

American University in Cairo

## AUC Knowledge Fountain

---

Theses and Dissertations

Student Research

---

Summer 6-15-2023

# The Role of E-Governance On Corruption in The Mena Region: A Panel Data Analysis

Doaa abdelwareth  
doaa800183174@aucegypt.edu

Follow this and additional works at: <https://fount.aucegypt.edu/etds>



Part of the [Public Affairs, Public Policy and Public Administration Commons](#)

---

### Recommended Citation

#### APA Citation

abdelwareth, D. (2023). *The Role of E-Governance On Corruption in The Mena Region: A Panel Data Analysis* [Master's Thesis, the American University in Cairo]. AUC Knowledge Fountain.

<https://fount.aucegypt.edu/etds/2068>

#### MLA Citation

abdelwareth, Doaa. *The Role of E-Governance On Corruption in The Mena Region: A Panel Data Analysis*. 2023. American University in Cairo, Master's Thesis. *AUC Knowledge Fountain*.

<https://fount.aucegypt.edu/etds/2068>

This Master's Thesis is brought to you for free and open access by the Student Research at AUC Knowledge Fountain. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of AUC Knowledge Fountain. For more information, please contact [thesisadmin@aucegypt.edu](mailto:thesisadmin@aucegypt.edu).

**The American University in Cairo**

**School of Global Affairs and Public Policy**

**THE ROLE OF E-GOVERNANCE ON CORRUPTION IN THE MENA  
REGION: A PANEL DATA ANALYSIS**

**A Thesis Submitted to the Public Policy and Administration Department**

**In partial fulfillment of the requirements for the degree of Master of Public  
Policy**

**By**

**Doaa Hosny Abdel Wareth Elsayed**

**Spring 2023**

## Acknowledgments

"وَقَالُوا حَسْبُنَا اللَّهُ سَيُؤْتِينَا اللَّهُ مِنْ فَضْلِهِ وَرَسُولُهُ إِنَّا إِلَى اللَّهِ رَاغِبُونَ"

First, I want to express my gratitude to God Almighty for providing me the perseverance and strength to complete this thesis. I thank God for his countless blessings, including the blessing of completing this study under the guidance of the supervisors of the American University in Cairo. A special word of admiration and gratitude goes out to my professors from the Department of Public Policy and Administration. They assisted me in completing this task and provided me with all the information I needed as well as their invaluable and priceless input to direct me appropriately. They have all my greetings and appreciation, especially my supervisor, Professor Shahjahan Bhuiyan, as well as to Professors Laila El Baradei, Ghada Barsoum, and Rana Hendy. They have all my love and respect for their excellent advice and kind support.

My sincere appreciation for the difficult circumstances and challenges created a solid personality to accomplish this valuable task. I thank myself, who repeatedly pushed me to improve over the days and achieve one goal after another boredom.

I dedicate this thesis to my mother, who had faith in me, and my father, who guided me through the uncertainty and several roadblocks and encouraged me through all the breakdowns.

Lastly, I want to thank all my brothers, friends, and kids for their endless love and kind support.

**Thanks to everyone who helped me achieve my goal!**

## Contents

<b>ABSTRACT</b>	<b>1</b>
<b>CHAPTER 1</b>	<b>2</b>
<b>INTRODUCTION</b>	<b>2</b>
1.1 Background	2
1.2 E-Governance	3
1.3 Corruption	9
1.4 Significance of the study	12
1.5 Research question	13
This study examines the answer to the does the e-government has a significant impact in eradicating corruption in MENA countries.	13
1.6 Research objective	13
1.7 Organization of the study	13
<b>CHAPTER 2</b>	<b>14</b>
<b>LITERATURE REVIEW</b>	<b>14</b>
2.1 E-Governance Development Index (EGDI) and corruption	14
2.2 Online Service Index (OSI) and corruption	17
2.3 E-Participation Index (EPI) and corruption	18
2.4 Human Capital Index (HCI) and corruption	19
2.5 Determinants of corruption	19
2.6 Research gap	20
<b>CHAPTER 3</b>	<b>22</b>
<b>METHODOLOGY AND DATA</b>	<b>22</b>
3.1 Theoretical Model	22
3.1.1 Transaction cost theory	22
3.1.2 Collective action theory	23
3.1.3 Function theory	24
3.1.4 Government centralization theory	24
3.2 Model specification and methodology	25
3.2.1 Data sources and model specifications	25
3.2.2 Research Methodology	28
<b>CHAPTER 4</b>	<b>32</b>
<b>RESULTS AND DISCUSSION</b>	<b>32</b>
4.1 Descriptive statistics	32
4.1 Panel unit root test	36
4.2 Granger causality test	36
4.3 Panel Generalized Method of Moments	37
4.3.1 Discussion of the long-run results of model 1	38
4.3.2 Discussion of the long-run results of model 2	40
4.3.3 Discussion of the long-run results of model 3	42

4.3.4 Discussion of the long-run results of model 4	45
<b>CHAPTER 5</b>	<b>48</b>
CONCLUSION AND POLICY RECOMMENDATIONS	48
5.1 Summary and Conclusion	48
5.2 Policy recommendation	50
<b>REFERENCES</b>	<b>52</b>

## List of Tables

Table 1 Ranking of MENA countries on EGDI .....	7
Table 2 Variables description and sources .....	26
Table 3 Descriptive Statistics of Control of Corruption and E-Government Variables.....	33
Table 4 Descriptive Statistics of Control Variables.....	35
Table 5 Results of ADF Panel Unit Root .....	36
Table 6 Detail results of Granger Causality .....	37
Table 7 Panel Generalized Method of Moments of model 1 .....	38
Table 8 Arellano-Bond Serial Correlation Test.....	39
Table 9 Panel Generalized Method of Moments of model 2 .....	40
Table 10 Arellano-Bond Serial Correlation Test of Model 2 .....	40
Table 11 Panel Generalized Method of Moments of model 3 .....	42
Table 12 Arellano-Bond Serial Correlation Test.....	43
Table 13 Panel Generalized Method of Moments of model 4 .....	45
Table 14 Arellano-Bond Serial Correlation Test.....	46

## Acronyms

<b>EGDI</b> E-governance Development Index
<b>EPI</b> Electronic Participation Index
<b>CPI</b> Corruption Perceptions Index
<b>OSI</b> Online Service Index
<b>WGIs</b> World Governance Indicators
<b>LLC</b> Levin Lin Chu test
<b>IPS</b> The Im Pesaran and Shin test
<b>ADF</b> Augmented Dickey Fuller test
<b>GMM</b> Generalized Method of Moments

## ABSTRACT

This study aims to understand the role of e-governance on corruption in Middle East and North African (MENA) countries. The study also links the adoption of e-governance to the promotion of sustainable development. The panel data of 17 MENA countries were collected from various secondary sources from 2003 to 2020. This study's empirical result was estimated using the Generalized Method of Moments econometric approach. This study has achieved four objectives by using the different proxies of e-government, namely the human capital index (HCI), the online service index (OSI), the e-participation index (EPI), and the e-government development index (EGDI), for the control of corruption. The time-series regression model proves the unidirectional causality between the e-governance proxies and corruption. The long dynamic empirical results show that the EGDI, EPI, and OSI significantly decline corruption in the MENA region. At the same time, HCI has an insignificant association with the control of corruption. Based on the results, the study recommends the utilization of information and communication technology (ICT) in the relevant government sectors to control corruption.

## CHAPTER 1: INTRODUCTION

### 1.1 Background

Economic theories, particularly transaction cost theory, and its role in minimizing the number of parties in each transaction has been credited as an effective tool that achieves good governance (Robins, 1987). In the world today, information and communication technology (ICT) is regarded as one of the most crucial instruments when it comes to increasing the economy's capacity as they are known to improve efficiency, improve the quality of provided services, and increase the general well-being for global citizens (Li et al., 2022). Discussions around technology and its role in economies followed various phases. Some examined how the application of technology promotes productivity and increases economic growth. Others examined the use of technology in economic policy implementation to achieve efficiency and effectively reach economic goals. Instead, some focused on technology as a tool to monitor the overall economic activities (Metcalf, 2010). It can be said that providing government services without modern communication technologies is challenging because citizens must deal with specific officials in a single location and at a single time. Service delivery can occur anytime and through several gates through these modern technologies to reduce transaction costs, lowering the incentives to engage in corrupt behavior.

The internet created a secure network allowing the government to implement policies and develop a governance framework that enhances effectiveness and fights many social and economic problems, including corruption (Adam & Fazekas, 2021). In addition, many countries rely heavily on the internet to effectively implement many service delivery and thus lower costs. This sparked the development of the idea of electronic government (Adeodato & Pournouri, 2020). The concept of e-governance embodies the tools of ICT utilized to operate things that are important for the governments, for example, to give access to the public about information related to government; to operate governmental operations such as conducting elections (biometric voting) and providing information to the people about their rights and to access to steps to ensure rights (Bannister & Connolly, 2012).

The present study will explore the role of e-governance on corruption in MENA nations. In this modern age, these two issues are considered the critical issues to achieving sustainable development goals. Numerous studies explore the nexus between these two issues (Castro & Lopes, 2022; Park & Kim, 2019). Khan (2021) pointed out that e-governance helps tackle corruption. To grasp the link between e-governance and



corruption, it is crucial to comprehend the concepts of e-governance and its associated terms, such as e-government, as well as the notion of corruption and its origins.

## **1.2 E-Governance**

E- governance is a multifaceted concept. It is a method of providing partners with governmental services over the internet. E-governance refers to using technology to access and deliver governmental and public services, for example, to citizens, businesses, and employees (Grigalashvili, 2022).

The United Nations (2019) defined e-governance as the provision of information by the government to the public through the use of ICT. The World Bank also followed the same approach and defined e-Government as ICT's significant role in connecting the public and government institutions (World Bank, n.d.)

Bhatnagar (2003) explained the concept of e-government as the implementation of government policies through the use the ICT among government institutions and citizens. From this perspective, e-governance is a subset that focuses chiefly on improving administrative efficiency.

Researchers argue that using modern technology and communication systems such as social media, mobile phones, and other methods can enhance the channels through which government services can be delivered. E-governance includes two levels of interactions: external and internal. On the one hand, it offers electronic communication systems whereby the purpose is smooth interaction, i.e., to connect government and citizens (Baroi & Alam, 2021). Moreover, it facilitates optimizing internal matters related to governmental work. In combination, these levels of interaction offer the stakeholders (such as the government officers, the law implementing agencies, and the citizens) to remain connected in a fair and accountable manner (Alhassan, 2019).

The two concepts related to external and internal e-governemnt were used interchangeably for decades for the same meaning to indicate the implementation of modern ICT in the interaction between government and people. Both include the utilization of ICT and information technology to ensure institutional effectiveness and efficiency (Lindgren, Melin, Sæbø 2021).

However, there is a specific way to differentiate between e-governance and e-government. A broader way to utilization of modern technology is followed by E-governance. It includes the process of government institutions that provide e-government services. Furthermore, it can be extended by using ICT in government institutions to function better (Pandey et al., 2020). At the same time, e-government follows an institutional and established approach. It concerned the adoption of ICT and modern technology in achieving institutional innovation to satisfy their tasks. In general, one can consider e-government as a step toward achieving e-governance (Alhassan, 2019).

Summing up the core of e-governance, it can be concluded that e-governance is applying ICT and modern technology in government functions to achieve innovative governance (Hooda, & Singla, 2020). Innovative and good governance includes some elements such as (Umbach, Tkalec 2022).

- **Simplicity:** in terms of the administrative techniques powered by ICT to facilitate the user process.
- **Morality:** engaging technology to achieve efficiency and prevent any corruptive behaviors.
- **Accountability:** building a solid information system in the administration process to facilitate and promotes efficiency.
- **Responsiveness:** developing the adopted systems and making them more responsive to developments.
- **Transparency:** making all administrative processes transparent to achieve equity and raise the power of law.

As part of e-government implementation, information technology is used to interact among governments (known as G2G), governments with businesses (known as G2B), and governments with citizens (known as G2C) (Alhassan, 2019).

The main strategic objectives of e-governance include facilitating governance among stakeholders, for example, the government, the citizens, and businesses. ICTs, in one way, connect the mentioned stakeholders. Governance-related matters are better

supported and managed through electronic means and mechanisms, such as exercising economic, political, and administrative authority (Ngonzi & Sewchurran, 2019).

The discussion shows that e-governance is not limited to governmental issues on the Internet. Instead, there are extended to social, political, and economic aspects of e-governance related to internal performance and relating to stakeholders, most importantly (Grigalashvili, 2022).

Evidence suggests that e-governance enhances the government's ability to handle the governance processes easily and swiftly. For example, services in the fields of education, telehealth, citizen participation, and management of localities are dimensions of governance that can be dealt with efficiently, quickly, and swiftly through e-governance (Pandey & Risal, 2020).

Many policymakers and practitioners have demonstrated e-government by using blockchain technology. It transforms government activities by using new ways of handling and processing information. Nakamoto (2008) invented blockchain technology. After 2008, blockchain technology evolved for general purposes and was used to resolve the problem of trust deficit. Over the past few years, many governments have been using this novel technology to handle a variety of functions and services, including educational credentialing, land registration, health care, food supply chain, financial transactions, auditing, taxation, voting and data management (Lemieux and Dener, 2021). This new blockchain technology is using a minimal level, especially in public sectors.

Tan et al. (2022) discussed the conceptual framework of blockchain technology in public sectors. This study used different types of government assessment in terms of infrastructure architecture, interoperability, application architecture, incentive mechanism, decision-making mechanism, organization of governance, consensus mechanism, governance control, and government accountability under micro, meso and macro-level analysis. The study concluded that implementing blockchain technology in these sectors increases efficiency.

In the future, many countries will use blockchain technology to control corruption. It has distinctive features for the eradication of corruption. It can provide

unprecedented security to the information and reliability of record management (Santiso, 2018).

An additional measure of electronic government is Online Services Index (OSI); this composite indicator measures ICT use by governments by assessing the technical features of national websites based on a survey of the online presence of Member States (Garcia-Murillo, 2013; Starke et al., 2016).

Another measure of e-governance is the e-government development index (EGDI), which was developed by UN e-government basis on the Telecommunications Infrastructure Index (TII), International Telecommunications Union (ITU), and Human Capital Index (HCI). These indices measure, through EGDI, the state of readiness and capacity of national institutions for one particular thing: the use of ICT in public services, particularly its provision. It helps to measure governmental performance, and providing suggestions to policymakers and researchers is highly pivotal.

Thus, e-governance can be assessed by using different indicators like blockchain technology, Online Services Index (OSI), Human Capital Index (HCI), the e-participation Index (EPI), and the e-government development index (EGDI).

