Journal of Business and Management Sciences, 2025, Vol. 13, No. 3, 59-69
Available online at http://pubs.sciepub.com/jbms/13/3/3
Published by Science and Education Publishing
DOI:10.12691/jbms-13-3-3

Exploring Future Scenarios for Strengthening Science, Technology, and Innovation Collaboration between Egypt and BRICS Countries

Mohamed Ramadan A. Rezk[1], Leonardo Piccinetti[2], Nahed Salem[1], Tarek Y. S. Kapiel[3], Mohammed Mahgoub Hassan[4,*],Trevor Uyi Omoruyi[5], Alaa A. El-Bary[6]

[1]Academy of Scientific Research and Technology (ASRT), 11516, Cairo, Egypt
[2]Sustainabile Innovation Technology Services Ltd, Ducart Suite, Castletroy, Ireland
[3]Cairo University, Giza, Egypt
[4]National Center for Research, Khartoum- Sudan
[5]Chester Business School, Queens Park Campus, Chester, United Kingdom
[6]Arab Academy for Science, Technology and Maritime Transport, Alexandria, Egypt
*Corresponding author: mohkadis@yahoo.com

Received May 10, 2025; Revised June 12, 2025; Accepted June 20, 2025

Abstract In this study, the potential enhancement of science, technology, and innovation (STI) collaboration between Egypt and the BRICS countries (Brazil, Russia, India, China, South Africa) and new members (Egypt, Ethiopia, Iran, Saudi Arabia, UAE) is analyzed by scenario analysis until 2040. It highlights the significance of Egypt's recent BRICS membership in 2024 and its alignment with the country's Vision 2030. The study identifies key drivers for STI collaboration, including government policies, economic and investment factors, technological capacity, and the private sector's role. The paper employs a methodology combining literature reviews, expert inputs, and scenario writing to develop three future scenarios: strategic partnership ("Green Zone"), full integration ("BRICS Harmony"), and limited engagement ("Narrow Path"). These scenarios reflect varying degrees of cooperation, driven by economic, political, and technological factors. These scenarios envision varying degrees of cooperation based on economic, political, and technological factors, with a focus on creating a sustainable, innovation-driven economy in Egypt. The paper emphasizes the importance of building robust international partnerships, investing in technology, and developing research infrastructure to enable Egypt to maximize the benefits of its BRICS membership and strengthen its role in the global digital economy. Policy recommendations are offered to ensure long-term success, including enhancing public-private partnerships, fostering innovation, and aligning national policies with BRICS standards.

Keywords: *Scenario Analysis, BRICS, Egypt, STI, Collaboration*

Cite This Article: Mohamed Ramadan A. Rezk, Leonardo Piccinetti, Nahed Salem, Tarek Y. S. Kapiel, Mohammed Mahgoub Hassan,Trevor Uyi Omoruyi, and Alaa A. El-Bary, "Exploring Future Scenarios for Strengthening Science, Technology, and Innovation Collaboration between Egypt and BRICS Countries." *Journal of Business and Management Sciences*, vol. 13, no. 3 (2025): 59-69. doi: 10.12691/jbms-13-3-3.

1. Introduction

Science, technology, and innovation cooperation is the primary driver of sustainable development and economic growth because we are experiencing a time of rapid technological expansion and global economic transition [1,2].Countries that foster global collaboration in research, technology, and innovation are better positioned to address common challenges, create new economic opportunities, and harness the benefits of emerging technologies [3]. Countries around the world have realized that no single country can address pressing issues such as climate change, food security, health pandemics, and other various challenges. Rather, partnerships that benefit from diverse expertise, resources, and perspectives are essential to finding transformative solutions. Therefore, most countries in the world have moved to form strategic alliances to cooperate with each other in various fields [4]. One of the most important of these partnerships is the BRICS group.

BRICS is an association comprised of the Federative Republic of Brazil, the Russian Federation, the Republic of India, the People's Republic of China, and the Republic of South Africa and represents a powerful group of growing economies that have changed the face of the global economy [5,6]. On January 1, 2024, Egypt underwent a momentous change by joining the BRICS bloc as a full member, along with Ethiopia, Iran, Saudi Arabia, and the United Arab Emirates. This expansion, which was first announced at the 15th BRICS Summit in

Johannesburg in August 2023 and later reinforced at the 16th BRICS summit in Kazan, Russia, in October 2024, bolsters the standing of BRICS influence in the world [7].

