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Blockchain and AI-Driven Framework for Measuring the Digital Economy in GCC

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Abstract

The rapid growth of the digital economy presents opportunities and challenges, particularly in the Gulf Cooperation Council (GCC) region, where economic diversification is essential. Accurate measurement of digital economic activity is crucial for developing effective policies and strategic decision-making. This study introduces a comprehensive Digital Economy Measurement (DEM) framework tailored for the GCC. The framework integrates blockchain technology for secure and transparent data management, FinGPT for advanced financial data analysis, and Conversational Agent (CA) for enhanced user interaction. The research methodology involves a step-by-step design, starting with identifying and categorizing relevant data sources, collecting data through APIs and web scraping, and utilizing smart contracts and oracles for validation and recording. The data is managed securely using decentralized storage solutions and regional nodes. We propose using FinGPT and CA to analyze data in-depth and extract valuable insights. User interaction is prioritized through CA, interactive dashboards, and natural language processing, which prioritize user interaction with interfaces tailored to GCC-specific languages and cultures. The study's contribution to the literature lies in its novel, integrated approach to measuring the digital economy in the GCC, addressing challenges related to data accuracy, privacy, and regulatory compliance. By leveraging blockchain, FinGPT, and CA, the DEM-GCC framework offers a robust and adaptable solution for understanding and fostering the region's digital economy.

Keywords:

Gulf Cooperation Council (GCC);
Digital Economy;
Digital Economy Measurement in GCC (DEM-GCC);
Generative AI; FinGPT;
Conversational Agent (CA);
Blockchain Technology.

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1- Introduction

The digital economy, characterized by the extensive incorporation of digital technologies in economic activities, is revolutionizing global markets [1, 2]. In this context, the Gulf Cooperation Council (GCC countries include Bahrain, Oman, Kuwait, Qatar, the Kingdom of Saudi Arabia, and the United Arab Emirates) countries are actively pursuing economic diversification to reduce their reliance on oil revenues by exploring alternative avenues for growth [3, 4]. Emphasizing the digital economy presents significant opportunities to stimulate creativity, improve efficiency, and promote sustainable economic development [2, 5, 6]. Accurately measuring the digital economy is essential for policymakers to understand its impact, identify growth opportunities, and formulate effective strategies [7]. However, this task is complex due to the dynamic nature of the digital economy and the diversity of data sources involved [8]. Traditional measurement frameworks often fall short, facing challenges like fragmented data, privacy concerns, and the lack of a universal definition [9-12].

Existing methods, such as the digital economy index [13] and the supply-use framework [14], provide regional insights and standardized measures but suffer from limitations like indicator selection and impact underestimation.

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Furthermore, there is a growing recognition of the need for comprehensive frameworks that cater to developing countries, though many proposals remain conceptual [12]. Conventional statistical methods and surveys often struggle to capture the full range of digital activities, necessitating more up-to-date and detailed data to inform policy decisions [15-17].

Blockchain technology offers promising solutions to these challenges by providing secure and transparent data management [18, 19]. As a decentralized and immutable ledger, blockchain ensures data integrity and reliability [20], with smart contracts automating data validation and recording transactions to reduce errors and fraud [21]. Additionally, blockchain's interoperability capabilities enhance the comprehensiveness of digital economy measurements by enabling data exchange across various platforms [22].

Advancements in artificial intelligence (AI) and machine learning further revolutionize data analysis capabilities [23-25]. FinGPT, a large language model for finance, efficiently handles and analyzes large volumes of financial data, providing valuable insights and predictive analytics [26, 27]. Incorporating FinGPT into digital economy measurement frameworks can significantly improve the precision and comprehensiveness of economic analysis, thereby aiding policymakers in their decision-making processes [28].

CA systems can engage in human-like dialogue using large language modeling (LLM) [28, 29]. Engineers specifically design these systems to understand, analyze, and respond to user inputs in a conversational manner, providing interactive and user-friendly interfaces for data access and analysis. CA plays a critical role in enhancing the usability of complex data systems by improving user engagement and accessibility.

This research investigates integrating blockchain technology with FinGPT and conversational agents [29] to enhance digital economy measurement (DEM) in GCC countries. The goal is to develop a comprehensive framework (DEM-GCC) that effectively utilizes blockchain, FinGPT, and CA for gathering, validating, and analyzing data from e-commerce transactions, digital payments, online services, gig economy activities, and social media interactions. This framework aims to overcome the constraints of conventional measurement methods by offering a secure, real-time, and comprehensive system for data collection and analysis.

The study's contribution to the literature lies in its novel, integrated approach to measuring the digital economy in the GCC, addressing challenges related to data accuracy, privacy, and regulatory compliance. By leveraging blockchain, FinGPT, and CA, the DEM-GCC framework offers a robust and adaptable solution for understanding and fostering the region's digital economy.

The study is organized as follows: Section 2 provides a literature review covering digital economy definitions and measurement challenges, as well as blockchain technology and generative AI. Section 3 outlines the methodology. Section 4 presents the adaptation plan for GCC countries. Section 5 includes an applicative case study demonstrating the framework in action. Section 6 discusses the implications for policy and practice, while Section 7 tackles challenges and limitations, and Section 8 concludes the discussion.

2- Literature Review

2-1- Digital Economy Definition and Measurement

2-1-1- Definition of Digital Economy

The digital economy is a global phenomenon, with estimates suggesting that it makes up around 7% to 10% of global GDP and 3% to 5% of global employment, highlighting its significant impact on the global economy [30].

The digital economy refers to an innovative economy that uses digital technologies and electronic communications to carry out economic and business activities in various sectors, such as e-commerce, digital marketing, digital financial services, software development, computer games, and cloud services [31-33]. It is widely acknowledged as an essential engine for economic growth and development across many advanced nations, and its influence on economic and business activities remains significant, leading to its continuous expansion [34].

Bukht & Heeks [8] define the digital economy as the economic activities resulting from online connections between individuals, businesses, devices, data, and processes. They propose three scopes: the core digital sector (IT/ICT), the true digital economy (the digital sector plus emerging digital and platform services), and the digitalized economy (the use of ICTs in all economic fields). This comprehensive view highlights the layered nature of the digital economy and its extensive reach across different aspects of economic activity.

According to Williams [11], the digital economy is the segment of economic output derived primarily or solely from digitalized initiatives with organizational models based on digital services or goods. According to this definition, the digital economy encompasses not only the creation of digital technologies, such as hardware or software, but also the utilization of these technologies to establish new business models and economic activities.

Barefoot et al. [14] state that the digital economy encompasses digital-enabling infrastructure, e-commerce transactions, and digital media content. This perspective emphasizes the foundational role of infrastructure and the transactional nature of the digital economy, as well as the importance of digital content in driving economic activities.

Oloyede et al. [12] suggest a more comprehensive definition that encompasses all economic, social, and governmental activities that enhance human life and depend on ICT. They emphasize the need for a comprehensive measurement approach that considers the unique characteristics of developing countries.

2-1-2- Digital Economy Measurement

The various definitions found in the literature highlight the complexity and multifaceted nature of the digital economy, which can be reflected in many challenges related to its measurement.

According to Williams [11], the digital economy can be measured by tracking various indicators, including:

E-commerce transactions:

- The volume and value of online sales, the types of products and services being purchased, and the demographics of online shoppers.
- Web analytics can be used to track website traffic, user behavior, conversion rates, and sales. These platforms provide insights into how users interact with an e-commerce site, helping businesses optimize their online presence.
- Tracking sales revenue, order volume, average order value, and customer lifetime value are fundamental metrics for measuring e-commerce success. This data can be gathered from e-commerce platforms, payment gateways, and accounting software.
- Gathering feedback through surveys, reviews, and social media can provide qualitative insights into customer satisfaction, preferences, and pain points. This information can guide improvements in products, services, and the overall customer experience.
- Customer surveys and feedback, social media analytics, market research, and competitive analysis, are used to provide qualitative insights into customer satisfaction, help assess brand awareness and customer perception, and provide insights into industry trends, market share, and potential growth opportunities.
- ***Digital payments:*** the flow of money in the digital economy, the popularity of different payment methods, and the average transaction value.

  Payment gateways, through service providers that authorize payments for e-businesses and online retailers, can track the volume and value of transactions processed. Web analytics, surveys, and government data are alternative methods and tools to measure and track digital payments.
- ***Online services:*** the usage data from websites and mobile apps, such as page views, clicks, and time spent on each page. Analytical tools, social media, surveys, and industry reports are the main methods to measure and track online services.
- ***Gig economy:*** the size and growth of the gig economy, the types of services being offered, and the earnings of gig workers.
- ***Social media interactions:*** the engagement of users on social media platforms, such as likes, shares, and comments

By collecting and analyzing data from these diverse sources, researchers and policymakers can gain a comprehensive understanding of the digital economy's size, growth, and impact.

- *Challenges of Measuring the Digital Economy*

Measuring the digital economy is a complex task due to the dynamic nature of the socio-economic and technological environment, as well as diverse data sources [8]. The main challenges particularly concern data sources and measurement frameworks [11, 12].

- *Challenges related to data sources*

Given the rise of digital transactions and data collection, data privacy and security are crucial. Any digital economy framework must protect data through encryption, anonymization, and compliance with data protection laws [11]. Trust, security, taxation, and income attribution are e-commerce challenges [35]. These issues highlight the need for strong regulations, secure payment systems, and transparent business practices to sustain growth.

The informal gig economy necessitates innovative measurement methods, such as online platforms and social media interactions. A major part of the digital economy, cross-border transactions, are delayed, costlier, and distrustful due to regulations, currency exchange fluctuations, logistical issues, and consumer protection concerns [12].

Traditional businesses face job displacement, new business models, and workforce upskilling and reskilling. Data center energy use and e-commerce delivery carbon emissions are also growing concerns [36]. Fuzzy boundaries between digital and traditional economies create hybrid models, complicating activity categorization and requiring reevaluation of economic measurement frameworks. Incomplete data, inconsistent collection methods, and limited access to relevant information cause data quality issues, especially in developing countries.

Due to rapid technological change and free digital services, pricing digital goods and services is difficult. Prices change with technology and market demand, resulting in unstable pricing models.

Finally, many digital activities, especially intermediary services and virtual goods, are invisible, making tracking and measurement difficult [37]. Payment gateways and cloud services hide digital transactions' economic impact. Intangible virtual goods and services, such as digital content and software, make measurement difficult [11, 12].

- *Challenges related to existing measurement frameworks*

The digital economy has completely transformed how we live, work, and interact. Nevertheless, the precise measurement of its size and impact continues to be a multifaceted challenge.

Traditional quantitative methods, including the Digital Economy Index and big data analysis [38-40], offer valuable insights; however, they are unable to fully capture the full picture.

