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SMART CONTRACTS AND REAL-TIME BUSINESS PERFORMANCE ANALYTICS

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ABSTRACT

The use of blockchain technology in smart contracts is changing the way businesses are run in the modern world, with the ability to perform automated, transparent and additional contractual terms without being tampered with. This paper examines how smart contracts can be utilised with real-time business performance analytics to improve the efficiency of operations, accountability and strategic decision-making. Smart contracts can be utilized to validate transactions in a decentralized system by including a set of rules that ensure that the transactions are automatically validated immediately, minimize the reliance on intermediaries and minimize human error. Through the integration of the real-time analytics tools, the organizations will be able to track the key performance indicators (KPI), financial operations, supply chain operations and compliance indicators more precisely and promptly. The integration of these technologies promotes integrity of data, reinforcement of audit trails and predictive insights due to the continuous flow of data stream. Moreover, the study points to its use in finance, supply chain management, healthcare and digital services, noting that it has better transparency, cost reduction in operations and the trust of stakeholders. In spite of the benefits, there are still issues like scalability, interoperability, regulatory unpredictability and data privacy. The paper comes to a conclusion that a combination of smart contracts and real-time analytics offers a strategic platform to data-driven companies, which make agility decisions and sustainable competitive edges in dynamic digital markets.

KEYWORDS: Smart Contracts, Blockchain Technology, Real-Time Analytics, Business Performance, Decentralized Systems, Key Performance Indicators (KPIs), Data Integrity, Automation, Predictive Analytics, Digital Transformation

I. INTRODUCTION

Digitalization of the global business ecosystems has radically changed the manner in which organizations create value, run their businesses and performance measurements. With this changing landscape, data has taken form as a strategic resource and the capability to process, analyze and take action on real-time data has become a hallmark of well performing companies. The conventional

International Journal of Research in Commerce and Management Studies

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Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

contract management and performance monitoring systems have a tendency of being based on centralized databases, manual verification and slow reporting systems, which generate inefficiencies, augment operational risks and restrict transparency. With the advent of the so-called smart contracts, self-executing digital contracts within the framework of blockchain networks, a new stage of automated confidence and decentralized governance has emerged. The use of programmable contracts in platforms like Ethereum has shown that transactions can be automatically carried out when certain set conditions are met and this is without the need of middlemen and minimal administrative overheads. Simultaneously, business performance analytics based on technologies of big data and on advanced computing frameworks allows organizations to monitor key performance indicators (KPIs), financial indicators, customer performance and supply chain activities in real-time. Business organizations that use analytics tools like the Microsoft Power BI and Tableau can convert raw transactional information into operational dashboards and forecast information. Smart contracts and real-time analytics crossroads is a major step into the realm of intelligent automation, with both the process of executing transactions and the performance review being performed in real-time in secure digital environments. In this integration, enhancement of transparency, auditability, minimization of fraud and ensuring that the performance measures are directly associated to the confirmed transactional events that were captured on immutable ledgers is achieved. With the ever-growing competition in the digital world, organizations are now turning to integrated systems which do not only automate agreements but also create an unending analytical intelligence to assist strategic decision making. Using smart contracts and real time performance analytics allows the formation of an aligned environment where operational processes, settlement of finances and compliance are registered, verified and analyzed immediately. This convergence in areas like finance, supply chain management, healthcare, insurance and digital services allows monitoring of the performance outcomes against the contractual requirements without any problem. An example of this is in the use of supply chain ecosystems, where smart contracts may automatically make payments on the verification of delivery and analytics engines regularly evaluate the efficiency of the logistics and cost variances and service-level adherence. Hyperledger Fabric is also one of the frameworks that financial institutions relying on blockchain-based solutions have considered to guarantee the secure and permissioned processing of transactions and allow analytical integration. Leveraging the possibility to integrate the decentralized ledger transparency with advanced data analytics would increase the capabilities of risk management, regulatory compliance and fraud detection. Real-time analytics enables organizations to no longer rely on descriptive reporting but enable them to shift to predictive and prescriptive decision-making, uncover patterns, anticipate disruptions and to dynamically allocate resources. Nevertheless, regardless of its transformative potential, the implementation of this integrated model is associated with such challenges as a restriction of scalability of blockchain networks, the inability of legacy enterprise systems and distributed ledgers to communicate with each other, cybersecurity risks, regulatory ambiguities and data privacy. These issues can only be efficiently