Becoming a member of BRICS is consistent with Egypt's Vision 2030, which identifies technology development, sustainable energy, and industrial productivity as objectives to achieve a diversified and knowledge-based economy [8]. The BRICS alliance consists of members that have differences and complementary strengths in multiple fields [9], notably in science, technology, and innovation. For instance, China's leadership in artificial intelligence and 5G, India's prowess in pharmaceuticals and IT, Russia's expertise in aerospace, Brazil's innovations in bioenergy [10], South Africa's progress in materials science, and energy technology contributions from new members such as Iran and the UAE provide Egypt with a great opportunity to accelerate its STI plan [11].

Conversely, Egypt's geographic situation better positions the BRICS for significant access to substantial markets in Africa and in the Arab world, more specifically the Middle East and Africa, where it could grow to 2.5 billion people by 2050 [12]. The Suez Canal, Egypt's key economic relevance, is expected to handle 12% of world trade in 2024 [12]. Furthermore, its vast population of over 110 million, with 60% under the age of 30, provides the demographic dividend needed to leverage technological training, while enterprise might enhance innovation [13]. Both with mutual interest in science, technology, and innovation, they will emphasise work on the digital economy initiatives and technology transfer [14].

The GDP trend of the BRICS expansion (BRICS) is an important source of same-day economic growth, growing from US$16.2 trillion in 2015 to US$30.6 trillion in 2024 (Figure 1). This dramatic growth has been driven by the consumption of large, growing economies in China and India, the new supply of the economies of Egypt, Ethiopia, Iran, Saudi Arabia, and the United Arab Emirates has influenced the economic growth of the BRICS. In comparison, the G7 economies (United States, Canada, United Kingdom, Germany, France, Italy, and Japan) have displayed steady economic growth moving from US$34 trillion in 2015 to US$46.3 trillion in 2024, and the economics of the European Union rising from US$16 trillion in 2015 to US$21.3 trillion in 2024 [15], however, BRICS have grown at a far faster rate than the G7 or the EU. The BRICS countries have shown higher annual GDP growth rates compared to the G7, indicating potential for future economic dominance. Their growth is supported by resource utilization, investments, and the establishment of a free trade system within the integration bloc [14,16].

For BRICS countries, some of the earliest were the Moscow Declaration on STI Cooperation among BRICS Nations signed by the Ministers of Science, Technology, and Innovations of BRICS and the BRICS STI Action Plan too, which were both set forth in 2015 [17,18] . Further actions have boosted this cooperation, such as the implementation of the BRICS STI Action Plan, the establishment of the BRICS Innovation Network (iBRICS Network) in Campinas, Brazil, in 2019, and the renewal of the BRICS STI Action Plan later [19,20].

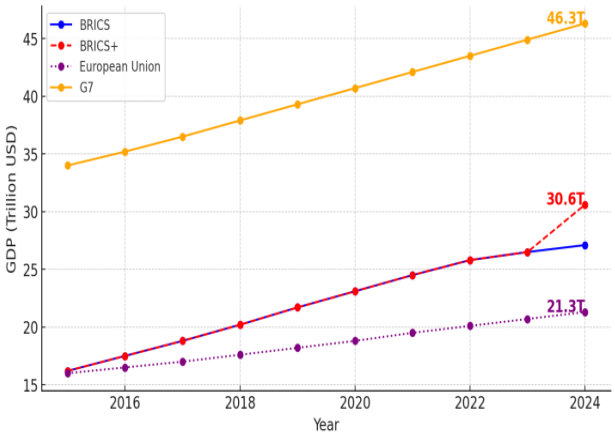

Figure 1. GDP Growth (2015-2024) Source: World bank, 2024

The Kazan Declaration of 2024 showcased the pledge to multilateralism alongside an appreciation for the role of STI in protecting national interests, development, and security. This declaration also recognizes STI cooperation amongst the BRICS countries and has also launched several initiatives, including the formation of the Space Research Union and the Technology Cooperation Initiative. These approaches focus on artificial intelligence, renewable energy, and space to show the commitment of BRICS nations to innovation and sustainable development [7].

