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The Impact of Automated Online Vehicle Registration System on Vehicle Documentation and Tax Compliance in Taraba State of Nigeria: A Five-Year Trends Analysis, Interpretations and Predictions

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ABSTRACT

This article investigates the transformative effects of an automated online vehicle registration system in Taraba State, Nigeria, over a five-year period. The study comprehensively analyzes tax-compliance trends following the introduction of the automated processes, which have streamlined registration procedures, enhanced documentation accuracy, facilitated data collection, and influenced tax compliance among vehicle owners. Utilizing a machine learning approach, the research aims to provide insights into the long-term implications of technological interventions in tax compliance within the unique context of Taraba State. The findings contribute to the broader discourse on the intersection of technology, socio-economic factors, governance, and fiscal policies, offering policymakers and stakeholders an insightful understanding of revenue generation in Taraba State. Specifically, the study highlights the sustained influence of automated systems on administrative efficiency and revenue generation, providing perspectives for optimizing policies and leveraging technology to enhance compliance and fiscal management.

1. Introduction

The application of information technology to streamline tax collection processes in various states across Nigeria is not a recent development. Research conducted by Nwamgbebu, Oketa, Odom, Nwambe, and Nweke–Charles (2019) has affirmed that the automation of tax collection in Nigeria represents a superior alternative to the conventional manual methods, primarily due to its significant advantage in preventing revenue leakages. Olatunji and Ayodele (2017) also explained that the adoption of information technology for tax collection portrays efficiency in tax planning, implementation and ease of collation.

According to Gylych, Ahmad Jibrin, Celik, and Isik (2022), the significant decline in recent years' oil prices has led to a noteworthy decrease in the financial resources allocated to the Three Tiers of Government (Federal, State, and Local governments of Nigeria) by the Federation Account Allocation Committee (FAAC). A 2021 report from This Day Live (2021) Newspaper, highlighted that, in response to diminishing Federal allocations, State Governments are prioritizing the enhancement of their Internally Generated Revenue (IGR) as an auxiliary source. Notably, taxes from vehicle registration, renewals and documentation under road taxes emerge as a crucial revenue stream within Taraba state's tax framework (Taraba State Government, n.d.).

1.1 The Intersection of vehicle documentation and tax compliance

Vehicle documentation or registration serves as a mechanism for states within Nigeria to generate internal revenue. This revenue is collected through the issuance of licensed documents to vehicle owners, each of which incurs a specified tax amount. According to legal requirements, a vehicle must possess specific documents, the nature and number of which depend on factors such as type, model, category, and usage of

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the vehicle. These essential documents encompass vehicle licenses, roadworthiness certificates, hackney permits (applicable to load-carrying and commercial vehicles), number plates, stickers, conductors' and drivers' badges for commercial vehicles, learners' permits, change of ownership certificates, and proof of ownership certificates (Gana and Emmanuel, 2014). It is obligatory for vehicle owners to renew these documents annually in any given state within Nigeria before their expiration.

To ensure compliance with tax regulations related to vehicle documentation, various government enforcement agencies (Gbadamosi and Adenigbo, 2017), including the Vehicle Inspection Officers (VIO), Federal Road Safety Corps (FRSC), and the Nigeria Police Force, are in place. These agencies play a crucial role in enforcing tax compliance. The correlation between the volume of vehicles traversing or operating within a state and the potential revenue generated is evident, as the issuance of these documents to vehicle owners becomes a significant source of income for the state.

Vehicle documentation and tax compliance is vital to increasing internally generated revenue for any state in Nigeria (Hermawan *et al*., 2022). Hence, in 2018 the Taraba state government opted for an automated online vehicle registration and renewal process known as the Electronic Vehicle Registration System (EVReg) to harness the potential of Information Technology is making this process seamless (Taraba State Government, n.d.). Arman (2021) highlighted that the benefits of having an automated online vehicle registration and documentation systems are to plug revenue leakages inherent in the subsisting manual vehicle documentation, reduce staff costs, sanitize vehicle documentation process, build a comprehensive data of vehicles within the state for the purpose of planning or addressing certain security matters, and increasing the level of tax compliance through real-time service delivery.