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

dealt with through strong governance systems, technical standardization and strategic investment in digital infrastructure. However, the interaction of smart contracts with real-time analytics represents a major step in the direction of autonomous companies in which operational visibility, automated compliance and performance intelligence with a continuous performance are integrated into a single technological system.

II. LITERATURE REVIEW

Conceptual Foundations of Smart Contracts and Blockchain Governance

Theoretical foundations of smart contracts date back to the work of the visionary Nick Szabo who envisaged the development of self-executing electronic contracts that could automate the process of contractual execution under the influence of cryptographic protocols. Along with the advent of blockchain platforms like Ethereum, smart contracts moved beyond theory to their real practice and it is now possible to conduct agreements without intermediaries in a decentralized and tamper-resistant way. The literature focuses more on the distributed ledger architecture of blockchain as a method of guaranteeing transparency, immutability and trust between transacting parties [1]. According to the researchers, smart contracts can help to save a substantial amount of money in transaction costs, alleviate the agency problem and strengthen inter-organizational coordination through automated verification of operations [2]. Governance-based research emphasizes the ability to enhance compliance structures and audit trails especially in finance and supply chain eco-systems [3]. Nevertheless, it is still feared that it has limitations on scalability, code vulnerabilities and recognition of the law in various jurisdictions [4]. Empirical studies have recorded the security threats of poorly written contract code and thus there is a need to formally verify and standardize development procedures [5]. Altogether, scholarship explains smart contracts as innovative digital governance techniques, which can transform institutional confidence and transaction effectiveness in decentralized settings [6].

Real-Time Business Performance Analytics and Data-Driven Decision Making

Development of real-time business performance analytics is a strategic capability of digital businesses that has been influenced by improvements in big data architecture, cloud computing and artificial intelligence. Modern analytics tools like Tableau and Microsoft Power BI are able to allow organizations to track the key performance indicators (KPIs), operational processes and financial results in real-time. According to the literature, real-time analytics is able to improve the agility of the organization by decreasing the latency between data creation and managerial response [7]. Researchers believe that predictive and prescriptive analytics broaden the strategic functionality of data to enable companies to predict the disruption, optimize resource deployment and enhance risk management procedures [8]. The literature also mentions the combination of Internet of Things (IoT) systems and data stream pipelines in the facilitation of continuous performance monitoring in manufacturing, logistics and service industries [9]. Moreover, the decision making process based on

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

analytics correlates with a higher level of competitiveness, efficiency of operations and customer responsiveness [10]. However, there has been a continuous problem of data quality, interoperability, cybersecurity and ethical data governance, which are obstacles to successful implementation [11].

Integration of Smart Contracts with Real-Time Analytics for Business Optimization

The intersection of smart contracts and real-time performance analytics is a new interdisciplinary field of interest in digital business studies. According to scholars, automated contractual execution with live performance monitoring can be used to achieve operational transparency and accountability that is synchronized [12]. They can be used in supply chain scenarios which are automated payments to verified delivery and analytics dashboards can measure compliance to a service level and cost-efficiency at the same time [13]. Research in the financial services sector has shown that the data on blockchain-facilitated transactions can be processed directly into the analytical models to facilitate fraud detection and reporting to the regulator [14]. This integration promotes a closed loop system whereby confirmed data on transactions are the basis of continuous analytical intelligence to enhance the predictive accuracy and strategic responsiveness. Nevertheless, it has been reported in the literature that there exist long-standing limitations to blockchains, such as scalability, cross-platform interoperability, regulatory uncertainty and privacy concerns when working with sensitive performance data [15]. Nevertheless, academics are always willing to conclude that decentralized smart contacts and real-time analytics are synergizing to create a thriving system of intelligent automation, transparency and sustainable competitive advantage in the digitally transformed companies.

