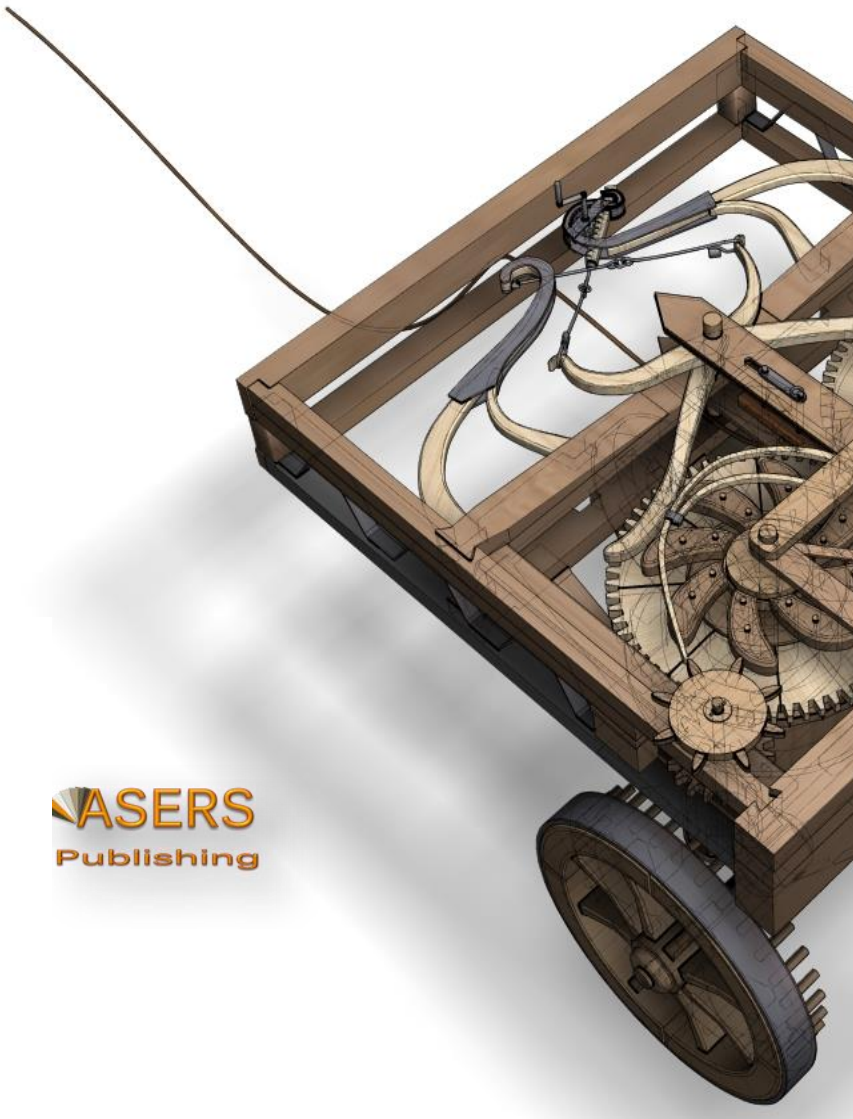
Theoretical and Practical Research in Economic Fields



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The Moderating Effect of Digitalisation on the Relationship between Corruption and Domestic Resource Mobilisation: Evidence from Developing Countries

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Abstract: ***Purpose:*** *Domestic Resource Mobilisation (DRM) is vital for government financing of essential sectors like infrastructure, education, and healthcare, but corruption impedes revenue collection and erodes trust in government institutions. Nevertheless, digitalisation offers a promising way to combat corruption and improve DRM. This study aims to explore how digitalisation can enhance transparency and efficiency in addressing these issues by specifically investigating how digitalisation can moderate the relationship between corruption and DRM in developing nations.* ***Methodology:*** *Utilizing panel data of 65 developing countries from 2007 to 2019, a Panel Corrected Standard Errors (PCSE) estimator was employed.* ***Findings:*** *The findings indicate that corruption negatively affects DRM, while digitalisation has a positive influence. Importantly, digitalisation was found to moderate the adverse impact of corruption on DRM, albeit after a certain threshold level of digitalisation. Across regions, the net effect of this interaction varied, with some regions experiencing negative consequences. Notably, the existence of a threshold level of digitalisation above which its influence becomes more pronounced in mitigating corruption's impact on DRM revealed that the association is non-linear.* ***Originality:*** *This study addressed an important gap in the literature by examining how digitalisation moderates the connection between corruption and DRM in developing countries, offering nuanced insights into the feasibility of leveraging digital technologies to bolster revenue mobilisation despite corruption challenges.* ***Implication:*** *These results have significant implications for policymakers, highlighting the potential of digitalisation to enhance revenue mobilisation and combat corruption in developing countries, albeit with context-specific considerations.*

Keywords: corruption; domestic resource mobilisation; digitalisation; panel corrected standard errors; developing countries

JEL Classification: C33; D73; E42; H71.

Introduction

Corruption and Domestic Resource Mobilisation (DRM) are pressing challenges faced by many developing countries, impacting their economic development and stability. DRM plays a crucial role in providing governments with the necessary financial resources to invest in vital sectors such as infrastructure, education, and healthcare (Jackson, 2023) However, corruption undermines revenue mobilisation efforts by hindering tax compliance and

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eroding trust in government institutions (Ajaz and Ahmed 2010). With external financing becoming increasingly uncertain, developing countries are compelled to focus on maximising DRM to drive sustainable growth and meet their socio-economic objectives.

Digitalisation has emerged as a potential solution to combat corruption and enhance DRM in these nations. The adoption of digital technologies in governance, financial systems, and public service delivery has shown promise in reducing opportunities for corrupt practices, enhancing transparency, and improving overall efficiency (Gupta *et al.* 2017). Digitalisation offers the potential to create more streamlined and accountable revenue collection processes, enabling governments to boost their resource mobilisation efforts and allocate funds more effectively to critical development initiatives.

Despite the optimistic outlook on the role of digitalisation in combating corruption and bolstering DRM, the specific moderating effect of digitalisation on the relationship between corruption and revenue mobilisation remains largely unexplored. While previous studies have individually investigated the impacts of corruption on DRM and the benefits of digitalisation in countering corruption, there exists a research gap in understanding the combined effects and interactions of these factors in developing countries. Therefore, this study aims to address this gap by examining how digitalisation influences the relationship between corruption and DRM, shedding light on whether and to what extent digital technologies can enhance revenue mobilisation efforts despite the presence of corruption in these contexts.