The current frameworks' limited scope is a significant obstacle. Studies like [13] provide regional details, but their selected indicators and weighting methods may not be universally applicable. When factors that are relevant in one context are irrelevant in another, comparisons can be challenging. Moreover, frameworks that solely focus on digital products and services, like Barefoot et al. [14], could potentially underestimate the impact of the digital economy. The distinction between traditional and digital sectors is becoming increasingly cluttered due to the partial digitalization of numerous economic activities. The current frameworks may overlook the significant contributions these partially digitalized activities make to the economy as a whole.

The tension between practical application and conceptual frameworks is another obstacle. Oloyede et al. [12] underscore the necessity for enhanced measurement frameworks in developing countries. Nevertheless, the roadmap they have proposed is devoid of specific implementation strategies. It is imperative to establish a framework that is both practical and implementable in a variety of contexts, while also capturing the intricacies of the digital economy. Additionally, existing frameworks frequently encounter difficulties in reconciling economic impact with user experience. Hrustek et al. [41] concentrate on user experience, which is valuable but does not directly correlate with economic measurement. The free digital services that have become essential to our daily lives, such as social media platforms, generate remarkable value for users. However, conventional GDP metrics are unable to accurately represent this value because these services are frequently free or have minimal costs [16].

Lastly, the digital landscape's rapid pace of change poses a challenge for data analysis. Time delays in data analysis can impede our ability to accurately monitor the digital economy [42]. Frameworks must be adaptable enough to reflect the dynamic nature of the digital world and the current state.

2-2- Blockchain Technology

Studies suggest that blockchain has the potential to revolutionize value exchange in markets [43]. The rise of the digital economy in the 21st century is associated with challenges in quantifying it due to data inconsistency, fraud, and a lack of transparency. Traditional methodologies frequently fail to fully capture the extent of digital transactions [44]. In this context, blockchain, a distributed ledger technology, has the potential to revolutionize the way the digital economy is measured [45, 46]. It provides a safe and tamper-proof means of recording and monitoring transactions. Its fundamental advantage lies in its decentralized architecture, which copies data across a network of computers instead of storing it on a single server. This unchangeable recording of all transactions makes data manipulation and alteration exceedingly challenging [20].

Its capacity to deliver data that is safe, transparent, and verifiable can greatly increase the precision and scope of economic measurement [47]. Below we discuss a few major domains where blockchain presents noteworthy benefits:

Blockchain technology is excellent for safely monitoring and validating transactions. Within the framework of the digital economy, this means getting a more precise image of the overall value of electronic transactions by keeping track of each purchase on a blockchain ledger [45]. This reduces the likelihood of fraud or manipulation, often associated with traditional methods [48]. Furthermore, blockchain allows for the transparent tracking of ownership and transfer of digital products and services, such as games, music, and subscriptions. This makes it possible to measure these quickly expanding marketplaces' values precisely.

In addition, Blockchain enables the establishment of safe and user-controlled digital IDs for decentralized identity management. Enabling individuals to control their data and determine its use in the digital economy fosters trust and engagement [44]. We can obtain important insights into the general state of the digital realm by measuring user involvement with these decentralized identities.

Self-executing contracts based on blockchain technology have the potential to automate several activities in the digital economy. According to Wang et al. [49], these contracts can monitor work completion and guarantee safe payments, hence offering easily accessible data for assessing economic activity in particular sectors. The transparent and unchangeable nature of blockchain transactions can enhance the trustworthiness of the digital economy. This may result in increased engagement and a more realistic portrayal of economic activities. It makes data easily accessible and verifiable, making it more accurate to measure economic trends in the digital sphere [50].

Even with all of these benefits, Catalini [51] lists a few problems with using blockchain technology to measure the economy. These include: a) Scalability: the huge amount of data created by the digital economy might be too much for current blockchain implementations to handle; b) Privacy issues: users' privacy data and openness need to be balanced; and c) Standardization: different blockchain platforms may not have the same protocols, which could lead to problems with compatibility. It is imperative to address these problems to ensure smooth data collection and analysis.

2-3- Generative Artificial Intelligence

Generative Artificial Intelligence is an advanced field in artificial intelligence that involves using large language models (LLMs) and other complex methods to enable machines to independently create new content [52, 53]. It is driving significant improvements in various industries by automating complex tasks, improving creative processes, and facilitating the creation of innovative applications [54, 55]. The capacity to provide unique content, streamline processes, and provide innovative solutions is revolutionizing conventional models and enhancing productivity and creativity to unprecedented levels [56, 57]. Generative AI is transforming software development with improved tools and methods that boost productivity, lower costs, and increase quality. AI-driven code creation, debugging, and testing shorten the development lifecycle and enable faster, more reliable software delivery [58]. Many industries have implemented generative AI, changing workflows, employment responsibilities, and human-technology interactions. Integration into healthcare, banking, entertainment, and manufacturing shows its ability to promote change and innovation [59]. LLMs have revolutionized the field of generative AI; however, it is difficult for users to understand how trustworthy LLM outputs are [60].

Generative AI enables complex autonomous agents to do tasks previously requiring human intervention [61]. Complex problem-solving, commercial transactions, trip itinerary planning, and conversational interactions are examples of these tasks [62]. These agents emulate human reasoning, decision-making, and interaction by employing large datasets and advanced machine learning [63]. Conversational agents provide customer service, answer questions, and encourage interactions using natural language [64]. LLMs' contextual understanding and accurate responses to user inputs improve user experience and operational efficiency [65].

An important advancement in this field is the Financial Generative Pre-Trained Transformer (FinGPT), a specialized large language model specifically created for financial purposes [27]. FinGPT utilizes GAI and financial data to improve the accuracy and reliability of financial analysis, forecasting, and decision-making. The FinGPT framework utilizes advanced technology to automatically gather and organize up-to-date financial information from a wide range of 34 different sources, such as news outlets, social media platforms, company filings, and research datasets, to ensure the high quality and relevance of the data used for training and fine-tuning the model.

FinGPT utilizes Reinforcement Learning with Stock Prices (RLSP) and Low-rank Adaptation (LoRA) to successfully adapt general-purpose LLMs to specific financial operations. RLSP utilizes market feedback to optimize the model, whereas LoRA facilitates efficient adaptation, resulting in a notable decrease in the computational resources and time needed for optimization. Users can personalize their own financial LLMs at a reasonable expense, making advanced financial analysis tools accessible to everyone [66].

There are several ways to use FinGPT, including providing automated financial advice services (robo-advisors), conducting sentiment analysis for algorithmic trading, and supporting low-code development platforms. These applications showcase the pragmatic usefulness of FinGPT in actual financial scenarios, providing advanced analysis and forecasts that support well-informed decision-making and foster innovation in the financial industry. FinGPT demonstrates the vast potential of generative artificial intelligence (AI) in specific domains, reinforcing the influence of AI-powered advancements in a variety of industries.

3- Research Methodology

The DEM-GCC framework aligns with Oloyede et al.'s [12] broader definition, recognizing the digital economy's impact on various aspects of life. It further refines the definition by focusing on the GCC context and incorporating blockchain, FinGPT, and conversational AI technologies. It proposes a novel approach by integrating blockchain for secure data management, FinGPT for financial analysis, and conversational AI for user interaction. It aims to provide a comprehensive, real-time, and secure measurement system tailored to the GCC region.

The methodology section explains in detail the composites of the DEM-GCC framework shown in Figure 1, their performance functions, and their relationships.

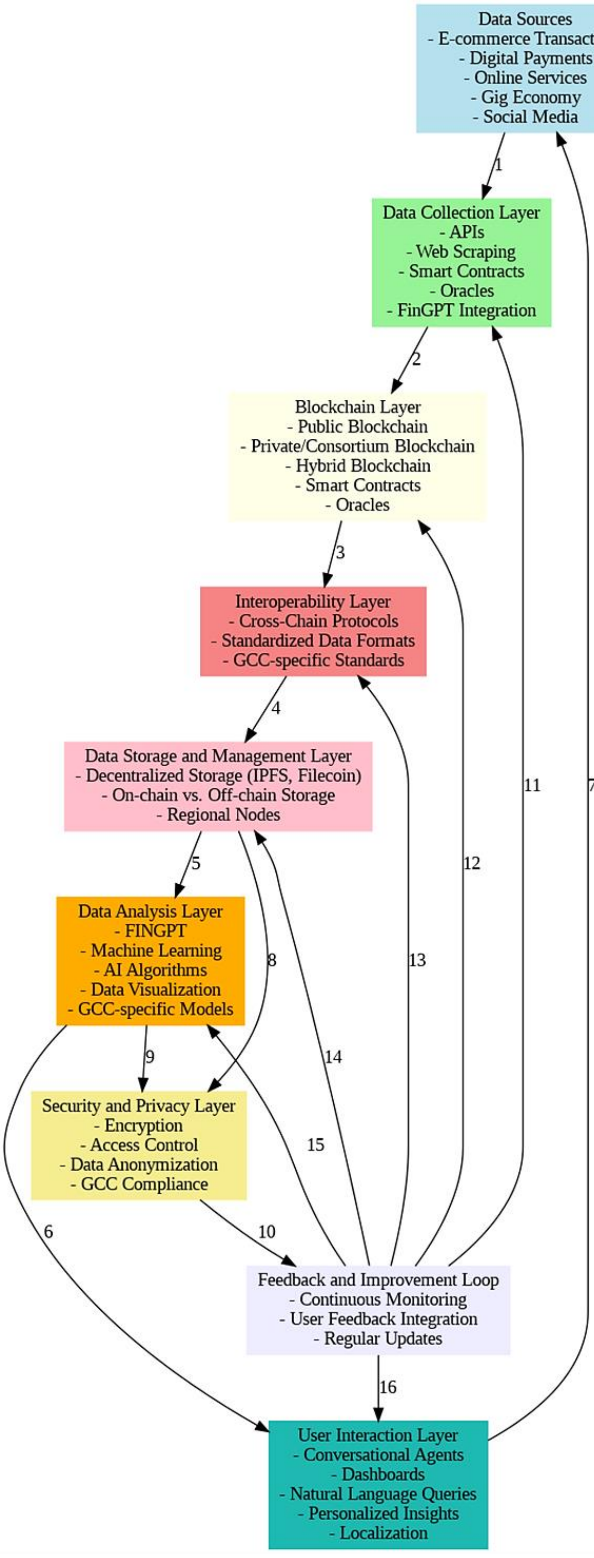

Figure 1. The DEM-GCC proposed framework

The initial phase of the methodology entails identifying and categorizing pertinent data sources that encompass diverse aspects of the GCC's digital economy. The sources mentioned encompass e-commerce transactions, digital payments, online services, gig economy activities, and social media interactions [67]. By specifically targeting these data streams, the framework ensures that the collected data is relevant and comprehensive for measuring the digital economy in the GCC region.