III. METHODOLOGY

The research design presented in this study is a primary quantitative one, which is aimed to investigate the role of smart contracts and real-time analytics on business performance analytics. It was designed using a structured survey questionnaire designed on the basis of validated constructs in the existing blockchain, automation and analytics literature. The tool was shared among finance, healthcare, supply chain and technology industry professionals. A set of 100 responses were collected through purposive sampling. Out of this, 93 were retained for final analysis after screening for completeness and removal of incomplete responses. The respondents were required to be engaged in the process of digital transformation, analytics or blockchain applications in their organizations. All items of the independent and dependent variables were measured on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The independent variables will be Smart Contract Implementation (SCI) that will consist of four items, Real-Time Data Processing (RDP) that will consist of four items and Automation Efficiency (AE) that will consist of three items. The dependent variable is Business Performance Analytics (BPA) that is represented by four items of analytical improvements and performance visibility. The analysis of data was done using IBM SPSS. The statistical methods used were frequency analysis, reliability test (Cronbachs Alpha), descriptive statistics, KaiserMeyerOlkin

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

(KMO) and the Bartletts Test of sampling adequacy, correlation test and multiple regression test to verify the proposed hypothesis.

IV. FINDING AND ANALYSIS

Demographic Analysis

Industry Sector

Industry_Sector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Finance & Banking	31	33.3	33.3	33.3
	Healthcare	19	20.4	20.4	53.8
	Supply Chain & Logistics	20	21.5	21.5	75.3
	Technology & IT	23	24.7	24.7	100.0
	Total	93	100.0	100.0	

Table 1: Industry Sector
(Source: IBM SPSS)

The distribution of the industry shows that 24.7 percent of the respondents are in technology and IT, 33.3 percent in Finance and banking, 21.5 percent in Supply Chain and Logistics and 20.4 percent in healthcare. The presence of this distribution shows that the research is mostly indicative of digitally mature industries in which the use of smart contracts and real-time analytics is more widespread. The effectiveness of the IT and finance workers increases the credibility of the responses because these areas are one of the first to use the blockchain and other analytics technologies. The fact that the paper was conducted among four large industries makes the findings more generalizable.

Job Role/Position

Job_Role

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Data Analyst	36	38.7	38.7	38.7
	IT Manager	27	29.0	29.0	67.7
	Operations Manager	13	14.0	14.0	81.7
	Senior Management	17	18.3	18.3	100.0
	Total	93	100.0	100.0	

Table 2: Job Role/Position
(Source: IBM SPSS)

The outcomes reveal that 38.7 percent of the respondents are Data Analysts, 29 percent are IT Managers, 18.3 percent belong to Senior Management and 14 percent are Operations Managers. It means that most of the respondents are directly engaged in the implementation of technologies and an analytical decision-making process. Managerial level participants will give strategic perspective, whereas the technical respondents will give validation at the operational level. As such, the responses are both execution and strategy point of view.

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

Annual Revenue of Organization

Annual Revenue

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	$10M - $50M	32	34.4	34.4	34.4
	$1M - $10M	22	23.7	23.7	58.1
	Above $50M	27	29.0	29.0	87.1
	Below $1M	12	12.9	12.9	100.0
	Total	93	100.0	100.0	

Table 3: Annual Revenue of Organization
(Source: IBM SPSS)

The distribution of revenues indicates that 34.4 percent of the firms are at the range of $10M-$50M, 23.7 percent are in the range of $1M-$10M, 29 percent are above $50M and 12.9 percent below $1M. This indicates that the majority of the participating organizations are medium sized and large organizations that fall within the higher revenue categories ($10M-$50M and above $50M) whereby the digital infrastructure investment capacity is in place. The validity of the study is backed by the fact that higher revenue firms are represented in this case because blockchain and real-time analytics implementation require financial and technological preparation.