2. Over Five Years of the Automation Process

Utilizing information technology to automate processes is often markedly more effective and efficient than relying on manual methods, assuming that the automated system is implemented and utilized effectively. The Taraba state Electronic Vehicle Registration (EVReg) system, designed for automating tasks related to vehicle documentation, tax collection, and collation, exemplifies this improvement. The implementation of this automated system has notably elevated the state's Internal Generated Revenue (IGR) compared to the previous manual processes. This prompts the question: What insights can the accumulated experience of over five years with the automated process provide us?

Conducted as an exploratory study, this study demands a comprehensive examination of various parameters. Elements spanning political, economic, social, technological, legal, and environmental dimensions, as encapsulated in a PESTLE analysis, exert potential influence over automated online systems. The primary aim of this research is to clarify the consequences of behavioural patterns demonstrated by vehicle owners within Taraba state in relation to tax compliance pertaining to vehicle registrations and renewals. Drawing on insights from Borella, De Nardi, Pak, Russo, and Yang (2023), the study emphasizes the importance of longitudinally modelling taxes to deepen the understanding of tax compliance within the evolving landscape of system reforms and policies.

3. Related Works

No previous research specifically investigates the influence of automated vehicle documentation and taxation compliance in Taraba state. Nevertheless, existing studies related to the automation of government taxation services share relevance with the focus of this research. The work conducted by Engin and Treleaven (2019) promotes the utilization of information technology to create automated data science systems, aiming to support civil servants and revolutionize public services on behalf of the government. Moreover, according to Chatama (2013) in his research, it was demonstrated that the adoption of Information Communication Technology (ICT) applications in tax administration significantly heightened and enhanced the overall tax collection for the Tanzania Revenue Authority. This improvement was attributed, in part, to additional socio-economic policies implemented by the government.

Various models for automating Motor Vehicle Administration (MVA) tasks, including the implementation of electronic vehicle registration systems, are gaining traction across multiple states in Nigeria (Okeke and Ezenwegbu, 2018). Research by Adisa and Eludiora (2021) has demonstrated the potential for enhancing the automation of vehicle registration and taxation. This involves incorporating biometric features to link vehicle owners' fingerprints with the Vehicle Identification Number (VIN), thereby enhancing vehicle licensing processes and enhancing security measures. Limitations of the manual vehicle registration process and the

clear need for the use of computer applications in Calabar Cross River state of Nigeria, was exposed by Atianashie Miracle (2023) research. A study conducted by Hossain, Khaled, Saju, Roy, Biswas, and Rahaman (2020) aimed to enhance the administration of motor vehicle licensing and documentation in Bangladesh by implementing a Blockchain-based Distributed Ledger system. The research demonstrated the potential for significantly increased effectiveness in government supervision of vehicle licensing and concurrently enhancing user experience through heightened transparency.

Existing research predominantly centres around the implementation of new motor vehicle registration and documentation models, often relying on information technology-driven applications to streamline and replace less secured or manual processes. While some studies emphasize on the non-functional requirements of the system, like security in these systems, others, exemplified by the work of (Hossain *et al*., 2020), delve into cutting-edge solutions such as integrating blockchain technology to enhance tax compliance through increased transparency.

In contrast, our study takes an intricate approach by not solely focusing on the software application model deployed for automating vehicle registration and documentation. Instead, we turn our attention to the EVReg application system already operational in Taraba state since April 2018, as documented in (Taraba State Government, n.d.). This system replaced the traditional manual methods, and our research extends beyond examining the application model itself. We leverage the wealth of data accumulated over the past five years of the implemented system to scrutinize its impact. Specifically, we aim to uncover patterns and identify factors influencing the revenue generated in the region through this system. This unique angle allows us to contribute valuable insights to the broader understanding of the effectiveness of automated vehicle registration and documentation processes.

4. Methodology

The study conducts an explanatory and trends analysis of empirical data to address the research question: How has the implementation of the automated online vehicle registration system impacted tax compliance and growth in Taraba State's IGR over the past five years from 2018 to 2022.? Additionally, the study examined the influence of policies and socio-economic activities on revenue generation from the vehicle registration and licensing process in the state.

