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Time Series Forecasting of English Proficiency in Libya: A Longitudinal Analysis Using Education First Standard English Test

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Abstract
English proficiency has become increasingly important in non English speaking nations for professional, educational, and cultural development. However, there is a notable gap in the research on empirical trends in the development of English language proficiency in Libya. This study aims to conduct an overall assessment of English language proficiency levels in Libya and to forecast future trends by utilising time series analysis to predict English proficiency levels over the coming decade. The study used data from the Education First Standard English Test to measure English proficiency in Libya. Advanced statistical techniques were used to analyse time series to forecast future proficiency levels and assess current proficiency levels. The analysis revealed the intricate relationships among systemic, pedagogical, and socio cultural factors affecting English language acquisition in Libya. Time series projections proved useful for developing insights into potential trends in expected proficiency development. The study aims to identify gaps in knowledge of English proficiency in Libya by providing empirical evidence and projecting future trends. The findings of this study emphasise the need for longitudinal studies and interventions to improve English language learning in the country's specific socio cultural setting.

تحليل طولي للتنبؤ بمستويات إتقان اللغة الإنجليزية في ليبيا وفقاً لإختبار Education First Standard English Test

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الملخص
تزداد أهمية إتقان اللغة الإنجليزية في الدول التي لا تتحدثها كلغة أم، حيث يرتبط هذا الإتقان بشكل مباشر بالتقدم المهني والأكاديمي والانفتاح الثقافي. لكن الدراسات التجريبية التي تتناول تطور مستويات الكفاءة في اللغة الإنجليزية داخل ليبيا لا تزال محدودة. تسعى هذه الدراسة إلى تقييم مستويات الكفاءة اللغوية في ليبيا بشكل شامل، مع التنبؤ بالاتجاهات المستقبلية لهذه المستويات خلال العقد القادم باستخدام تحليل السلاسل الزمنية. اعتمدت الدراسة على بيانات مؤشر Education First Standard English Test للغة الإنجليزية لقياس مستويات الكفاءة اللغوية في ليبيا. استخدم الباحث أساليب إحصائية متقدمة لتحليل السلاسل الزمنية بغرض التنبؤ بالمستويات المستقبلية وتقييم الوضع الحالي. كشف التحليل عن التفاعلات المعقدة بين العوامل التعليمية و المنظومية والاجتماعية و الثقافية التي تؤثر في اكتساب اللغة الإنجليزية في السياق الليبي. أظهرت النماذج التنبؤية قدرتها على رصد الاتجاهات المحتملة لتطور الكفاءة اللغوية. تساهم هذه الدراسة في سد الفجوة المعرفية حول واقع الكفاءة في اللغة الإنجليزية في ليبيا من خلال تقديم أدلة تجريبية وتوقعات مستقبلية قائمة على البيانات. تشير النتائج إلى ضرورة إجراء دراسات طولية وتطبيق تدخلات مستهدفة لتطوير تعليم اللغة الإنجليزية بما يتناسب مع الخصوصية الاجتماعية و الثقافية للمجتمع الليبي.

الكلمات المفتاحية
كفاءة في اللغة الانجليزية، ليبيا، تحليل السلاسل الزمنية، اختبار اللغة الانجليزية **EF SET**، الدراسات الطولية.

I. INTRODUCTION

In many non English speaking countries, the importance of the English language is paramount, playing a critical role in professional, educational, and cultural spheres [1]. Within the healthcare sector, for instance, English is vital for the standardisation of protocols to access international research, which is essential for professional advancement [2]. Furthermore, it serves as a gateway to global learning resources, Consequently, expanding English proficiency facilitates effective international collaborations and enriches the overall academic experience [3].

Also, the English language plays a significant role in cultural exchange, thereby fostering cross cultural interactions [4]. As the global vanguard for scientific and

technical knowledge dissemination, English maintains a preeminent status in global research [5].