The primary research question driving this study is: How does digitalisation moderate the relationship between corruption and revenue mobilisation in developing countries? To answer this question, the study will focus on the following specific objectives: (i) To assess the level of corruption in selected developing countries and its impact on revenue mobilisation efforts, (ii) To examine the extent of digitalisation initiatives implemented in these countries and their potential influence on curbing corruption and enhancing DRM, and (iii) To analyse the moderating effect of digitalisation on the relationship between corruption and revenue mobilisation, considering various contextual factors and governance mechanisms.

The current literature has widely recognised corruption and DRM as critical issues in developing countries, and scholars have explored the role of digitalisation in combating corruption and improving DRM separately. However, there remains a research gap in understanding the joint effect of digitalisation on the corruption-revenue mobilisation nexus. This study seeks to address the gap by providing empirical evidence and a nuanced understanding of how digitalisation can impact revenue mobilisation efforts even in the presence of corruption in developing countries.

The remaining sections of the study will be organised as follows: Section Two will address the Literature Review - this will provide a comprehensive review of existing literature on corruption, DRM, and digitalisation in developing countries. It will highlight the gaps in the current knowledge and establish the rationale for investigating the moderating effect of digitalisation on the relationship between corruption and revenue mobilisation. Section Three will address the Methodology –this section will outline the research design, data collection methods, and analytical techniques employed in the study. It will also justify the selection of countries and data sources, ensuring the robustness of the findings. Section Four will provide details of the Empirical Findings - here, the study will present its empirical results, analysing the level of corruption, the extent of digitalisation, and the relationship between corruption and DRM in the selected developing countries. The moderating effect of digitalisation will be assessed using regression or other relevant statistical methods. Section Five will discuss and present the Implications of the empirical findings and conclusion. The implications of the study's results for policymakers, practitioners, and scholars will be discussed, emphasizing the potential role of digitalisation in enhancing DRM despite corruption challenges. This section will also conclude the study by summarising key findings in relation to its contributions to existing literature and the suggestion of avenues for future research. It will also provide practical suggestions for policymakers to leverage digitalisation in improving revenue mobilisation and combat corruption in developing countries.

1. Literature Review

The literature review is divided into two sections namely, Theoretical and Empirical reviews as outlined in the subsequent sections.

1.1. Theoretical Review

Corruption and inefficient revenue mobilisation pose significant challenges to economic development in developing countries. The interaction between corruption and revenue mobilisation is a complex and multifaceted issue. Digitalisation, characterized by the adoption and integration of digital technologies, has been touted as a

potential solution to mitigate corruption and enhance revenue mobilisation. This theoretical literature review aims to explore the theoretical foundations of the moderating effect of digitalisation on the relationship between corruption and revenue mobilisation in developing countries.

Corruption and Revenue Mobilisation: Corruption has long been recognized as a major impediment to economic growth and development. A vast body of literature explores the adverse effects of corruption on revenue mobilisation in developing countries (Mauro 1995; Tanzi and Davoodi 1998). Studies show that corruption leads to revenue leakages, misallocation of resources, and weakened tax systems, thus hindering the government's ability to mobilize funds for public goods and services.

The Role of Digitalisation in Combating Corruption: Digitalisation, often synonymous with e-governance and e-government, involves the use of digital technologies to enhance the efficiency, transparency, and accountability of public institutions. Digitalisation offers tools such as e-filing, online tax payment systems, and electronic monitoring, which can help reduce opportunities for corruption and enhance revenue collection (Máchová *et al.* 2018). Digital platforms enable citizens to interact with the government and access public services without intermediaries, thereby reducing the scope for bribery and rent-seeking behaviors.

Digitalisation and Revenue Mobilisation: Studies suggest that digitalisation can positively impact revenue mobilisation by increasing tax compliance and reducing tax evasion (Bird and Zolt 2008; Bellon *et al.* 2022). Digital tax systems provide efficient and automated methods for tax assessment and collection, minimizing human discretion and opportunities for corruption. Moreover, digitalisation can facilitate data integration, enabling tax authorities to identify discrepancies and uncover hidden sources of revenue.

The Moderating Effect of Digitalisation on Corruption and Revenue Mobilisation: Theoretical arguments propose that digitalisation can moderate the relationship between corruption and revenue mobilisation in developing countries. Digital platforms and automated processes decrease the direct interaction between taxpayers and tax officials, which can minimize opportunities for corrupt practices. By reducing face-to-face interactions, digitalisation may curb the power of corrupt intermediaries who exploit administrative inefficiencies.

However, the effectiveness of digitalisation as a moderating factor depends on various contextual factors, including the level of institutional capacity, internet penetration, and digital literacy (World Bank, 2016). Therefore, in countries with weak governance structures, the impact of digitalization on reducing corruption and improving revenue mobilization might be limited.

In summary, the theoretical literature suggests that digitalisation has the potential to play a crucial role in moderating the relationship between corruption and revenue mobilisation in developing countries. By enhancing transparency, accountability, and efficiency in tax administration, digital technologies can reduce corruption and improve revenue collection. However, the effectiveness of digitalisation in combating corruption and enhancing revenue mobilisation depends on the overall governance environment and the level of institutional readiness in each specific country.

1.2. Empirical Review

In the landscape of developing countries, the intricate dynamics between corruption, resource mobilisation, and the advancing wave of digitalisation have emerged as a focal point for scholarly inquiry and policy considerations. This empirical literature review embarks on an exploration of the moderating role played by digitalisation in shaping the intricate interrelationship between corruption and resource mobilisation within these contexts. By analyzing a curated collection of empirical studies and theoretical frameworks, this review aims to provide a nuanced understanding of how digitalisation, as both a tool and a disruptor, influences the link between corruption and DRM, offering insights that hold significance for effective governance, sustainable development, and technological adaptation in the developing world.

DRM and Corruption

To begin, it is crucial to understand that measuring DRM is a complex task, and there is no direct way to measure it. Researchers commonly use proxies, with tax revenue and domestic savings being the most frequently suggested proxies (Gupta *et al.* 2017; Bhushan and Samy 2010; Culpeper and Bhushan 2010). Notwithstanding, the literature consistently indicates that corruption has a negative impact on DRM, regardless of the measure or methodology used.