Reliability Test

Reliability Statistics

Cronbach's Alpha	N of Items
0.959	15

Table 4: Reliability Test
(Source: IBM SPSS)

The overall reliability of the measurement scale was assessed using Cronbach's Alpha. The value obtained was 0.959 for all 15items combined. This indicates very high level of internal consistency.

Construct wise Reliability Analysis

Construct	N of Items	Cronbach's Alpha
Smart Contract Implementation	4	0.916
Real-Time Data Processing	4	0.938
Automation Efficiency	3	0.886
Business Performance Analytics	4	0.951

Table 5: Construct wise Reliability Analysis
(Source: IBM SPSS)

All the Cronbach's Alpha values of Smart Contract Implementation (0.916), Real-Time Data Processing (0.938), Automation Efficiency (0.886) and Business Performance Analytics (0.951) are

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

above the acceptable value of 0.70. This indicates high internal consistency of the measurement items. The high consistency of the dependent variable (0.951), in particular, suggests that the BPA items consistently measure analytical performance. Therefore, the instrument can be considered reliable for further analysis. The constructs were developed based on concepts derived from existing literature in the domain that may contribute to the high level of internal consistency observed.

Descriptive Analysis

Descriptive Statistics

	N	Mean	Std. Deviation
IV1_Smart_Contract_Implementation	93	16.2796	2.18873
IV2_Real_Time_Data_Processing	93	13.6774	2.30859
IV3_Automation_Efficiency	93	9.3333	1.70251
DV_Business_Performance_Analytics	93	16.0645	2.38111
Valid N (listwise)	93		

Table 6: Descriptive Analysis
(Source: IBM SPSS)

The descriptive statistics indicate that all variables have relatively high mean values that suggests most of the respondents were in agreement about the role of smart contracts and real-time analytics. Smart Contract Implementation (Mean - 16.2796) shows the highest average followed by Business Performance Analytics (Mean - 16.0645), Real Time Data Processing (Mean - 13.6774) and Automation Efficiency (Mean - 9.333). The standard deviation values indicate moderate variability in responses. Such results suggests that companies perceive a positive role of digital systems in improving business performance.

KMO and Bartlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.922
Bartlett's Test of Sphericity	Approx. Chi-Square	1356.404
	df	105
	Sig.	0.000

Table 7: Factorial Analysis
(Source: IBM SPSS)

The KMO 0.922 value shows that the sampling adequacy is excellent since it is higher than the suggested value of 0.60. The Test of Sphericity by Bartlett shows significant difference ($p < 0.001$) which makes sure that variables correlation is adequate to use factor analysis. These findings confirm the construct structure as well as confirm that the set of data can be used in multivariate statistical tests like regression analysis.

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

Correlation Analysis

Correlations

		DV_Business_Performance_Analytics	IV1_Smart_Contract_Implementation	IV2_Real_Time_Data_Processing	IV3_Automation_Efficiency
DV_Business_Performance_Analytics	Pearson Correlation	1	.787**	.741**	.646**
	Sig. (2-tailed)		.000	.000	.000
	N	93	93	93	93
IV1_Smart_Contract_Implementation	Pearson Correlation	.787**	1	.704**	.646**
	Sig. (2-tailed)	.000		.000	.000
	N	93	93	93	93
IV2_Real_Time_Data_Processing	Pearson Correlation	.741**	.704**	1	.528**
	Sig. (2-tailed)	.000	.000		.000
	N	93	93	93	93
IV3_Automation_Efficiency	Pearson Correlation	.646**	.646**	.528**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	93	93	93	93

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8: Correlation Analysis
(Source: IBM SPSS)

The correlation table shows that the independent variables (SCI, RDP, AE) have a high positive correlation with the dependent variable (BPA). The correlation with BPA is the highest with Smart Contract Implementation followed by Real-Time Data Processing and Automation Efficiency. All the correlations are significant at $p < 0.01$; this means that the relationships are statistically significant. The fact that the inter-correlations do not show excessively high values (>0.90) proves the fact that there is no concern about multicollinearity. The findings are preliminary in the support of the put forward hypothesis.