Our critical review of the literature presents a mixed picture, which at times is also quite contradictory in the study of English proficiency, particularly within the Libyan context and similar English as a foreign language settings. In the literature review, significant priority gaps and directions are observed, including the lack of long term and time series research in Libya, which is a notable gap. There is a dearth of in depth time series or longitudinal studies which track English proficiency trends specifically in Libya. Long term data is important for the study of language acquisition and intervention results in Libya's special socio cultural setting [6].

Although there is a large body of work on educational trends in the Libyan region, a significant gap remains in the field, Specifically, existing academic literature remains predominantly descriptive, focusing primarily on cross sectional assessments of current proficiency levels and immediate structural challenges. Also, a gap in the research on models that predict or report on the long term development of English in the country has been seen. This study presents a wide ranging examination of where we are now and what the future may hold for the English Language Proficiency (ELP) in Libya.

The research utilised data from the Education First Standard English Test (EF SET) [1] to analyse English proficiency in Libya, employing cutting edge methods. A time series analysis was conducted to project the Libyan English proficiency index over the next decade. The paper is organised into Five Sections. The literature review is represented in Section 2. Section 3 details the methodology, followed by the result, and the conclusion and future work drawn in Sections 4, and 5.

II. LITERATURE REVIEW

The trajectory of the ELP within modern institutional frameworks is shaped by a complex interplay of systemic, pedagogical, and socio cultural factors [7]. Rather than viewing these dimensions as isolated variables, human capital development theory requires a holistic synthesis that evaluates how institutional friction and instructional constraints compound over time to influence structural trends in national language outcomes [8]. In the context of Libya, historical literature documents substantial pedagogical stagnation [7], [9], yet it frequently fails to link these qualitative educational deficits with quantitative, predictive assessments of human capital trajectory [10], [11]. This review synthesizes prior research to build a coherent theoretical framework that addresses these gaps, justifying the shift from descriptive analysis to advanced state space predictive modelling [12], [13].

A. *Systemic and Pedagogical Friction: The Institutional Reality*

The overarching barrier to elevating linguistic capabilities in Libya stems from a persistent tension between theoretical the primary barrier to linguistic advancement lies in the misalignment between macro level policy and classroom realities. National policies indeed suggest using modern ways to communicate, but pedagogical delivery often defaults to teacher centric, grammar translation modalities [7]. Because of this difference between theory and practice, many studies show that there is a large gap between the official plans for Communicative Language Teaching (CLT), besides Task Based Language Teaching (TBLT), and how people teach in reality [7]-[9], [14-16].

These traditional frameworks often induce passive rote learning, which leads to less talking, lower interest in learning and a lack of skill in the language [7]-[9], [16]-[19]. If teachers use new digital tools like the flipped classroom, students are more involved, yet institutions suffer from acute infrastructural deficits [8],[9], [15], [17]-[21].

By looking at the structure of the system, it is clear that the lack of change is also because of how teachers are trained, but also how tests are made. For many teachers, the specific skills that are needed to teach students how to communicate are not present [9]. Although researchers say that teachers must learn from each other through regular mentoring and coaching to make teaching better, schools do not often use those methods [14], [16], [22], [23].

There is also a problem because public exams have a strong influence on what happens in class [15]. On the national tests, the focus is on remembering facts and naming parts of grammar instead of showing that a person can communicate [16]. To ensure students pass, teachers are encouraged to "teach to the test", and this situation makes students continue to learn without participating. It prevents them from speaking or writing easily in secondary schools and universities [14]-[16], [23]. Table I presents synthesis of systemic deficits and educational volatility.

TABLE I: SYNTHESIS OF SYSTEMIC DEFICITS AND EDUCATIONAL VOLATILITY

Core Institutional Dimension	Documented Structural Deficits in Literature	Resulting Impact on Time Series Data Lines
Curriculum & Pedagogy [7], [14]	Rigid grammar translation methods; failure to implement intended CLT and TBLT frameworks.	Creates a stagnant or downward baseline level (l_t) in long term proficiency scores.
Assessment & Policy [15], [16]	Heavy washback effects from public examinations favoring rote memorization over active use.	Induces artificial fluctuations and localized volatility (e_t) around exam cycles.
Professional Development [9], [14]	Lack of sustained, collaborative teacher training and modern mentoring infrastructures.	Inhibits positive trend growth (b_t), capping national proficiency momentum over time.