- *Data collection layer*

The data collection stage employs various techniques to acquire data from the specified sources [11]. The data sources utilize APIs to retrieve real-time data, guaranteeing its timeliness and relevance. When there are no APIs available, web scraping techniques are employed to directly extract data from websites. Smart contracts deployed on blockchain networks automate the process of validating and recording transaction data, guaranteeing precision and openness. Blockchain oracles are employed to retrieve external data and securely incorporate it into the blockchain, while FinGPT is integrated to handle and evaluate financial data, thereby augmenting the comprehensiveness and precision of the gathered information.

- *Blockchain layer*

The blockchain layer guarantees the secure and transparent administration of the gathered data [68]. Public blockchains are employed to ensure transparency by providing public access to non-confidential data [69-71]. Private and consortium blockchains are utilized for managing sensitive data that necessitates limited access [72]. Hybrid blockchain solutions integrate the advantages of public and private blockchains, offering versatility in data administration. Smart contracts streamline procedures such as data verification, transaction logging, and implementation of business rules, while oracles guarantee the secure integration of data from external sources into the blockchain.

- *The interoperability layer*

The interoperability layer specifically caters to the requirement of seamless data interchange among diverse blockchain networks and systems [73]. Cross-chain protocols enable the exchange of information and transfer of data across diverse blockchain platforms. Standardized data formats guarantee uniformity and compatibility of data among various systems, while adherence to GCC-specific standards ensures that all data management and exchange adhere to regional regulations and norms.

- *Data storage and management*

The primary objective of the data storage and management layer is to securely and optimally store the gathered data. IPFS and Filecoin are utilized as decentralized storage solutions to guarantee the availability and security of data [74, 75]. Essential information is stored on the blockchain to ensure it cannot be altered, while extensive datasets are stored outside the blockchain to enhance efficiency [76]. Regional nodes are established in GCC countries to adhere to local data residency laws and regulations, guaranteeing that data storage practices conform to regional requirements.

- *Data analysis*

The data analysis layer employs sophisticated tools and methodologies to extract significant insights from the gathered data. FinGPT is utilized for its sophisticated financial analysis capabilities, which involve the processing and examination of financial transactions and trends [77]. Machine learning models are trained on datasets that are specific to the GCC region to recognize patterns and make predictions. On the other hand, AI algorithms are employed for in-depth analysis and extraction of valuable insights. Data visualization tools generate graphical representations of data, facilitating the comprehension of insights [78]. Models specific to GCC are created to customize the analysis according to the economic context and unique features of the region.

- *The user-system interaction*

The user interaction layer facilitates the interaction between users and the system, enabling users to gain insights. FinGPT-powered conversational agents provide accurate responses to user inquiries regarding the digital economy. Interactive dashboards present essential metrics and patterns, while natural language processing enables users to interact with the system intuitively. Customized analysis is offered according to user preferences and requirements, and the interfaces are adapted to the Arab language and cultures specific to the GCC, improving user involvement and ease of use.

- *Security and privacy*

The security and privacy layer guarantee the safeguarding of data and adherence to regional regulations. The data is encrypted during transmission and while stored to safeguard it from unauthorized access. Strong access control mechanisms limit data access to authorized users exclusively, while data anonymization techniques are employed to safeguard user identities. Strictly adhering to GCC data protection regulations ensures the lawful and ethical handling of data.

- *The feedback and improvement loop*

The feedback and improvement loop guarantee the ongoing enhancement of the system. The performance of the system is constantly monitored to promptly identify and resolve any issues. User feedback is gathered and incorporated to enhance the features and functionality of the system. Periodic updates are implemented to ensure that the system remains current with the most recent technological advancements and user requirements, guaranteeing its continuous relevance and precision. The framework aims to offer a strong solution for measuring and analyzing the digital economy in the GCC region. It utilizes blockchain technology and FinGPT to enhance accuracy and provide valuable insights.

The explanations of connection between different components of the framework are provided in Table 1.

Table 1. Linkage between the components of the DEM-GCC framework

Link	Connection	Explanation
1	Data Sources to Data Collection Layer	Data from e-commerce, digital payments, online services, gig economy, and social media is collected using APIs, web scraping, smart contracts, oracles, and FinGPT.
2	Data Collection Layer to Blockchain Layer	Collected data is integrated with the blockchain using smart contracts and oracles for secure, immutable record-keeping and decentralized processing.
3	Blockchain Layer to Interoperability Layer	Blockchain data is made interoperable across different blockchain systems via cross-chain protocols, standardized data formats, and GCC-specific standards.
4	Interoperability Layer to Data Storage and Management Layer	Interoperable data is stored and managed using decentralized storage solutions (IPFS, Filecoin) with on-chain vs. off-chain storage considerations and regional nodes.
5	Data Storage and Management Layer to Data Analysis Layer	Stored data is analyzed using tools like FinGPT, machine learning, AI algorithms, data visualization techniques, and GCC-specific models.
6	Security and Privacy Layer to Data Collection Layer	Ensures data collected is encrypted, access-controlled, anonymized, and compliant with GCC regulations.
7	Blockchain Layer to Security and Privacy Layer	Ensures blockchain data follows encryption, access control, and compliance with GCC regulations.
8	Data Analysis Layer to Interoperability Layer	Analyzed data informs adjustments and improvements in interoperability protocols for better system integration.
9	Security and Privacy Layer to Data Analysis Layer	Ensures data analysis adheres to privacy and security standards, preventing unauthorized access and maintaining data integrity.
10	Security and Privacy Layer to Feedback and Improvement Loop	Continuously monitors and updates security measures based on feedback for ongoing compliance and protection.
11	Blockchain Layer to Feedback and Improvement Loop	Feedback from the blockchain layer identifies areas for improvement in smart contracts and oracles.
12	Blockchain Layer to User Interaction Layer	Allows user interaction with blockchain data through conversational agents, dashboards, natural language queries, and personalized insights.
13	Interoperability Layer to User Interaction Layer	Enables seamless user interaction across different systems and standards through interoperable protocols.
14	Data Analysis Layer to Feedback and Improvement Loop	Provides insights and feedback from data analysis to improve system accuracy and relevance.
15	Security and Privacy Layer to Feedback and Improvement Loop	Ensures the feedback loop incorporates privacy and security considerations in all updates and changes.
16	Feedback and Improvement Loop to User Interaction Layer	Regular updates based on user feedback and continuous monitoring enhance user experience with localized content and improved interfaces.

4- Adaptation plan for GCC Countries

To ensure the successful implementation and adoption of the DEM-GCC framework in the diverse regulatory and technological landscape of the GCC countries, a tailored adaptation strategy is essential. This section outlines the key steps involved in adapting the framework to meet the specific needs and challenges of the region.

4-1- Regulatory and Compliance Strategy

A key requirement for this project's success is to ensure that the proposed framework for DEM-GCC adheres to the diverse regulatory environments of GCC countries and aligns with international standards. To achieve this, we follow a structured approach (Figure 2) that involves comprehensive research, the development of a compliance framework, and ongoing audits and reviews.

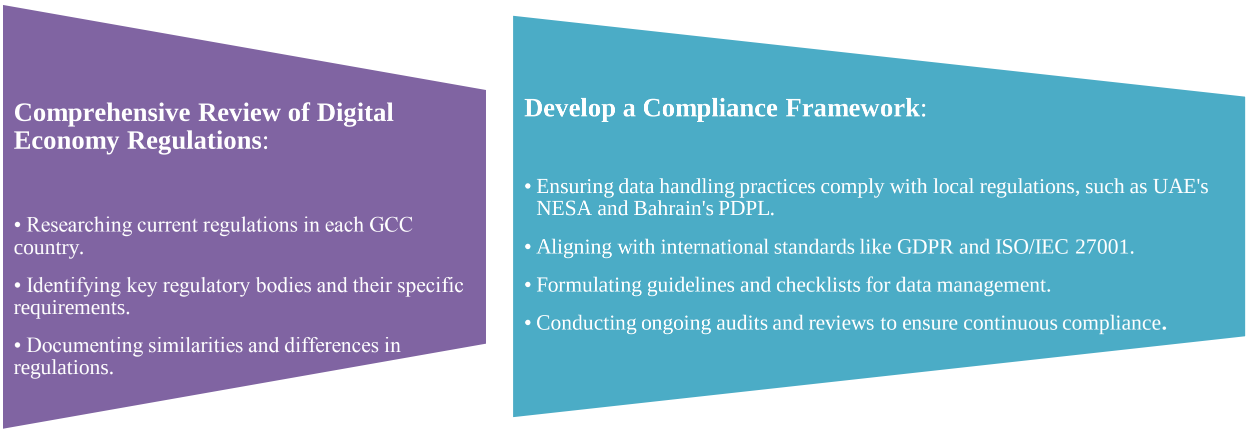

Figure 2. Regulatory and compliance strategy

3-1-1- Comprehensive Review of Digital Economy Regulations

To adapt the DEM-GCC framework, the first step is to conduct thorough research on the existing digital economy regulations in each GCC country. This involves collecting detailed information on current regulations from official government publications, legal databases, and consultations with legal experts. Understanding the regulatory landscape is crucial, as each GCC country may have unique requirements and compliance standards.

Identifying the primary regulatory entities in each country is essential. For instance, in the UAE, the Telecommunications Regulatory Authority (TRA) oversees digital economy regulations, while in Saudi Arabia, the Communications and Information Technology Commission (CITC) plays a similar role. By determining the specific criteria set by these entities concerning data gathering, retention, manipulation, and confidentiality, we can ensure that the DEM-GCC framework meets all necessary legal requirements.

A comparative analysis of these regulations across GCC countries will help identify commonalities and differences. This step involves documenting the similarities and differences in regulations, creating a comprehensive understanding of the compliance landscape. We can formulate guidelines to ensure full compliance of our framework through a regulatory map that outlines the specific requirements and compliance obligations in each country.

The diverse regulatory frameworks across the GCC present challenges, including variations in requirements and frequent updates. To address these challenges, it is crucial to engage with local legal experts and consultants who can provide insights and stay informed about regulatory changes. Additionally, implementing a regulatory watch mechanism will help monitor updates and ensure timely adjustments to the compliance framework.

3-1-2- Developing a Compliance Framework

After understanding the regulatory landscape, the next step is to develop a compliance framework that adheres to local regulations and aligns with international standards. This framework will ensure that all data handling practices, including collection, storage, and processing, meet the specific requirements of each GCC country.

For example, compliance with the UAE's National Electronic Security Authority's (NESA) regulations involves implementing robust cybersecurity measures and data protection protocols. Similarly, adhering to Bahrain's Personal Data Protection Law (PDPL) requires establishing procedures for data subject rights, breach notifications, and data transfers.

Adopting international standards is also essential. Aligning data handling practices with the General Data Protection Regulation (GDPR) ensures comprehensive data protection and privacy. Implementing the ISO/IEC 27001 standard for information security management establishes a systematic approach to managing sensitive data, providing an additional layer of compliance and security.