Employing an Auto Regressive Distributed Lag (ARDL) approach, Abu and Staniewski (2022) assessed the impact of corruption on domestic savings in Nigeria and found that reducing corruption can increase long-term domestic savings. Similar results were observed in studies by Abu, Karim and Aziz (2013) and Swaleheen (2008) using different data and methodologies. Using tax revenue as a measure, Gauthier and Goyette (2014) also found an inverse relationship between bribery and tax payments in Uganda. Ajaz and Ahmad (2010) and other

studies also found a negative effect of corruption on tax revenue in developing countries. These findings collectively highlight the detrimental impact of corruption on DRM, whether measured through tax revenue or domestic savings.

Corruption and Digitalization

While the research in this field is relatively recent, it is steadily expanding. In a recent paper, Romero-Martinez and Garcia-Muina (2021) investigated how digitalization can act as an anti-corruption tool in Spain, revealing that greater digitalization has the potential to reduce corrupt practices. Similarly, Addo (2021) explored the control of petty corruption in Ghana's public administrations through digitalization, drawing on a 30-year case study and interviews with 91 individuals. The study found that digitalization, through changes in work practices and organizational arrangements, can effectively control corruption over time by reducing opportunities for corrupt practices.

A specific study by Setor *et al.* (2021) examined the link between digital payment transactions and corruption across 111 developing countries from 2010 to 2018. Using the Corruption Perception Index, they discovered a negative relationship between digital payments and corruption, suggesting that digital payment systems have the potential to reduce corruption by eliminating middlemen and increasing transparency in payment processes. Furthermore, digital payment methods have been shown to minimize petty corruption and information asymmetries, as payment data becomes transparent, and economic rents in billing and payments are limited (Ghosh 2017; Krolikowski 2014). This was exemplified in India's direct mobile payment system for welfare beneficiaries (Government of India 2015).

Moderating role of digitalization on the relationship between corruption and DRM

Given the paucity of studies in this regard, related studies are empirically reviewed to provide an insight into such dynamic relationships. Li *et al.* (2023) conducted an empirical investigation into the correlations between financial development and six distinct governance indicators, both individually and in combination, with inclusive growth in 48 African economies spanning 2000 to 2019. Employing Panel Quantile Regression with Fixed Effects estimations and Dumitrescu and Hurlin causality tests following rigorous econometric analysis, the study discerned that the interaction of financial development with corruption control significantly influences inclusive growth in middle-income African countries. In the broader African context and middle-income countries, the interaction of financial development with political stability, absence of violence/terrorism, and governance at large is pertinent to inclusive growth. However, for all country groupings, the interaction of financial development with voice and accountability, as well as with the rule of law, is connected to inclusive growth.

Examining 193 countries over the period 2010 to 2019, Adeleye *et al.* (2023) investigated the influence of the institutional quality index (IQI) and information and communication technology (ICT) on inclusive growth. Utilizing the panel spatial correlation consistent (PSCC-FE), instrumental variable-generalized method of moments (IV-GMM), and simultaneous quantile regressions (SQREG) models, the study assessed differential effects based on economic development levels (high-, low-, lower-middle-, and upper-middle-income countries). Notably, the IQI exhibited a consistent positive impact across all models in the full sample, while the impact of ICT varied, with mobile phones demonstrating a significant positive effect. Interaction effects were found to be contingent on the choice of ICT indicator. In sub-samples, both IQI and ICT, along with their interaction, displayed significant heterogeneous effects, consistently yielding positive outcomes (or negative interactions) in high-income countries. These findings underscore the imperative for policymakers to prioritize institutional quality and ICT to ensure that economic growth translates into improved living conditions across income groups.

In his work, Afolabi (2023) investigates how trade misinvoicing impacts DRM in Nigeria. By utilizing annual data spanning the years 1981 to 2018 and employing the Dynamic Ordinary Least Squares (DOLS) estimation method, the study conclusively demonstrates that trade misinvoicing detrimentally influences DRM. The research underscores the sensitivity of domestic resources to trade misinvoicing dynamics, as well as the significant roles played by factors such as public debt, official development assistance, trade openness, and inflation in shaping domestic resource mobilisation. Moreover, the study underscores the pressing need to address trade misinvoicing promptly to enhance Nigeria's capacity to finance developmental objectives and achieve the Sustainable Development Goals (SDGs). By bridging the gap in the comprehension of how trade misinvoicing affects DRM in the Nigerian context, this study makes a valuable contribution to the existing literature.

Oyinlola *et al.* (2020) conducted a study investigating governance's role in the relationship between resource mobilisation and inclusive growth. The research employs the Generalized Method of Moments (GMM) estimation technique to analyze this connection in 27 sub-Saharan African countries during 1995–2015. Utilizing both aggregate and disaggregated tax data, the study concludes that the persistence of inclusive growth significantly influences its current state in the region. While all dimensions of governance have a direct positive

impact on inclusive growth, neither aggregate nor disaggregated taxes exhibit a substantial effect. Interestingly, governance dimensions do not significantly enhance the link between resource mobilisation and inclusive growth. Consequently, low tax efforts and a growing governance infrastructure suggest a need for robust tax reforms and improved governance to actualize inclusive growth, prompting comprehensive institutional development and enhanced accountability mechanisms.

Adu *et al.* (2023) re-evaluate the impact of tax systems on poverty and inequality in Ghana, addressing potential asymmetries. They employ the Nonlinear Autoregressive Distributed Lag (NARDL) estimation method and analyze time-series data spanning 1983 to 2016. Results indicate asymmetric links: direct taxes influence poverty positively (negatively), while indirect and overall tax systems affect poverty adversely. Conversely, the relationship between tax systems and inequality is symmetric, with long-term positive ties observed mainly for indirect taxes. The study suggests a poverty reduction strategy involving tax reduction and emphasizes the significance of an indirect tax-based policy to address inequality in Ghana.

The empirical literature review provided above indicates that digitalisation has the potential to mitigate corruption and enhance DRM in developing nations by improving transparency, efficiency, and accountability. While the existing literature recognises corruption and DRM as crucial concerns, the interaction between digitalisation and the corruption-revenue mobilisation relationship has not been fully explored. This study aims to address this gap by examining how digitalisation moderates the connection between corruption and DRM in developing countries, offering nuanced insights into the feasibility of leveraging digital technologies to bolster revenue mobilisation despite corruption challenges. The comprehensive research design and methodology outlined in the study are poised to provide robust empirical evidence, ultimately aiding policymakers, practitioners, and scholars in understanding the role of digitalisation in these contexts and fostering effective revenue mobilisation strategies. The investigation is expected to be particularly pertinent to Africa, as it offers insights into how digitalisation could impact revenue mobilisation efforts in the presence of corruption within the developing country's specific context.