B. *Socio Cultural and Resource Constraints*

National English proficiency levels are intrinsically linked to socio cultural dynamics and resource constraints [20]. It is common for people to view English in two

[1]https://www.ef.com/wwen/epi/

different ways, they see the language as a necessary tool for success, counterbalanced by anxieties regarding cultural dilution [20]. As a result of this tension, students often do not participate in lessons that require them to lead their own learning, which creates a continuous problem for teachers who try to use methods based on conversation [17], [24]-[26].

By looking at the school environment, it is clear that a lack of physical materials creates many difficulties [18]. For most students, there are very few chances to hear or speak English in daily life outside of school, and this situation prevents them from using the language in a functional way [18]. Moreover, because there is not enough money for technology, schools cannot provide the digital programs or original documents that are necessary to keep students interested in their studies [10], [18], [19], [27], [28].

Because of this lack of resources, the misalignment between institutional output and macroeconomic demand is widening. When researchers look at this issue, they see that the skills of university graduates do not meet the standards for communication in current jobs [21]. Addressing this divergence requires a curricular shift towards functional communicative competencies and target driven speaking modules [15]-[17], [22].

C. *Theoretical Synthesis: Connecting Pedagogical Gaps to Econometric Modelling*

In this study the author shows that gaps in the implementation of the CLT and the TBLT [7] are not only problems in individual classrooms. To the contrary those factors are large institutional forces that change the statistical characteristics of data about language proficiency in Libya. When an educational system has policies that conflict [15], teachers who do not have enough training [9] and a lack of available resources [18], the resulting proficiency levels do not change in a straight or simple way. The failures in the system create a mix of long term patterns and high levels of local variation that are visible in data collected over time.

Because of this behaviour in the system, the choice of the method for analysis is necessary. Traditional ways to predict data, like linear regressions or moving averages, are based on the idea that educational factors change at a constant rate but this idea is not correct in environments where institutions are not stable. And standard autoregressive models are not suitable because they require data to be stationary and they remove important structural information. To solve those problems in analysis, this study uses Holt's Linear Trend (HLT) state space modelling. The HLT structure is designed to manage data that is not stationary using math to divide the signal into two parts [12]-[13].

D. *Critical Gaps in Extant Literature and Present Contribution*

Many researchers have explored language education in Libya through qualitative methods. However, a review of the structure of this literature shows multiple functional problems that make the information difficult to use for planning future strategies.

Researchers in previous studies used designs that covered only a short period. Because there is a lack of research that follows subjects over many years, it is not possible to measure how changes in policy or teaching methods affect students over a long duration. Prior research focuses on secondary schools in specific areas. In this way, researchers ignore primary schools and universities, this focus prevents a complete view of how skills in language grow or decrease as students move through different levels of education. The literature does not contain measurements that are based on standard tests. Authors use questionnaires about how people feel those documents show what individuals think rather than how well they can use a language according to a set standard. A gap exists between the problems people see in classrooms and the state of the economy. On that account, the nexus between academic output and local employment markets remains unexamined.

It is also important that the existing literature does not include models that use numbers to predict future trends over time. Although researchers have listed many qualitative problems, like a lack of resources, they have not connected those descriptions to predictions based on data.

This study provides information to fill the gaps in the research. By moving away from assessments based on opinions, this research creates a base of information using test scores collected over multiple years. To go beyond simple descriptions, this study uses a system of mathematical equations to show how the language skills of the population in Libya will likely change over the next ten years. On this basis, the method provides individuals who make policy with a tool to identify structural volatility and systemic friction, to measure progress and to change specific parts of the educational structure.

III. METHODOLOGY

In the long term, linguistic proficiency trajectories at a macro demographic scale are inherently shaped by longitudinal educational policies and structural shifts. To show and predict how the ELP in Libya will change over the next ten years, this study creates a strong system that uses advanced time series econometrics, but the study does not use traditional linear structural models due to their structural inability to accommodate non linear parameter shifts and heteroscedastic variance within the series. This methodology uses an optimised state space smoothing architecture. Moreover, it uses non parametric uncertainty quantification so that the forecasts are stable.