The current R&D expenditure among BRICS countries as a percentage of GDP in 2022 (Figure 2) shows significant variation. China, investing 2.41% of its GDP in research and development, is notable, although it is just below the global average of 2.63. The UAE's 1.3% indicates a strategic emphasis on innovation. Brazil (1.16%) and Russia (1.09%) have a moderate investment, but they sit just above the 1% threshold. Egypt (0.96%), South Africa (0.83%), and Iran (0.83%) have similar modest expenditures, reflecting potential areas for increased growth. India, despite its size and economic potential, invests only 0.65% of GDP, suggesting scope for greater investment. Saudi Arabia, although ambitious in its future targets, currently allocates 0.8% to R&D as per the data available, along with Ethiopia, which invests the lowest among BRICS Plus members at 0.3% [15]. generally, while BRICS countries demonstrate diverse commitment levels toward R&D investment, China distinctly leads the group, highlighting the country's prioritization of innovation-driven growth.

The BRICS countries play an important role in the world economy and global trade and investment and are increasing their participation in technology [21,22,23,24]. BRICS countries' recent investments in technology have attracted attention, and they have become a part of the nations that conduct research around the world. In evaluating the BRICS members capabilities to innovate, research, and develop technology through performance, from examining the correlation between Global Innovation Index (GII) 2024 and the GDP of each member to examining the congruency of economic power and innovation in the BRICS (Figure 3).

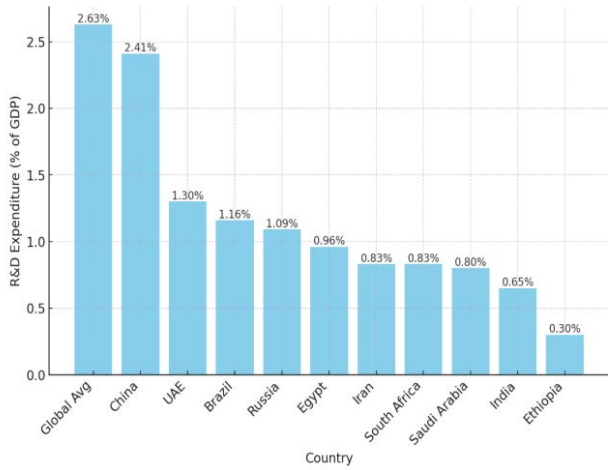

Figure 2. R&D Expenditure (% of GDP, 2022) *Source: World bank, 2024*

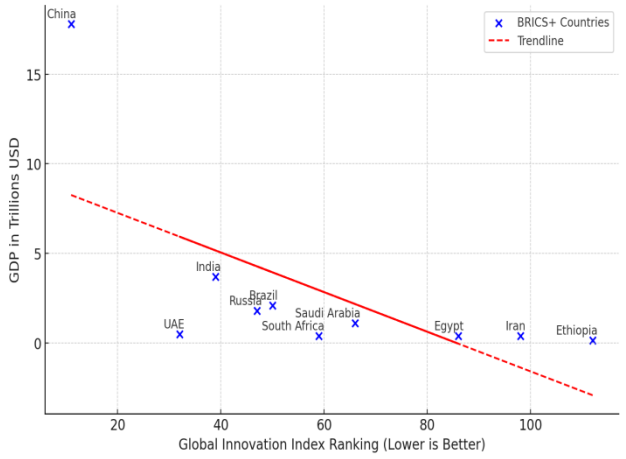

Figure 3. GII vs. GDP (2024) Source: [25]

With a GII Rank of 11 among 133 countries, China ranks first in innovation performance due to high levels of investment in R&D and a growing higher education sector. The recently added BRICS member United Arab Emirates (UAE), now ranked 32nd in GII rankings, has made a significant leap as a country reliant on oil until recently and is investing in technology and infrastructure. With respectable GDP standings, India is in a strong position at GII Rank 39. Saudi Arabia, at rank 47 has also been striving to diversify its economy in renewable energy, biotechnology, and advanced research. Brazil (50), while relatively strong in their economy compared to others in GII ranking at 50. Then Russia at rank 59 has a strong scientific research base, even with geopolitical tensions. Egypt, Iran, and Ethiopia still face challenges in innovation and supporting economical growth, even with trying to promote education and the technology sector [25].