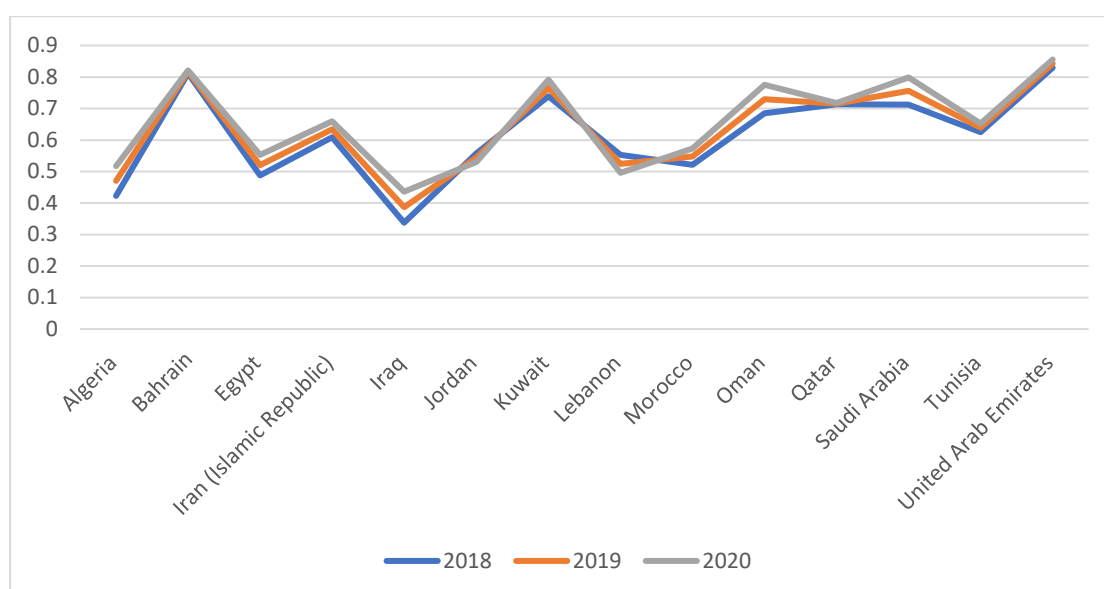
ICT is another indicator to measure the assessment of e-government. In this modern age, ICT is used to promote the accountability and transparency of government institutions. The public can easily monitor government institutions through new mobile phone applications, artificial intelligence, and media reporting through ICT.

MENA region experienced little concern about the concept of e-governance. Instead, the transformation to e-governance included technological changes in administrative and regulatory aspects. The reforms include engaging in digitalization in processing public policies and functions. Lately, many initiatives have been launched to promote e-governance in MENA countries. The present study was conducted in the MENA countries, so it is essential to discuss the situation of e-governance in this region.

Many MENA countries have established citizen-centric e-government systems crucial to their economic and technological development to lower transaction costs and low performance in social and economic development (Hujran et al., 2020). These

countries are trying to bring structural transformation to their institutions and shift them into digitalization. These countries have introduced ICT, which has made significant progress (OECD, 2017). **Error! Reference source not found.** represents selected MENA countries and their rankings in EGDI over recent years.

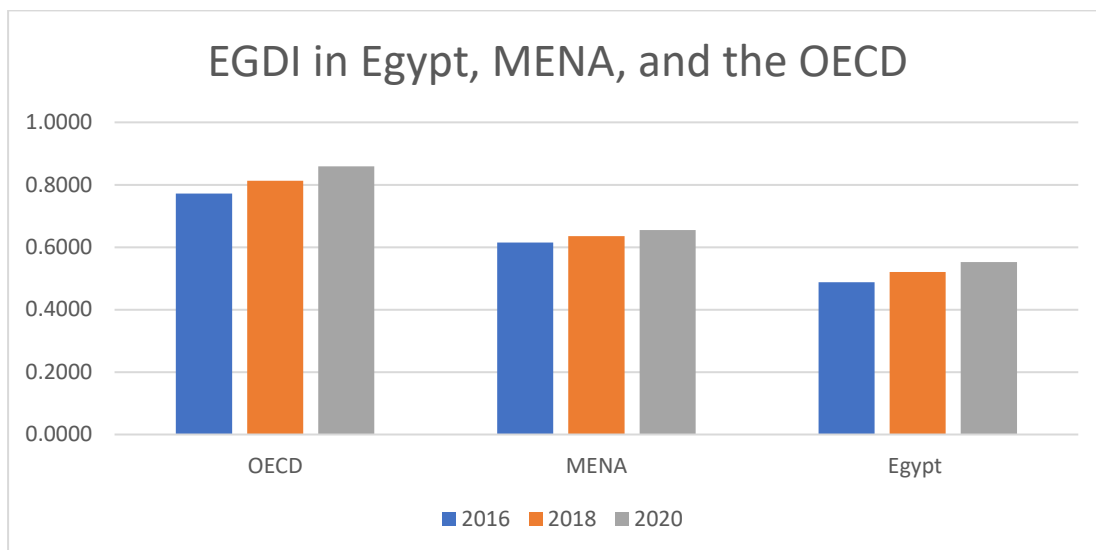
**Figure (1) Ranking of MENA countries on EGDI**



**Source: Author's calculation based on UN E-government survey (2020).**

The above graph denotes that the value of EGDI of some member countries shows that countries with high-income levels, such as Saudi Arabia, Kuwait, Bahrain, Oman, and the United Arab Emirates, have achieved high values of e-government and are classified as very high EGDI countries with EGDI greater than 0.75 (UN E-Government knowledge, 2021). On the other hand, few middle and low-income MENA countries have achieved a lower-level of e-governance.

**Figure (2), A comparison between the MENA e-government development index, OECD, and Egypt.**



**Source: The graph is based on the author's calculations**

The above graph illustrates the total average in MENA region compared to the average in OECD and Egypt.

The OECD developed a strategy to promote e-government in the MENA countries, including some general policy recommendations and sub-procedures to facilitate the performance including (OECD, 2017):

1. Raising the level of transparency and inclusiveness in government administration and regulation.
2. Encouraging the cointegration between government, citizens, businesses, and other actors in policy formulation and designing an administrative system for optimal service delivery.
3. Developing a culture of data management in government. The data analysis is the primary tool to identify the actual status of all productivity levels and the primary tool to build an opinion and policy recommendation for service facilitation.
4. Raise the attitude of public commitment and political support to achieve vital steps in the process of application.
5. Coordinate digital strategy implementation across the government using effective administrative and governance frameworks.

6. The process of e-governance requires some external aspects. It is critical to ensure a healthy level of international coordination with other governments.
7. Ensure some business proposals to sustain funding and benefit the private sector to confirm the digital transformation.
8. Select the digital technology that fits the given tasks based on the available assets.
9. Consider the optimal legal and regulatory frameworks that allow the smoothness of service delivery.

Applying e-governance in economic institutions is intensively productive as it optimizes economic resources and prevents market losses and distortions. The sectors in which it can be applied and the application mechanism defines its success and productivity. Furthermore, the intersection between governance's economic, social, and administrative aspects comes mainly from corruptive behavior (BOYALI, 2022).

In the MENA region, there is a broad diversification in both the interpretation of e-governance and the status of reaching e-governance in each country. Some nations use the term as an indicator for facilitating government service delivery. Others add the use of e-governance to raise productivity. Some countries raised the concept of making e-governance a general vision in the process of each small transaction.

These different interpretations are reflected in various rankings for each MENA region country. The diversification could not be linked only to the income inequalities and resource availability or infrastructure discussed by most studies. Instead, it is the meaning of the e-governance process that each country follows (Bhatnagar, 2003; Mistry, 2012; Mistry, Jalal, 2012; Seo, Mehedi, 2016).

The way of thinking about e-governance is the invisible hand that could effectively implement e-governance. It defines the level of success and productivity in moving towards e-governance.

### **1.3 Corruption**

Corruption is a worldwide critical phenomenon that puts grave constraints on society's development (Myint, 2000). The effects of this problem are serious on all

dimensions, economically, socially, politically, and legally. Corruption exists in every country, regardless of its development level. Fighting corruption has become one of the most important goals for all governments in adequately addressing public policy (Mistry, 2012).

Myint (2000) defined corruption as using government offices for private purposes. Government officials use their government office for personal benefits. Following this definition, the corrupt government official's behavior includes nepotism, bribery, extortion, influence peddling, and cronyism of government assets for private use.

Sources of corruption differ in nature and field. They may be economic, social, legal, managerial, or political. The key source is the poor bureaucracy, administrative systems, and political instability (Dimant and Tosato, 2017). Government size and structure are considered significant sources of corruption. The larger the government's size is, the higher the corruption level. This is for the reason that a large government size increases bureaucracy and government intervention's power in the economic fields. However, Bel (2021) indicated a positive relationship between government size and corruption levels. The positive relation is because a high level of bureaucracy would cause higher corruption within the large size of government. Poor transparency is also another major cause of corruption in many developing countries. Dominik and Christina (2017) pointed out that corruption causes many distortions in the market economy. In many cases, corruption puts restrictions on the process of economic development.

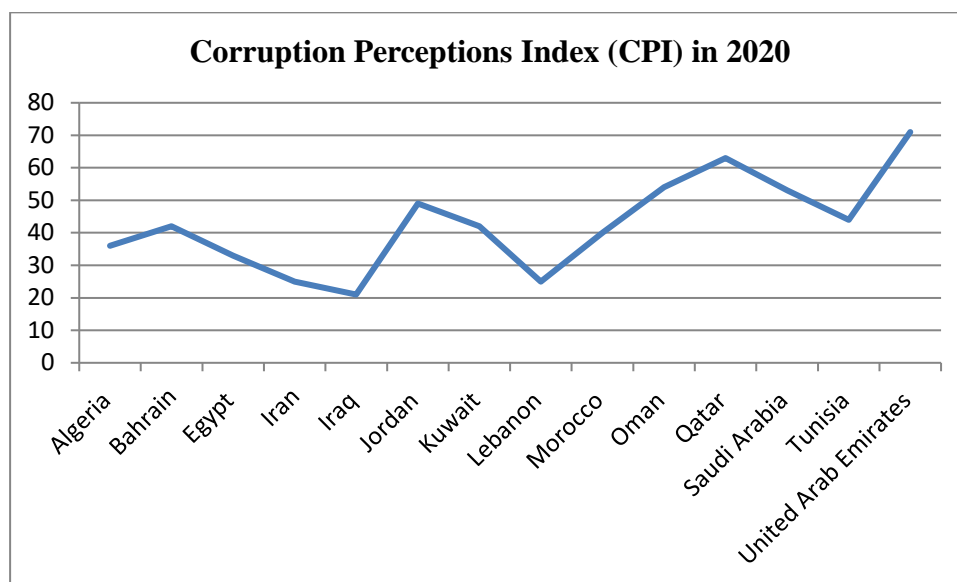
In general, corruption is responsible for inefficiency across many domains, for instance, lowering the GDP, lack of competitiveness in market sectors, and observance in lack of investments due to lack of trust; it is also responsible for inequality across the different social classes whereby Marxist philosophy is applicable such as due to corruption the rich become more prosperous (Bratsis, 2014).

The present study is conducted in the MENA region. In this region, poor socio-economic development and violation of fundamental rights are the primary reasons for corruption. This affects not only the economic situation directly but indirectly impacts crimes. Political and economic instability are significant impacts of corruption in the



Middle East. Political instabilities created many corruptive behaviors for many years. Political corruption is the significant prominent type. The high levels of corruption lowered the quality of public services as well as lowering the quality of institutions.

**Figure (3) CPI (Corruption Perceptions Index) in 2020**



**Source: Author's calculation based on data from Transparency International**

The MENA region experiences high levels of corruption. According to Transparency International, the MENA countries scored an average of 43 out of 100 in the Corruption Perceptions Index (CPI) in 2020, reflecting little progress in fighting corruption (CPI, 2020). The UAE acquires the highest scores -with a score of 71/100- and Qatar scoring 63/100. Lower levels are experienced in Iraq at 21/100 and Iran at 25/100.

Figure shows the scores of MENA countries from international ranking in the CPI in 2020.

Corruption in the MENA region varies enormously according to its level, features, values, and impact.

Figure shows the corruption levels in the MENA region and that most countries in the region score high corruption levels. Corruption in MENA countries records strong diversification based on the most intensive corruptive sectors. As countries build robust digital procedures, corruption goes down.

Thus, controlling corruption is mandatory to stimulate economic growth and economic development. The necessity to find an influential force in controlling corruption becomes a must. E-governance can be the most potent method through its specific, powerful techniques.

Corruption is a worldwide critical phenomenon that severely constrains society's development (Dhaoui, 2022). Corruption exists in all countries regardless of the level of development. Fighting corruption is one of the main targets for all governments. Without prevailing corruption, no country can achieve sustainable development goals (Hoffiani, 2019). Corruption is a hurdle to achieving sustainable development goals (SDGs) in a multifaceted manner such as first, the context of eradicating hunger and poverty; second, preventing people from knowing about their rights and making them think about meeting basic needs only; third, moral corruption such as indulgence in environmentally hazardous activities as environmental deterioration one of the biggest threats. In this regard, e-governance can play a pivotal role as it provides better access and ease in access to information, better monitoring and makes the government and those in authority accountable.

The study analyzed the relationship between e-governance and corruption in MENA countries. It also identifies the critical e-government variables, including EGDI, EPI, OSI, and HCI, which are the significant determinates of corruption in the MENA region.

#### **1.4 Significance of the study**

The poor performance of the MENA countries in achieving the SDGs has put pressure to bring reforming their public institutions to increase their effectiveness and efficiency. Most MENA countries are trapped in world financial agencies (IMF, World Bank) to fulfill their financial requirements (IMF, 2003). The IMF structural adjustment program (SAP) has slightly upgraded its public institutions to achieve sustainable economic growth, but most of these countries are still lagging behind other developing countries. The massive deregulations and corruption in the public institutions of these countries are failed to fulfill the public expectations. The internal pressure from the public and external pressure by international organizations through the acceleration of globalization has motivated these countries to pay special attention to improving

governance and redesigning public management (Davoodi, Abed 2003). For this purpose, most MENA countries seek a solution to fulfill their public benefits through modernization by improving public institutions. The present study contributes by focusing on the role of e-government on corruption. E-government is considered the instrument to bring reform in the institutions. For this purpose, this study explores tools to control corruption like EGDI, EPI, OSI and HCI. This study is very significant because it is the first study that uses the four proxies of e-Government to measure the control of corruption.

### **1.5 Research question**

This study examines whether e-government has a significant impact in eradicating corruption in the MENA countries.

### **1.6 Research objective**

- To better understand the role e-governance plays for the control of corruption in the MENA nations.

### **1.7 Organization of the study**

The study is comprised of five chapters. The study's problem statement, research questions, objectives connected to the topics being studied, the role of e-governance in eliminating corruption, and the study's organization are all provided in the first chapter. The second chapter reviews the pertinent research-related literature before highlighting the research gap. The methods and conceptual framework are covered in Chapter 3. The fourth chapter examines the empirical results and focuses on the findings and discussion. Chapter five succinctly concludes the study.

## **CHAPTER 2: LITERATURE REVIEW**

This chapter discusses the published literature as to how e-Government indexes play a role in reducing corruption. The first section discusses the literature on the role of the e-governance development index (EGDI) on corruption; the second section examines the relationship between the online service index (OSI) and corruption, and the third part investigates the role of e-Participation index (EPI) on the control of corruption. The fourth explores the nexus between the human capital index (HCI) on corruption, the fourth section debates a few other determinants of corruption, and the last section highlights the research gap.

### **2.1 E-Governance Development Index (EGDI) and corruption**

EGDI is an essential indicator of e-Government because it assesses the e-government policies and strategies a country adopts in their institutions. This section discusses the role of EGDI in controlling corruption from various perspectives like global perspectives, regions, and panels of countries and individual country cases.