The compliance framework should include detailed guidelines and checklists covering all aspects of data management. These guidelines should be tailored to address sector-specific requirements like e-commerce, finance, and healthcare, ensuring comprehensive coverage of all regulatory aspects.

Ongoing audits and reviews are critical to maintaining compliance. Regular internal audits will help assess adherence to established guidelines and identify areas for improvement. Engaging third-party auditors for independent assessments ensures objectivity and thoroughness in verifying compliance with regulatory standards. Continuous improvement processes based on audit findings will enhance compliance efforts and adapt to changing regulations.

The dynamic nature of regulations and the need for ongoing monitoring present challenges. Establishing a dedicated compliance team responsible for monitoring regulatory updates and managing compliance activities is essential. Utilizing automated compliance tools and software can streamline compliance monitoring and reporting, making the process more efficient and effective.

4-2- Putting Data Protection and Privacy into Practice

A critical goal is to ensure the security of user data by implementing strict data protection measures that adhere to both local and international privacy laws. This step, highlighted in Figure 3, delineates the essential procedures required to accomplish this objective, with a particular emphasis on the implementation of data protection measures and the guarantee of adherence to local legislation.

3-2-1- Enforcing Data Protection Measures

To effectively safeguard user data, we suggest implementing several key data protection measures:

Encryption is a crucial element in safeguarding data. All sensitive data must be encrypted using robust encryption algorithms like AES-256, both during transmission and storage. Encryption guarantees the indecipherability and security of data, even if intercepted or accessed without authorization. This is critical to protecting the confidentiality and integrity of user data against potential breaches.

Strong access control mechanisms are required to restrict data access to only authorized personnel. Role-based access control ensures that individuals can only access data relevant to their specific roles. This lessens the possibility of unauthorized data exposure and access. Only those with a legitimate need to know can handle sensitive information, thanks to access control.

Data anonymization techniques are necessary to safeguard individual privacy, particularly in the context of data analytics. We suggest employing methods such as data masking, pseudonymization, and generalization to obfuscate personal identifiers, thereby impeding the ability to link data to specific individuals while still enabling meaningful analysis. Anonymization protects user identities and ensures compliance with privacy laws by preventing the disclosure of personal information.

Data Minimization: To mitigate privacy risks, it is imperative to gather only the data that is essential for analysis. Data minimization principles dictate the avoidance of unnecessary data that could compromise user privacy. Organizations can reduce the risk of privacy breaches and ensure responsible handling of user data by focusing on the minimum amount of data required for a specific purpose.

3-2-2- Adherence to Local Regulations

Adhering to local privacy laws is crucial for ensuring that data protection practices are compliant with regional legal requirements. This involves several important steps:

Comply with Local Privacy Laws is the first step. It is necessary to adhere to the specific privacy laws of each GCC country. As an illustration, adherence to Saudi Arabia's Personal Data Protection Law (PDPL) and the UAE's Federal Law No. 2 of 2019 is necessary for ensuring data protection practices. To ensure legal compliance, it is crucial to comprehend and conform to these local regulations.

Privacy legislation mandates the essential obligation of obtaining and overseeing user consent for data collection and handling. Implementing consent systems ensures users are aware of and approve of the use of their data, thereby enhancing transparency and promoting trust.

Effective data breach management entails creating and executing a comprehensive plan to handle any instances of data breach or unauthorized access promptly. In the event of a violation, this plan should outline the sequential actions to take, including notifying affected users and regulatory bodies of the breach and mitigating any potential harm. A well-defined breach management plan ensures a swift and coordinated response, minimizing the impact of data breaches on users and maintaining regulatory compliance.

By following the steps provided in Figure 3, organizations can ensure the protection of user data and compliance with privacy laws. This helps users gain trust and confidence in the secure and responsible handling of their data. Implementing these data protection measures and adhering to local regulations are critical components of the DEM-GCC framework, contributing to the overall goal of fostering a secure and trustworthy digital economy in the GCC region.

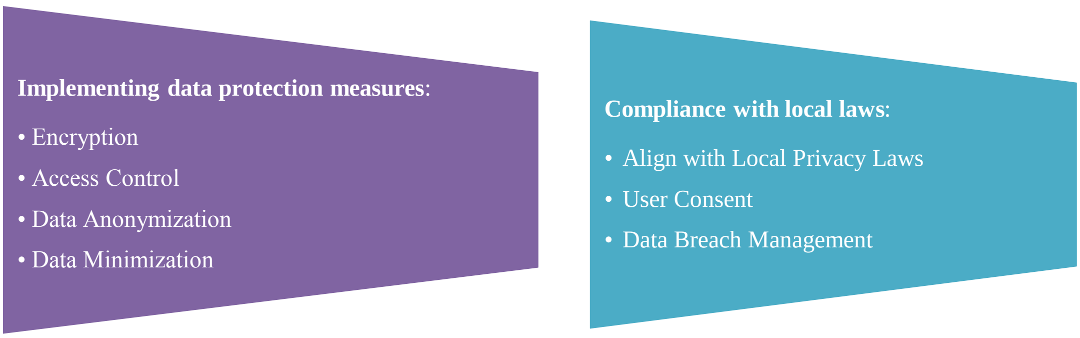

Figure 3. Implementation of Data Protection and Privacy

4-3- Technological Infrastructure Development

The technological infrastructure is the foundation of a thriving digital economy. To this end, significant investments are necessary in several key areas:

Blockchain Nodes: Blockchain technology is a cornerstone of secure and transparent data management. The DEM-GCC framework will establish and maintain blockchain nodes to facilitate decentralized data collection and storage. Blockchain ensures data integrity and immutability, allowing for transparent and trustworthy transactions. The framework will employ a combination of public, private, and consortium blockchains to balance the needs for transparency, security, and performance. Public blockchains will provide data transparency and accessibility, while private and consortium blockchains will offer enhanced security for sensitive information, allowing controlled access among trusted parties.

High-Speed Internet Infrastructure: A robust high-speed internet infrastructure is essential for the efficient collection, transmission, and analysis of data. We suggest direct investments in upgrading existing networks and establishing new connections to guarantee robust and reliable internet access in both urban and rural areas. This infrastructure will support the seamless operation of digital services and the integration of emerging technologies, thereby fostering an inclusive digital economy.

Regional Data Centers: The creation of regional data centers is another critical component. Strong security measures, such as advanced encryption, multi-factor authentication, and regular security audits, will equip these centers to safeguard data from unauthorized access and breaches. We suggest also implementing redundancy protocols to ensure data availability and disaster recovery, ensuring continuous data access and integrity in the event of failures or attacks. This secure and efficient data storage infrastructure will be pivotal in supporting the digital economy's growth.

Ensuring Fair and Equal Access: One of the paramount goals of the DEM-GCC framework is to ensure equitable access to digital infrastructure. This involves addressing the disparity in access to digital resources between urban and rural areas through strategic initiatives.

Collaboration with telecommunications providers: Forming alliances with telecommunications providers is essential to broadening internet coverage to underserved and remote areas. These partnerships will leverage existing infrastructure and deploy new technologies, such as 5G, to enhance connectivity. By expanding internet access, we can ensure that all regions benefit from digital advancements, thereby promoting inclusivity and reducing the digital divide.

Collaborative Endeavors: The successful implementation of technological infrastructure requires a collaborative effort between government agencies and private sector entities. This collaboration will promote the sharing of resources and expertise, accelerating infrastructure development.

Public-Private Partnerships: Encouraging public-private partnerships will be critical in pooling resources, sharing knowledge, and leveraging expertise in constructing digital infrastructure. By bridging the gap between government initiatives and private sector innovation, these partnerships will ensure the employment of the best practices and technologies.

Regional Cooperation: Promoting regional cooperation among GCC countries will further enhance infrastructure development. By sharing best practices, technologies, and investments, GCC countries can collectively address common challenges and opportunities. This regional cooperation will lead to a more efficient and effective implementation of the technological infrastructure, fostering a unified approach to the digital economy.

4-4- Standardization and Interoperability Framework

To strengthen the digital economy, it is necessary to encourage the use of standardized data formats and cross-chain protocols, as well as the establishment of interoperability standards across GCC countries within the DEM-GCC framework. All GCC countries can utilize standardized data formats developed and promoted by the Gulf Standardization Organization (GSO). This will guarantee the uniformity and compatibility of data gathered from diverse sources. There will be a push to promote the implementation of international data standards, such as ISO standards, to enhance global compatibility and streamline integration with international systems.

To facilitate seamless communication and data sharing between diverse blockchain networks, we suggest creating and implementing interoperable protocols. This entails developing interoperability frameworks that facilitate the exchange of data among public, private, and consortium blockchains. Regional entities and interested parties will be involved in these protocols, ensuring that they align with the GCC region's requirements and regulations. Working groups with delegates from each GCC nation need to be established to formulate and implement interoperability standards. The standards need to be frequently revised to keep pace with technological advancements and changing regulatory environments.

4-5- Cybersecurity Measures

To ensure protection for the digital infrastructure and data, DEM-GCC must establish extensive cybersecurity frameworks and employ state-of-the-art threat detection technologies. One should start by implementing cybersecurity measures such as multi-factor authentication (MFA), intrusion detection systems (IDS), and regular security audits, all customized to adhere to the specific regulations of each GCC country. Regular security assessments and penetration testing are essential to this undertaking to actively detect and resolve potential security vulnerabilities. Periodic security audits help us maintain compliance with established cybersecurity policies and standards, ensuring a strong defense against emerging threats.

Utilizing sophisticated technologies such as AI and machine learning to identify and prevent threats is an additional crucial element. Khan et al. [79] examine the use of an artificial intelligence-powered access control system as an essential element for managing and protecting the information assets of the financial sector in the GCC region. Organizations that use web-enabled remote access and deploy applications across multiple networks face numerous challenges due to the dynamic and intricate nature of access control security rules. These challenges include increased operational complexity and monitoring difficulties. These tools have the capability to detect atypical patterns and possible risks in real-time, offering a flexible and proactive approach to cybersecurity. In addition, implementing regular training and awareness programs for employees will provide them with the necessary knowledge and skills to identify and address cybersecurity threats efficiently, thereby establishing a more secure and resilient digital environment.

4-6- Economic Diversification and Analysis

To promote economic diversification and gain a comprehensive understanding of the impact of digital technologies, it is imperative to carry out comprehensive economic analyses. By collecting extensive data on digital economy activities and their influence on different sectors, we can create advanced analytical models to evaluate the extent to which these technologies contribute to economic diversification.

With these insights, the DEM-GCC framework can be modified to better support diversification objectives. This entails formulating policy suggestions derived from the analysis, which may include providing incentives for the adoption of digital technologies, fostering the growth of startups, and allocating resources to improve digital infrastructure. Customized approaches targeting specific industries, such as fostering financial technology advancements within the financial sector or enhancing online learning platforms in education, can optimize the advantages of digital technologies.