A. *Data Source and Proxy Validity*

In this research the researcher uses a measurement that was taken from the EF SET database. It is the average annual score for the EPI in Libya between the years 2011 and 2025. Table II presents examples of what tasks people may perform at each proficiency level and the score range for each.

TABLE II: EF SET PROFICIENCY BANDS AND COMPETENCY BENCHMARKS

Band (EF SET Score)	Competency Benchmarks and Functional Tasks
Very high proficiency (600+)	Use nuanced and appropriate language in social situations Read advanced texts with ease Negotiate a contract with a native English speaker
High proficiency (550 - 599)	Make a presentation at work Understand TV shows Read a newspaper
Moderate proficiency (500 - 549)	Participate in meetings in one's area of expertise Understand song lyrics Write professional emails on familiar subjects
Low proficiency (450 - 499)	Navigate an English speaking country as a tourist Engage in small talk with colleagues Understand simple emails from colleagues
Very low proficiency (< 450)	Introduce oneself simply (name, age, country of origin) Understand simple signs Give basic directions to a foreign visitor

Historically, the assessment mechanism concentrated predominantly on standardised reading and listening matrices to maximise broad scale scoring efficiency. However, a critical structural integration in 2025 expanded the assessment engine to encompass explicit writing and speaking metrics, establishing a holistic communicative baseline.

B. *Methodological Limitations: Self Selection and Sampling Bias*

It is crucial to ground the generalizability of these findings within the structural limitations of the underlying data source. The education first dataset is the result of a method where individuals choose to participate in an online assessment, this non probability sampling approach is a form of data collection that depends on volunteers. Because participants decide for themselves to take the test, the information contains a bias that is part of this selection method. The demographic segment participating in these online assessments is fundamentally unrepresentative of the socio economically diverse Libyan population. The sampled demographic exhibits an over representation of cohorts characterised by stable digital connectivity and high institutional literacy. Moreover, they often have clear reasons to get certificates for their language skills because of their studies or jobs. As an example, many of the people are students at universities, researchers who are starting their careers, and professionals targeting multinational labour markets, whereas lower socio economic strata remain under represented. If people are in older age groups, they are also not present in large numbers. Due to poor internet connections in areas away from cities, individuals from those locations are also rare in this sample.

Consequently, the baseline and projected EPI scores must be interpreted not as a universal national demographic census, but strictly as a *Standardised Proxy for Digitally Accessible Academic and Professional Cohorts in Libya*, the data is still an important tool for research, even if the information does not show specific details about the age or gender of the people. If Libya does not have a central system to test English skills on a regular basis, researchers must use this information. In this context, the dataset is the largest and most consistent set of numbers that individuals can use for study over a long period. For those who do research on education at a large scale, those numbers are the most standard evidence that exists. Table III presents observed historical Libyan EF EPI scores from 2011 to 2025.

TABLE III: OBSERVED HISTORICAL LIBYAN EF EPI SCORES (2011–2025)

Year	Libyan EPI Average Score
2011	385
2012	398
2013	418
2014	369
2015	360
2016	359
2017	367
2018	377
2019	388
2020	385
2021	390
2022	390
2023	392
2024	405
2025	395

C. *Data Pre-Processing and Diagnostic Assessment*

The dataset used for forecasting and time series analysis is comparatively small, as shown in Table III. The pre-processing operations encompassed handling missing values, detecting outliers, assessing stationarity, and selecting appropriate models. The data in Table III indicate missing values in years 2011 and 2020; however, by using Tukey's fences method, no outlier values are present. Missing observations were resolved by applying mean imputation based on adjacent temporal vectors.

Although the Augmented Dickey Fuller Test (ADF) test can be utilised to evaluate stationarity, its reliability may be compromised due to the limited size of the dataset. Similarly, tests such as the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PCF) also lack reliability for selecting time series algorithms owing to the restricted dataset size. Consequently, this limitation necessitates the adoption of simpler time series algorithms, which are essential for effective forecasting.