Numerous studies explored the link between e-governance and corruption globally. In a panel of 175 nations from 2003 to 2019, Castro and Lopes (2022) empirically explored how e-government affected the level of corruption. The panel regression estimated various corruption control determinants like accountability, e-government, internet access, political stability, and economic prosperity. Furthermore, it explored that EGDI played a significant role in controlling corruption and improving governance. From 2003 to 2016, 214 nations' empirical data on the relationship between corruption and e-government were investigated by Park and Kim (2020). The fixed effect concluded that e-government significantly declined corruption. Yalaman (2019) developed a model with panel data of 193 countries from 2003 to 2017. The study indicated that e-governance significantly declined corruption. The effect of e-governance on applications mainly focused on the applications used in e-government. Basyal et al. (2018) pointed out the link between e-governance and corruption from 2003 to 2014, considering many other determinates, including economic prosperity, inflation, and good governance. The study developed a heterogeneous model using panel data for 176 countries worldwide. The study showed that e-government had no positive impact on declining corruption, while good governance and economic

prosperity significantly contributed to declining corruption. While it also found that there was no evidence of inflation and political rights to reduce corruption.

There is also available literature on the different regions like Latin America region, MENA region, European Union (EU), and South Asian region that classified the geographical aspects, political regimes, or even economic development status. Kalesnikaite et al. (2022) examined the impact of EDGI on bureaucratic corruption by controlling political culture, urbanization, inflation, and economic development. This study was carried out in the Latin America region from 2008 to 2018. The empirical results were estimated by the fixed effect and found that e-government significantly declined bureaucratic corruption. It also concluded that urbanization and economic development declined corruption while inflation and political culture increased corruption.

Dhaoui (2021) investigated the electronic government's role in various aspects of social and economic development in the MENA region from 2003 to 2018. Findings showed that digitalization plays a vital role in controlling corruption through effective governance. This study concluded that good e-governance positively affects sustainable development.

Setyobudi and Setyaningrum (2019) examined the impact of e-governance on the CPI. The study concluded that the e-government declined the CPI. The study assumed that following e-governance techniques on the transaction level and promoting transformation to modern technology makes the impact effective regarding corruption eradication in developed countries. On the other side, in the developing states, e-governance is in infancy mode, for example, at the information and interaction stage only and, therefore, not that effective.

Lupua and Lazrb (2015) tested the relationship between EGDI and corruption in the European Union (EU) and non-EU countries. The analysis covered two separate periods 2004, 2007, and 2012. The study conducted two models, one for EU countries and the other for non-EU countries. The study found that the EGDI application causes lower corruption in EU and non-EU countries. It also showed that over time countries benefit more from the application of modern technology.

Many studies empirically examine how the EGDI affects corruption in individual country analysis. Cárdenas and González (2022) conducted their study in Mexico to examine the impact of EGDI on corruption from 2015 to 2019. The study confirmed the inverse relationship between EGDI and control of corruption.

Some micro-level studies explored the link between EGDI and corruption. Purnamasari et al. (2022) conducted a micro-level study, and data were collected through questionnaires, government officials, business representatives, media, and NGOs in Malaysia and Indonesia in 2021. The study found that the Penta-helix of e-government significantly combated corruption.

In Nigeria, Abdulkareem et al. (2021) pointed out that adopting Information and communication technology (ICT) played a significant role in combatting bureaucratic corruption. This study's result was estimated using the primary data collected through questionnaires and interviews.

Alahmadi (2018) conducted a micro-level study based on a questionnaire in Yemen to investigate the relationship between e-governance and corruption. There are attributes and indicators, for instance, having a look and control over monopoly power, discretion, and most importantly, the intervening factors such as the middleman, which probably have the most crucial role in corruption. The research concluded that ICT is essential in e-governance to minimize corruption.

E-governance plays a significant role in accountability to the developing countries for the international donor organizations (IMF, World Bank) to provide funds to the developing countries. Ventrone (2021) concluded that developed countries and international donor agencies consider e-governance and that ICT and its components are indicators of accountability in governance. Taker governments are thus moving towards Western firms, the only available sources of knowledge and technologies. The difficulties experienced by developed countries are beaten, and developing countries are motivated to adopt more ICTs for e-governance simply to get more aid.

The extensive body of literature demonstrates how important it is to address the connection between corruption and e-governance in order to advance economic and sustainable development, particularly in developing nations. The responsibility of

controlling corruption can be fully granted if e-governance is applied effectively to facilitate and promote economic activity.

Additionally, the idea of optimally controlling corruption by motivating e-governance and improving its techniques is critical. Thus, the study provided a specific analysis of the MENA region's main aspects of governance and e-governance and presented why corruption is critical and essential to development plans. It was also critical to clarify the status of each concept in the MENA region.

## **2.2 Online Service Index (OSI) and corruption**

Providing efficient online service to citizens is an objective to ensure e-government. The online service evolves the e-Government services through a service that is innovative in the availability, connectivity, and superiority of the public services (reference?). It promotes accountability and transparency, which is considered an effective tool to eradicate corruption for the government (Garcia-Murillo, 2013; Starke et al., 2016). Through online services, the public and government institutions interact with each other. The new mobile applications, extensive data analysis, artificial intelligence and website play a significant role in to fight against corruption through access to public information, digitization in public service, monitoring officers' activities and enabling corruption reporting.

Jha and Sarangi (2022) pointed out the nexus between the government online services index with control of corruption. The empirical results found that online services through ICT and internet services significantly played a role in controlling corruption.

Fan et al. (2021) investigated online services' role in reducing firms' corruption pressure. This study used the data of 39796 firms from 76 countries from 2007 to 2016. The study came to the conclusion that the relationship between online services and corruption is the function of the competitive environment (protection of property rights, check and balance). A strong competitive environment decline corruption, while a weak competitive environment increases corruption.

Park and Kim (2020) studied the effect and role of the online services index on corruption in 214 countries from 2003 to 2016. The empirical analysis revealed that online services of the government decline corruption.

Starke et al. (2016) examined the role of government service delivery on corruption in 157 countries from 2003 to 2013. The study found that online services of government institutions declined corruption.

### **2.3 E-Participation Index (EPI) and corruption**

The EPI shows the involvement of information technology to enhance the accessibility of information and public service. Many studies explored the nexus between EPI and corruption prevention.

Using ICT, Adam and Fazekas (2021) examined EPI's relationship with corruption. The study found that ICT can eradicate corruption in numerous ways: promoting accountability and transparency, facilitating corruption reporting, government-citizen interactions, and enabling citizen participation. While on the hand, ICT can promote corruption through the dark web and misuse of technologies.

Wang et al. (2020) empirically estimated the non-linear association between EPI and control of corruption in a panel of 133 countries. The study concluded that EPI has a U-shaped association with the control of corruption.

Ingrams and Schachter (2019) attempted to explore the impact of EPI on corruption in 104 cities in South Africa from 2013 to 2017. The study concluded that EPI declined corruption in the presence of high accountability demand.

Lee (2017) examined the e-government by using the proxies of EPI and EGDI on corruption in OECD and non-OECD countries. The empirical result concluded that EPI and EGDI played a positive role in controlling corruption.

Zheng (2016) explained the nexus between e-participation Index on corruption. The empirical result concluded that e-participation significantly influences the perception of corruption. The countries that have higher e-participation declined corruption.



## **2.4 Human Capital Index (HCI) and corruption**

The labor quality assesses human capital by the quality of education and worker training. There are many studies that empirically connected human capital with corruption.

Fagbemi et al. (2022) investigated the empirical evidence between human capital and corruption in Nigeria from 1996 to 2019. The empirical results were calculated by using the ARDL econometric approach. The empirical result instructed that poor human capital increased corruption in Nigeria. Furthermore, this study also explored the uni-directional causality between human capital and corruption.

Emara (2020) pointed out corruption's association to human development in Egypt from 1995 to 2018. ARDL econometric approach was developed to investigate and understand the long-run relationship between corruption and human development. The empirical results concluded that corruption negatively and significantly impacts human development in the long run.

ThiHoa (2020) identified the nexus between corruption and human capital in Vietnamese provinces. The empirical results estimated that corruption negatively and positively affects human capital.

## **2.5 Determinants of corruption**

Apart from the e-government, information communication technology, and human capital, there are many other determinants of corruption.

Institutional quality is one of the essential determinants of corruption. The World Bank has estimated the institution quality in six parameters: Voice and Accountability, the Rule of Law, Government Effectiveness, Political Stability, Regulatory Quality, and Control of Corruption. Taylor et al. (2022) examined the role and impact of institutional improvement on corruption from 1996 to 2020. The study concluded that improving institutional quality can decline corruption. Furthermore, this study also evaluated that controlling corruption is considered a country-specific case. Policymakers and political leaders can improve their institutions and thereby control corruption.

The population is considered an essential determinant of corruption. There is a mixed impact of population on corruption. The massive unplanned population indirectly increases corruption as a result of massive unemployment. The unemployed population have a motive for corruption. Dunu (2016) explored that population growth increases unemployment and corruption in Nigeria. While on the other hand, the planned and educated population decline in corruption (Zheng, 2016).

## **2.6 Research gap**

In the last few decades, the topic of corruption has been considered under the concern of many international organizations such as IMF and the World Bank. Studies show the link between e-government and corruption for the purpose of controlling corruption. Recently, many researchers and policymakers have warned that the developing countries fail to control corruption, then these countries will fail to achieve SDGs (Hope, 2021; Christopher & James, 2019). This study evaluates the research gap by focusing on the following research questions:

Firstly, it explores the role of e-government on corruption. Many studies have explored the link between these two variables (Castro & Lopes, 2022; Kalesnikaite et al., 2022; Dhaoui, 2021; Abdulkareem et al., 2021; Park & Kim, 2020; Yalaman, 2019). Evidence shows that there were limited previous studies that examined the long-run dynamics in the MENA countries. On the other hand, MENA countries are facing rampant corruption.

Secondly, the research question examined the impact of e-Participation on corruption. Many scholars have empirically examined the impact of e-participation on corruption (Adam & Fazekas, 2021; Wang et al., 2020; Ingrams & Schachter, 2019; Lee, 2017; Zheng, 2016). This study contributes to investing e-Participation's long-run dynamics on corruption in MENA countries.

The third question explores the online service index on corruption. Numerous pieces of literature explored that online service decline corruption (Cárdenas & González, 2022; Purnamasari et al. 2022; Abdulkareem et al. 2021; Ventrone, 2021; Alahmadi, 2018). The fourth question explores the nexus between the human capital index and corruption (Fagbemi et al., 2022; Emara, 2020; ThiHoa, 2020). Limited

literature empirically examined the link between human capital on corruption in MENA countries.

This study is novel because it is perhaps the first one, according to my knowledge, that uses the four proxies of e-Government: e-government development index, e-participation index, online service index, and human capital index to measure the control of corruption. This study also diverges from the prevailing literature mainly in its methodological novelty, use of different explanatory variables, and moderating effect of different dummy variables related to governance. The study outcomes contributes and seem like the provocation for policy and decision-makers to design and implement the policies successfully in the MENA countries.

## **CHAPTER 3: METHODOLOGY AND DATA**

This chapter highlights the theoretical frame, sample period, and proposed methodology. The first section covers the theoretical model supporting different theories. The second section builds the model by using the theoretical framework. The third section will examine the proposed methodology.

### **3.1 Theoretical Model**

The present study analyzes the effect and role of e-governance on corruption in the MENA countries. In countries where a high incidence of corruption prevails, the inflow of resources declines, negatively affecting investment activities. Investment is an essential component of aggregate demand. The volume of aggregate demand declines due to declining investment activities, which causes unemployment and poverty. No country can achieve the sustainable development goals prevailing massive corruption. Many countries use e-government technology to cope with corruption. There are no typical models that examine the mechanism of e-Government and corruption. Most theoretical models cover the mechanism between institutional quality and organizational economics. So, the relationship between e-Government and corruption can be explained indirectly by other factors such as economic growth, investment growth, etc.

The following theories explain good-governance structures and encourage modern mechanisms to eradicate corruption.

#### **3.1.1 Transaction cost theory**

Transaction cost is a common economic concept that links many economic fields (reference?). The central analysis of the concept is concerned with institutional and organizational economics (reference?). As institutional economics deals with the governance and institutional frameworks, the transaction cost determines the type of organization and administration that achieve efficiency (Robins, 1987).

Transaction cost deals with two fundamental concepts of human beings. The first term is limited rationality, which implies that each individual is rational; this rationality is conditioned by some aspects, such as data availability or uncertainties.

The second is opportunism which implies that every individual seeks their self-interest (Ojha, Palvia & Gupta, 2014).

Providing government services without e-governance is challenging because citizens must deal with specific officials in a single location and at a single time. However, with e-governance, service delivery can occur anytime and through several gates. As a result, e-governance reduces transaction costs, lowering the incentives to engage in corrupt behavior. In general, if the desired transaction is simple, it has a more negligible transaction cost, reducing the requirement for corruptive conduct (Alshehri, Drew 2010).

Another critical benefit of e-governance is lowering the level of uncertainty. As e-governance publishes all data and information online to citizens, it makes them aware of their rights and responsibilities. As a result, the government conducts its service delivery efficiently. Citizen performs their transactions with the government with low transaction cost. It thus could be concluded that e-government is a critical way for the government to fight corruption (Nam, 2019).

There are steps suggested for improvement, for example, ensuring e-government and the information related to it; second, devising a system that provides ease of access to government-related matters such as search engines and queries from the government (Alonso, Ambur, Amutio, Azañón, Bennett, Flagg, Sheridan, 2009).

### **3.1.2 Collective action theory**

Several decades ago, the concept of corruption was explained by referring to the principal-agent problem when one (the agent) is compensated for working in favor of another (the principal) (Graycar, 2022). Recently, Milner-Smyth, (2017) has been used this theory to explain why systemic corruption persists despite anti-corruption laws in many countries. Nowadays, this theory goes beyond the usual principal-agent problems and emphasizes significant factors like trust in how one individual perceives the behavior of others. Persson et al. (2013) pointed out that corruption is a collective problem because people rationalize their behavior with perceptions of how others behave in the same situation. When corruption evolves in society, everyone starts to perform activities with this evil. In such an environment, most individuals are familiar

with the negative consequences of corruption. Still, they are involved in this evil as they believe it is impossible to be honest in the corrupt system (Marquette & Peiffer, 2015).

Under such a scenario, the anti-corruption principal-agent model fails because no one enforces the anti-corruption norms. Institutional corruption leads to corrupt practices at an individual level that badly violates the anti-corruption rules. In such circumstances, collective and coordinated approaches such as reform through digitalization or other organizations must combat corruption.

### **3.1.3 Function theory**

Function theory assumes that e-government can perform functions that enable the government to achieve goals required to lower corruption (Ojha et al., 2008). For instance, the electronic payment for taxes lowers the time, effort, and sometimes money required to complete the transaction (Donovan, 2012). This will lower transaction costs and the total number of layers (Basel Institute on Governance, 2017).

The business sector can contribute to developing e-government tools through public-private partnerships (reference?). They may also serve as a conduit for communication and closer alignment with corporate needs. When the private sector is allowed to participate in government consultation processes, it should do so (Olatubosun & Madhava Rao 2012).