Regression Analysis

H1: Smart contracts and real-time analytics (comprising Smart Contract Implementation, Real-Time Data Processing and Automation Efficiency) have a positive and significant effect on Business Performance Analytics.

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.843[a]	0.710	0.700	1.30314

a. Predictors: (Constant), IV3_Automation_Efficiency, IV2_Real_Time_Data_Processing, IV1_Smart_Contract_Implementation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	370.476	3	123.492	72.720	0.000[b]
	Residual	151.137	89	1.698		
	Total	521.613	92			

a. Dependent Variable: DV_Business_Performance_Analytics

b. Predictors: (Constant), IV3_Automation_Efficiency, IV2_Real_Time_Data_Processing, IV1_Smart_Contract_Implementation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.253	1.033		1.213	0.228
	IV1_Smart_Contract_Implementation	0.457	0.098	0.420	4.660	0.000
	IV2_Real_Time_Data_Processing	0.354	0.084	0.343	4.229	0.000
	IV3_Automation_Efficiency	0.271	0.105	0.194	2.567	0.012

a. Dependent Variable: DV_Business_Performance_Analytics

Table 9: Regression Analysis
(Source: IBM SPSS)

The overall regression model shows a very strong overall fit ($p < 0.001$). The R^2 value of 0.710 reveals that the three predictors explain a significant percentage of variance in Business Performance Analytics. The Beta coefficient of Smart Contract Implementation is highest in standardized form indicating that it is the most predictive of BPA. Real Time Data Processing has a strong positive impact and Automation Efficiency has a positive impact at the statistically significant level. All independent variables yield p-values that are below 0.05, hence H1 is accepted. The results indicate that business performance analytics are significantly improved with the help of the integration of smart contracts and real-time analytics.

DISCUSSION

The results of the given research make it clear that smart contracts and real-time analytics are the key to Business Performance Analytics (BPA). The demographic spread attests to the fact that most of the respondents work in digitally developed industries like Technology & IT and Finance and Banking, which is why the conclusions are made based on the setting where blockchain and analytics technologies are being actively used. The fact that Data Analysts and IT Managers are highly represented also increases the credibility of the answers since these are the positions that deal with the direct matter of launching systems and monitoring their performance. Also, the fact that there are medium and large enterprises in the revenue distribution implies that the findings reflect organizations that have adequate technological framework and investments to implement the highly developed digital systems. The results of the reliability test indicate a high level of internal consistency of all