D. *Predictive Modelling: HLT*

The historical EPI trajectory exhibits substantial non linear variations and non stationarity. The historical sequence is marked by distinct structural breaks and localized volatility transitions between 2014 and 2016. Traditional algorithms to predict future numbers, like Autoregressive and Moving Average methods, require the average and the spread of data to stay the same over time but the actual data from Libya shows that those values do not stay the same. Similarly, the Autoregressive Integrated Moving Average method makes data more stable by subtracting past values from current ones. Applying mathematical differencing to a restricted time series

heavily attenuates the underlying signal to noise ratio. Moreover, because models based on historical lags lead to overfitting, this limitation induces predictive instability.

To mitigate these limitations, this study uses the HLT model, which is also called Double Exponential Smoothing, inside a state space structure. By using this method, the researcher find the basic pattern separating the data into a Level (α) and a Trend (β). As this process does not use differencing, it keeps all the important information in the series. Due to the way the model is built, three main equations control how it functions:

$$\hat{y}_{t+h/t} = l_t + hb_t \quad (1)$$

$$l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1}) \quad (2)$$

$$b_t = \beta(l_t - l_{t-1}) + (1 - \beta)b_{t-1} \quad (3)$$

Where:

- Equation (1) is used for forecasting, while Equations (2) and (3) dynamically update the level and trend components, respectively.
- y_t denotes the empirical EF EPI score observed at year t.
- $\hat{y}_{t+h/t}$ represents the projected forecast for an h step ahead temporal horizon.
- l_t signifies the smoothed level of the time series at time t.
- b_{t-1} isolates the linear trend (slope) component at time t.
- α and β represent the smoothing coefficients restricted to the domain [0, 1], controlling the update rates for the level and trend, respectively.

E. Model Validation: Rolling Origin Cross Validation

In this study, the researcher use a dynamic rolling origin cross validation strategy that follows an expanding window framework. It is necessary to use this method to confirm that results are valid and to avoid situations where the model fits the training data too closely. To begin the process, the researcher uses data from the eight years between 2011 and 2018 as the first training anchor. As the process continues, the model is tested across seven sequential temporal folds from 2019 to 2025. By using a 1 step ahead execution scheme, the model is able to incorporate new empirical observations into its information set as time moves forward.

There are two primary metrics used to measure how accurately the model performs, which are the Root Mean Square Error (RMSE) and the Mean Absolute Percentage Error (MAPE).

F. Uncertainty Quantification: Residual Bootstrapping

In light of the limited sample size and the inherent socio political volatility that characterises the Libyan setting, the theoretical validity of such a Gaussian based confidence interval with standard deviation as a measure of spread might be limited. To obtain a more robust estimate of uncertainty, this study has employed the Residual Bootstrapping approach.

In this approach, residuals $e_t = y_t - \hat{y}_t$ from the final model are used to form an empirical error pool. Subsequently, 1,000 Monte Carlo simulations are carried out by drawing randomly from the error pool with replacement as in (4).

$$y_{t+h/t} = \hat{y}_{t+h} + e_{sampled} \quad (4)$$

This non parametric method allows for the computation of a probabilistic 95% confidence interval that reflects the true volatility profile of Libya's EPI scores rather than an idealised normal distribution.

G. Diagnostic Analysis

A residual diagnostic assessment was done to ensure the statistical soundness of the forecasting framework. “Fig. 1” shows the Residual Stem Plot, which provides primary evidence that the model effectively split the data into a predictable “signal” and a “noise” component.