These provide possibilities to influence policy and advocate for private-sector interests. Participating actively in these procedures sends a message to the government about commitment and expectations in policy areas important to businesses, such as anti-corruption and anti-bribery (Brinkerhoff & Crosby, 2002).

### **3.1.4 Government centralization theory**

The proper formulation of public policy necessitates the consideration of a wide range of market factors. The broad framework against which government intervention can be judged is market failure, one of the essential aspects (Rondinelli, 1981). The effectiveness of government initiatives can have an impact on market outcomes (Rausser, Lichtenberg & Lattimore, 1981). Thus, public choice, market failure, and social interest theories can give a solid foundation for determining the best government intervention strategy (Dollery & Worthington, 2014).

The government, in general, has an unavoidable responsibility to interact with the market economy. The advantages obtained from such intervention can be used to measure the effectiveness of such a function, as concluded by (Tanzi, 1997).

One of the significant responsibilities of the government is to avoid market failure is correct externalities (Henson & Traill, 1993). Within the process of economic development, governments have to support the economic activities that generate positive externalities and discourage economic activities that generate negative externalities to the environment (Samuelson, 1954). The debates are still arising about which economic activities to control from the government and how.

The role of the government has a severe responsibility on the government's shoulders to efficiently monitor economic and public activities. The monitoring system required techniques to link different government agencies through one centralized system such as e-governance (Barthwal, 2003).

Theoretically, and in light of the mentioned above, e-governance is most obviously linked to corruption because of its impact on lowering transaction costs. Consequently, it can be said that the transaction cost theory studies the optimal e-governance mechanisms that help elucidate how e-governance governs internal and external stakeholders effectively and controls corruption. This facilitates the ability of the government to restrict any distortions and control corruption in its early stages.

## **3.2 Model specification and methodology**

### **3.2.1 Data sources and model specifications**

This research analyzes and studies the data from 17 MENA countries, considering their different characteristics based on data availability and the introduced indexes related to control of corruption and e-government indicators. The data used in this research were collected from the World Bank database and the UN database, covering the period from 2003 to 2020, which is considered representative of the time of the digital revolution in the region. Based on previous literature and theoretical framework (Adam & Fazekas, 2021; Bixby et al., 2019; Fagbemi et al., 2022; Thi Hoa, 2020) the functional form is proposed as:

Control of corruption = f( E-government, Voice, and accountability, Political stability, the rule of law, Regulatory quality, Government effectiveness, GDP per Capita)

In the functional form, the left-hand side variable is control of corruption, treated as the dependent variable, measured by controlling corruption from the World Governance Indicators (WGIs). On the right side, a few independent variables are included. The leading independent variable is “e-government”, which is assessed by the E-Government Development Index (EGDI), Online Service Index (OSI), E-Participation Index (EPI) and Human Capital Index (HCI). Apart from the E-government variables, few control variables are included in this study. The detail of the variables is discussed in Table 1.

**Table 1 Variables description and sources**

Variable Name	Long definition	Source
Control of Corruption	A frequent Irregular payment from governmental officials to the public is called corruption. Innovation and strict laws play a significant role in controlling corruption.	Worldwide Governance Indicators (WGI)
Online Service Index (OSI)	OSI evolves the E-Government services through smart service in terms of the availability, connectivity, and quality of the public services. Through online services, the public and government institutions interact with each other.	Vision 2021
E-Government Development Index (EGDI)	EGDI assessed the e-government policies and strategies a country adopts in their institution.	UN e-government survey
E-Participation Index(EPI)	The EPI shows the involvement of information technology to improve the accessibility of information and public service to the citizens.	WEF
Human Capital Index(HCI)	The labour quality assesses human capital by the quality of education and worker training	World bank
Voice and Accountability	It includes legal system, civil and political rights, transparency, respect for minorities, freedom, democratic behaviour and independent media.	Worldwide Governance Indicators (WGI)



Political Stability and Absence of Violence/Terrorism	It includes political stability, lack of wars and political violence, and unpredictable rules fluctuations.	Worldwide Governance Indicators (WGI)
Government Effectiveness	Effective government policies, adequate public servant departments	Worldwide Governance Indicators (WGI)
Regulatory Quality	Government annulment in the economy controls prices, trade, taxation, etc.	Worldwide Governance Indicators (WGI)
Rule of Law	Laws about crime, property laws, intellectual property rights	Worldwide Governance Indicators (WGI)
GDP per capita	The annual income per person in terms of constant dollar	WDI indicators
Population density	The person living per square kilometre area	WDI indicators

Four models are estimated based on different E-Government indicators to explore the impact of E-Government on corruption.

In the first model E-Government development index is used as the key independent variable as the model can be written as:

$$\begin{aligned}
 & \text{control of corruption}_{it} \\
 & = \beta_0 + \beta_1 E - \text{gov dev.} + \gamma_1 \text{voice and accountability} \\
 & + \gamma_2 \text{politucal stability} + \gamma_3 \text{Rule of law} + \gamma_4 \text{reg. quality} \\
 & + \gamma_5 \text{gov. eff.} + \gamma_6 \text{GDP}_{per\ capita} + \gamma_7 \text{population density} \\
 & + \gamma_8 \text{Polity IV} + \varepsilon_{it}
 \end{aligned}$$

In the second model, the E- participation index is used as the key independent variable, and the model can be written as:

$$\begin{aligned}
 & \text{control of corruption}_{it} \\
 & = \beta_0 + \beta_1 E - \text{part.} + \gamma_1 \text{voice and accountability} \\
 & + \gamma_2 \text{politucal stability} + \gamma_3 \text{Rule of law} + \gamma_4 \text{reg. quality} \\
 & + \gamma_5 \text{gov. eff.} + \gamma_6 \text{GDP}_{per\ capita} + \gamma_7 \text{population density} \\
 & + \gamma_8 \text{Polity IV} + \varepsilon_{it}
 \end{aligned}$$

In the third model, e-governance is measured using the e-government Development index and e-participation index. The model can be written as follows:

$$\begin{aligned}
 \text{control of corruption}_{it} &= \beta_0 + \beta_1 E - \text{gov dev.} + \beta_2 E \\
 &- \text{part.} + \gamma_1 \text{voice and accountability} + \gamma_2 \text{politucal stability} \\
 &+ \gamma_3 \text{Rule of law} + \gamma_4 \text{reg. quality} \\
 &+ \gamma_5 \text{gov. eff.} + \gamma_6 \text{GDP}_{\text{per capita}} + \gamma_7 \text{population density} \\
 &+ \gamma_8 \text{Polity IV} + \varepsilon_{it}
 \end{aligned}$$

In the fourth model, e-governance is measured by the E-government Development index, E- Participation index, Human capital index, and online service index.

$$\begin{aligned}
 \text{control of corruption}_{it} &= \beta_0 + \beta_1 E - \text{gov dev} \\
 &+ \beta_2 \text{telecomm index.} + \beta_3 \text{human capital index.} + \beta_4 \text{online service index.} \\
 &+ \gamma_1 \text{voice and accountability} + \gamma_2 \text{politucal stability} + \gamma_3 \text{Rule of law} \\
 &+ \gamma_4 \text{reg. quality} + \gamma_5 \text{gov. eff.} + \gamma_6 \text{GDP}_{\text{per capita}} + \gamma_7 \text{population density} \\
 &+ \gamma_8 \text{Polity IV} + \varepsilon_{it}
 \end{aligned}$$

### 3.2.2 Research Methodology

The Methodology for this research contains two types of tests:

- (i) Panel unit root testing
- (ii) Conducting Granger causality tests.
- (iii) Conducting GMM model to assess the relationship between control of corruption and e-governance.

#### I. Panel unit root testing

The study applies a panel unit root test for the reliability of parameters. The study uses many panel stationarity checks to examine the stationarity characteristics of the variables. There is a different test of panel unit root tests used in empirical research like Levin et al. (2002) and Im et al. (2003), and Maddala and Wu (1999). The most frequently used test is the “Levin-Lin-Chu” (LLC) (1993, 2002) technique extension of the Augmented-Dickey-Fuller test (ADF). It supposes that all panel groups have the

same autoregressive (AR) (Levin et al., 2002). The structure of the *LLC* analysis may be specified as follows:

$$\Delta(\text{Control of corruption})_{it} = \rho(E - \text{Govt.})_{it} + \beta_{0i} + \beta_{1i}t + \epsilon_{it},$$

$$i = 1, 2, \dots, N, t = 1, 2, \dots, T \text{ --- (3.3)}$$

Where  $t$  is time tendency ( $\beta_{1it}$ ), country-fixed effects are included.  $\epsilon_{it}$ , is supposed to be distributed across and independently each and chase a stationary ARMA method for every individual.

$$\epsilon_{it} = \sum_{j=1}^{\infty} \theta_{ij} \epsilon_{it-j} + \varphi_{it} \text{ --- (3.4)}$$

Although First-generation tests (LLC (Levin Lin Chu test), and IPS(The Im Pesaran and Shin test)) are the most widely used panel unit-root testing, IPS and LLC techniques have the drawback of supposing independence in each panel cross-section (Hoang & McNown, 2006). With the assumption of a homogeneous panel, the IPS method expansion of LLC permits heterogeneity by considering the ADF checks and probability ratio. But, in comparison to LLC, short-time observations are essential for an advanced check power (Hoang & McNown, 2006).

$$\Delta x_{it} = \alpha_i + \pi_{it} + \beta_i x_{i,t-1} + \sum_{j=1}^k \varphi_{it} \Delta x_{i,t-1} + \epsilon_{it} \text{ --- (3.5)}$$

Consistent with previous literature (i.e. Khraief et al., 2020; Kongbuamai et al., 2020) panel stationarity checks were used to investigate the degree of integration between variables of interest. Unlike the LLC and IPS tests, which use bias-corrected estimators, the Bruiting test employs unbiased estimators (Jorg Breitung, 2015) because its results are regarded vital. The MW test is a non-parametric variant of the Fisher test. It aggregates individual stationarity test p-values to yield results that are independent of lag length. However, it was more advanced than the IPS and LLC checks (Maddala & Wu, 1999). Finally, the Hadri stationarity test is based on residual LM (Lagrange-Multiplier) checks, whereas OLS residuals are derived by regressing results on a comparison (Hadri, 2000).

## II. Granger causality tests

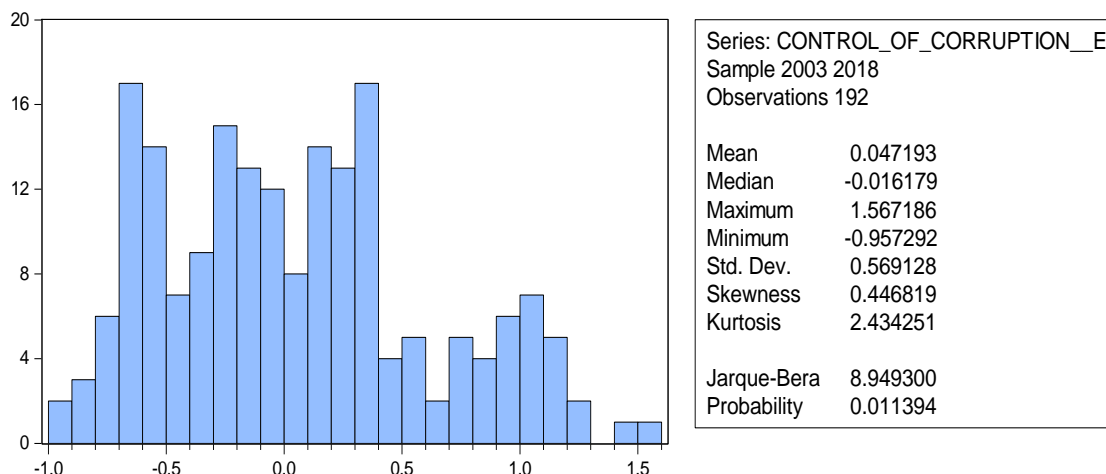
The test is a time-series-based regression. This test investigates the possible causal impact of control of corruption on e-governance. The initial step in testing stationarity assumption is the Augmented Dickey-Fuller (ADF) test, regarded as a reliable and mainly used test. Through ADF, the researcher tested the question of whether the data was stationary. This was assessed through p-values

$$R_t = \alpha_0 + \sum_{j=1}^p \gamma_j R_{t-j} + \sum_{j=1}^p \beta_j P_{t-j} + \varepsilon_t \text{ --- (3.6)}$$

The null hypothesis of no impact of the independent variables on the control of corruption is that the slope coefficients  $\beta_j$  in the above equation equals zero. The lag length  $p$  is an essential issue for the Granger-causality test. The lag length was chosen according to the best Akaike Information Criterion (AIC). Also, granger causality tests the inverse relation, which tests whether the control of corruption impacts the independent variables or not.

## III. Panel data model

According to previous empirical studies, Park econometric model and tested variables were implemented because it offers powerful and relevant. The dependent variable is the “control of corruption”, and the leading independent variable is “e-governance”. It is most common when analyzing the panel data to use a mixed effects model, however the central assumption (that are errors  $\varepsilon_i$ 's) is connoted as independent as well as normally distributed with mean vector 0 and covariance matrix  $\sigma_\varepsilon^2 I_{m_i}$ . So we need to check normality before running this model. The normality test is checked using the Jarque-Bera test for normality, in which the null hypothesis for the Jarque-Bera test is "data follows normal distribution". The results are shown in tables and graphs below for control of corruption, and it was found that the assumption of normality is not held for all control of corruption. This is because the p-value of the test is less than 0.05, with a confident 95%. Thus, control of corruption not follows a normal distribution in our case.



GMM (generalized method of moments), as mentioned by Arellano and Bond (1991), was a practical test that was further formalized by Hansen (1982). One of the core advantages of this particular test is its applicability in the data distribution without complete knowledge, whereby only specified moments derivation is required, along with easy applicability in computations. In addition, in the case of moment conditions than model parameters, this test is appropriate as it is helpful in the specification of the proposed model, for example, the difference of the variables when estimating the equations.

For instance, the GMM has another advantage in dealing with cross-sectional-specific effects and explanatory variables such as endogenous ones. Control is brought in unobserved cross-sectional-specific effects by using instrumental variables. This leads to a regression equation controlling the potential level effects whereby the accuracy can be checked for validity. The critical two tests for GMM estimation are:

- **Sargan–Hansen test or Sargan's test:** this is a test applied to over-identifying restrictions (in a statistical model) such as to know whether instrumental variables are precise or not.  $H_0$  is simple, i.e., no over-identification.
- **The Arellano-Bond test** is utilized to assess the errors in correlation and to know whether the errors are correlated or not. The  $H_0$  in this regard is no autocorrelation, whereby the accuracy is assessed when  $H_0$  is not rejected.

## **CHAPTER 4: RESULTS AND DISCUSSION**

This chapter analyzes the empirical results of the impact of e-governance on corruption control in the MENA countries. In the MENA region, these countries face lower, middle, and higher levels of corruption. It was observed that in the literature, e-governance is a significant tool to decline corruption. This chapter empirically estimates this relationship. For this purpose, the first step, this study discusses the descriptive statistics of all the concerned variables. The second step checks the order of integration by using the different unit root tests. In the third step, it checks granger causality. The fourth step explores the long-run coefficients of all the independent variables to measure the dependent variable using the Generalized Panel Method of Moments.