To maintain the continued significance and efficiency of these strategies, it is imperative to establish mechanisms for continuous monitoring of metrics related to the digital economy. Regular evaluations will aid in tracking progress and impact, allowing for the implementation of essential changes and improvements, ultimately guaranteeing our efforts align with our economic diversification goals.

4-7- Sustainable Funding Models

To guarantee continuous investment in digital infrastructure, creating comprehensive funding models that leverage diverse sources is crucial. These models will ensure sustained growth and development, fostering a resilient digital economy in the GCC region. This section explains the various funding mechanisms and strategies to secure and manage investments in digital infrastructure effectively.

Government funding and grants: Governments play a pivotal role in securing essential project funding. By allocating specific budgets for public digital initiatives, governments can provide a stable financial foundation for digital infrastructure projects. Additionally, governments can actively seek and receive grants specifically designated for these initiatives from national and international sources. These grants can significantly boost funding availability and support large-scale projects that may not be feasible with government budgets alone.

Public-Private Partnerships and Tax Incentives: Public-private partnerships (PPPs) are effective mechanisms to attract private-sector investments into digital infrastructure. Through PPPs, governments can collaborate with private companies to share resources, expertise, and risks associated with infrastructure projects. These partnerships create a cooperative atmosphere, leveraging the strengths of both sectors to advance digital infrastructure efficiently.

Tax incentives are another powerful tool to encourage private-sector participation. By offering tax breaks, deductions, or credits to companies that invest in digital infrastructure, governments can make these investments more attractive. Such incentives reduce the financial burden on private entities, making it more feasible for them to contribute to public digital initiatives.

Community involvement and crowdfunding: Engaging local communities in funding digital infrastructure can have a transformative impact. Crowdfunding platforms provide a means to solicit funds for targeted projects from a broad base of supporters. Projects that involve the community in the funding process can garner extensive backing and foster a sense of ownership among local populations. This active engagement helps cultivate a supportive environment for digital initiatives and ensures that the projects align with community needs and priorities.

Profitable Frameworks for Digital Services: To ensure the long-term viability of digital infrastructure, it is crucial to establish profitable frameworks for digital services. Implementing recurring payment services, charges for individual transactions, and fees for public services can help to generate consistent revenue streams. Reinvesting these revenues can support maintaining and expanding the digital infrastructure. For example, governments and private entities can develop subscription-based models for certain digital services, ensuring a steady inflow of funds. Transaction fees for digital payments and online services can also contribute to a sustainable revenue model. Additionally, fees for accessing public digital services, such as e-government portals or digital health services, can further bolster funding.

Resilient financial management practices: Effective financial management practices are critical to ensuring efficient fund allocation and transparency in all financial operations. This involves implementing robust financial planning, budgeting, and auditing processes to manage resources effectively. Transparent financial practices foster trust and accountability among stakeholders, including the public, private investors, and international donors.

Regular financial reporting and audits can guarantee the appropriate and efficient use of funds. This transparency not only fosters confidence among investors and donors, but also guarantees the sustainable and ethical management of digital infrastructure projects.

5- Case Study Application: Measuring E-commerce Growth for a Travel Agency in the GCC

We demonstrate in Appendices 1 to 3 the simplified application of the proposed DEM-GCC framework to a traveling agency operating in Kuwait, a GCC country, offering a range of services such as booking flights, hotels, and tours, as well as digital payments and customer interactions via their online platform (Figure 4).

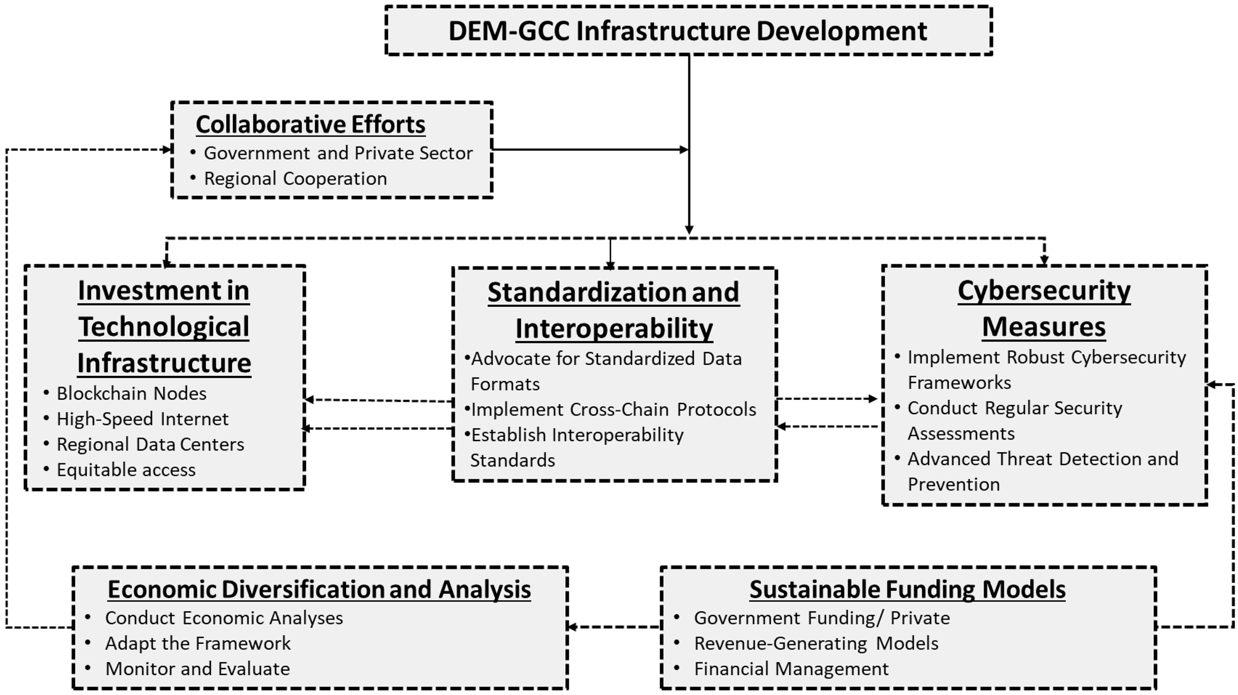

Figure 4. The DEM-GCC technological infrastructure development

This case study demonstrates the process of gathering, organizing, examining, and presenting data on the travel agency's online operations of the travel agency by making use of the different layers and components of the framework.

- Identification of Data Sources: Initially, the framework determines the primary data sources that are relevant to the travel agency's operations. The data encompasses information gathered from various sources, such as the agency's online booking platform for flights, hotels, and tours, transaction records from payment gateways like STC Pay and Stripe, usage data from the agency's website and mobile app, data from freelance tour guides and travel consultants, and interaction data from social media profiles.
- Collecting Data: The data collection process entails employing various techniques to acquire data from these sources. We equip the booking system with APIs to retrieve real-time booking data. Web scraping techniques enable data extraction from competitor websites. The Ethereum blockchain implements smart contracts to authenticate and document booking transactions, ensuring accuracy and transparency. We use blockchain oracles to retrieve external data, as well as FinGPT for financial analysis.
- The blockchain layer is a fundamental component of a blockchain system. Within the blockchain layer, the gathered data is securely administered through the utilization of blockchain technology. Smart contracts streamline the process of verifying and documenting transaction data. While public blockchains ensure transparency, private and consortium blockchains manage confidential information that requires restricted access. Hybrid blockchain solutions integrate the advantages of public and private blockchains to enable flexible data management.
- Interface Compatibility: This layer facilitates frictionless data interchange between various blockchain networks and systems. Cross-chain protocols facilitate the transmission of information and data between different blockchain platforms. Standardized data formats ensure data consistency and compatibility, while GCC-specific standards ensure compliance with regional regulations.

- Storing and Managing Data: Data storage and management are implemented to guarantee both security and efficiency. IPFS and Filecoin are utilized as decentralized storage solutions to guarantee the availability and security of data. The blockchain is utilized to safeguard critical data from unauthorized alterations, whereas larger datasets are stored outside of the blockchain to optimize efficiency. Regional nodes are established in Gulf Cooperation Council (GCC) countries to adhere to local data residency regulations.
- Data analysis layer: The data analysis layer utilizes sophisticated tools and methodologies to derive significant insights from the gathered data. FinGPT is employed for advanced financial analysis, handling, and scrutinizing financial transactions and patterns. Machine learning models, which have been trained on datasets specific to the GCC (Gulf Cooperation Council), are capable of recognizing patterns and making predictions. AI algorithms are employed to conduct thorough analysis and extract valuable insights, while data visualization tools generate graphical representations of data to enhance comprehension.
- User Interface: This layer enables user engagement with the system. Conversational agents, utilizing the capabilities of FinGPT, offer precise and reliable answers to user queries. Interactive dashboards present essential metrics and patterns, while natural language processing enables users to interact with the system in an instinctive manner. Personalized analysis is provided according to user preferences and requirements.
- Security and Privacy: Ensuring data protection and regulatory compliance is of utmost importance, prioritizing security and privacy. Information is encoded during the process of being sent and stored in order to safeguard it from unauthorized individuals. Robust access control mechanisms restrict data access to authorized users, while data anonymization techniques safeguard user identities. Adhering to GCC data protection regulations guarantees the legal and moral handling of data.
- Feedback and Iterative Process: The system undergoes continuous improvement through a feedback and enhancement loop. The system's performance is continuously monitored in order to promptly detect and address any issues that may arise. System features and functionality are enhanced by gathering and integrating user feedback. Regular updates are implemented to ensure that the system remains up-to-date with the latest technological advancements and user requirements.
- Code Implementation: The code provided in Appendix I exemplifies the practical utilization of the DEM-GCC framework within the context of the case study. The explanation of how the code is implemented is provided below:

  Data Collection:

  - APIs are utilized to retrieve booking data in real-time.
  - Web scraping is the process of extracting data from websites belonging to competitors.
  - Smart contracts verify and document transactions on the Ethereum blockchain.

  Blockchain Interaction:

  - Blockchain data management guarantees the secure storage of data.
  - Smart contract deployment streamlines transaction processes.

  Interoperability:

  - Cross-Chain Data Transfer facilitates the transfer of data between the Ethereum and Hyperledger platforms through the utilization of Polkadot.
  - Standardization guarantees data compatibility and adherence to GCC standards.

  Data Storage:

  - IPFS Storage securely stores data on a decentralized platform.
  - Data encryption ensures the confidentiality and integrity of data.

  Data Analysis:

  - FinGPT Integration offers sophisticated financial analysis capabilities.
  - Machine learning models are capable of identifying anomalies and making predictions about trends.

  User Interaction:

  - A conversational agent utilizes LangChain for seamless natural language interaction.
  - The dashboard offers dynamic visual representations.

