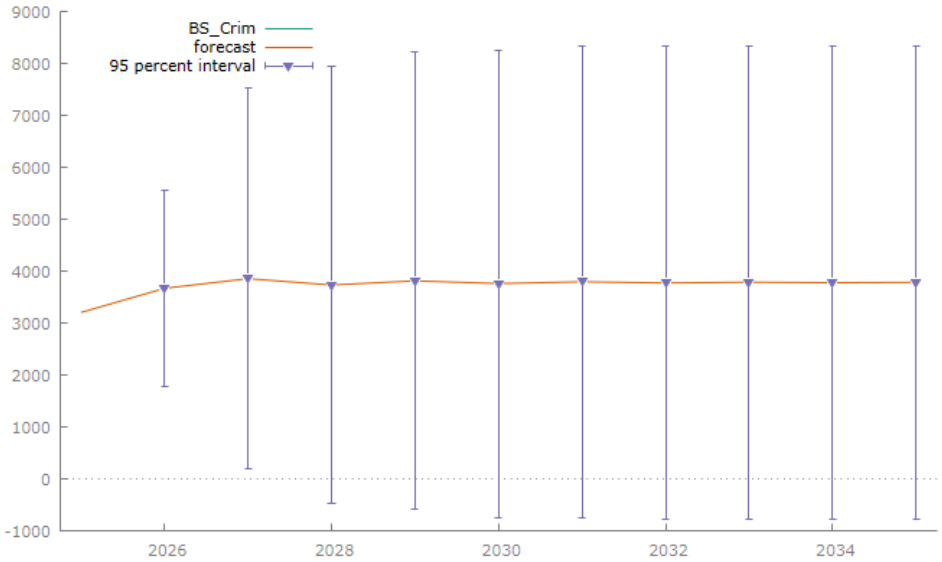


Figure 20. Forecasted Bachelor of Science in Criminology LRC Book Borrowed from 2026-2035

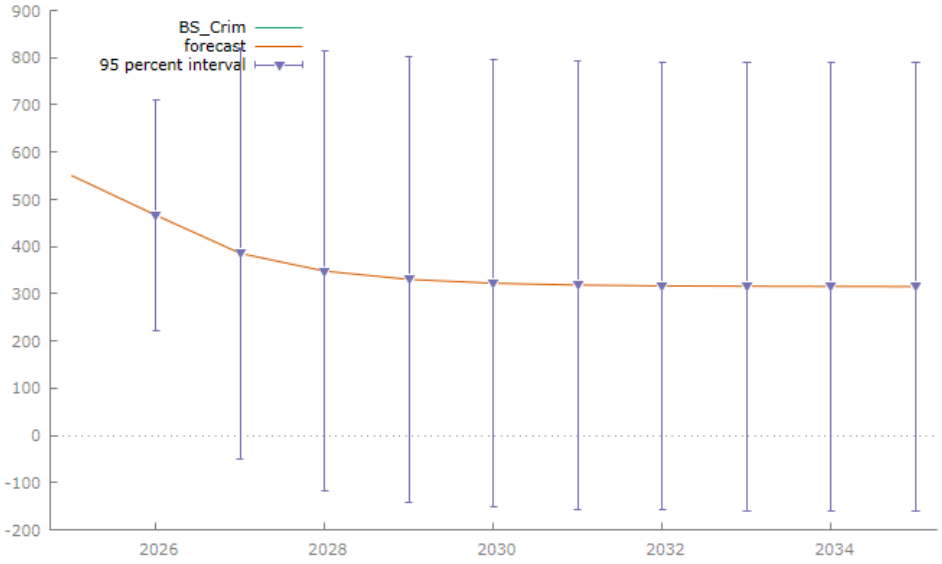


Figure 21. Forecasted Bachelor of Science in Industrial Security Management LRC Visitation from 2026-2035