### **4.1 Descriptive statistics**

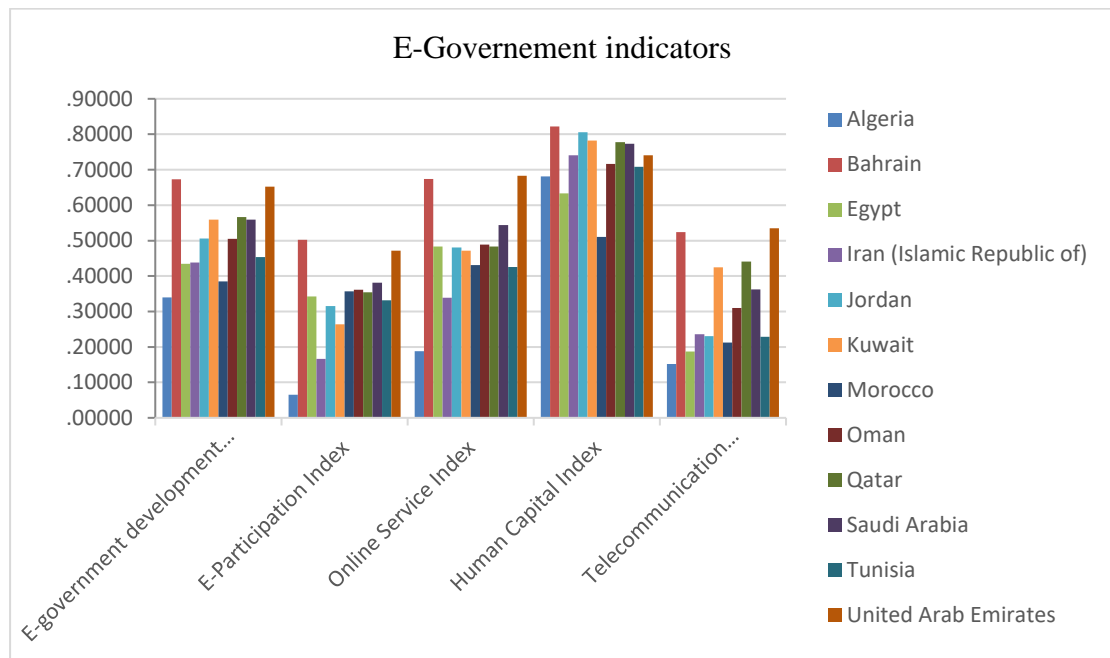
Descriptive statistics discuss the statistical summary of the variables. It demonstrates the variable's different features like mean, standard deviation, minimum and maximum values. Descriptive statistics are brief descriptive coefficient that summarizes a given data representing an entire population or a population sample. Descriptive statistics is divided into two first measures of variability (spread) and second measures of central tendency. Measures of central tendency include the mean, median, and mode, and variability measures include the variables' standard deviation and mean value. Each descriptive statistic cut-down slew of data in a complex summary. This study covers the time from 2003-2020. Table 2 Descriptive Statistics of Control of Corruption and E-Government Variables discussed the descriptive statistics about the impact of e-Government on corruption in this study.

**Table 2 Descriptive Statistics of Control of Corruption and E-Government Variables**

	control of corruption	E-participation index	Online service index	E-Government development	Human capital index
$\bar{X}$	0.047193	0.325942	0.474144	0.505997	0.724239
$\bar{X}$	-0.016179	0.239224	0.478472	0.503017	0.730000
Max.	1.567186	0.943800	0.944400	0.829500	0.893260
Min.	-0.957292	0.000000	0.034930	0.238410	0.443030
Std. Dev.	0.569128	0.275294	0.226439	0.136320	0.096068
Jarque-Bera	8.949300	19.02125	6.902896	5.325363	13.72056
<b>Probability</b>	<b>0.011394</b>	<b>0.000074</b>	<b>0.031700</b>	<b>0.069761</b>	<b>0.001049</b>
Sum	9.061040	62.58096	91.03565	97.15143	139.0538
Sum Sq. Dev.	61.86616	14.47527	9.793492	3.549382	1.762758
Observations	192	192	192	192	192

It is observed that the dependent and all independent variables are not generally distributed except for the e-Government development index, as the p-values associated with these variables are less than 5% except for this variable.

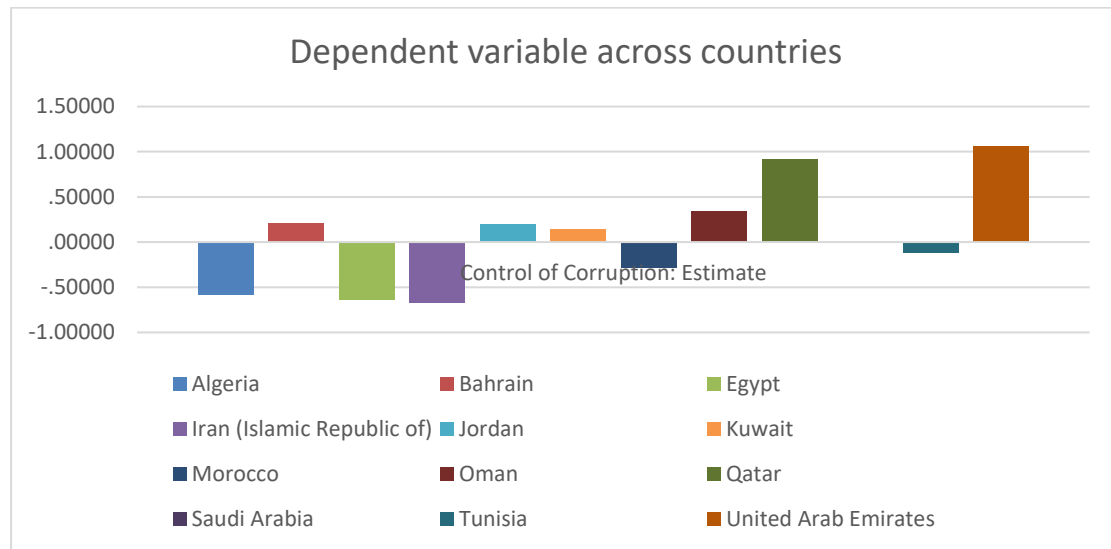
**Figure (4) Trend of E-Government indicators in MENA countries in 2020**



**Source: Author's calculation based on the UN database**

The highest average of e-government development index is in Bahrain, while the least average was in Algeria. While the highest average of E-participation index was in Bahrain, while the least average was in Algeria. The highest average of online service index was in Bahrain, while the least average was in Morocco. The highest average of the telecommunication infrastructure index was in Bahrain, while the least average was in Algeria.



**Figure (5) Trend of control of corruption in MENA countries**

**Source: Author's calculation based on the World Bank database**

It is clear from the above figure that the highest average of control of corruption is for the UAE.

Table 3 presents the descriptive statistics of all control variables discussed in this study.

**Table 3 Descriptive Statistics of Control Variables**

	GDP per capita	E-govt. effectiveness	Polity iv	Political stability	population density	Regulatory quality	The rule of law estimate	Voice and accountability
$\bar{X}$	18226	0.09495	-5.5000	-0.2212	200.34	-0.0392	0.0725	-0.9798
$\bar{X}$	10346	0.07707	-7.0000	-0.3717	72.9593	0.0621	0.1453	-0.9790
Max.	65129	1.50926	7.00000	1.22362	2012.10	1.11105	0.95843	0.30458
Min.	2235.4	-0.87774	-10.0000	-1.75362	7.7097	-1.72011	-1.05645	-1.90719
Std. Dev.	18375	0.50875	4.18298	0.79308	424.116	0.66501	0.51351	0.41429
<b>Jarque-Bera</b>	<b>44.684</b>	<b>7.72046</b>	<b>53.3948</b>	<b>10.1994</b>	<b>840.344</b>	<b>18.3582</b>	<b>14.0183</b>	<b>4.79925</b>
<b>Probability</b>	<b>0.0000</b>	<b>0.02106</b>	<b>0.00000</b>	<b>0.00609</b>	<b>0.00000</b>	<b>0.00010</b>	<b>0.00090</b>	<b>0.09075</b>
Sum	349952	18.2309	-1056.00	-42.4718	38466.2	-7.53454	13.9321	-188.126
Sum Sq. Dev.	6.45E+1	49.4368	3342.00	120.135	3435603	84.4696	50.3656	32.7827
Observation	192	192	192	192	192	192	192	192

From the following, it is clear that the control variables are generally not distributed except for the voice and accountability index, as the p-values associated with these variables are less than 5% except for this variable.

#### 4.1 Panel unit root test

The study started by checking the significance level of all the variables in panel data of MENA countries. Table 4 below shows the panel unit test's stationary results using the ADF - Fisher Chi-square (ADF) test. The null hypothesis of this test is that there is no evidence of stationery. Table 4 enumerates the results of the panel unit test by using the ADF test.

**Table 4 Results of ADF Panel Unit Root**

<b>Variable</b>	<b>ADF test</b>	<b>p-value</b>
Control of corruption	-2.87645	0.0022
E-government development(EGDI)	-3.5736	0.0002
E-participation index(EPI)	-0.41167	0.3404
$\Delta$ E-participation index( $\Delta EPI$ )	-6.1802	0.0000
Online service index (OSI)	-4.3946	0.0000
Human capital index (HCI)	-2.4655	0.0068
GDP per capita	-5.43804	0.0000
Government effectiveness index	-1.98489	0.0236
Political stability	-0.619	0.2679
$\Delta$ Political stability	-3.8787	0.0001
Population density	-10.0279	0.0000
Regulatory quality	-1.5960	0.0552
$\Delta$ Regulatory quality	-3.22341	0.0006

The results yield stationary results at a confidence level of 95%, except for the E-participation index, telecommunication index, political stability, polity IV, and regulatory quality are not stationary at the levels but became stationary after taking the first difference.

#### 4.2 Granger Causality test

The Granger Causality test was applied to check whether the variable caused dependent variables. So, it is used the Granger Causality test to check unidirectional o bidirectional. The empirical results show that the probability value of the e-government development index (EGDI) and control of corruption are statistically significant, so the null hypothesis is rejected. Table 5 shows the detailed results of Granger causality between different e-government indicators and control of corruption with a 95% confidence interval.

**Table 5 Detail results of Granger Causality**

Null Hypothesis:	F-Statistic	Prob.
EGDI does not granger cause control of corruption	4.41017	0.0136
Control of corruption does not granger cause EGDI	2.74056	0.0675
EPI does not granger cause control of corruption	6.12837	0.0027
Control of corruption does not granger cause EPI	2.97069	0.0541
HCI does not granger cause control of corruption	4.82610	0.0092
Control of corruption does not granger cause HCI	1.74886	0.1772
OSI does not granger cause control of corruption	3.88846	0.0224
Control of corruption does not granger cause OSI	0.18412	0.8320

The table shows the uni-directional causality between EGDI and the control of corruption. It explains that EGDI impacts the control of corruption, and control of corruption also significantly impacts the EGDI. It demonstrates the evidence of endogeneity between EGDI and control of corruption.

The probability value between the Human capital index (HCI) and control of corruption are statistically significant at a 1% level of significant motive for the researcher to reject the null hypothesis. In the same way, the probability value between the e-participation index (EPI) and control of corruption are statistically significant, showing the rejection of the null hypothesis in both cases. It presents the uni-directional causality between EPI and the control of corruption. It presents the uni-directional causality between HCI and control of corruption means that HCI granger causes the control of corruption.

### **4.3 Panel Generalized Method of Moments**

In assessing the model's impact, the independent variables should also include the lagged dependent variables, since without the lagged, the independent indicators do not allow sufficient insights and information. Such a lagged integration displays the entire history of the independent variables and their estimated influences. In GMM, all these issues with heterogeneity were removed from the functional form by taking 1st differences. An actual tricky situation occurs. The issue was that the lagged dependent correlates with the disturbance term. To tackle such difficulty, instrumental variables were employed.

### 4.3.1 Discussion of the long-run results of model 1

E-government development index significantly positive impact on the control of corruption, and this effect = 0.20731, this with confident 95% as the p-value of the coefficient less than 5%, this mean that one unit increasing E-government development index will increase the control of corruption by 0.20731 units on average by fixing all other variables. These results are consistent with Castro & Lopes (2022), Kalesnikaite et al. (2022), Dhaoui (2021), Abdulkareem et al. (2021), Park and Kim (2020) and Yalaman (2019).

**Table 6 Panel Generalized Method of Moments of model 1**

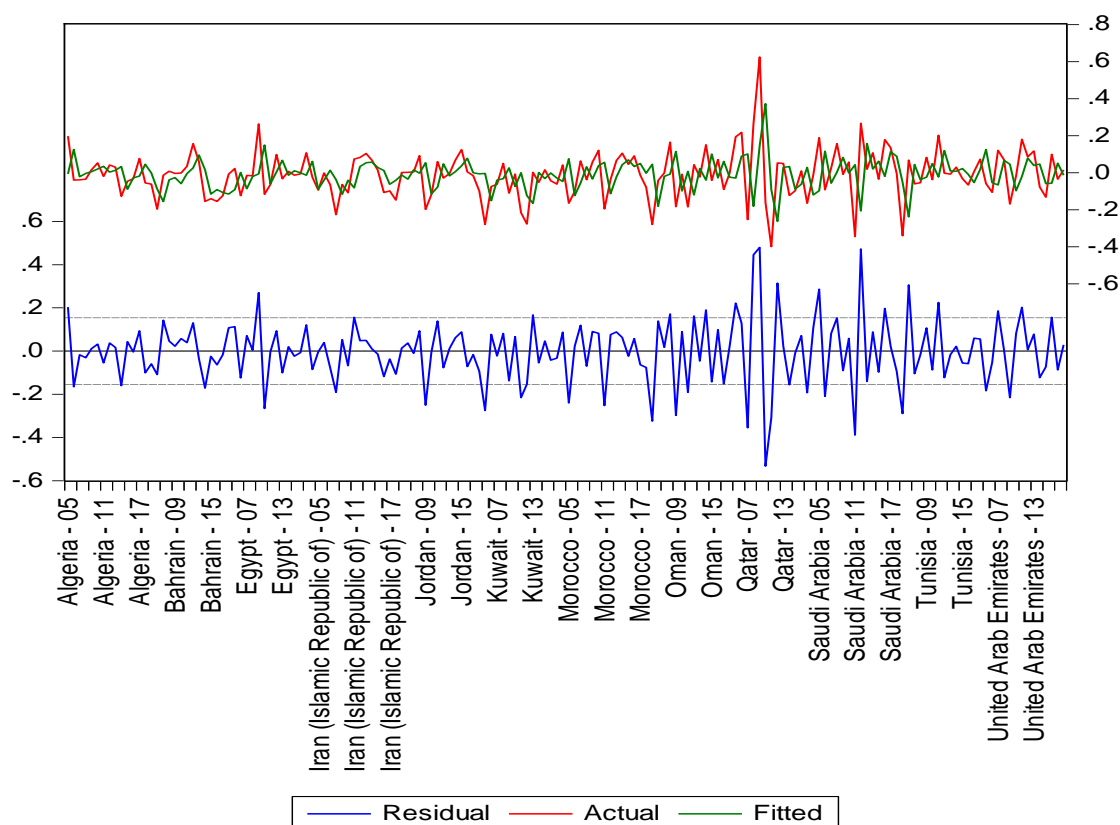
<b>Dependent variable: Control of corruption</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
<b>Control of corruption e(-1)</b>	0.588503	0.071403	8.241951	0.0000
<b>E-government development</b>	0.20731	0.034201	6.061421	0.0000
<b>GDP per capita</b>	9.52E-07	8.99E-06	0.105946	0.9158
<b>Polity iv</b>	-0.008926	0.019691	-0.453283	0.6510
<b>Population density</b>	-0.000417	0.000160	-2.600623	0.0102
<b>Regulatory quality estimation</b>	-0.106377	0.095414	-1.114898	0.2666
<b>The rule of law estimate</b>	0.008548	0.145111	0.058910	0.9531
<b>Voice and accountability</b>	0.052794	0.155588	0.339316	0.7348
Mean dependent variable:0.011483, S.D. dependent var:-0.126709, S.E. of regression: 0.154333, Sum squared resid:3.810990, J-statistic=65.58821, Instrument rank: 80,Prob(J-statistic):0.689714				

The only control variable that has a significant impact on the control of corruption was population density; that is, there was a significant negative impact of population density on the control of corruption, and this effect = -0.000417, with confident 95% as the p-value of the coefficient less than 5%, this means that increasing population density by 1 would decrease the control of corruption by 0.000417 units on average, and fixing all other variables (Dunu, 2016). A long-run result of model 1 was estimated using the GMM econometric approach in Table 6. In model 1, the E-government was measured by using the proxy of the E-government development index.