The future scenarios of BRICS countries have been a topic in recent years. The literature on the future scenarios of BRICS highlights the importance of strategic planning, cooperation, and integration among these emerging powers, where the increasing prominence of BRICS countries has been explored and proposes a strategic future scenario in which an alliance is formed between the Southern African Development Community (SADC) and the Southern Common Market (MERCOSUR), with South Africa and Brazil positioned as pivotal leaders in fostering economic and political cooperation, and emphasizes the role of regional partnerships in strengthening the global influence of emerging economies [26]. Different potential future ways for BRICS countries have been explored based on levels of political and economic collaboration, offering four distinct scenarios that outline their possible paths in the international system. The need for strategic planning and cooperation among the BRICS members is emphasized to maximize their collective impact on the global stage [27].

The evolution of BRICS and their contribution to a more multipolar world order is discussed; the history of BRICS, from its inception in 2001 to its current steps towards greater institutionalization, is traced. Where the BRICS countries are regarded as key players in the reform of the global order to better reflect the shifting balance of power in the international system [28]. The strategic role that BRICS can play in the context of global challenges such as climate change and global governance reform has been explored. Despite existing limitations, BRICS has the potential to improve cooperation and design effective multilateral policies that address pressing global issues [29]. Moreover, one of the main scenarios for the futures of BRICS relates to increased economic integration among the member states. The creation of the New Development Bank (NDB) as well as the Contingent Reserve Arrangement (CRA) both signify this trend with loans for development projects and an expression of enhanced economic cooperation [30]. However, the successfulness of these loans and agreements will rely on the BRICS nation's ability to coordinate and attain shared economic policies, as well as cope with internal inequalities [31]. The paper considers scenarios for Egypt-BRICS STI cooperation developing until 2040 through the scenario-writing method to discuss the research question: How to strengthen STI with Egypt and the BRICS countries in the next 15 years, and what are the possible implications and pathways? Three scenarios are developed: strategic partnership, full integration, and limited interaction representing different levels of involvement and cooperation between Egypt and the BRICS countries. The focus of the paper will be to provide policymakers with practical implications for opportunities, barriers, and strategy ideas regarding how to strengthen this cooperation.

2. Methodology

In the methodology applied in this research, the development of the exploratory framework was undertaken based on an overall review of the literature, complemented by a mix of expert opinion. The literature selected for review includes academic papers, policy documents, and reports concerning Egypt's relations with BRICS, as well as STI cooperation in general. This literature review established a baseline toward understanding the current state and prospects of cooperation. Additionally, primary input from academics and government experts was sought. Diverse perspectives were included in these reviews, and experts varied in their views and positions, which reflected global trends and region-specific issues.

In the second phase, we focused on identifying the critical drivers that could either shape or determine the trajectory and outcomes of STI cooperation between Egypt and the BRICS countries. The drivers were developed from the analyses of the first phase of our data collection, examining three areas: economic, political, and technological factors. Economic factors involved trade volumes, investment flows, and availability of funds to support STI work (e.g. funding for STI-related projects), which are relevant to an understanding of the economic position of Egypt and BRICS countries. Political factors were based on geopolitical alignments, agreements, national policies related to innovation, and the previously mentioned level of political commitment to facilitating an STI partnership. While technological factors included areas such as technological capabilities, R&D infrastructure, digital transformation trends, the ability to transfer knowledge between cooperating countries, etc. The most important key factors were identified based on their potential impact on cooperation outcomes, and which have a strong influence on Egypt-BRICS cooperation in STI over the next decade.

The final stage involves scenario writing [32], wherein the identified key drivers are utilized as inputs to construct three plausible future scenarios. The identified key factors were used to construct three scenarios that project a possible future for Egypt-BRICS cooperation in STI by 2040. Scenario writing was used as a strategic foresight tool to explore a range of plausible outcomes based on varying degrees of engagement and interaction. The three scenarios were developed: strategic partnership, full integration, and limited engagement. Each scenario was designed by manipulating key drivers (e.g., increasing or decreasing political alignment, economic investment, or technological synergy) and anticipating their interaction over time.