2. Methodology

2.1. Theoretical Framework

The relationship between corruption and DRM is conceptualized using the tax buoyancy[2] framework as its theoretical basis. Nonetheless, for the specific objectives of this research, adjustments and expansions are made to the original tax buoyancy model.

According to the original model, tax buoyancy measures the sensitivity of tax revenue to fluctuations in economic growth, assuming infrequent discretionary adjustments to tax rates and regulations (Osoro 1993). Consequently, when economic growth is strong, tax buoyancy is high, and tax revenues tend to increase at a faster rate. Conversely, during economic downturns, tax buoyancy may be low, and tax revenues may tend to decline. In the traditional approach for estimating the elasticity of a specific tax, denoted as "*k*", Osoro (1993) proposed a tax buoyancy model as follows:

$$TR_k = e^{\alpha_k} Y^{\delta_k} e^{\varepsilon} \quad (1)$$

where: *TR* is tax revenue, k is the type of tax revenue, Y represents economic growth (GDP), α is a constant term, δ is the buoyancy parameter, e is the base of the natural log, and ε is the error term. In this model, the tax base and tax revenue are directly linked to the growth in output/income.

However, while maintaining the original context, we propose an extension of the model to include corruption as another factor which can directly impact the generated level of tax revenue. In this study, we put forth the hypothesis that a higher level of corruption in an economy could decrease the effectiveness of the tax system, resulting in reduced tax revenue. When corruption is prevalent, individuals and businesses are more likely to evade taxes and engage in illicit activities to avoid their tax obligations. Additionally, corrupt public officials may misappropriate or fraudulently divert funds that should have been collected as taxes. Therefore, the overall result could be a decline in the generation of tax revenue.

Considering this extension, we now consider tax revenue as a function of economic growth and corruption. Furthermore, we assume that corruption negatively impacts tax revenue, implying that higher corruption is associated with low tax revenue. Mathematically, the extended model can be written as:

[2] Tax buoyancy is among of various methods employed to gauge a country's revenue productivity or ability to mobilize domestic finance. Other measures include divisia index method, Constant Rate Structure (CRS) method, proportional adjustment method and the dummy variable method (Wawire 2017).

$$TR_k = e^{\alpha_k} Y^{\delta_k} Crr^{\beta_k} e^{\varepsilon} \quad (2)$$

where: *Crr* is the level of corruption, and β is the revenue elasticity of corruption. Taking natural logarithm on both sides of equation (2), we obtain equation (3) in its linear form:

$$lnTR_k = \alpha_k + \delta_k \ln(Y) + \beta_k \ln(Crr) + \varepsilon \quad (3)$$

In equation (3), the variables have been transformed using the natural logarithm. The term α_k represents the intercept, δ_k the coefficient for $\ln(Y)$(the natural logarithm of GDP), and β_k represents the coefficient of $\ln(Crr)$(the natural logarithm of the level of corruption). The variable ε stands for the error term. In this linear form, specifically, the coefficient $\beta_k$can be estimated through a regression analysis to provide valuable insight into the effect of corruption on tax revenue.

2.2 Empirical Model

Based on the extended version of the theoretical framework, the empirical model is constructed as:

$$lnTR_{it} = \alpha_0 + \gamma_1 lnCorr_{it} + \gamma_2 lnDig_{it} + \gamma_3 (lnCorr * lnDig)_{it} + \gamma_4 lnGDP_{it} + \gamma_5 lnInf_{it} + \gamma_6 lnOpn_{it} + \gamma_7 lnPop_{it} + \gamma_8 lngovtrust_{it} + \varepsilon_{it} \quad (4)$$

where: *TR* is Total revenue for country *i* at time *t*, *Crr* is the level of corruption for country *i* at time *t*, *Dig* is digitalisation level of country *i* at time *t*, *GDP* is Gross Domestic Product, measuring the growth rate for country *i* at time *t*, *Inf* is inflation for country *i* at time *t*, *Opn* is trade openness for country *i* at time *t*, *Pop* is the rate of population for country *i* at time *t*, *govtrust* represents the level of trust in governments for country *i* at time *t*. The variable α_0 is the intercept, while γ_i are the parameters to be estimated for *i*=1, 2, 3, …, 8. ε is the error term assumed to be independently and identically distributed with zero mean and constant variance.

In brief, DRM pertains to how countries raise and utilize their own financial resources, primarily through government taxation and private sector savings (Osoro 1993). This study focuses on measuring DRM using Tax Revenue (TR), which comprises compulsory charges imposed by the government, excluding fines and penalties. Corruption (Crr) is assessed through the World Bank's control of corruption (Coc) variable[3], with expectations of a negative impact on DRM due to its association with tax evasion, illicit economic activities, and potential misappropriation of funds. Digitalization (Dig) measures the adoption of Information Communication Technologies (ICT) and is expected to positively influence DRM by reducing tax compliance costs and fraud (Ndung'u 2017). Gross Domestic Product (GDP) serves as an indicator of national income and is anticipated to positively affect DRM, reflecting higher living standards, and providing a larger revenue generation market (Chelliah 1971). Inflation (Inf) serves as a proxy for macroeconomic stability, with high inflation levels negatively impacting DRM by eroding purchasing power and taxpaying capacity. Openness to Trade (Opn) measures the percentage of exports and imports in GDP, potentially positively affecting DRM by facilitating DRM. A larger population size (Pop) in a country is expected to have a positive impact on DRM, as it creates a larger tax base, increased economic activity, and a larger labor force (Bodnár and Nerlich 2022). Lastly, Trust in government (Govtrust) is crucial for revenue generation, as higher trust leads to greater compliance with tax laws, while lower trust can result in evasion and reduced revenue. Building trust between the government and citizens is essential for a healthy revenue system. A breakdown of variable sources is provided in Appendix 1.

2.3 Estimation Technique

This study used Panel Data from 2007 to 2019 to investigate how digitalization influences the connection between corruption and DRM in developing countries (see appendix 2 for countries under consideration). The study chose to use static panel data analysis instead of dynamic panel data analysis because dynamic estimation involves incorporating lagged variables, which would reduce available data points due to the unbalanced panel data in this study. This could result in less robust statistical results.

Static panel data analysis typically employs three primary estimators: Pooled Ordinary Least Squares (POLS), Random Effect Model (REM), and Fixed Effect Model (FEM). POLS assumes no relationship between explanatory variables and errors, but it overlooks individual-specific effects. FEM, on the other hand, addresses individual heterogeneity and controls for time-invariant unobservable factors that might be correlated with independent variables.