**Table 7 Arellano-Bond Serial Correlation Test**

Test order	m-Statistic	rho	SE(rho)	Prob.
AR(1)	-3.960507	-1.302989	0.328995	0.0001
AR(2)	-1.754755	-0.591867	0.337294	0.0793

Regarding the model's goodness of fit, we do not reject the null hypothesis of the Sargan-test, which means that the model was correctly specified (no-overidentification), with a confidence of 95%, as the p-value was more significant than 5%. Also, the null hypothesis of the Arellano-Bond Serial Correlation Test was not rejected. This was confident 95% as the p-value of AR(2) was greater than 5%, so the model was correctly specified. Also, the absence of serial correlation was supported by the following graph as the residuals are scattered randomly. In addition, the fitted value was almost the same as the actual values.

**Figure (6)**

### 4.3.2 Discussion of the long-run results of model 2

In model 2, the EPI was used as the proxy for E-government. The long-run empirical results were estimated using the GMM econometric approach in Table 8.

**Table 8 Panel Generalized Method of Moments of model 2**

<b>Dependent variable: Control of corruption</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
<b>Control of corruption (-1)</b>	0.554755	0.094182	5.890222	0.0000
<b>E participation index</b>	0.204044	0.059686	3.418646	0.0008
<b>GDP per capita</b>	2.02E-06	9.69E-06	0.208469	0.8351
<b>Polity iv</b>	-0.015361	0.024709	-0.621674	0.5350
<b>Population density</b>	-0.001219	0.000461	-2.642832	0.0090
<b>Regulatory quality estimation</b>	-0.147902	0.088254	-1.675862	0.0957
<b>The rule of law estimate</b>	0.121556	0.183638	0.661929	0.5090
<b>Voice and accountability</b>	0.055451	0.180969	0.306414	0.7597
Mean dependent variable: -0.011483, S.D. dependent variable: 0.126709, S.E. of regression: 0.150109, Sum squared resid: 3.605232, J-statistic: 64.19896, Instrument rank: 79, Prob(J-statistic): 0.703192				

The study have found a significant positive impact of the E-participation index on the control of corruption, and this effect = 0.204, with 95% as the p-value of the coefficient less than 5%. This means that increasing the e-participation index by 1 would increase the control of corruption by 0.204 units on average and fix all other variables (Adam & Fazekas, 2021; Wang et al., 2020; Ingrams & Schachter, 2019; Lee, 2017; Zheng, 2016).

The only control variable that has a significant impact on the control of corruption was population density; that is, there was a significant negative impact of population density on the control of corruption, and this effect = -0.001219, this with confident 95% as the p-value of the coefficient less than 5%, this means that increasing population density by 1 decreases the control of corruption by 0.001219 units on average, and fixing all other variables (Dunu, 2016).

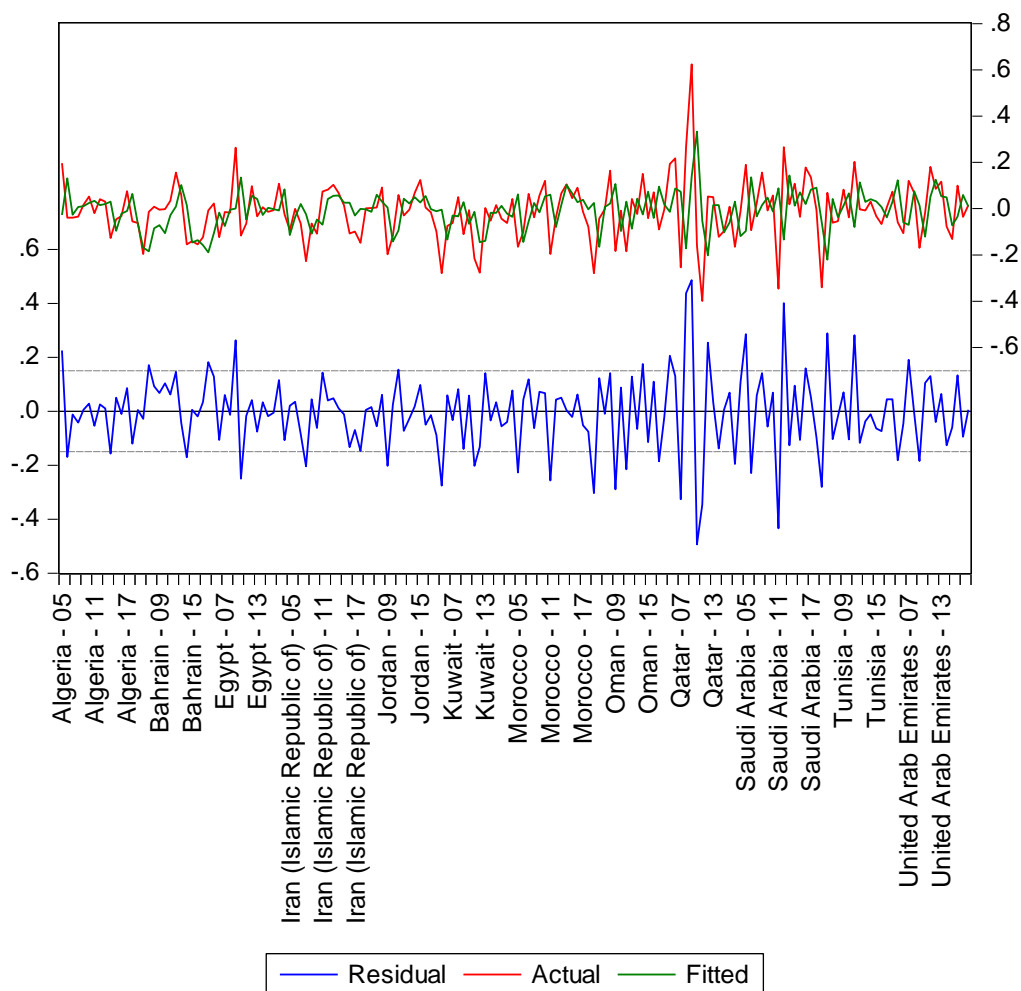
Regarding the model's goodness of fit, we do not reject the null hypothesis of the Sargan-test, which means that the model was correctly specified (no-over-identification), with a confidence of 95%, as the p-value was more significant than 5%.

**Table 9 Arellano-Bond Serial Correlation Test of Model 2**

<b>Test order</b>	<b>M-Statistic</b>	<b>rho</b>	<b>SE(rho)</b>	<b>Prob.</b>
<b>AR(1)</b>	-3.684531	-1.149418	0.311958	0.0002
<b>AR(2)</b>	-1.427942	-0.454011	0.317948	0.1533

Also, the null hypothesis of the Arellano-Bond Serial Correlation Test was not rejected, with confident 95% as the p-value of AR(2) was greater than 5%, so the model was correctly specified. Also, the absence of serial correlation was supported by the following graph as the residuals are scattered randomly. In addition, the fitted value was almost the same as the actual values.

Figure shows the trend graph of the residual and actual value of the model to examine the serial correlation.



**Figure 7 Trend of the graph of the residual and actual value of the E-Participation Index**

### 4.3.3 Discussion of the long-run results of model 3

The third model includes two proxies of E-Government as E-government development index and the E-participation index.

**Table 10 Panel Generalized Method of Moments of model 3**

<b>Dependent variable: Control of corruption</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
<b>Control of corruption e(-1)</b>	0.515963	0.081569	6.325510	0.0000
<b>E-government development</b>	1.045040	0.156224	6.689335	0.0000
<b>E participation index</b>	0.492953	0.157589	3.128086	0.0021
<b>GDP per capita</b>	3.33E-06	9.36E-06	0.355396	0.7228
<b>Polity iv</b>	0.000411	0.023795	0.017287	0.9862
<b>Population density</b>	-0.000989	0.000372	-2.658812	0.0086
<b>Regulatory quality estimation</b>	-0.192991	0.101809	-1.895614	0.0598
<b>The rule of law estimate</b>	0.141798	0.163080	0.869502	0.3859
<b>Voice and accountability</b>	-0.044928	0.155661	-0.288627	0.7732
Mean dependent variable: -0.011483, S.D. dependent variable: 0.126709, S.E. of regression: 0.150141, Sum squared resid: 3.584207, J-statistic: 59.01865, Instrument rank: 80, Prob(J-statistic): 0.844115				

The E-Government development index positively significantly impacts the control of corruption. One unit increase in the E-Government development index controlled the corruption by an average of 1.045 units, keeping other variables constant (Castro & Lopes, 2022; Kalesnikaite et al., 2022; Dhaoui, 2021; Abdulkareem et al., 2021; Park & Kim, 2020; Yalaman, 2019).

The second E-Government proxy used in this model was the E-participation index. If other variables remain constant, one unit increase in the E-participation index significantly controls corruption, an average of 0.4929 units (Zheng, 2016).

Population density has a negatively significantly impact on the control of corruption. The Probability value of population density is less than 1% significant, which means one unit increase in the population density, the control of corruption decline an average of 0.000989 units by keeping other variables constant. Similar



results were calculated by Dunu (2016) in Nigeria, which pointed out that massive population growth increased unemployment and corruption.

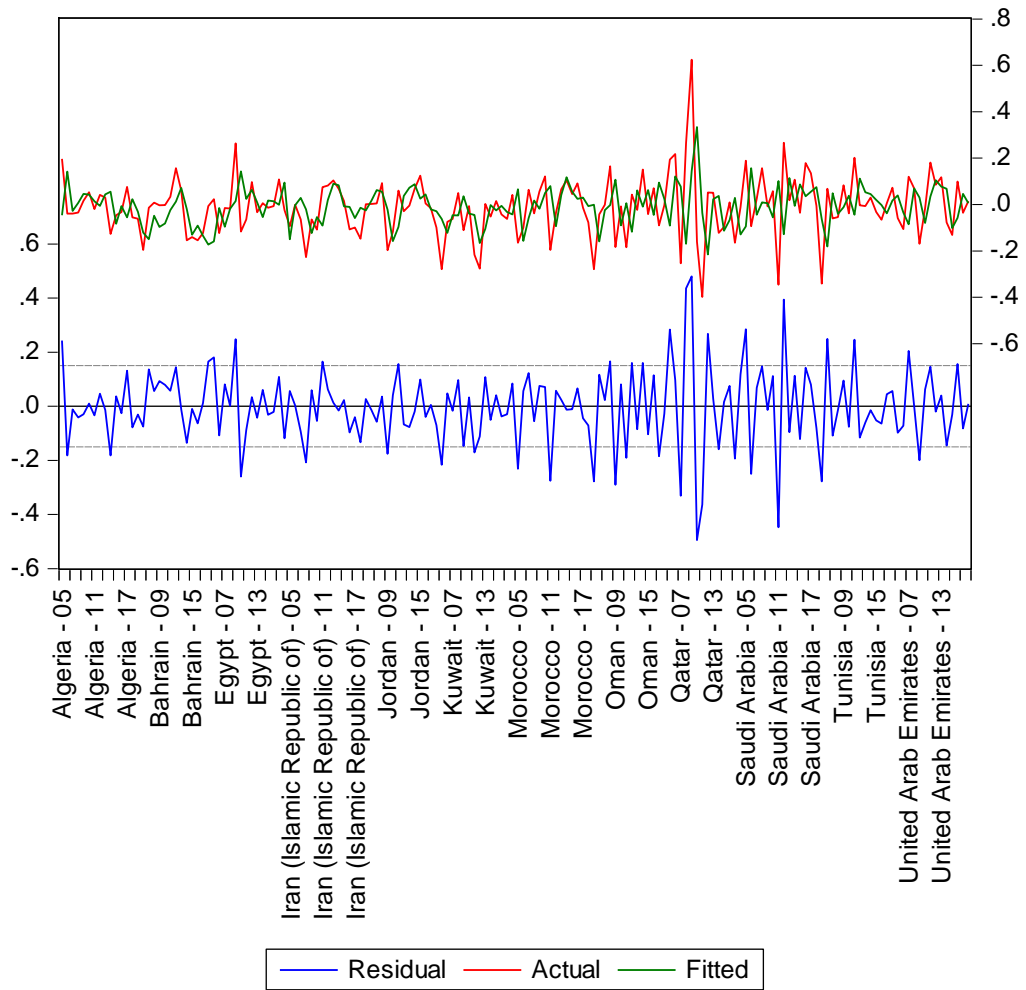
Most MENA countries face poor/bad governance, which ultimately increases corruption (Magen, 2013). Regulatory quality estimation is another control variable in this study. It is considered the critical variable to measure institutional quality. It is a significantly negative impact on the control of corruption. It can be explained as one unit increase in regulatory quality estimation than an average, and the control of corruption significantly declined by 0.192991 units. Similar results were calculated by Taylor et al. (2022).

The Sargan-test indicated that this model was correctly specified at a 95% confidence interval and that the probability value was greater than the 5% significance level.

**Table 11 Arellano-Bond Serial Correlation Test**

<b>Test order</b>	<b>M-Statistic</b>	<b>rho</b>	<b>SE(rho)</b>	<b>Prob.</b>
<b>AR(1)</b>	-3.480942	-1.119778	0.321688	0.0005
<b>AR(2)</b>	-1.789102	-0.567096	0.316973	0.0736

Table 11 shows the Arellano-Bond serial correlation test, with confident 95%, as the p-value greater than 5%. Also, the null hypothesis of the Arellano-Bond Serial Correlation Test was not rejected. This is confident 95% as the p-value of AR(2) was greater than 5%, so the model was correctly specified. Also, the absence of serial correlation was supported by the following graph as the residuals are scattered randomly. In addition, the fitted value was almost the same as the actual values.



**Figure 8 Trend graph of the residual term**

#### 4.3.4 Discussion of the long-run results of model 4

In model 4, different proxies of E-Government are included.