Data for this investigation were sourced directly from monthly reports generated by the EVReg system implemented and documented by the Board or Internal Revenue of Taraba State. The compiled reports provide a detailed breakdown of monthly revenue generated, and vehicle data for the state. It is essential to note that the data used in this analysis encompassed two primary activities: motor vehicle registration and motor vehicle renewal.

Taraba state has sixteen local government areas (Taraba State Government, n.d.) and thirteen motor vehicle registration centres spread across the state from which the data collections by the application and Motor Licencing Officers (MLAs) of the Board of Internal Revenue (BIR) is done.

Furthermore, the data collected for this study are only for Motor-Vehicles, this comprises of Trucks, Lorries, Tankers, Tractors, Buses, Pickups, Vans, and Saloons. On the other hand, the category of Motorcycles which comprises of Motorcycles, Tricycles, or any vehicle with a mechanical engine and fewer than four tyres are not considered for this study.

4.1 Machine learning techniques: descriptive statistics and interpretations

Exploring the annual fluctuations in the number of registered vehicles spanning over the six years period from the inception and adaption of the Automated Online Vehicle Registration Systems (EVReg) for registering motor vehicles in Taraba state. Figure 4.1.1. shows the total number of registered motor vehicles in the state for each year after full adaption from 2019, we can see a steady peak level of compliance with the EVReg system.

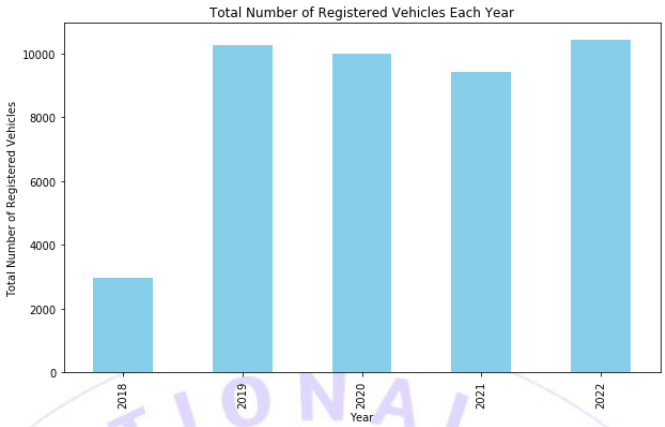

Figure 4.1.1: Number of Registered Motor-Vehicles for each year from 2018 to 2022.

There is a noticeable increase in the total number of registered vehicles from 2018 to 2022. The year 2022 has the highest total registrations, suggesting a potential peak in vehicle registrations during that year. This indicates an overall upward trend in vehicle registrations over the analysed period.
Interpreting the yearly bar chart in Figure 4.1.1. We can use relevant elements of the PESTLE analysis to assess the reasons for the variations in the total number of registered vehicles for each year.

2018: The EVReg system was adapted and integrated from the month of April. It was a government policy to use ICT to bust IGR for the state's economic benefit (TVC News, 2018). The technology was innovative and started to attract more motorist into tax compliance thereby steadily increasing throughout the year. The significant increase from August to December, reaching the highest point in December with 814 registered vehicles shows that during the harvest of farm produce to the festive periods of the end of the year. People tend to buy cars and renew motor vehicle documents for traveling across the country.

2019: The year started with 644 registered vehicles in January, and there was a general upward trend, reaching the peak in December with 1171 registered vehicles. This is due to more awareness by motorist, as the system has proven to be reliable and efficient.

2020: The beginning of the year saw a decline in registrations due to the treat of the COVID 19 outbreak and resulting lockdowns in the state (Aluor, 2020). The substantial increase from April to August was as of a result from the ease of the lockdown. The peak was reached in December with 1083 registered vehicles.

2021: The number of registrations in January 2021 was 910, and the registrations fluctuated throughout the year. There was another peak in August (the sales and harvest of farm produce begins) with 1192 registered vehicles.

2022: The year started with 936 registered vehicles in January, and there was a fluctuating pattern throughout the year. The peak was reached in December with 1145 registered vehicles. However, it saw the highest number of tax compliance and vehicle registration from inception based on Figure 4.1.1.