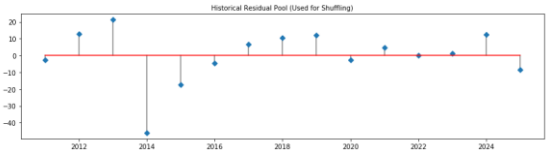

Figure 1. Visual Diagnostic of Historical Residuals for the Model

To facilitate strategic planning and policy assessment, the results of the residual bootstrapping simulations are categorised into three distinct scenarios. These scenarios represent the probabilistic distribution of potential outcomes for Libya's English proficiency through 2036:

- **Baseline Scenario:** This represents the median forecast generated by the Holt Winters model. It assumes that the current momentum in English language acquisition and educational policy remains consistent with the average historical trajectory observed since 2011.
- **Optimistic Scenario:** This path represents the upper bound of the 95% confidence interval. It simulates a future where "positive shocks" such as accelerated digital transformation, educational reform, or increased international integration match the most successful growth periods in the historical dataset.
- **Pessimistic Scenario:** This path represents the lower bound of the confidence interval. It accounts for potential "negative shocks" (e.g., socio political instability or resource constraints) by sampling from the largest negative residuals in the historical pool.

IV. RESULTS

The structural validity and forecasting precision of the developed model were extensively validated. The applicability and generalisation potential of the forecasting model are demonstrated by its validation using an “Rolling Origin Cross Validation”, the historical data from 2011 to 2018 establish the initial training anchor, followed by sequential testing across seven temporal folds from 2019 to 2025. By using a 1 step ahead execution scheme, the model is able to incorporate new empirical observations into its information set as time moves forward.

The two primary error metrics quantified the statistical precision of the forecasting model, the MAPE, which was

calculated to be 1.84%, signifying "excellent" relative accuracy by the standards of the existing economic research, and the RMSE, calculated to be 9.14, signifying "low" variance and therefore establishing the stability of the forecasting model, since the RMSE is an error quantifier for contexts where larger values signify increased variance. The parameter optimisation process via Maximum Likelihood Estimation (MLE) yielded a level smoothing ($\propto$) coefficient of 0.8320 and a trend smoothing coefficient (β) of 0.0000.

Table IV and "Fig. 2" present the projected trajectory for 2026–2036 under three scenarios (baseline, optimistic, and pessimistic).

TABLE IV: PROBABILISTIC FORECAST OF THE EPI FOR LIBYA (2026-2036)

Year	Pessimistic	Baseline	Optimistic
2026	364.90	397.15	429.41
2027	365.60	397.86	430.12
2028	366.31	398.57	430.83
2029	367.02	399.28	431.54
2030	367.73	399.99	432.24
2031	368.44	400.69	432.95
2032	369.14	401.40	433.66
2033	369.85	402.11	434.37
2034	370.56	402.82	435.08
2035	371.27	403.53	435.78
2036	371.98	404.23	436.49

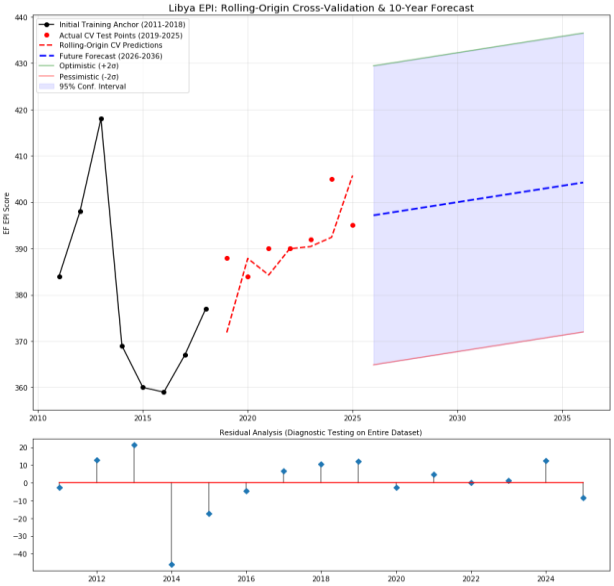

Figure 2. Longitudinal Analysis of Libya EPI Scores: Historical Performance and Bootstrapped Projections (2011-2036)

Because socio political disruptions in Libya introduce deep non linearities, executing a deterministic point forecast ceases to be a viable methodological option, the future trajectory must instead be framed through a probabilistic continuum of expectations. Taking the year 2026 as a case in point, empirical realities are expected to fluctuate between a pessimistic floor of 364.90 and an optimistic ceiling of 429.41. Rather than viewing these boundaries as isolated extremes, any numeric realisation within this corridor represents a valid statistical expectation, validating our deployment of uncertainty quantification to chart a highly unstable educational ecosystem.