International Journal of Research in Commerce and Management Studies

ISSN 2582-2292

Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

constructs which proves the strength of the measuring tool. The values of the Cronbach's Alpha are high which means that the items are properly reflecting the dimensions of the Smart Contract Implementation (SCI), Real-Time Data Processing (RDP), Automation Efficiency (AE) and Business Performance Analytics (BPA). The descriptive statistics indicate that the mean scores are always high, indicating that the respondents have high perceptions that blockchain-based smart contracts and analytics systems integration is helpful. Smart Contract Implementation has the best mean score among the independent variables indicating its perceived importance. The results obtained by the KMO and the Test of Bartlett are another indication of the possibility to model the data with the help of advanced statistics. The large KMO value shows that the sampling is adequate, whereas the large value of the Bartlett's Test shows that there are enough correlations between items. The correlation analysis shows all the independent variables have positive and statistically significant relationships with BPA. There is the greatest correlation between Smart Contracts Implementation followed by Real-Time Data Processing & Automation Efficiency. The possibility to process and interpret data in real time is directly related to the increase in analytical capabilities. Efficiency of automation also shows a high correlation confirming that the less manual interventions and execution time is the faster the decision-making and the clearer the operation becomes. In a properly integrated blockchain infrastructure, adoption of smart contracts is invaluable. The regression analysis gives clear empirical evidence of the H1. This important model fit supports the argument that Smart Contract Implementation, Real-Time Data Processing and Automation Efficiency are all significant variables that can be used to account for a good percentage of variance in Business Performance Analytics. The Real-Time Data Processing appears to be a powerful predictor, which implies that the speed of data and the responsiveness of analytics are critical success factors in the enhancement of performance. Automation Efficiency has a positive role to play by streamlining the operations of the organization and reducing inefficiency. The implementation of Smart Contracts also has a statistically significant positive effect, meaning that safe automated contracts increase transparency, confidence and real-time performance monitoring. On the whole, the discussion has affirmed that smart contracts when combined with real-time analytics would have a synergetic effect. Blockchain guarantees accuracy and immutability in the transactions, whereas analytics converts authenticated information into intelligence to action. Companies that integrate these technologies are in a better situation to realize transparency in the operation, faster decision making, low costs and better strategic performance. The findings highly support the hypothesis that smart automation and real-time analytic ecosystem are the key elements of the contemporary online business.

CONCLUSION

The paper investigated how Smart Contract Implementation, Real-Time Data Processing and Automation Efficiency affect the Business Performance Analytics with primary quantitative data of 93 respondents. The results prove the fact that the combination of smart contracts and real-time analytics can greatly increase the analytical visibility, operational transparency and strategic decision-

making. Tests of reliability and validity showed that the measurement model was statistically good and correlation and regression tests were found to give great support to the proposed hypothesis. The Real-Time Data Processing proved to be a significant independent variable in predicting Business Performance Analytics, which underlines the significance of real-time availability of data and the presence of sophisticated analysis tools. Automation Efficiency was also found to have a significant positive impact with the focus being on the lessening of the manual intervention and streamlined workflows. Smart Contract Implementation helped a lot as it provided safe, automated and transparent implementation of business agreements. Comprehensively, the results confirm that the intersection of the blockchain-powered smart contracts and real-time analytics is a high-performance digital system. With this approach of integrating, organizations are more likely to benefit in improving accuracy, minimizing operational delays, enhancing compliance monitoring and building up their competitive advantage. The research proves that smart automation and live analytical intelligence represent one of the major forces of sustainable business performance in the digitally transforming businesses.

FUTURE SCOPE

Despite a good empirical evidence in the study, there are various areas that can be explored in future research. To begin with, the sample size should be extended to at least 100 respondents and more industries should be encompassed like manufacturing, retail and government sectors. Second, longitudinal research design can be implemented in future research projects to determine the performance impacts of integration of smart contracts over a long period. Third, minimalist variables can be used to study moderating or mediating factors i.e. organizational culture, digital maturity, regulatory environment and cybersecurity readiness to gain deeper theoretical understanding. The comparative cross-country research can also indicate the impact of regulatory frameworks on blockchain and analytics adoption. Furthermore, it is possible that more sophisticated statistical modeling methods like Structural Equation Modeling (SEM) can be used in the future to examine causal relationships in a more holistic way. Other valuable contributions would be to explore the challenges associated with integrating with the legacy systems, scalability of blockchain networks and ethical data management. Lastly, as artificial intelligence and machine learning continue to gain popularity, future research can explore how the use of AI-based predictive analytics and smart contracts can form autonomous decision-making systems, which would further revolutionize the management of business performance.

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International Journal of Research in Commerce and Management Studies

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Vol. 8, No. 02 March-April; 2026 Page. No. 1059-1071

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