4.2 Monthly variation and time series analysis

The line chart in Figure 4.2.1. shows the monthly variation in the number of registered vehicles over the entire period of five years, starting from inception in the year 2018 to the year 2022. The points on the line represent the registered vehicles for each month which shows some fluctuations, with varying levels of registrations each month.

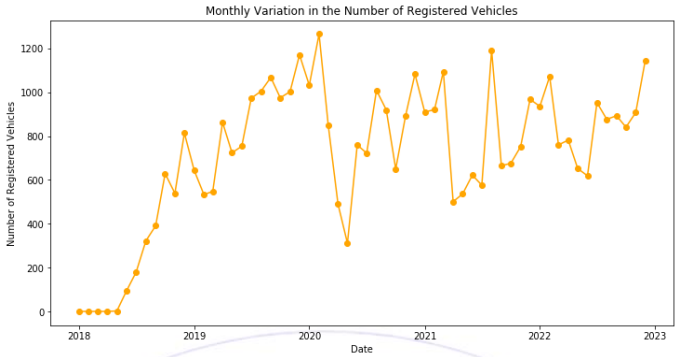

Figure 4.2.1: Monthly variation in the number of registered vehicles for each year from 2018 to 2022.

Some months exhibit exceptionally higher registration numbers, contributing to the overall trend. The seasonality in the number of registered vehicles with certain months consistently showing higher or lower registration numbers. These outliers are influenced by factors we intend to consider in this study.

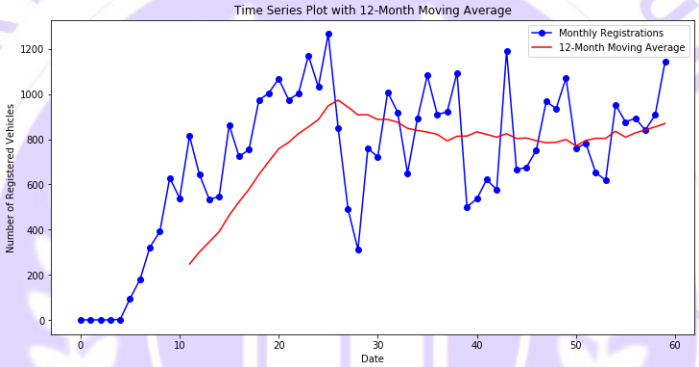

Figure 4.2.2: Time Series Plot and Moving Average of number of registered vehicles.

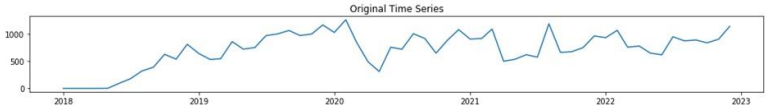

Figure 4.2.3: Original Time-Series of registered vehicles.

The time series plot in Figure 4.2.2. shows the monthly variation in the number of registered vehicles over the entire period of five years. An overall increasing trend with some fluctuations, especially in the latter part of the time series is present.

The red line represents the 12-month moving average, which smoothens out short-term fluctuations and highlights long-term trends. The increasing trend is more evident in the moving average plot. From around mid-2019, there is a noticeable upward trend in the number of registered vehicles, reaching a peak around mid-2022. This suggests a positive upward growth pattern in tax-compliances and vehicle registrations in Taraba state over the years. These observations indicate a general acceptance of the automated system in Taraba state. The moving average helped in identify the underlying trend by removing noise from the data.

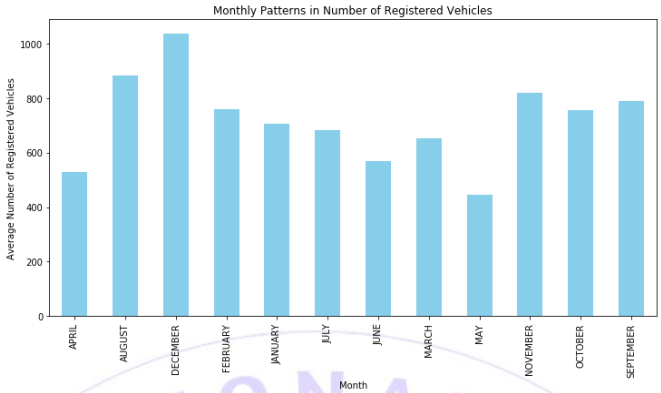

Figure 4.2.4: Monthly patterns in number of registered vehicles.