**Table 12 Panel Generalized Method of Moments of model 4**

<b>Dependent variable: Control of corruption</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
<b>Control of corruption e(-1)</b>	0.535068	0.106063	5.044800	0.0000
<b>E-government development</b>	0.817367	0.133774	6.110046	0.0000
<b>Online service index</b>	0.473762	0.235617	2.010726	0.0461
<b>Human capital index</b>	0.040250	0.427966	0.094049	0.9252
<b>Political stability</b>	0.176783	0.075512	2.341123	0.0205
<b>GDP per capita</b>	-5.77E-08	1.25E-05	-0.004632	0.9963
<b>Polity iv</b>	-0.022285	0.024963	-0.892720	0.3734
<b>Population density</b>	-0.000355	0.000338	-1.049905	0.2954
<b>Regulatory quality estimation</b>	-0.086864	0.133874	-0.648851	0.5174
<b>The rule of law estimate</b>	-0.102934	0.137624	-0.747934	0.4556
<b>Voice and accountability</b>	0.192784	0.216619	0.889967	0.3748
Mean dependent variable: -0.011483, S.D. dependent variable: 0.126709, S.E. of regression: 0.147522, Sum squared resid: 3.416771, J-statistic: 47.88906, Instrument rank:70, Prob(J-statistic): 0.849138				

The first proxy, E-Government, significantly positively impacts the control of corruption, and this effect = 0.5350. It means keeping other variables constant. One unit increases the E-Government index control corruption by an average of 0.5350 units (Cárdenas & González, 2022; Purnamasari et al., 2022; Abdulkareem et al., 2021; Ventrone, 2021; Alahmadi, 2018).

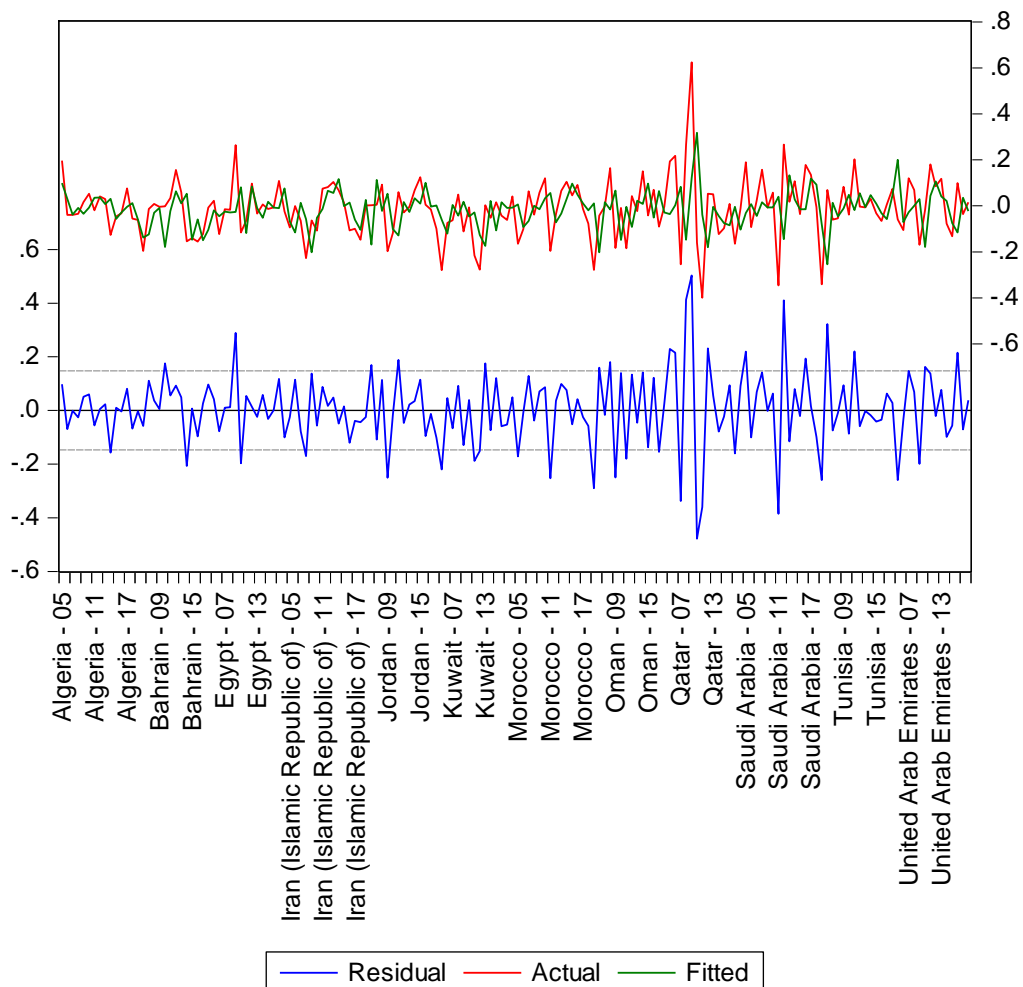
The online service index has used another proxy for E-Government. The significant probability value and t-statistics value of the online service index show that one unit increase in the online service index control corruption by an average of 0.817 units (Jha & Sarangi, 2022; Fan et al. 2021; Park & Kim, 2020; Starke et al., 2016). The Human capital index was also included in this model to present the E-Government. The nominal probability value of the Human capital index shows that it does not impact the control of corruption. In this study, political stability was included as the control variable. It is an essential indicator of governance. In model 4, the political stability variable was statistically significant. It shows that one unit increases political stability and declines control of corruption, an average of 0.1767 units. This result is in line with the results of Taylor et al. (2022). While reaming, all control variables have no significant impact on the control of corruption.

**Table 13 Arellano-Bond Serial Correlation Test**

Test order	M-Statistic	rho	SE(rho)	Prob.
AR(1)	-3.365838	-1.133542	0.336778	0.0008
AR(2)	-1.246292	-0.395455	0.317305	0.2127

The Arellano-Bond Serial Correlation test's probability value was statistically insignificant at AR(2). It shows the model's absence of serial correlation and correctly specifies the model.

To check the absence of serial correlation, **Error! Reference source not found.** traced the residual and actual terms of the model. The graph shows that the residuals are scattered randomly. In addition, the fitted value is almost the same as the actual values.



**Error! Reference source not found. Trend graph of the residual term**

In light of the above, this chapter discussed the four models' empirical results using the granger causality test and GMM econometric approach. The granger causality test shows the uni-directional causality between EGDI and corruption. It shows the endogeneity issue, so the GMM model is used to estimate the empirical results of the four models. The empirical result found that EGDI, EPI, and OSI declined corruption in the MENA countries. At the same time, HCI has no contribution to controlling corruption.

## **CHAPTER 5: CONCLUSION AND POLICY**

### **RECOMMENDATIONS**

#### **5.1 Summary and Conclusion**

E-governance applies information technology in public administration through the interactions among government and/to government (known as G2G), government to business (known as G2B), or between government to citizens (known as G2C) based on the different ICT techniques. E-governance creates various forms of interactions using internet-based technology and mobile apps between governments and other entities, for example, a. e-registration, b) e-participation, c) e-taxation, d) e-mobilization, e) e-education, f) e-service delivery, g) e-feedback, h) e-policing, i) e-debate, and few more as well. In other words, it is the application of technological infrastructure to implement government activities.

The essential element of e-government is that E-governance lowers the transaction cost of governments in developing countries to deliver all they want and facilitates the delivery process. Nevertheless, progress in implementing such reforms has been far more limited than expected.

MENA region experienced little concern about the concept of E-governance. Instead, the transformation to e-governance included technological changes in administrative and regulatory aspects. The reforms include engaging in digitalization in processing public policies and functions. Lately, many initiatives have been launched to promote e-governance in MENA countries.

For MENA countries, establishing citizen-centric E-government systems is a crucial part of their economic and technological development to lower transaction costs and low performance in social and economic development compared with other regions in the world.

The MENA region needs to acknowledge the causes of sustainable development challenges and the mechanism of achieving the goals. Achieving development goals will lower the levels of corruption in the region, reflecting the necessity of implementing Electronic governance.

The present study has achieved the four objectives of examining the impact of E-Governance on corruption. The study is conducted from 2003 to 2020. To achieve the objective, four different proxies of E-government are included in this study named as E-government Development index, E- participation index, online service index, and human capital index.

Before applying the appropriate econometric technique, this study used the panel unit root test of ADF to check the order of integration. The result shows that all variables become stationary at I(0) or I(1) and not any variable that becomes stationary at I(2). It shows the mixed order of integration.

The study has followed a Granger causality test and a GMM econometric approach to examine the impact of e-governance on corruption. To check the issue of endogeneity, the Granger causality test was used. It showed the uni-directional causality between the E-government development index and the control of corruption. In the same way, there was also exist uni-directional causality between the E-participation index and control of corruption. The uni-directional causality demonstrates the evidence of the issue of endogeneity in the model. To overcome the issue of endogeneity, instrument variables are included in these models. In panel data, GMM econometric approach can handle the instrument variables.

To achieve the first objective, the impact of the E-Government development index on corruption. The empirical result shows that the E-government development index increases corruption control (Castro & Lopes, 2022; Kalesnikaite et al., 2022; Dhaoui, 2021; Abdulkareem et al., 2021; Park & Kim, 2020; Yalaman, 2019). The lag value of the control of corruption is included as the instrumental variable with the E-government development index.

To achieve the second objective nexus between the E-Participation index with corruption, the lag value of control of corruption was included as the instrumental variable with the E-participation index. The long-run results show that E-participation positively controls corruption (Adam & Fazekas, 2021; Wang et al., 2020; Ingrams & Schachter, 2019; Lee, 2017; Zheng, 2016).

To achieve the third objective to examine the nexus between online service and control of corruption, the lag value of control of corruption was included in the model. The long-run result by GMM found that the online service index significantly declines corruption (Jha & Sarangi, 2022; Fan et al., 2021; Park & Kim, 2020; Starke et al., 2016).

The fourth objective was to investigate the impact of the human capital index on corruption. The empirical results found an insignificant association between the human capital index with corruption.

Apart from the E-government proxies, some control variables are also included in this study. The most significant variables are the governance variables and population density. In this study, population density inversely impacts the control of corruption. Similar results were calculated by Dunu (2016) for Nigeria, which pointed out that massive population growth increased unemployment and corruption. The second control variable was the governance variable. Most MENA countries face poor/bad governance, which is essential in increasing corruption. Taylor et al. (2022) examined similar results. While reaming, all control variables have no significant impact on the control of corruption. In a nutshell, statistically, there is a significant association between e-governance and corruption reduction. The enhancement in e-government leads to a reduction in corruption.

## **5.2 Policy recommendation**

From the previous data analysis for both e-governance and corruption examined in the study, the following recommendations are suggested to use e-governance effectively to control the corruption in the MENA region.

- As the deep econometric analysis for the relationship between e-governance and corruption indicated a strong positive impact of e-governance on corruption, it is critical to specify the significant components of the E-government index that affect the control of corruption and work on enhancing them.
- These components include online service and political stability. Thus, it is critical to enhance the use of ICT in more public transactions, especially those with high value-added on the national and international levels.



- It is critical to understand the nature of corruption and its different linkages with e-governance. E-government should include a long-term action plan to achieve a whole technology status in the delivery of government services.
- MENA countries need to gain citizens' trust in their Governments and Public Institutions. This could be implemented through partnerships between governments and citizens.
- Educating the public about e-governance can play a pivotal role; for example, public opinion is vital in bringing political changes that can effectively enhance e-governance for their improvement.
- To promote the growth of e-government, investing in human capacity and skills are crucial. Governments should put several agendas and plans to encourage the development of basic and advanced ICT skills across society since they are necessary to enable the growth of e-government and have also emerged as a new worldwide skill.
- A personal data protection authority should be established to create a conceptual, institutional, and policy framework.
- A plan for attracting, fostering, and retaining technical expertise is required to guarantee security and privacy in national and government ICT systems.
- MENA countries should collaborate with other global agencies and countries. It can help cultivate the culture of learning and can bring about ideas of e-governance to a single table to devise uniform policies.
- Countries should take advantage of public-private partnerships, such as sharing financial risks associated with large IT projects and access to skills and advanced services.
- The implementation of e-Government must take into account several factors, including the priority given to electronic services, the state of the infrastructure owned, the status of service operations as they currently stand, and the financial and human resource requirements. For that purpose, a method of organizing e-Government development activities is recommended for the growth of the government.

## REFERENCES

- Abdulkareem, A. K., Ishola, A. A., & Abdulkareem, Z. J. (2021). E-Government and Bureaucratic Corruption in Nigeria: Successes and Challenges. *Jurnal Study Pemerintahan*, 12(1), 1-20.
- Adam, I., & Fazekas, M. (2021). Are emerging technologies helping win the fight against corruption? A review of the state of evidence. *Information Economics and Policy*, 57, 100950.
- Adam, I., & Fazekas, M. (2021). Are emerging technologies helping win the fight against corruption? A review of the state of evidence. *Information Economics and Policy*, 57, 100950.
- Adeodato, R., & Pournouri, S. (2020). Secure implementation of e-governance: A case study about estonia. In *Cyber Defence in the Age of AI, Smart Societies and Augmented Humanity* (pp. 397-429). Springer, Cham.
- Alhassan, G. S. (2019). "E-governance for Sustainable Development in Ghana: Issues and Prospects" A Thesis Submitted to Graduate Program in Sustainable Development in partial fulfillment of the requirements for the Degree of Master of Science in Sustainable Development @ the Department of Public Policy and Administration, The American University in Cairo, Egypt.
- Almutairi, F., L, Thurasamy, L. F., and Yeap, J. A. L. (2020). Historical Development of E-Government in the Middle East. *International Journal of Recent Technology and Engineering*, 8 (5): 22-36.
- Alshehri, M., & Drew, S. (2010). Implementation of e-government: advantages and challenges. In *International Association for Scientific Knowledge (IASK)*.
- Backus, M. (2001). E-Governance and Developing Countries: Introduction and examples. Research report No. 3.
- Bannister, F., & Connolly, R. (2012). Defining e-Governance. *E-Service Journal*, 8(2), 3–25. <https://doi.org/10.2979/eservicej.8.2.3>

- Baroi, H. S., & Alam, S. (2021). Operationalizing the Right to Information Act through e-governance in Bangladesh: challenges and opportunities. *International Journal of Public Administration*, 44(8), 685-698.
- Basel Institute on Governance. (2017). New perspectives in e-government and the prevention of corruption. Basel Institute on Governance Working Paper 23. ISSN: 2624-9650.
- Basyal, D. K., Poudyal, N., & Seo, J. W. (2018). Does E-government reduce corruption? Evidence from a heterogeneous panel data model. *Transforming Government: People, Process and Policy*. <https://doi.org/10.1108/TG-12-2017-0073>.
- Basyal, D. K., Poudyal, N., and Seo, J. (2018). Transforming Government: People, Process and Policy Does E-government reduce corruption? Evidence from a heterogeneous panel data model. DOI: 10.1108/TG-12-2017-0073.
- Bel, G. (2021). Beyond government size: Types of government intervention and corruption. *Regulation & Governance*, 16(4), 1174-1196.
- Bhatnagar, S. (2003). Transparency and Corruption: Does E-Government Help” DRAFT Paper prepared for the compilation of CHRI 2003 Report Open Sesame: looking for the Right to Information in the Commonwealth, Commonwealth Human Rights Initiative, 1-9.
- Bhuiyan, S. H., (2010). E-Government in Kazakhstan: Challenges and Its Role to Development. *Public Organiz Rev*, 10:31–47. DOI 10.1007/s11115-009-0087-6.
- Bratsis, P. (2014). Political corruption in the age of transnational capitalism: from the relative autonomy of the state to the White Man’s Burden. *Historical Materialism*, 22(1), 105-128.
- Brinkerhoff, D. W., & Crosby, B. (2002). *Managing policy reform: Concepts and tools for decision-makers in developing and transitioning countries*. Kumarian Press.
- Cárdenas, G. C., & González, R. V. (2022). Mapping of clusters about the relationship between e-government and corruption in Mexico. *Competitiveness Review: An International Business Journal*. <https://doi.org/10.1108/CR-05-2022-0064>.