3. Current STI Collaboration Between Egypt and BRICS Countries

Cooperation in science, technology, and innovation between Egypt and BRICS countries is of one of importance to diplomatic and economic relations. Egypt has been actively engaged with BRICS countries in various fields even before joining BRICS in 2024, and there are many areas of cooperation, including renewable energy, space technology, artificial intelligence, and healthcare innovations [7]. Egypt has signed bilateral and multilateral agreements with BRICS countries to enhance cooperation in several fields. Through agreements such as cooperation between Egypt and Russia, they have established a strategic partnership in the energy sector, with a particular focus on nuclear energy.

This partnership is largely motivated by Egypt's need to diversify its energy portfolio and Russia's capabilities in the field of nuclear energy. The most important contract between Egypt and Russia came in 2015 when the Egyptian government and Rosatom, Russia's state-owned nuclear energy company, signed a deal to partner together. Under this deal, Russia will fund 85% of the $25 billion Dabaa project through a government loan, while Egypt will fund the remaining 15%. Located on the Mediterranean coast of Egypt, the facility will consist of four VVER-1200 (Water-Water Power Reactor) reactors, with a maximum capacity of 4,800 MW [33,34]. Plant construction started in 2022 and is due to see the first reactor go online in 2030 [35]. Egypt and China have developed a close relationship in the field of space technology, along with scientific collaboration, with China being a significant contributor to the advancement of Egypt's space capabilities. One of the major achievements in this cooperation was the launch of EgyptSat-2 in 2019 and the recently launched MisrSat-2 in 2023, both of which were planned with Chinese help and manufactured in Egypt's very first satellite integration center, established with Chinese collaboration [36] Beyond space collaboration, China and Egypt are engaging in scientific research under various programs, including the China-Egypt University of Science and Technology, and collaborative research work with Academy of Scientific Research and Technology [37]

Table 1. The collaboration between Egyptian researchers and BRICS countries in academic publications

BRICS Country	Co-authored publications	Co-authors in Egypt	Citations	Citations per Publication	Institutions
Saudi Arabia	57223	40799	895598	15.7	159
China	16344	11793	451086	27.6	1466
India	11531	9398	330538	28.7	1414
United Arab Emirates	6722	6977	188598	28.1	104
Russian Federation	4388	5923	198896	45.3	424
Iran	3321	4511	171341	51.6	311
Brazil	2560	5169	156372	61.1	379
South Africa	2196	3088	122886	56	124
Ethiopia	691	1679	84151	121.8	80

Source: Scopus, 2025

Egypt has also established strong scientific collaboration with India, Brazil, and South Africa in research, technology transfer, and innovation, which overlaps with broader South-South Cooperation mechanisms such as BRICS. R&D cooperation, in line with Egypt's aim to build scientific capacity and develop technology, covers renewable energy, space technology, biotechnology, and agriculture. Egypt cooperates with India in biotechnology, pharmaceuticals, and space technology. Egypt and the Indian Space Research Organization have cooperated in knowledge exchange in satellite development and remote sensing applications to build Egypt’s space capabilities. Egypt and Brazil have cooperated in crop development, water management, and biofuel studies. In addition to South Africa, Egypt has joined the scientific innovation, space cooperation, and renewable energy research as the two countries work together under the African Union Science, Technology, and Innovation Strategy for Africa and under the Africa 2063 Strategy [38] to promote innovation in digital technology, artificial intelligence, and sustainable

environments. Through various cooperation with BRICS countries as well as cooperation with new member states, Egypt is establishing itself as a regional hub for science and innovation, with benefits realized through technology transfer, funding collaborative research, and knowledge exchange with BRICS countries.