[3] For ease of interpretation, the control of corruption scale of -2.5 to 2.5 (best) was rescaled using the formular; $Crr = 2.5 - Coc) \times 2$. This translates into a new scale of 1 – 10 (worst).

Adopting the FEM formulation, equation (4) can be restated as:

$$lnTR_{it} = \alpha_0 + \gamma_1 lnCrr_{it} + \gamma_2 lnDig_{it} + \gamma_3 (lnCorr * lnDig)_{it} + \gamma_4 lnGDP_{it} + \gamma_5 lnInf_{it} + \gamma_6 lnOpn_{it} + \gamma_7 lnPop_{it} + \gamma_8 lngovtrust_{it} + \mu_{it} \quad (5)$$

where: $\mu_{it} = \vartheta_i + \varepsilon_{it}$ and; ϑ_i is the individual-specific effect?

When there is no relationship between the explanatory variables and individual-specific effects, the Fixed Effect Model (FEM) becomes inconsistent and unreliable. In such cases, the Random Effect Model (REM) becomes the most suitable and dependable estimator. REM assumes that there is no correlation at all between the explanatory variables and individual-specific effects, resulting in a covariance of zero between these variables. It is important to note that the choice between FEM and REM is determined using the Hausman test. This test hypothesizes that REM is the preferred model under the null hypothesis, while the alternative hypothesis suggests that FEM is the better model.

In situations where the model faces issues related to heteroskedasticity and serial correlation, this study will turn to the Panel-Corrected Standard Errors (PCSE) estimator. This estimator is known for its ability to handle heteroskedasticity and serial correlation problems, enhancing both the reliability and efficiency of the analysis, as demonstrated by Beck and Katz (1995). PCSE can be computed using either Ordinary Least Squares (OLS) or the Prais-Wintsen estimator.

2.4 The Moderating Effect of Digitalization on the Relationship between Corruption and DRM

The study anticipates that digitalization will play a favorable role in moderating the effect of corruption on DRM. Consequently, the coefficient (γ_3) associated with the interaction term $(lnCrr * lnDig)$ is expected to be positive. Most importantly, both γ_1 and γ_3 must be statistically significant to have a conclusive outcome, otherwise the outcome becomes inconclusive. While several outcomes might emerge, it is the expected that $\gamma_1 < 0$ and $\gamma_3 > 0$. This would imply that as digitalization gains prominence, its positive influence could help mitigate the adverse repercussions of corruption on DRM. However, if the coefficient is negative, it could imply that digitalization might exacerbate the negative influence of corruption on DRM.

3. Research Results and Discussion

3.1 Descriptive Statistics

Table 1 presents a summary of the series, including results for the mean, standard deviation (St. dev), minimum (min), and maximum (max) values. The mean score for DRM, measured as tax revenue, is 2.56, with a standard deviation of 0.66. Additionally, the mean corruption score, rated on a scale of 1 (indicating least corruption) to 10 (indicating highest corruption) in developing countries, is 1.65[4]. The mean digitalisation score is established at 3.49, with a standard deviation of 0.53. In general, the standard deviation indicates varying levels of variability within the data.

Table 1. Descriptive Statistics

Variable	Obs.	Mean	Std. dev	min	max
LnTR	844	2.56	0.66	-0.36	3.98
LnCrr	845	1.65	0.41	-0.62	2.07
LnDig	845	3.49	0.53	1.75	4.54
lnGDP	845	3.08	0.22	-1.11	3.68
LnInf	845	4.36	0.24	-1.31	5.79
LnOpn	843	4.27	0.54	3.03	6.09
LnPop	845	4.14	0.13	3.87	4.46
lnGovtrust	706	0.99	0.38	0.22	1.87

Source: Authors computation

3.2 Correlation

Table 2 presents the results of the correlation matrix, illustrating the degree and potential relationships among the series. The correlation scores within the series are generally suitable for utilisation within the model and for conducting the analyses. In absolute terms, the highest correlation score was observed between lnPop and lnIct,

[4] It is worth pointing out that without the log transformation, the mean corruption score is 5.51.

indicating a positive correlation between these variables. Conversely, the lowest correlation score was noted for lnGovtrust and lnInf, also indicating a positive association. While these results offer insights into the possible relationships among the variables, it is important to note that they have not been tested for statistical significance against any predetermined threshold.

Table 2. Correlation Matrix

	lnTr	lnCrr	lnDig	lnGDP	lnInf	lnOpn	lnPop	lnGovtrust
LnTR	1.000							
LnCrr	-0.062	1.000						
LnDig	-0.016	-0.526	1.000					
LnGDP	0.053	0.030	-0.056	1.000				
LnInf	0.091	0.014	-0.013	-0.033	1.000			
LnOpn	-0.037	-0.561	0.339	-0.033	-0.060	1.000		
LnPop	-0.138	-0.542	0.778	-0.051	-0.027	0.466	1.000	
lnGovtrust	-0.155	-0.649	0.409	-0.077	0.005	0.483	0.468	1.000

Source: Authors computation

3.3 Pre-Estimation Tests

Autocorrelation Test and Heteroskedasticity Test

The study employed the Wooldridge test to identify autocorrelation in panel data and employed the Likelihood-ratio test to evaluate the presence of heteroskedasticity. The compelling findings, as presented in Table 3, undeniably confirm that the models are indeed affected by both first-order autocorrelation and heteroscedasticity issues. This revelation significantly emphasises and reinforces the study's adoption of the PCSE estimation approach.

Table 3. Autocorrelation and Heteroskedasticity Test

Tests	Model 1 (Non-Interaction)	Model 2 (Interaction)
Autocorrelation	F(1, 64)=167.934 *Prob>F=0.000*	F(1, 64)=9.126 *Prob>F=0.004*
Heteroskedasticity	LR chi2(104)=1329.23 *Prob>chi2=0.000*	LR chi2(104)=1422.89 *Prob>chi2=0.000*

Source: Authors computation

PCSE Regression Result and Analysis

Having established that the models exhibit issues of autocorrelation and heteroscedasticity, the PCSE estimator was employed. The models were regressed with the correction for first-order autocorrelation and, as a default, the estimator is robust to heteroskedasticity. In Table 4, the PCSE regression outcomes present estimation results for two models: Model 1 (without the interaction term) and Model 2 (with the interaction term). In both cases, the variation explained by the regressors was approximately 74%, as indicated by the R-squared value. The statistical significance of parameters was assessed at the 5% level of significance. The analysis of the results will follow as outlined below:

Model 1

As expected, the primary variables of interest, Corruption and Digitalisation, exhibited a statistically significant negative and positive association with DRM, respectively. GDP, which measures market size, and trade openness also displayed the anticipated signs, although only the former was statistically significant. In contrast, population growth and trust in government deviated from the study's expectations.