Figure 22. Forecasted Bachelor of Science in Industrial Security Management LRC Book Borrowed from 2026-2035

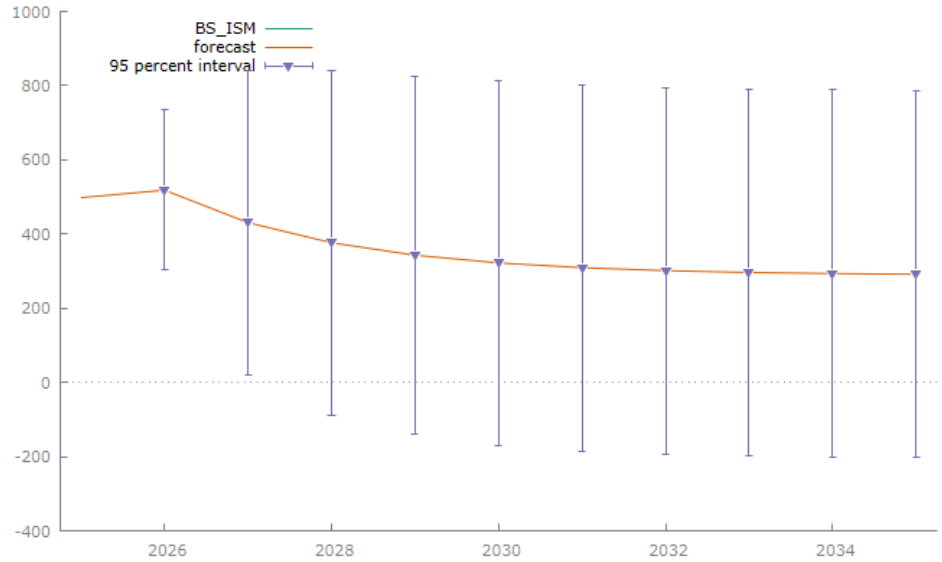
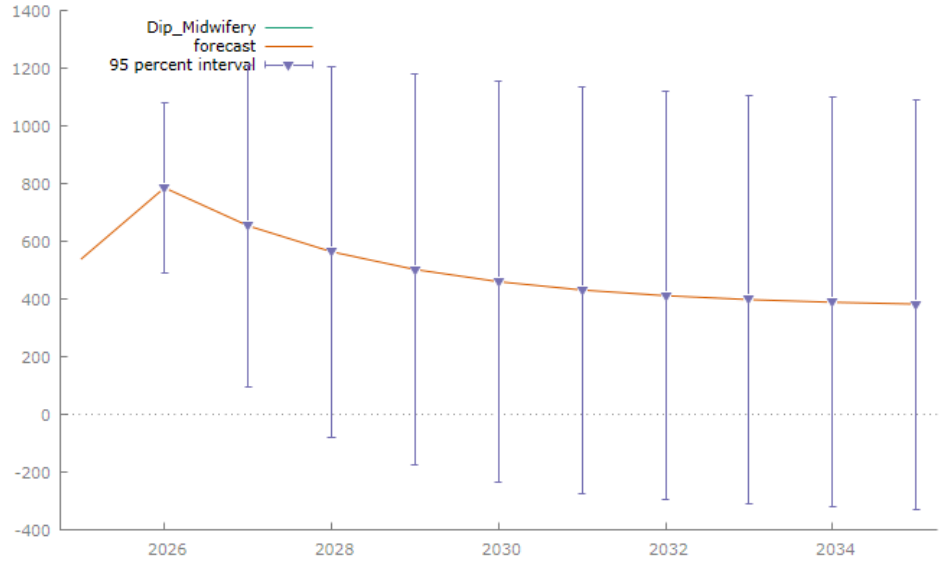


Figure 23. Forecasted Diploma in Midwifery LRC Visitation from 2026-2035

Figure 24. Forecasted Diploma in Midwifery LRC Book Borrowed from 2026-2035



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