Figure 4.2.4. above, code calculates the average number of registered vehicles for each month and then creates a bar chart to visualize the monthly patterns.

4.2.1 Interpretation of the results

1. December has the highest average number of registered vehicles (1036.2). This is due to various factors, such as year-end holidays (Christmas and New year celebrations), weddings and reunions with family members. All these are part of a tradition in Nigeria (Ogunfeitimi and Adebajo, 2023).

2. August also shows a high average (854.67), indicating increased registrations during the farm produce harvest months in Taraba state. Especially Yam tubers. This could also be influenced by factors like weddings and travel plans.

3. November follows with an average of 820.17 registered vehicles. This might be influenced by end-of-year celebrations as the month of December by early planners, leading to higher vehicle registrations.

4. September has a relatively high average (786.67), possibly reflecting the end of the third quarter and potential incentives for vehicle purchases.

5. January, February, and March show decent averages, which could be attributed to the start of the year and potential promotions or incentives during this period.

6. May, June, and April have lower averages compared to other months, suggesting a potential dip in registrations during these months. A major factor contributing to this low growth in vehicle registration is the start of the faming season. Most people invest in farming, from seeds, fertilisers, herbicides, weeding etc. which is very costly (Sanchi *et al*., 2022).

These interpretations provide insights into the monthly variations in vehicle registrations, helping us understand patterns and potential influencing factors.

Trend Component:

The time series plot as described in Figure 4.2.3 has already shown that there will be an ever-growing tax compliance with regards to increasing numbers of vehicle registrations in Taraba state. The trend component represents the long-term movement or direction in this data. In this case, the trend shows an increasing pattern, starting from around 95 in July 2018 and gradually rising to 1068 in September 2019. This indicates a general upward trend in the number of registered vehicles during this period. However, there was a steady and slow fall of less than 5% from 975 in October 2019 to 936 in January 2022. This indicates a steady number of registrations with some slower months. There was a steady pickup rise from 1072 in February 2022 to 1145 in December 2022.

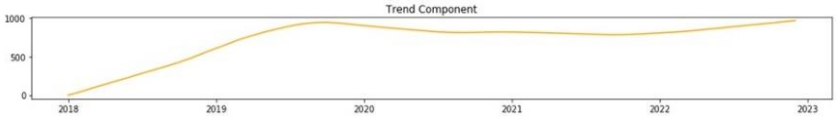

Figure 4.2.5: Trend Component of registered vehicles

Seasonal Component:

The seasonal component represents the repeating pattern within a specific time frame. The seasonal component values are relatively small compared to the trend and represent the regular fluctuations in registrations. Positive values indicate a contribution to the trend, while negative values indicate a decrease. In almost every December from 2018 to 2021, there is a positive contribution to the trend, suggesting an increase in registrations during that specific month with the exception of 2022 which had the highest increase in January instead.

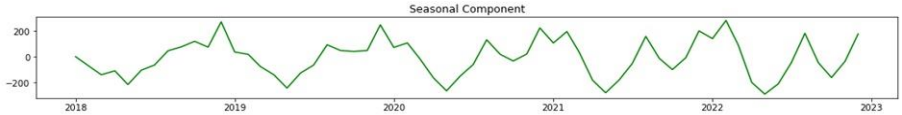

Figure 4.2.6: Seasonal Component of registered vehicles

Residual Component:

The residual component represents the random or irregular fluctuations in the data that are not explained by the trend or seasonality. These values are the differences between the observed values and the sum of the trend and seasonal components. Positive values indicate overestimation, while negative values indicate underestimation of the trend and seasonality. We can see that in August 2018, the observed registrations were lower than expected based on the trend and seasonality, resulting in a negative residual value (-137.78). Overall, the decomposition provides insights into the underlying patterns in the data, allowing us to understand the long-term trend, regular seasonal variations, and random fluctuations.