The study reveals that a 1% increase in corruption diminishes the capacity of developing nations to generate domestic revenue by 0.32%, all other factors remaining constant (ceteris paribus). This finding aligns with studies conducted by Gauthier and Goyette (2014), and Ajaz and Ahmad (2010), all of which identified corruption as a hindrance to revenue mobilisation.

Table 4. PCSE Estimation results

	Model 1	Model 2
lnCrr	-0.321**	-2.412***
	(0.105)	(0.721)
lnDig	0.268***	-0.657
	(0.0569)	(0.337)
lnCrr*lnDig		0.522**
		(0.175)
lnGDP	0.169***	0.162***
	(0.0474)	(0.0468)
lnInf	0.0536	0.0440
	(0.0570)	(0.0572
lnOpn	0.0454	0.0627
	(0.0479)	(0.0480)
lnPop	-1.975***	-2.031***
	(0.425)	(0.410)
lnGovtrust	-0.163**	-0.190**
	(0.0626)	(0.0611)
_cons	9.537***	13.51***
	(1.702)	(1.929)
Obs	760	760
R-Squared	0.738	0.738
Standard errors in parentheses		
* p<0.05, ** p<0.01, *** p<0.001		

Source: Authors computation

Corruption can manifest through tax evasion, involvement in illicit economic activities that lead to tax avoidance, and potential misappropriation of funds by corrupt revenue officials. The pervasiveness of corruption in developing countries likely contributes to high revenue leakages, misallocation of resources, and weakened tax systems, which in turn impede governments' ability to generate domestic revenue. Consequently, this impediment hampers the implementation of developmental plans, leading to increased debt accumulation and overreliance on aid.

In contrast, assuming all other factors remain equal, a 1% increase in digitalisation results in a 0.27% increase in DRM in developing countries, indicating a positive impact of digitalisation on revenue mobilisation. The introduction of digital technologies in the economic system enhances processes, creates revenue opportunities, and improves efficiency by reducing tax compliance costs. Digitalisation offers efficient and automated methods for tax assessment and collection, thereby reducing opportunities for corruption as it eliminates the need for face-to-face interactions (Bird and Zolt, 2008). Data integration through digitalisation significantly enhances RM by enabling tax authorities to identify discrepancies and uncover hidden revenue sources. Implicitly, this finding aligns with the work of Adeleye *et al.* (2023).

Furthermore, a 1% increase in economic activities leads to a 0.17% increase in DRM in developing countries, assuming all other factors remain constant (ceteris paribus). This finding suggests that economic growth resulting from increased economic activities in the market reflects improved living standards and development, providing a larger market size for revenue generation (Chelliah, 1971). Unlike economic growth (GDP), both population growth and trust in government exhibit a statistically significant negative association with revenue mobilisation in developing countries.

The findings reveal that a 1% increase in population size reduces revenue mobilisation by 1.98%, assuming all other factors remain constant. This finding, although deviating from the study's initial expectation, can be explained by two plausible factors within the study's context. Firstly, developing countries may have a high dependency ratio among their population, indicating that a larger proportion of the population is outside the workforce or unemployed. If these individuals do not engage in meaningful economic activity contributing to economic expansion at a similar growth rate as the population, then tax revenue as a share of GDP may decline. Secondly, if population growth primarily involves an increase in lower-income groups, their contribution to raising revenue levels may be less compared to higher-income groups, subsequently reducing per capita tax revenue.

Similarly, a 1% increase in government trust is found to reduce DRM by 0.16% in developing countries, assuming all other factors remain constant. The study initially expected that higher levels of trust between a government and its citizens would result in greater tax compliance, leading to increased tax collection and reduced tax evasion. However, the political, economic, and social structures in developing countries can play a dominant role in revenue generation. For instance, the high level of informality in developing countries can lead to lower tax revenue regardless of government trust. Moreover, even if citizens trust the government, developing countries often lack the administrative and enforcement capacity required for effective DRM.

Model 2

In this analysis, the primary focus is on the moderating effect of digitalisation on the relationship between corruption and DRM. The results presented in Table 4 indicate that the parameters of interest, γ_1 and γ_3, enter with the expected signs (γ_1 < 0 and γ_3 > 0) and were found to be statistically significant. This discovery suggests that Digitalisation (Dig) moderates the detrimental impact of corruption on DRM in developing countries by complementing efforts to combat corruption, thereby increasing revenue collection through taxation. Consequently, a higher level of digitalisation corresponds to a greater likelihood of combating corruption and mitigating its adverse effects on DRM. This finding provides robust empirical support for studies by Bird and Zolt (2008), Máchová, Volejníková and Lněnička (2018) and Adeleye *et al.* (2023) regarding the positive influence of introducing digital technologies into the tax system.

Calculating the Net Effect

Furthermore, the moderating effect of digitalisation can be determined by computing the net or conditional effect of corruption on DRM. As previously mentioned, the coefficients γ_1 and γ_3 must be statistically significant for this evaluation. The moderator term can be assessed using three scores: mean, maximum, or minimum score, as recommended by Cohen *et al.* (2013). In line with Ofori, Osei and Alagidede (2022), this study utilises the mean score. The computation is performed using the following equation:

$$\frac{\partial lnTR}{\partial lnCrr} = \gamma_1 + \gamma_3 \overline{lnDig} = 0 \qquad (6)$$

where, $\overline{lnDig}$ represents the mean digitalisation score which is 3.49.

In line with equation (6), the net effect is calculated as;

$$\frac{\partial lnTR}{\partial lnCrr} = -2.412 + (0.522 \times \overline{lnDig})$$

$$\frac{\partial lnTR}{\partial lnCrr} = -2.412 + (0.522 \times 3.49)$$

$$\frac{\partial lnTR}{\partial lnCrr} = -0.592$$

Utilising the mean digitalisation score, a negative net effect of -0.59% was determined. This result implies that introducing digital technologies at the current mean value of 3.49 to mitigate the adverse impact of corruption on DRM by 1% is expected to result in a negative net effect of approximately -0.59%. In simpler terms, the potential advantages gained from reducing corruption in the presence of digitalisation to enhance DRM are outweighed by negative consequences, which might encompass increased costs, inefficiencies, or unintended adverse outcomes.