Security:

- Encryption and decryption ensure the integrity of data.
- Access control guarantees that only authorized individuals can access data.

Monitoring:

- The integration of Prometheus allows for the monitoring of system metrics and performance.

Collection of Feedback:

- User feedback is gathered to consistently enhance the system.

Deployment:

- Docker and Kubernetes are utilized for the efficient deployment of applications.

6- Comparison of Study's Results to Previous Research

The DEM-GCC framework addresses the challenges of measuring the digital economy by leveraging advanced methodologies and innovative approaches, as demonstrated in comparison with existing literature.

Firstly, the DEM-GCC framework overcomes data privacy and security challenges by integrating robust encryption, anonymization techniques, and strict compliance with data protection laws, ensuring the secure handling of digital transactions. This approach aligns with and enhances existing recommendations for protecting data within the digital economy [11].

In the same line with previous research [35], regarding the measurement of e-commerce challenges, such as trust, security, taxation, and income attribution, the DEM-GCC framework employs secure payment systems and transparent business practices, which are essential for fostering sustainable growth.

For the informal gig economy, the DEM-GCC framework utilizes data from online platforms and social media interactions to provide a more comprehensive understanding of this sector. This approach goes beyond the innovative measurement methods proposed by Oloyede et al. [12] by incorporating real-time data collection and analysis. Cross-border transactions are accurately tracked through the DEM-GCC framework's integration of diverse data sources, including APIs and web scraping. This method addresses the delays, costs, and distrust associated with varying regulations and logistical complexities, offering a more efficient solution than previous frameworks.

The impact on traditional businesses is mitigated by the DEM-GCC framework's ability to monitor job displacement, the emergence of new business models, and the need for workforce upskilling and reskilling. Additionally, the framework assesses the environmental sustainability of the digital economy by tracking data center energy consumption and e-commerce delivery carbon emissions, addressing growing concerns in the literature [36].

The DEM-GCC framework also tackles the issue of fuzzy boundaries between digital and traditional economies by creating hybrid models that categorize activities more accurately. This reevaluation of economic measurement frameworks ensures that partially digitalized activities are not overlooked, enhancing the work of previous studies such as those by Xu and Li [13] and Barefoot et al. [14].

Addressing data quality issues, particularly in developing countries, the DEM-GCC framework improves upon the methodologies proposed by Oloyede et al. [12] by providing complete and consistent data collection methods and broader access to relevant information.

Finally, the DEM-GCC framework uncovers hidden transactions by integrating data from various platforms and systems, making intermediary services and virtual goods more visible and trackable. This comprehensive view of digital economic activity addresses the invisibility issues noted in the literature, providing a more accurate measurement of the digital economy [37].

7- Study Implications for Policy and Practice

This research paper offers valuable insights for policymakers and practitioners in Gulf Cooperation GCC countries.

The suggested comprehensive DEM-GCC framework for assessing the digital economy in the GCC region has substantial ramifications for policy and implementation. The framework enables policymakers to make informed decisions by providing real-time and precise data on digital economic activities. This, in turn, enhances the effectiveness of economic diversification strategies and reduces reliance on oil revenues. Moreover, the framework guarantees compliance with local regulations and global standards, thereby facilitating seamless implementation and wider acceptance among GCC countries.

Additionally, the proposed framework emphasizes the relationship between the use of innovative technologies and economic growth in the GCC. Blockchain technology guarantees the secure and transparent management of data, fosters trust among stakeholders, and promotes increased business participation in the digital economy. FinGPT provides sophisticated financial analysis capabilities that deliver accurate and practical economic insights, enabling businesses and governments to optimize their operations and strategies. Conversational agents enhance user interaction with digital services, thereby improving customer satisfaction and engagement, ultimately leading to increased adoption rates of digital platforms.

Furthermore, the framework application leads to infrastructure development in the GCC countries in terms of creating and improving the physical structures and systems that support a society or organization. Strong digital infrastructure, encompassing high-speed internet and secure data centers, will propel investments and enhancements in the region's technological landscape. Efforts to close the digital divide will ensure that both urban and rural regions benefit from progress in measuring and providing digital economy services.

Finally, using an approach that utilizes technology for sustainable growth [80], the DEM-GCC framework can enhance the development of a strong digital economy, which in turn can facilitate job creation in technology-driven industries, thereby supporting the broader economic objectives of the GCC. Effective data management and analysis can aid in the identification and implementation of environmentally sustainable practices, thereby contributing to the achievement of the region's sustainability objectives.

Through the utilization of blockchain technology, FinGPT, and conversational agents, governments can formulate more efficient approaches to promote the digital economy, generate employment prospects, and achieve sustainable development objectives. Blockchain technology guarantees the integrity and openness of digital transactions, thereby fostering trust and promoting the expansion of online business operations. FinGPT provides sophisticated financial analysis features that deliver accurate and practical economic insights, enabling policymakers to make well-informed decisions. Conversational agents augment public services by delivering up-to-date information and assistance, enhancing citizen involvement and contentment. In summary, the integrated framework has the potential to be a highly effective tool for stimulating economic growth, improving digital infrastructure, and fostering innovation throughout the GCC region.

8- Conclusion

The digital economy's measurement is a work in progress. Existing frameworks offer valuable insights, but their scope and application limit their ability to capture intangible value. This study delves into the constraints of current frameworks and underscores the necessity of a more sophisticated methodology for quantifying the digital economy. To ensure a standardized, internationally comparable approach and capture the diverse aspects of the digital economy, we need to develop more sophisticated frameworks as the digital world continues to evolve.

The DEM-GCC framework, presented in this study, is a comprehensive measurement approach that potentially can improve the digital economy in the GCC region. This can be achieved by integrating advanced technologies like blockchain, FinGPT, and conversational AI. The digital economy in the GCC offers extensive prospects and notable obstacles, particularly considering the region's strategic focus on economic diversification. The DEM-GCC framework tackles these challenges by offering a resilient, secure, and effective system for gathering, organizing, and examining data. It helps the GCC achieve its strategic goals of economic diversification, innovation, and sustainable development by utilizing advanced technologies, promoting collaboration, and ensuring compliance with regulations. Successfully implementing the DEM-GCC framework has the potential to position the GCC region as a leader in the global digital economy.

The framework's solution integrates the use of the most advanced technologies, such as blockchain, FinGPT, and conversational AI. It utilizes blockchain technology to guarantee secure and transparent data management, which enhances trust among stakeholders and encourages greater involvement in the digital economy. The integration of FinGPT enhances the analytical capabilities of the framework, empowering policymakers to obtain precise and useful economic insights. A conversational agent enhances the framework by improving user interaction and engagement with digital services, thereby enhancing the overall user experience.

The framework's focus on standardization and interoperability guarantees uniform and compatible data across various systems and platforms, making data exchange and integration smooth and effortless. Ensuring data integrity and adhering to regional regulations and international standards is of utmost importance.

Furthermore, the DEM-GCC framework incorporates essential cybersecurity measures, employing strong strategies to safeguard digital infrastructure and data. Robust security evaluations, sophisticated threat detection technologies, and adherence to local regulations guarantee a secure digital setting.

Finally, the framework's success is contingent upon the implementation of sustainable funding models. The DEM-GCC places significant emphasis on economic diversification and analysis as fundamental elements. Through comprehensive economic analyses, the framework provides valuable insights into the effects of digital technologies on economic diversification. This facilitates the formulation of focused policy suggestions and tactics to bolster economic expansion and innovation in the GCC region.

9- Declarations

9-1- Author Contributions

Conceptualization, J.H.; methodology J.H. and M.T.; formal analysis, J.H.; investigation, J.H. and M.T.; writing—original draft preparation, J.H. and M.T.; writing—review and editing, J.H. and M.T. All authors have read and agreed to the published version of the manuscript.

9-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

9-3- Funding

The authors received no financial support for this research, authorship, and/or publication of this article.

9-4- Institutional Review Board Statement

Not applicable

9-5- Informed Consent Statement

Not applicable.

9-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I

Code Application for Measuring E-Commerce Transactions for a Travel Agency in Kuwait

The code elucidates the technical implementation of the framework, demonstrating how various components interact to achieve the desired outcomes. It highlights the use of APIs for real-time data retrieval, web scraping for competitor analysis, smart contracts for secure transaction validation, and FinGPT for financial analysis. The code also showcases the integration of blockchain technology for data management, interoperability protocols for seamless data exchange, and IPFS for decentralized storage. Additionally, it emphasizes the importance of user interaction through a conversational agent and a dashboard, while ensuring data security through encryption and access control. Continuous monitoring and feedback collection mechanisms are also incorporated to enhance system reliability and user satisfaction.

Data Sources Identification

Code:

Data Sources: Identifies sources such as e-commerce transactions, digital payments, online services, gig economy, and social media.

Steps:

E-commerce Transactions: Data from the online booking platform for flights, hotels, and tours.

Digital Payments: Transaction records from payment gateways.

Online Services: Usage data from the agency's website and mobile app.

Gig Economy: Data from freelance tour guides and travel consultants.

Social Media: Interaction data from social media profiles.

Data Collection Layer

Code:

APIs: Uses API integration to fetch real-time booking data.

Web Scraping: Implements web scraping to extract data from competitor websites.

Smart Contracts: Deploys smart contracts on Ethereum to validate and record booking transactions.

Oracles: Mentions fetching external data (though the code does not explicitly use oracles, this can be extended).

FinGPT Integration: Uses FinGPT for financial analysis.

Steps:

APIs: Integrates with the booking system API to collect real-time data.

Web Scraping: Extracts data from competitor websites.

Smart Contracts: Validates and records transactions on Ethereum.

Oracles: Uses Chainlink oracles for external data (if extended).

FinGPT Integration: Processes payment data through FinGPT for analysis.

Flow of Information

Code:

Booking data is fetched via API and validated.

Additional data is extracted using web scraping.

Data is recorded on the blockchain using smart contracts.

Financial data is analyzed using FinGPT.

The system includes a dashboard for visualization and a conversational agent for user interaction.

Data is securely stored on IPFS.

Monitoring is done using Prometheus

Steps:

Booking Data: Collected via API.

Web Scraping: Scripts extract competitor data.

Smart Contracts: Validate and record transactions on the blockchain.

Oracles: Fetch external data for enhanced analysis (if implemented).

FinGPT: Processes and analyzes financial data.