- Cartwright, J. (1985). The politics of preserving natural areas in the third world states. *The environmentalist* 5(3), 179-186.
- Castro, C., & Lopes, I. C. (2022). E-Government as a Tool in Controlling Corruption. *International Journal of Public Administration*, 1-14. <https://doi.org/10.1080/01900692.2022.2076695>.
- Charron, N. (2009). The impact of socio-political integration and press freedom on corruption. *The Journal of Development Studies*, 45 (9): 1472–1493.
- Christopher, S. M., & James, L. N. (2019). Pursuing Sustainable Development Goals in Uganda: Do Anti-corruption Strategies of Management Development Institutes Matter?. *Journal of Public Administration and Policy Research*, 11(4), 38-47.
- Colande, D., and Huei-Chun. S. (2015). Making sense of economists' positive-normative distinction. *Journal of Economic Methodology* 4(2): 32-43.
- Corruption perceptions index. (2020). Transparency international. [www.transparency.org/cpi](http://www.transparency.org/cpi)
- Davoodi, M. H. R., & Abed, M. G. T. (2003). *Challenges of growth and globalization in the Middle East and North Africa*. International Monetary Fund.
- Dhaoui, I. (2021). E-Government for Sustainable Development: Evidence from MENA Countries. *Journal of the Knowledge Economy* <https://doi.org/10.1007/s13132-021-00791-0>
- Dhaoui, I. (2022). E-government for sustainable development: Evidence from MENA countries. *Journal of the Knowledge Economy*, 13(3), 2070-2099.
- Dimant, E., and Tosato, G. (2017). Causes and effects of corruption: what has past decade's empirical research taught us? A survey. *Journal of Economic Surveys*, 00, (0): 1–22.
- Dollery B. E., and Worthington, A. C. (2014). The Evaluation of Public Policy: Normative Economic Theories of Government Failure. *Journal of Interdisciplinary Economics* 7(1): 22-37.

- Dominik, E., and Christina, H. (2017). Causes and consequences of corruption: An overview of empirical results. German Economic Institute (IW), Cologne. IW-Report, No. 2/2017.
- Donovan, K. (2012). Mobile money for financial inclusion. *Information and Communications for development*, 61(1), 61-73.
- Dunu, O. U. (2016). Corruption and population increase in Nigeria: analysis of their impact on selected macroeconomic variables.
- Edgar, G., André, U., and Jakob, Z. (2013). sustainable development in the MENA region. Menara FUTURE NOTES No. 20, March 2019.
- Egypt national anti-corruption strategy. (2020). National report. Egypt.
- Elgohary, E. M. (2022). The Role of Digital Transformation in Sustainable Development in Egypt. *The International Journal of Informatics, Media and Communication Technology*, 17 (4): 33-46.
- Emara, A. M. (2020). The impact of corruption on human development in Egypt. *Asian Economic and Financial Review*, 10(5), 574-589.
- Fagbemi, F., Osinubi, T. T., Nzeribe, G. E., & Bankole, T. O. (2022). Human Capital Development Challenge: Why Corruption Eradication is a Panacea in Nigeria. *Journal of Development Policy and Practice*, 24551333221090312.
- Fan, Q., Kuper, P., Choi, Y. H., & Choi, S. J. (2021). Does ICT development curb firms' perceived corruption pressure? The contingent impact of institutional qualities and competitive conditions. *Journal of Business Research*, 135, 496-507.
- Garcia-Murillo, M. (2013). Does a government web presence reduce perceptions of corruption? <https://doi.org/10.1080/02681102.2012.751574>, 19(2), 151–175.
- Govinda, C., and Hari, G. (2009). Regulatory instruments to control environmental externalities from the transport sector. *European Transport\TrasportiEuropei*, 41: 80-112.

- Graycar, A. (2022). Corrupt procurement: rethinking the roles of principals and agents. *Policy Design and Practice*, 1-18.
- Grigalashvili, V. (2022). E-government and E-governance: Various or Multifarious Concepts. *International Journal of Scientific and Management Research*, 5(1).
- Hands, D. and Wade, C. (2009). The Positive-Normative Dichotomy and Economics. Philosophy of Economics, UskaliMäki (ed.), Vol. 13 of D. Gabbay, P. Thagard and J. Woods (eds.), Handbook of the Philosophy of Science.
- Henson, S., & Traill, B. (1993). The demand for food safety: Market imperfections and the role of government. *Food Policy*, 18(2), 152-162.
- Hooda, A., & Singla, M. L. (2020). Reengineering as a strategic stance for e-governance success-mediating role of core competencies: A mixed method study. *Transforming Government: People, Process and Policy*, 14(2), 205-235.
- Hoffiani, M. (2019). The Nexus between Corruption, Sustainable Development and Rule of Law. Orebro University press.
- Hope Sr, K. R. (2021). Reducing corruption and bribery in Africa as a target of the sustainable development goals: applying indicators for assessing performance. *Journal of Money Laundering Control*.
- Hujran, O., Abu-Shanab, E., &Aljaafreh, A. (2020). Predictors for the adoption of e-democracy: an empirical evaluation based on a citizen-centric approach. *Transforming Government: People, Process and Policy*, 14(3), 523-544.
- IMF(2003). The IMF and the Middle East and North Africa(MENA). <https://www.imf.org/external/np/exr/ib/2003/081503.htm>.
- Ingrams, A., & Schachter, H. L. (2019). E-participation opportunities and the ambiguous role of corruption: A model of municipal responsiveness to sociopolitical factors. *Public Administration Review*, 79(4), 601-611.
- International Journal of Communication*, 10(0), 21.  
<https://ijoc.org/index.php/ijoc/article/view/5712>

- Jha, C. K., & Sarangi, S. (2022). How Advances in Information and Communication Technologies Impact Corruption?. *Available at SSRN*.
- Kalesnikaite, V., Neshkova, M. I., & Ganapati, S. (2022). Parsing the impact of E-government on bureaucratic corruption. *Governance*. <https://doi.org/10.1111/gove.12707>.
- Khan, A. (2021). Electronic government and corruption: Systematic literature review, framework, and agenda for future research. *Technological Forecasting and Social Change*, 167: 18-32.
- Khan, A., Krishnan, S. and Dhir, A. (2021). Electronic government and corruption: Systematic literature review, framework, and agenda for future research. *Technological Forecasting & Social Change*, 167: 120-127.
- Kulin, J., and Johansson, I. (2019). The Role of Government in Protecting the Environment: Quality of Government and the Translation of Normative Views about Government Responsibility into Spending Preferences. *International Journal of Sociology*, 49: 110–129.
- Lee, E. (2017). The Impact of E government on Corruption Control. MARTIN School of Public Policy & Administration.
- Lee, E. (2017). The impact of e-government on corruption control.
- Lemieux, V. & Dener, C. (2021). *Blockchain technology has the potential to transform government, but first we need to build trust.* [or https://blogs.worldbank.org/governance/blockchain-technology-has-potential-transform-government-first-we-need-build-trust](https://blogs.worldbank.org/governance/blockchain-technology-has-potential-transform-government-first-we-need-build-trust).
- Li, J., Chen, L., Chen, Y., & He, J. (2022). Digital economy, technological innovation, and green economic efficiency—Empirical evidence from 277 cities in China. *Managerial and Decision Economics*, 43(3), 616-629.
- Lindgren, I., Melin, U., & Sæbø, Ø. (2021). What is e-government? Introducing a work system framework for understanding e-government. *Communications of the Association for Information Systems*, 48(1), 43.

- Lupua, D. L., and Corina, G. (2015). Influence of e-government on the level of corruption in some EU and non-EU states. *Procedia Economics and Finance*, 20: 365 – 371.
- Magen, A. (2013). *The crisis of governance in the Middle East: Implications for democracy, development & security*. International Institute for Counter-Terrorism (ICT).
- Marquette, H., & Peiffer, C. (2015). Corruption and collective action. *DLP Research Paper*.
- Metcalf, J. S. (2010). Technology and economic theory. *Cambridge Journal of Economics*, 34(1), 153–171. <http://www.jstor.org/stable/24232028>
- Milner-Smyth, P. (2017). Consequences of corruption. *HR Future*, 2017(7), 30-31.
- Ministry of Planning and Economic Development. Egypt Vision 2030. <https://mped.gov.eg/EgyptVision?lang=en>
- Mishrif, A., & Selmanovic, S. (2010). E-government in the middle east and north africa: The role of international organizations in the experience of egypt and morocco. In 6th International Conference on Public Administration (pp. 905-926). UNIV ELECTRONIC SCIENCE & TECHNOLOGY CHINA PRESS.
- Mistry, J. J., & Jalal, A. (2012). An empirical analysis of the relationship between e-government and corruption. *International Journal of Digital Accounting Research*, 12.
- Myint, U. (2000). Corruption: Causes, Consequences And Cures. *Asia-Pacific Development Journal*, 7 (2): 122-136,
- Nam, T. (2019). Does e-Government raise effectiveness and efficiency?: Examining the cross-national effect. *Journal of Global Information Management (JGIM)*, 27(3), 120-138.
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized Business Review*, 21260. <https://bitcoin.org/bitcoin.pdf>.
- Ngonzi, T., & Sewchurran, K. (2019). User-stakeholders' responsiveness: A necessary input for achieving in e-governance transformation in developing countries. *The Electronic Journal of Information Systems in Developing Countries*, 85(6), e12107.
- OECD digital government studies. (2017). Benchmarking Digital Government Strategies in MENA Countries. OECD.



- Ojha, A., Palvia, S. and Gupta, M. P. (2014). A Model for Impact of E-Government on Corruption: Exploring Theoretical Foundations. All content following this page was uploaded by MP Gupta.
- Ojha, A., Palvia, S., & Gupta, M. P. (2008). A model for impact of e-government on corruption: Exploring theoretical foundations. *Critical thinking in e-governance*, 160-170.
- Olatubosun, O., & Madhava Rao, K. S. (2012). Empirical study of the readiness of public servants on the adoption of e-government. *International Journal of Information Systems and Change Management*, 6(1), 17-37.
- Pandey, D. L. and Risal, N. (2020). E-Governance: A Study Of The Concept And Implementation In The Emerging Economy. *Corporate Governance and Sustainability Review*, 4 (2): 24-39.
- Park, C. H., & Kim, K. (2020). E-government as an anti-corruption tool: Panel data analysis across countries. *International Review of Administrative Sciences*, 86(4), 691-707. <https://doi.org/10.1177%2F0020852318822055>.
- Park, C. H., & Kim, K. (2020). E-government as an anti-corruption tool: Panel data analysis across countries. *International Review of Administrative Sciences*, 86(4), 691-707.
- Park, C. H., and Kim, K. (2019). E-government as an anti-corruption tool: panel data analysis across countries. *International Review of Administrative Sciences*, 86(4): 691–707.
- Persson, A., Rothstein, B., & Teorell, J. (2013). Why anticorruption reforms fail—systemic corruption as a collective action problem. *Governance*, 26(3), 449-471.
- Proskuryakova, L., Abdrakhmanova, G., and Pitlik, H. (2011). Public Sector E-Innovations. The impact of e-government on corruption.
- Purnamasari, P., Amran, N. A., Nu'man, A. H., Frendika, R., Nor, M. N. M., & Ismail, M. S. (2022). Penta-Helix Model of E-Government in Combating Corruption in Indonesia and Malaysia: Religiosity as a Moderating Role. *F1000Research*, 11(932), 932.
- Kumar, R., & Gupta, P. (2016). Air pollution control policies and regulations. In *Plant responses to air pollution* (pp. 133-149). Springer, Singapore.

- Rausser, G. C., Lichtenberg, E., & Lattimore, R. (1981). Developments in theory and empirical applications of endogenous governmental behavior.
- Robins, J. A. (1987). Organizational economics: Notes on the use of transaction-cost theory in the study of organizations. *Administrative science quarterly*, 68-86.
- Rondinelli, D. A. (1981). Government decentralization in comparative perspective: theory and practice in developing countries. *International review of administrative sciences*, 47(2), 133-145.
- Samuelson, P. A. (1954). the pure theory of public expenditure. *Review of economics and statistics*, 36; 17-26.
- Santiso, C. (2018). Will Blockchain Disrupt Government Corruption? [https://ssir.org/articles/entry/will\\_blockchain\\_disrupt\\_government\\_corruption#bio-footer](https://ssir.org/articles/entry/will_blockchain_disrupt_government_corruption#bio-footer).
- Schoeberlein, J. (2019). Corruption in the Middle East & North Africa Regional Trends from the 2019 Global Corruption Barometer and Country Spotlights. Transparency International Anti-Corruption Brief, 10.
- Setyobudi, C, Setyaningrum, R. A. (2019). E-government and corruption perception index: a cross-country study. *Jurnal Akuntansi dan Auditing Indonesia* 23(1): 121-126.
- Starke, C., Naab, T. K., & Scherer, H. (2016). Free to expose corruption: The impact of media freedom, internet access and governmental online service delivery on corruption. *International Journal of Communication*, 10, 21.
- Tan, E., Mahula, S., & Cromptvoets, J. (2022). Blockchain governance in the public sector: A conceptual framework for public management. *Government Information Quarterly*, 39(1), 101625. <https://doi.org/10.1016/j.giq.2021.101625>.
- Taylor, I. W., Ullah, M. A., Koul, S., & Ulloa, M. S. (2022). Evaluating the impact of institutional improvement on control of corruption—A system dynamics approach. *Systems*, 10(3), 64.

- ThiHoa, T. (2020). The effects of corruption on the human capital accumulation process: Evidence from Vietnam. *Economics of Transition and Institutional Change*, 28(1), 69-88.
- Umbach, G., & Tkalec, I. (2022). Evaluating e-governance through e-government: Practices and challenges of assessing the digitalisation of public governmental services. *Evaluation and program planning*, 93, 102118.
- United nations, sustainable development report. (2020).
- Ventrone, O. (2021). International organizations, e-government and development. DOI: 10.4018/978-1-60566-254-1.ch003.
- Wang, L., Luo, X. R., & Jurkat, M. P. (2020). Understanding inconsistent corruption control through e-government participation: Updated evidence from a cross-country investigation. *Electronic Commerce Research*, 1-28.
- World Bank group. (2021). Egypt economic monitor.
- World Bank (2021), world development report.
- Yalman, G, Ö. (2019). The Relationship Between E-Government And Corruption: An Empirical Analysis Using Panel Data. International Public Finance Conference/Turkey 24-27, 2019, Antalya – Turkey.
- Zheng, Y. (2016). The impact of E-participation on corruption: a cross-country analysis. *International Review of Public Administration*, 21(2), 91-103.