From a methodological perspective, the forecast projects an absolute parallel improvement of exactly 6.53 EPI points across all three scenarios from 2026 to 2036. This near identical absolute progression across the pessimistic, baseline, and optimistic trajectories is a direct mathematical consequence of the MLE optimisation, which constrained the trend smoothing parameter ($\boldsymbol{\beta}$) to 0.0000. In Holt's state space formulation, when $\boldsymbol{\beta} = \mathbf{0}$, the trend component remains fixed, meaning that the long term growth trajectory is governed exclusively by the historical deterministic (α) drift rather than updating dynamically with short term innovations. Consequently, the conditional variance remains stable, and the probabilistic corridors reflect a constant interval width derived from the residual standard deviation ($\boldsymbol{\alpha}$). Methodologically, forcing ($\boldsymbol{\beta}$) to zero prevents exponential or explosive divergence over a ten year out of sample horizon, providing a realistic representation of a rigid educational ecosystem where long term momentum is heavily restricted by structural inertia.

The statistical baseline forecast exhibiting a marginal, near flat linear growth increment (approximately 0.71 points annually) indicates profound pedagogical realities that have been documented in the literature. Historically, the empirical dataset captures significant fluctuations, notably a minor peak in 2013 followed by a sharp decline in 2014. The 2013 peak indicates a brief positive deviation from the mean, capturing localized parameter variance, before a sharp decline in 2014. On the contrary, the 2014 decline represents a profound structural break within the time series trajectory. This structural break induced an abrupt shift in the historical baseline level, which significantly attenuated the trend smoothing momentum, restricting the capacity of the model to dynamically update from short term innovations. Viewed through the lens of human capital development theory, this stagnant baseline trajectory is a structural consequence of rigid grammar translation methods and a failure to implement the CLT frameworks [7], [14]. Because teaching practices focus on memorization rather than active communication, linguistic human capital acquisition is restricted, holding the national average within the "Low Proficiency" band.

Crucially, it must be explicitly acknowledged that from an educational standpoint, the projected improvements across all three scenarios remain confined within the EF SET 'Very Low Proficiency' band (scores below 450). Because scores ranging from 350 to 436 all fall within this single proficiency category, the projected numerical gains do not translate into a shift to a higher functional milestone. This underscores that while the model captures statistically significant relative movements, the real world educational impact remains non significant demonstrating that minor programmatic adjustments are insufficient to drive meaningful functional improvements.

The substantial corridor between the optimistic scenario (436.51 points by 2036) and the pessimistic scenario (371.99 points by 2036) illustrates the high stakes of strategic intervention. The optimistic threshold demonstrates that if targeted structural reforms are executed such as upskilling teacher pedagogical content knowledge and reforming examination structures to

minimize negative washback effects [9], [15] the national trajectory can achieve substantial momentum. The optimistic threshold demonstrates that if targeted structural reforms are executed, the national trajectory can achieve substantial momentum. Conversely, the pessimistic pathway represents the lower probabilistic boundary, assuming that underlying structural constraints remain unaddressed.

The analytical verification of the diagnostic testing on the residual series ($e_t = y_t - \hat{y_t}$) further establishes the mathematical validity of the developed forecasting framework. The calculated residual standard deviation ($\alpha = 16.25$) demonstrates that the variance is tightly bounded. The empirical distribution of the error terms, as visually substantiated in the lower panel of "Fig. 2," indicates that the residuals operate as an Independent, Identically Distributed ($i.i.d.$) sequence with a mean tracking zero. This verification confirms that the state space equations have successfully extracted the structural trend components, leaving only irreducible white noise.

To change the projected path of the ELP in Libya and move towards the optimistic scenario, specific structural and systemic changes are required.