Turning Point

However, having met the pre-conditions for digitalisation to mitigate the impact of corruption on DRM, the existence of a turning point cannot be disregarded. To address this, the point at which the impact of digitalisation dominates and becomes positive was calculated using equation (6). Although somewhat simplistic, the proposed approach involves solving for $\overline{lnDig}$ as outlined below:

$$\frac{\partial lnTR}{\partial lnCrr} = -2.412 + (0.522 \times \overline{lnDig}) = 0$$

$$\overline{lnDig} = \frac{2.412}{0.522} = \mathbf{4.621}$$

From this analysis, it can be determined that any value below the threshold means digitalisation score of 4.621 will result in a negative net effect. This implies that within that range, the interaction between corruption and digitalisation does not enhance DRM. Conversely, any mean digitalisation value above this threshold yields a positive net effect, indicating that digitalisation's influence on mitigating corruption could enhance revenue mobilisation in developing countries.

Evidence of a turning point indicates that the effect of digitalization on the relationship between corruption and DRM is not linear. The moderation of corruption's negative effect after the turning point suggests that the positive effects of digitalization on DRM might take time to manifest fully. Probably, this gradual process could be attributed to factors such as the adoption rate of digital technologies, institutional changes, and the development of a digital culture.

Comparative analysis

A comparative analysis of the moderating effect across regions is presented in Table 5. Regionally, the results indicate that two outcomes were inconclusive for the Middle East and North Africa (MENA) and South America. In contrast, outcomes for East Asia, Latin American Countries, and the Caribbean (LACandCA), Sub-Saharan Africa (SSA), and South Asia were conclusive, although only one of these outcomes did not align with the study's expectations (LACandCA). Surprisingly, despite having a positive net effect, the results revealed that the introduction of digital technologies would diminish the positive influence of corruption on DRM. This finding is entirely contrary to our initial assumption.

However, in the case of East Asia, Sub-Saharan Africa (SSA), and South Asia, digitalisation was discovered to alleviate the impact of corruption on DRM. Nevertheless, when considering the net effect, only East Asia, with its mean digitalisation score, experienced a positive net effect, reducing corruption by 0.033%. In contrast, for both SSA and South Asia, a mean digitalisation scores above 3.820 and 3.519, respectively, is required for the influence of digitalisation to effectively mitigate the adverse effects of corruption on DRM.

Table 5. Comparative analysis

Regions	Mean Digitalisation Score	γ_1	γ_3	Net effect	Turning Point
East Asia	3.745	-1.105*	0.304**	0.033	
LACandCA	3.750	4.713**	-1.220***	0.138	
MENA	3.781	4.612	-1.917**	Inconclusive	
SSA	3.815	-4.252**	1.113***	-0.006	3.820
South America	3.036	-1.637	-0.281	Inconclusive	
South Asia	3.055	-3.899***	1.108***	0.514	3.519

Source: Authors computation

Conclusions: Implications and Suggestions for Policy Actions

The empirical findings and analysis presented in this study offer valuable insights into the complex dynamics of DRM in developing countries, with a particular focus on the impact of corruption and digitalisation. These findings address a critical research gap by shedding light on the joint effect of digitalisation on the corruption-revenue mobilisation nexus, an area that has remained relatively understudied.

Firstly, it is evident from the results that corruption has a detrimental effect on DRM in developing countries. A 1% increase in corruption is associated with a 0.32% decrease in domestic revenue. This emphasises the urgent need for anti-corruption measures and reforms in these nations. Policymakers should prioritize efforts to reduce corruption through stricter enforcement of anti-corruption laws, enhancing transparency in government operations, and promoting a culture of accountability. Furthermore, measures to strengthen tax administration and reduce opportunities for corruption in tax collection processes are crucial. This may include the implementation of digital solutions for tax assessment and collection, as digitalisation has been found to have a positive impact on DRM by mitigating the adverse effect of corruption.

Secondly, the study highlights the positive influence of digitalisation on DRM. A 1% increase in digitalisation is associated with a 0.27% increase in domestic revenue. To harness the benefits of digitalisation fully, policymakers should invest in the development of digital infrastructure and technologies. This includes expanding access to the internet and promoting digital literacy among citizens and businesses. Governments should also prioritise the modernisation of tax systems by introducing digital tools for tax assessment, payment,

and reporting. These measures can help reduce tax evasion and improve tax compliance, ultimately leading to higher revenue collection.

Additionally, the study found the moderating effect of digitalisation on the relationship between corruption and DRM in developing countries to be non-linear. Understanding this non-linearity is crucial for policymakers, as it suggests that the benefits of digitalization may not be immediately apparent and could require a certain level of technological advancement. The specific digitalization score of 4.6 as the turning point implies that it's not just the presence of digital technologies but the quality and extent of digitalization that matters. Policymakers and stakeholders should focus on the depth and sophistication of digital infrastructure rather than just its mere existence. This underscores the importance of investing in comprehensive digitalization strategies.

Across regions, the moderating effect varies significantly, suggesting that policymakers should consider regional differences in their policy approaches. In regions where digitalisation has a positive moderating effect, such as East Asia, efforts should be made to accelerate digitalisation initiatives. In regions where a higher threshold of digitalisation is needed to realise positive effects, such as Sub-Saharan Africa and South Asia, policymakers should focus on building the necessary digital infrastructure and capabilities.

In conclusion, addressing corruption and promoting digitalisation are key policy actions for enhancing DRM in developing countries. By implementing anti-corruption measures and embracing digital technologies, governments can improve revenue collection, reduce economic disparities, and advance sustainable development. This study bridges a significant research gap by elucidating how these two factors interact and offers actionable insights for policymakers to navigate the complex landscape of revenue mobilisation in the digital age, ultimately contributing to the betterment of developing nations. Importantly, by examining how digitalisation moderates the association between corruption and DRM in developing countries, new and insightful revelations emerged. The study becomes the first to establish a possible turning point level on the moderating effect of digitalization on the relationship between corruption and DRM, suggesting a nonlinear relationship.

Credit Authorship Contribution Statement

Talatu Jalloh: Mr. Talatu Jalloh played a pivotal role in conceptualizing the research topic, collecting data, analyzing the methodology (including developing the theoretical framework), estimating the results, and providing a comprehensive analysis of the findings. Additionally, both Mr. Jalloh and the co-author contributed to developing the abstract and conclusion.