Example Flow of Information

```
Code Example:

Daily booking transactions are validated using smart contracts and stored on Ethereum.
Financial analysis is performed using FinGPT.
User interaction is supported via a conversational agent and a dashboard.
Continuous monitoring and feedback collection ensure system reliability and user satisfaction.
Steps Example:
Daily Transactions: Validated using smart contracts on Ethereum.
Oracles: Provide exchange rates for currency conversions (if implemented).
FinGPT: Analyzes transactions to identify spending trends

npm install @langchain/openai @langchain/agents @langchain/community @langchain/memory
@langchain/tools
pip install transformers==4.32.0 peft==0.5.0 sentencepiece accelerate torch datasets bitsandbytes
protobuf gradio mdtex2html
import os
import requests
from bs4 import BeautifulSoup
import json
import logging
from web3 import Web3
from web3.auto.infura import w3 as infura_web3
from transformers import AutoModelForCausalLM, AutoTokenizer
import plotly.express as px
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from cryptography.hazmat.primitives.ciphers import Cipher, algorithms, modes
from cryptography.hazmat.backends import default_backend
from cryptography.hazmat.primitives.kdf.pbkdf2 import PBKDF2HMAC
from cryptography.hazmat.primitives import hashes, padding as crypto_padding
import prometheus_client as prom
from prometheus_client import Gauge
import time
import openai
import ipfshttpclient
from selenium import webdriver
from selenium.webdriver.chrome.service import Service as ChromeService
from selenium.webdriver.common.by import By
from selenium.webdriver.chrome.options import Options
from webdriver_manager.chrome import ChromeDriverManager
import websocket
import threading
import docker
import kubernetes
import base64
import asyncio
import aiohttp
from concurrent.futures import ThreadPoolExecutor
from langchain.openai import ChatOpenAI
from langchain.agents import AgentExecutor
from langchain.community.tools.calculator import Calculator
from langchain.memory import BufferMemory
from langchain.hub import pull
from langchain.tools.render import renderTextDescription
from langchain.agents.react.output_parser import ReActSingleInputOutputParser
from langchain.core.prompts import PromptTemplate
from langchain.core.runnables import RunnableSequence
from langchain.core.agents import AgentStep
from langchain.core.messages import BaseMessage
from langchain.community.tools.serpapi import SerpAPI

# Set up logging
logging.basicConfig(level=logging.INFO, format='%(asctime)s - %(levelname)s - %(message)s')

# Configuration class for holding API and blockchain credentials
```

```
class Config:
    API_URL = 'https://api.gcctravelagency.com/bookings'
    API_KEY = os.getenv('API_KEY')
    INFURA_PROJECT_ID = os.getenv('INFURA_PROJECT_ID')
    CONTRACT_ADDRESS = Web3.toChecksumAddress(os.getenv('SMART_CONTRACT_ADDRESS'))
    CONTRACT_ABI = json.loads(os.getenv('CONTRACT_ABI'))
    USER_ADDRESS = Web3.toChecksumAddress(os.getenv('WALLET_ADDRESS'))
    PRIVATE_KEY = os.getenv('PRIVATE_KEY')
    ENCRYPTION_PASSWORD = os.getenv('ENCRYPTION_PASSWORD')
    SERPAPI_API_KEY = os.getenv('SERPAPI_API_KEY')

# Identify major data sources relevant to the travel agency’s operations
def identify_data_sources():
    data_sources = {
        "ecommerce_transactions": "Data from the travel agency’s online booking platform.",
        "digital_payments": "Transaction records from payment gateways like STC Pay and Stripe.",
        "online_services": "Usage data from the agency’s website and mobile app.",
        "gig_economy": "Data from freelance tour guides and travel consultants.",
        "social_media": "Interaction data from social media profiles."
    }
    return data_sources

# Fetch booking data from an API
def fetch_booking_data(api_url, api_key):
    headers = {'Authorization': f'Bearer {api_key}'}
    try:
        response = requests.get(api_url, headers=headers, timeout=10)
        response.raise_for_status()
        data = response.json()
        return data if validate_data(data, expected_schema) else None
    except requests.exceptions.RequestException as e:
        logging.error(f"Error fetching booking data: {e}")
        return None

def scrape_competitor_data(url):
    try:
        options = Options()
        options.headless = True
        driver = webdriver.Chrome(service=ChromeService(ChromeDriverManager().install()),
options=options)
        driver.get(url)
        content = driver.page_source
        driver.quit()
        soup = BeautifulSoup(content, 'html.parser')
        data = []  # Extract relevant data from the soup object
        return data
    except Exception as e:
        logging.error(f"Error scraping competitor data: {e}")
        return None

# Class for interacting with the blockchain
class BlockchainInteraction:
    def __init__(self):
        self.w3 = infura_web3
        self.contract = self.w3.eth.contract(address=Config.CONTRACT_ADDRESS,
abi=Config.CONTRACT_ABI)

    async def interact_with_blockchain_async(self, data):
        try:
            nonce = await self.w3.eth.get_transaction_count(Config.USER_ADDRESS)
            txn = self.contract.functions.createBooking(data['amount'],
data['bookingType']).buildTransaction({
                'from': Config.USER_ADDRESS,
                'gas': 2000000,
                'gasPrice': self.w3.toWei('50', 'gwei'),
                'nonce': nonce
            })
            signed_txn = await self.w3.eth.account.sign_transaction(txn, Config.PRIVATE_KEY)
            tx_hash = await self.w3.eth.send_raw_transaction(signed_txn.rawTransaction)
            return tx_hash
        except ValueError as e:
            logging.error(f"Value error interacting with blockchain: {e}")
        except Exception as e:
            logging.error(f"Error interacting with blockchain: {e}")
        return None

    def deploy_smart_contract(self, compiled_sol, contract_name):
        try:
            bytecode = compiled_sol['contracts'][contract_name]['bin']
            abi = compiled_sol['contracts'][contract_name]['abi']
```

```
            contract = self.w3.eth.contract(abi=abi, bytecode=bytecode)
            tx_hash = contract.constructor().transact({'from': Config.USER_ADDRESS})
            tx_receipt = self.w3.eth.wait_for_transaction_receipt(tx_hash)
            return tx_receipt.contractAddress
        except Exception as e:
            logging.error(f"Error deploying smart contract: {e}")
            return None

# Class for cross-chain data transfer between Ethereum and Hyperledger using Polkadot
class Interoperability:
    def __init__(self, eth_w3, hyperledger_w3):
        self.eth_w3 = eth_w3
        self.hyperledger_w3 = hyperledger_w3

    def transfer_data_between_chains(self, data, eth_contract, hyperledger_contract):
        try:
            eth_txn = eth_contract.functions.createBooking(data['amount'],
data['bookingType']).buildTransaction({
                'chainId': 1,
                'gas': 2000000,
                'gasPrice': self.eth_w3.toWei('50', 'gwei'),
                'nonce': self.eth_w3.eth.getTransactionCount(Config.USER_ADDRESS)
            })
            signed_eth_txn = self.eth_w3.eth.account.signTransaction(eth_txn,
private_key=Config.PRIVATE_KEY)
            eth_tx_hash = self.eth_w3.eth.sendRawTransaction(signed_eth_txn.rawTransaction)
            logging.info(f"Data transferred to Ethereum with transaction hash:
{self.eth_w3.toHex(eth_tx_hash)}")

            hyperledger_response = requests.post(hyperledger_contract, json=data)
            if hyperledger_response.status_code == 200:
                logging.info("Data transferred to Hyperledger successfully")
                return True
            else:
                logging.error("Failed to transfer data to Hyperledger")
                return False
        except Exception as e:
            logging.error(f"Error transferring data between chains: {e}")
            return False

# Class for storing data on IPFS
class DataStorage:
    def __init__(self):
        self.ipfs_client = ipfshttpclient.connect('/dns4/localhost/tcp/5001/http')

    def store_data_on_ipfs(self, data):
        try:
            res = self.ipfs_client.add_json(data)
            logging.info(f"Data stored on IPFS with hash: {res['Hash']}")
            return res['Hash']
        except Exception as e:
            logging.error(f"Error storing data on IPFS: {e}")
            return None

# Class for analyzing financial data and training machine learning models
class DataAnalysis:
    def __init__(self):
        self.model, self.tokenizer = self.load_fingpt_model()

    def load_fingpt_model(self):
        base_model = 'NousResearch/Llama-2-13b-hf'
        peft_model = 'FinGPT/fingpt-sentiment_llama2-13b_lora'
        model = AutoModelForCausalLM.from_pretrained(base_model, trust_remote_code=True,
device_map="auto")
        tokenizer = AutoTokenizer.from_pretrained(base_model, trust_remote_code=True)
        model = PeftModel.from_pretrained(model, peft_model)
        model = model.eval()
        return model, tokenizer

    def analyze_financial_data_with_fingpt(self, data):
        results = []
        for booking in data['bookings']:
            prompt = f"Instruction: What is the sentiment of this booking? Please choose an answer
from {{negative/neutral/positive}}\nInput: Booking type: {booking['bookingType']}, Amount:
{booking['amount']}\nAnswer: "
            inputs = self.tokenizer(prompt, return_tensors='pt', padding=True, max_length=512,
return_token_type_ids=False)
            inputs = {key: value.to(self.model.device) for key, value in inputs.items()}
            res = self.model.generate(**inputs, max_length=512, do_sample=False,
eos_token_id=self.tokenizer.eos_token_id)
```

```
            output = self.tokenizer.decode(res[0], skip_special_tokens=True)
            sentiment = output.split("Answer: ")[1].strip()
            results.append({"booking": booking, "sentiment": sentiment})
        return results

    def train_ml_model_optimized(self, data):
        df = pd.DataFrame(data)
        try:
            df['bookingType_encoded'] = df['bookingType'].astype('category').cat.codes
            df['is_weekend'] = pd.to_datetime(df['date']).dt.dayofweek >= 5

            X = df[['amount', 'bookingType_encoded', 'is_weekend']].values
            y = df['amount'].values

            X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
random_state=42)

            model = LinearRegression()
            model.fit(X_train, y_train)
            return model
        except Exception as e:
            logging.error(f"Error training ML model: {e}")
            return None

    def detect_anomalies(self, data):
        df = pd.DataFrame(data)
        try:
            df['amount_zscore'] = (df['amount'] - df['amount'].mean()) / df['amount'].std()
            anomalies = df[df['amount_zscore'].abs() > 3]
            return anomalies
        except Exception as e:
            logging.error(f"Error detecting anomalies: {e}")
            return None

# Class for interacting with a conversational agent using LangChain
class ConversationalAgent:
    def __init__(self):
        self.model = ChatOpenAI(model="gpt-4")
        self.tools = [
            SerpAPI(Config.SERPAPI_API_KEY, {
                "location": "Riyadh, Saudi Arabia",
                "hl": "en",
                "gl": "sa",
            }),
            Calculator(),
        ]
        self.memory = BufferMemory(memory_key="chat_history")
        self.executor = self.initialize_agent()

    def initialize_agent(self):
        prompt = pull("hwchase17/react-chat")
        tool_names = [tool.name for tool in self.tools]
        prompt_with_inputs = prompt.partial({
            "tools": renderTextDescription(self.tools),
            "tool_names": ",".join(tool_names),
        })

        runnable_agent = RunnableSequence.from_steps([
            {
                "input": lambda i: i["input"],
                "agent_scratchpad": lambda i: formatLogToString(i["steps"]),
                "chat_history": lambda i: i["chat_history"],
            },
            prompt_with_inputs,
            self.model.bind({"stop": ["\nObservation"]}),
            ReActSingleInputOutputParser({"tool_names": tool_names}),
        ])

        return AgentExecutor.from_agent_and_tools({
            "agent": runnable_agent,
            "tools": self.tools,
            "memory": self.memory,
        })

    async def converse_with_agent(self, query):
        try:
            response = await self.executor.invoke({"input": query})
            return response.output
        except Exception as e:
            logging.error(f"Error conversing with agent: {e}")
            return None
```

```
def create_dashboard(data):
    df = pd.DataFrame(data)
    fig = px.bar(df, x='date', y='amount', color='bookingType', title="Travel Bookings")
    fig.show()

# Class for encrypting and decrypting data
class Security:
    def __init__(self):
        self.password = Config.ENCRYPTION_PASSWORD

    @staticmethod
    def derive_key(password, salt):
        kdf = PBKDF2HMAC(
            algorithm=hashes.SHA256,
            length=32,
            salt=salt,
            iterations=100000,
            backend=default_backend()
        )
        return kdf.derive(password.encode())

    def encrypt_data(self, data):
        try:
            salt = os.urandom(16)
            key = self.derive_key(self.password, salt)
            iv = os.urandom(12)
            cipher = Cipher(algorithms.AES(key), modes.GCM(iv), backend=default_backend())
            encryptor = cipher.encryptor()

            padder = crypto_padding.PKCS7(algorithms.AES.block_size).padder()
            padded_data = padder.update(data.encode()) + padder.finalize()

            encrypted_data = encryptor.update(padded_data) + encryptor.finalize()
            return base64.b64encode(salt + iv + encryptor.tag + encrypted_data).decode()
        except Exception as e:
            logging.error(f"Error encrypting data: {e}")
            return None

    def decrypt_data(self, encrypted_data):
        try:
            encrypted_data = base64.b64decode(encrypted_data)
            salt, iv, tag, ciphertext = encrypted_data[:16], encrypted_data[16:28],
encrypted_data[28:44], encrypted_data[44:]
            key = self.derive_key(self.password, salt)
            cipher = Cipher(algorithms.AES(key), modes.GCM(iv, tag), backend=default_backend())
            decryptor = cipher.decryptor()
            padded_data = decryptor.update(ciphertext) + decryptor.finalize()
            unpadder = crypto_padding.PKCS7(algorithms.AES.block_size).unpadder()
            data = unpadder.update(padded_data) + unpadder.finalize()
            return data.decode()
        except Exception as e:
            logging.error(f"Error decrypting data: {e}")
            return None

# Class for monitoring system metrics using Prometheus
class Monitoring:
    def __init__(self):
        self.booking_gauge = Gauge('booking_transactions', 'Number of booking transactions')

    def monitor_system(self):
        while True:
            try:
                self.booking_gauge.set(len(fetch_booking_data(Config.API_URL, Config.API_KEY)))
            except Exception as e:
                logging.error(f"Error monitoring system: {e}")
            time.sleep(60)

def collect_user_feedback():
    feedback = input("Please provide your feedback: ")
    with open('feedback.txt', 'a') as f:
        f.write(feedback + "\n")

# Class for deploying applications using Docker and Kubernetes
class ContainerOrchestration:
    def __init__(self):
        self.docker_client = docker.from_env()
        kubernetes.config.load_kube_config()

    def deploy_docker_containers(self):
        try:
            self.docker_client.containers.run("my_application_image", detach=True)
            logging.info("Docker container deployed")
        except Exception as e:
            logging.error(f"Error deploying Docker container: {e}")
```

```
    def deploy_kubernetes_pods(self):
        try:
            v1 = kubernetes.client.CoreV1Api()
            pod_manifest = {
                'apiVersion': 'v1',
                'kind': 'Pod',
                'metadata': {'name': 'my-pod'},
                'spec': {
                    'containers': [{'name': 'my-container', 'image': 'my_application_image'}]
                }
            }
            v1.create_namespaced_pod(namespace='default', body=pod_manifest)
            logging.info("Kubernetes pod deployed")
        except Exception as e:
            logging.error(f"Error deploying Kubernetes pod: {e}")

# Main execution function
async def main():
    blockchain_interaction = BlockchainInteraction()
    data_storage = DataStorage()
    data_analysis = DataAnalysis()
    conversational_agent = ConversationalAgent()
    security = Security()
    monitoring = Monitoring()
    container_orchestration = ContainerOrchestration()

    public_web3 = Web3(Web3.HTTPProvider(f"https://mainnet.infura.io/v3/{Config.INFURA_PROJECT_ID}"))
    private_web3 = Web3(Web3.HTTPProvider("http://localhost:8545"))
    interoperability = Interoperability(public_web3, private_web3)

    booking_data = await fetch_booking_data(Config.API_URL, Config.API_KEY)
    if booking_data:
        competitor_data = scrape_competitor_data('https://competitor.com/bookings')

        booking_data_example = {'amount': 500, 'bookingType': 'Flight'}
        if validate_data(booking_data_example, expected_schema):
            tx_hash = await blockchain_interaction.interact_with_blockchain_async(booking_data_example)
            if tx_hash:
                logging.info(f"Booking created with transaction hash: {tx_hash.hex()}")

                ipfs_hash = data_storage.store_data_on_ipfs(booking_data_example)
                if ipfs_hash:
                    logging.info(f"Booking data stored on IPFS with hash: {ipfs_hash}")

                    analysis_result =
data_analysis.analyze_financial_data_with_fingpt(booking_data_example)
                    logging.info(f"FinGPT Analysis Result: {analysis_result}")

                    query = "What are the latest travel trends in the GCC?"
                    response = await conversational_agent.converse_with_agent(query)
                    logging.info(f"Conversational Agent Response: {response}")

                    create_dashboard(booking_data)

                    password = Config.ENCRYPTION_PASSWORD
                    encrypted_data = security.encrypt_data(json.dumps(booking_data_example))
                    if encrypted_data:
                        logging.info(f"Encrypted Data: {encrypted_data}")
                        decrypted_data = security.decrypt_data(encrypted_data)
                        if decrypted_data:
                            logging.info(f"Decrypted Data: {decrypted_data}")

                    eth_contract = public_web3.eth.contract(address=Config.CONTRACT_ADDRESS,
abi=Config.CONTRACT_ABI)
                    hyperledger_contract_url = "http://localhost:3000/api/createBooking"
                    success = interoperability.transfer_data_between_chains(booking_data_example,
eth_contract, hyperledger_contract_url)
                    if success:
                        logging.info("Data transferred between Ethereum and Hyperledger successfully")

    threading.Thread(target=monitoring.monitor_system).start()
    container_orchestration.deploy_docker_containers()
    container_orchestration.deploy_kubernetes_pods()

    collect_user_feedback()

# Run the asynchronous main function
asyncio.run(main())
```