Primarily, structural reform requires the institutionalisation of sustained professional development initiatives focus on modern pedagogical strategies, the CLT, and the TBLT. Providing continuous support and mentorship to instructors, both locally and through partnerships with international institutions or training programs abroad, will ensure that instructors are well equipped with contemporary pedagogical methodologies and proficient assessment techniques.

Concurrently, aligning national curricula with international benchmarks, such as the Common European Framework of Reference for Languages, is essential. The curriculum should prioritise practical communicative competencies rather than solely focusing on grammatical structures. Additionally, guaranteeing that educational institutions possess access to standardised instructional materials is necessary to support baseline pedagogical delivery.

Integrating digital infrastructure can also optimise resource accessibility, particularly in underserved regions, can be an invaluable asset for learners. Online educational courses, language acquisition applications, and interactive digital platforms have the potential to augment the educational process significantly. Expanding informal exposure via caption supported multi media channels can further supplement formal instructional frameworks.

Lastly, establishing or reinforcing community based language centres that provide affordable English language classes and resources for all age groups can help reach a broader audience and foster a language learning culture.

V. CONCLUSION AND FUTURE WORK

In this paper, a mathematical system to measure and predict EPI in Libya over ten years from 2026 to 2036 is developed. By using the HLT model in a state space form and adding non parametric residual bootstrapping, the analytical architecture successfully isolates the underlying deterministic drift of the national educational ecosystem from confounding institutional shocks, yielding a MAPE of 1.84% and an RMSE of 9.14. These constrained error metrics establish the stability of the long term forecast. For these reasons, the findings are reliable for macro level educational policy planning.

When the structural optimisation of the model occurs, the result is a trend smoothing coefficient (β) of 0.0000, this numerical limit shows that the long term ELP momentum in Libya is fixed by historical institutional practices. It does not change when short term programs are introduced. As a result, the baseline model predicts a small linear growth increase of approximately 0.71 points every year. To reach a national score of 404.23 by the year 2036, the model follows this steady path. By looking at the probabilistic forecasting corridor, one sees that the lowest score is 364.90 and the highest score is 436.49. All those values are located inside the 'Very Low Proficiency' category of the EF SET metrics. This finding is significant because it describes how the projected increases are measurable in numbers, but their practical educational utility is functionally non existent. Superficial administrative adjustments remain insufficient to transition the national student body out of this long term state of limited progress.

Historical anomalies within the time series confirm that structural breaks significantly alter the trajectory of national proficiency scores. For a short time in 2013, data reached a high point, indicating a brief positive variance deviation, followed by an abrupt structural break in 2014, signaling severe systemic dislocation across the data stream. When the researcher uses the theory of human capital development to explain the situation, it is found that the if there is no long term plan to update English teaching methods used in Libya and structural pedagogical updates, the national index will remain stagnant, necessitating comprehensive macro level educational policy reforms.

Despite the rigours application of econometric modelling, the empirical findings of this study must be evaluated within the context of several inherent limitations. A primary limitation of this study is the finite historical horizon, consisting of fifteen annual data points extracted from EF SET records starting in 2011. Because of this short amount of time, the statistical strength is low, and the time series models or forecasting architectures lack mathematical flexibility. As data is scarce, it is necessary for future studies to use datasets that are larger and occur at higher frequencies. With stricter ways of sampling, researchers can produce more definitive statistical indicators of national English proficiency.

In the current model, the projections are limited because they depend on how Libyan test takers performed on one examination platform in the past. As the EF SET is a standardised metric that is cross referenced internationally, it is useful for assessing national language levels, yet relying on a singular metric omits exogenous socio institutional covariates that influence language acquisition in transitioning contexts.

The empirical boundaries and structural insights established in this study define several critical paths for subsequent academic inquiry. To mitigate self selection and sampling biases inherent in digitally sourced voluntary data, subsequent research should deploy stratified probability sampling frameworks across diverse socioeconomic strata. This approach will capture under represented cohorts, specifically rural populations and older demographic brackets, currently absent from voluntary online metrics.

Additionally, future efforts should initiate longitudinal experimental studies to quantify the transition from grammar translation models to the CLT frameworks.

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