Emerson A. Jackson: Mr. Emerson A. Jackson significantly contributed to conceptualizing the research topic and contextualizing it by writing the research background/introduction. He also conducted a thorough review of both theoretical and empirical literature. Furthermore, both Mr. Jackson and the co-author collaborated on developing the abstract and conclusion.

Declaration of Competing Interest

The authors assert that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Appendices

Appendix 1: Summary Data description

Variable	Definition	Source	Expected sign
Tr	Tax revenue in percent of GDP	IMF, World Revenue Longitudinal data. https://data.imf.org/?sk=77413f1d-1525-450a-a23a-47aeed40fe78	
Crr	Corruption, rescaled from -2.5 (worst) to 2.5 (best), to 1(best) to 10 (worst)	World Governance Indicators, World Bank Databank. https://databank.worldbank.org/	-
Dig	ICT accessibility and integration of communication systems within the population.	UNCTAD stats, https://unctad.org/statistics	+
GDP	GDP growth (annual %)	World Development Indicators, World Bank Databank. https://databank.worldbank.org/	+
Inf	Consumer Price indices, annual	UNCTAD stats, https://unctad.org/statistics	-
Opn	Sum of exports and imports as share of GDP	World Development Indicators, World Bank Databank. https://databank.worldbank.org/	+
Pop	Population ages 15-64, (% of total population)	World Development Indicators, World Bank Databank. https://databank.worldbank.org/	+
Govtrust	Public trust in politicians measured on a scale of 1 -7(best) value	World Economic Forum, Global Competitive Index Historical dataset. https://www3.weforum.org/docs/GCR2017-2018/GCI_Dataset_2007-2017.xlsx	+

Appendix 2: List of countries

SSA	MENA	East Asia	LACandCA	South America	South Asia
Benin	Bahrain	Cambodia	Barbados	Argentina	Bangladesh
Botswana	Egypt	China	Costa Rica	Bolivia	India
Burundi	Jordan	Hong Kong SAR, China	Dominican Republic	Brazil	Nepal
Cameroon	Kuwait	Indonesia	El Salvador	Chile	Pakistan
Cote d'Ivoire	Mauritania	Malaysia	Guatemala	Colombia	
Gambia, The	Morocco	Mongolia	Honduras	Ecuador	
Ghana	Oman	Philippines	Jamaica	Paraguay	
Kenya	Qatar	Singapore	Mexico	Peru	
Lesotho	Saudi Arabia	Thailand	Nicaragua	Uruguay	
Madagascar	Tunisia	Vietnam	Panama		
Mali	United Arab Emirates				
Mauritius					
Mozambique					
Namibia					
Nigeria					
Senegal					
South Africa					
Tanzania					
Uganda					
Zambia					
Zimbabwe					

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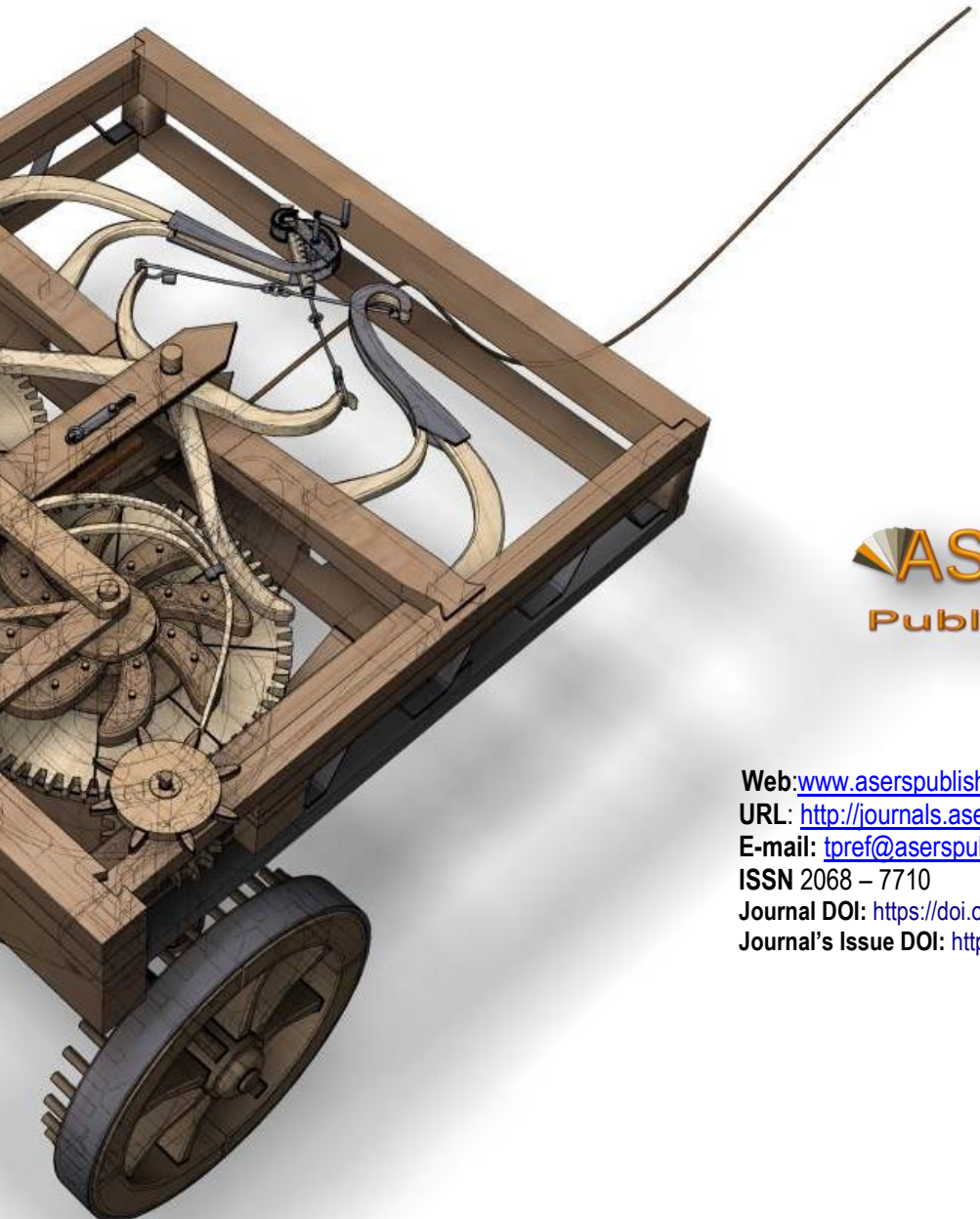

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