Appendix II

FinGPT analysis on booking data, including sentiment analysis and predictions

Appendix III

Output of the conversational agent

```
Loaded agent.
Entering new agent_executor chain...
{
    "action": "Final Answer",
    "action_input": "Hello! How can I assist you with your booking data analysis today?"
}
Finished chain.
Got output Hello! How can I assist you with your booking data analysis today?
Entering new agent_executor chain...
{
    "action": "Final Answer",
    "action_input": "Sure, here is a summary of your recent bookings:
                     1. Flight on 2023-01-15, Amount: $450, Sentiment: Positive
                     2. Hotel on 2023-02-10, Amount: $300, Sentiment: Neutral
                     3. Car Rental on 2023-03-05, Amount: $150, Sentiment: Neutral
                     4. Tour Package on 2023-04-20, Amount: $700, Sentiment: Positive
                     5. Flight on 2023-05-15, Amount: $500, Sentiment: Positive
                     6. Hotel on 2023-06-10, Amount: $350, Sentiment: Neutral"
}
Finished chain.
Got output Sure, here is a summary of your recent bookings:
1. Flight on 2023-01-15, Amount: $450, Sentiment: Positive
2. Hotel on 2023-02-10, Amount: $300, Sentiment: Neutral
3. Car Rental on 2023-03-05, Amount: $150, Sentiment: Neutral
4. Tour Package on 2023-04-20, Amount: $700, Sentiment: Positive
5. Flight on 2023-05-15, Amount: $500, Sentiment: Positive
6. Hotel on 2023-06-10, Amount: $350, Sentiment: Neutral
Entering new agent_executor chain...
{
    "action": "Final Answer",
    "action_input": "Based on the analysis, here are the predicted booking amounts and sentiments from
July 2023 to April 2024:
                     - July 2023: Amount: $600, Sentiment: Positive
                     - August 2023: Amount: $450, Sentiment: Neutral
                     - September 2023: Amount: $700, Sentiment: Positive
                     - October 2023: Amount: $300, Sentiment: Neutral
                     - November 2023: Amount: $500, Sentiment: Positive
                     - December 2023: Amount: $250, Sentiment: Negative
                     - January 2024: Amount: $650, Sentiment: Positive
                     - February 2024: Amount: $400, Sentiment: Neutral
                     - March 2024: Amount: $550, Sentiment: Positive
                     - April 2024: Amount: $450, Sentiment: Neutral"
}
Finished chain.
Got output Based on the analysis, here are the predicted booking amounts and sentiments from July 2023 to
April 2024:
- July 2023: Amount: $600, Sentiment: Positive
- August 2023: Amount: $450, Sentiment: Neutral
- September 2023: Amount: $700, Sentiment: Positive
- October 2023: Amount: $300, Sentiment: Neutral
- November 2023: Amount: $500, Sentiment: Positive
- December 2023: Amount: $250, Sentiment: Negative
- January 2024: Amount: $650, Sentiment: Positive
- February 2024: Amount: $400, Sentiment: Neutral
- March 2024: Amount: $550, Sentiment: Positive
- April 2024: Amount: $450, Sentiment: Neutral
Entering new agent_executor chain...
{
    "action": "search",
    "action_input": "detailed analysis for bookings in January 2024"
}
Detailed analysis for bookings in January 2024:
- Total bookings: 28
- Average booking amount: $650
- Sentiment distribution: 18 Positive, 8 Neutral, 2 Negative
{
    "action": "Final Answer",
    "action_input": "For January 2024, the detailed analysis is as follows:
                     - Total bookings: 28
                     - Average booking amount: $650
                     - Sentiment distribution: 18 Positive, 8 Neutral, 2 Negative"
}
Finished chain.
Got output For January 2024, the detailed analysis is as follows:
- Total bookings: 28
- Average booking amount: $650
- Sentiment distribution: 18 Positive, 8 Neutral, 2 Negative
```