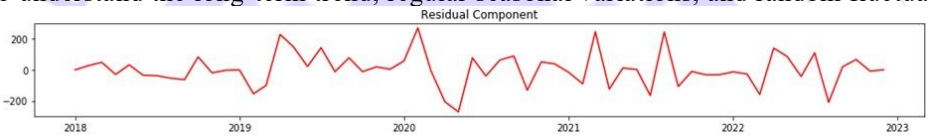

Figure 4.2.7: Residual Component of registered vehicles

4.2.2 Descriptive statistics comparison of the 5 years automated system with the 3 years manual system

The Dataset for the number of motor vehicles registered and renewed in Taraba state during the manual process in the year 2015, 2016 and 2017 could not be obtained due to poor record keeping. However, we could still make a comparison with the revenue amount generated for Vehicle Licences overall for each month of these years with those of the years and months of automation.

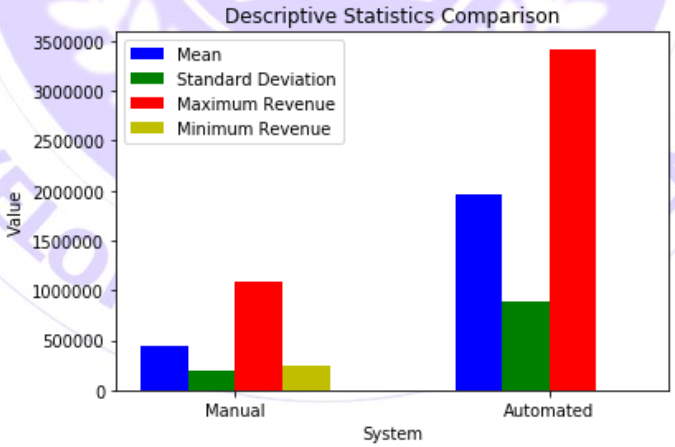

Figure 4.2.8: Descriptive Statistics Comparison of the Manual and Automated System

The data was obtained from the Board of Internal Revenue Taraba state and based on the comparison of revenue collected from Vehicle Licence (VL) documentation and collections between the manual operation years and automated systems operating years as described in Figure 4.2.8. we can see the following analysis;

The Mean Comparison: The mean revenue generated by the automated system (approximately ₦1,966,396) is significantly higher than that of the manual system (approximately ₦442,284). This suggests that the automated system is more efficient in generating revenue compared to the manual system.

Standard Deviation Comparison: The standard deviation of revenue generated by the automated system (approximately ₦889,918) is substantially higher than that of the manual system (approximately ₦192,010). This indicates that the revenue generated by the automated system has higher volatility or variability compared to the manual system, which may imply higher risk but also potentially higher rewards.
Maximum Revenue Comparison: The maximum revenue realized by the automated system (₦3,420,625) is significantly higher than that of the manual system (₦1,090,125). This suggests that the automated system has the potential to achieve higher revenue peaks compared to the manual system.
Minimum Revenue Comparison: The minimum revenue recorded for the automated system is zero, which may be due to the initial adaptation period or technical issues. In contrast, the minimum revenue for the manual system is ₦241,625. This indicates that the manual system consistently generated revenue even in its lowest-performing periods.
Overall, the findings suggest that the automated system has the potential to lead to improvements in revenue generation compared to the manual system, as evidenced by its higher mean and maximum revenue.

5. Results and Discussion

The data shown on Figure 4.1.1 illustrates a consistent growth in tax compliance, as evident by the number of vehicle registrations in Taraba state. Beginning in 2018 with the lowest recorded total of 2,971 registered vehicles, the figures steadily grew to reach a peak in 2022, totalling 10,438 registered vehicles.
However, a notable dip occurred in 2020, attributed to the impact of the COVID-19 pandemic and associated lockdown measures—an event categorized as a health and safety factor within the framework of the social and legal PESTLE analysis. These events had a lasting influence, extending into the subsequent year, 2021.
The evaluation of this trend is can further be refined through the application of the Compound Annual Growth Rate (CAGR). CAGR, defined as;

$$\mathrm{CAGR}(t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)}\right)^{\frac{1}{t_n - t_0}} - 1$$

where $V(t_0)$ is the initial value, $V(t_n)$ is the end value, and $t_n - t_0$ is the number of years. Therefore, the CAGR of the number of registered vehicles over the five-year period spanning the end of 2018 to the end of 2007 is:

$$\text{CAGR } (0,5) = (10{,}438/2971)^{1/5} - 1 = \mathbf{0.278}.$$

This means that the compound average annual growth rate is approximately 27.8%. This means that, on average, the number of vehicles registered grew incrementally by 27.8% each year over the five-year period.
Moreover, the examination of monthly variations and time series patterns, as illustrated in Figure 4.2.1 and Figure 4.2.2, reveals an insightful perspective on growth dynamics. While an impressive annual growth rate of 27.8% is sustained, this pattern does not uniformly translate to monthly increments. In essence, a consistent upward growth is discernible, characterized by regular steep ascents.
Notably, the most substantial decline occurred in May 2020, registering a mere 311 vehicles during the height of the lockdown period. The graphical representation of Trend, Seasonal, and Residual Components in Figure 4.2.4 underscores the significance of monthly variations. These fluctuations are attributed to multifaceted factors, including governmental policies, health and safety concerns, and electoral events. Economic considerations, particularly the cost associated with early seasonal farming, consistently contribute to reduced vehicle registrations during the rainy seasons, specifically in April, May, and June. Figure 4.2.3 illustrates this trend, with May consistently emerging as the month with the lowest tax compliance. This phenomenon can be attributed to diminished disposable income following the peak farming period, thereby influencing spending behaviour of people living in Taraba state.

This study focuses exclusively on a specific dimension of tax compliance, namely motor vehicle registrations. While this provides valuable insights into patterns within Taraba state, it is important to acknowledge the broader landscape of taxation in Nigeria, encompassing collections by Local, State, and Federal Governments. The trends observed in vehicle registration taxes may exhibit similarities in other regions; however, disparities can arise due to variations in economic conditions and governmental policies across states. It is crucial to recognize that certain taxes remain relatively immune to these fluctuations, being obligatory in nature. Notably, taxes such as Pay-As-You-Earn (PAYE), applicable to civil servants and salaried workers, stand out as examples of mandatory contributions less susceptible to external factors. This study's scope is intentionally confined to motor vehicle registrations, and while indicative of broader trends,

it does not comprehensively capture the diversity and complexity inherent in the entirety of Nigeria's tax landscape.

6. Conclusion

In conclusion, this study underscores the profound positive impact of automating vehicle registration systems on tax compliance and Internal Generated Revenue (IGR). The implementation of automated software not only facilitates the efficient and effective operation of businesses but also unveils observable trends influencing tax compliance. By leveraging a real-time system software with a robust database and curbed revenue leakages, this research successfully enabled the utilization of machine learning techniques to analyse five years' worth of data and identify revenue collection trends in Taraba state.

Significantly, the study reveals a noteworthy 27.8% yearly growth in motor vehicle registrations, attesting to the high growth rate associated with automation. Furthermore, an insightful examination of the impact of Political, Economic, Social, Technological, Legal, and Environmental factors on tax compliance emphasizes the multifaceted nature of revenue collection dynamics. External events such as the COVID-19 pandemic, seasonal farming fluctuations between April and June, and year-end holidays were identified as factors influencing tax compliance.

Drawing from the study's findings, several recommendations are proposed for the Taraba state government to enhance the efficiency of automated vehicle registration and tax compliance. These include advocating for the enforcement of vehicle inspections and registrations with mobile courts during low compliance months, introducing incentives such as reduced taxes or registration fees for prompt renewals, and extending the systems automation capabilities to other tax collection systems within the state.

While this study focused primarily on trends and impacts in the context of vehicle registrations and document renewals, there exists ample opportunity for further exploration. Subsequent research endeavours could explore the quantification of registered vehicles through categorization based on factors such as make, type, model, or purpose within the state. This investigation would aim to shed light on the underlying reasons behind trends and variations in tax compliance observed over the five-year period. This additional research would contribute valuable insights and enhancing our understanding of the broader implications and potential refinements in the world of automated tax compliance systems.

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