The partnership between Egyptian researchers and researchers in BRICS countries in scholarly publications indicates that this is a fluid and shifting relationship. In Table (1), the data is summarized showing international publications from the SCOPUS database for international collaboration published by Egyptian research organizations and BRICS countries from 2019-2024. Egypt has strong partnerships with Saudi Arabia (57,223), China (16,344), and India (11,531) where the number of joint publications indicates strong academic and research partnerships. Despite the decrease in publications with China and India, the citations per publication are higher for the publications with China (27.6) and India (28.7) indicating that the publications are likely of increased academic impact. The number of institutions involved in these collaborations varies greatly. For example, China and India are significantly more engaged with Egypt, with 1,466 and 1414 institutions participating in the collaboration, compared to 159 from Saudi Arabia, 424 from the Russian Federation, and 104 from the UAE. This disparity suggests that China's and India's academic systems are deeply integrated with international research networks, whereas smaller countries or those with fewer institutions (like the UAE) may be more selective or focused on their partnerships. The diverse nature of the data can create new opportunities to build on its academic collaborations between Egypt and BRICS countries; this could involve identifying new areas of joint research interest or strengthening institutional networks to revitalize these partnerships [39]

4. Key Drivers of Scenarios

The drives were selected with the aim of identifying the main factors for building scenarios for future of scientific and technological cooperation between Egypt and BRICS countries, through analyzing the factors affecting innovation, research and development, and investmentsthat affect the collobration in future. The factors were divided into six main groups that reflect the critical aspects for enhancing this cooperation. Government policies and international cooperation include factors related to government support, regulatory compatibility, and technological diplomacy, which play a major role in determining the extent of countries' openness to scientific partnerships. Economic and investment factors include access to funding, private sector participation, and foreign direct investment, as these factors are pivotal in supporting research projects and developing modern technologies. Given the importance of enhancing local investments, a special category was allocated to the private sector and direct investments in Egypt, which include the business environment, technology and industrial zones, and government-private partnerships, to support Egypt's integration into the innovation and manufacturing system of BRICS countries. Geopolitical and social factors are an important factor in determining the stability of relations between Egypt and BRICS countries, and their impact on the continuity of scientific cooperation. On the other hand, technological and research factors are major drivers for technology transfer, intellectual property protection, and the establishment of a joint research infrastructure, which facilitates the implementation of joint scientific projects between Egypt and BRICS countries. Finally, human and educational factors play a pivotal role in enhancing knowledge exchange, joint research and development, and developing talents capable of supporting innovation strategies. This grouping of drivers aims to provide a comprehensive analytical framework that helps formulate effective future scenarios for enhancing scientific and technological cooperation between Egypt and BRICS countries, ensuring integration in research and innovation, and benefiting from joint economic opportunities. The positive and negative trends of the factors have been identified as shown in Table 2.

Table 2. list of key drives of change

Main Drivers	Positive Direction	Negative Direction
1. Government Policies and International Cooperation Drivers		
Government Support	Encourages investment in technology and R&D through funding and tax incentives.	Instability or withdrawal of government support can halt projects and reduce investments.
Trade Policies and Tariffs	Facilitates trade by removing barriers and promotes innovation through technology imports.	High tariffs may hinder technology transfer and restrict international partnerships.
Public-Private Partnerships (PPP)	Accelerates major projects by leveraging public and private sector funding.	Bureaucratic challenges and unclear contracts may lead to project failures.
Institutional Capacity	Enhances government efficiency in supporting innovation and entrepreneurship.	Weak institutional capacity can complicate investment procedures and slow down innovation.
Science & Technology Policy Alignment	Simplifies international cooperation in R&D and technology transfer.	Misalignment may result in duplication of efforts and hinder partnerships.
Tech Diplomacy & International Relations	Strengthens global collaboration in research and innovation, opening new markets.	Political conflicts may impose restrictions on scientific and technological exchange.
2. Economic and Investment Factors		
Economic Investment	Enhance infrastructure, production capacity, and job creation.	Insufficient investment may slow down growth and hinder innovation.
Access to Funding	Supports the growth of startups and the development of new technologies.	Limited funding may restrict the advancement of technological initiatives.
Private Sector Involvement	Encourages entrepreneurship and increases market competitiveness.	Weak private sector participation may lead to excessive government dependence and slow technological progress.
Foreign Direct Investment (FDI)	Introduces foreign capital, knowledge, and technology transfer.	Regulatory instability and political uncertainty may deter foreign investors.

Main Drivers	Positive Direction	Negative Direction
Venture Capital & Startup Funding	Boosts innovation by supporting startups in their early stages.	Lack of venture capital may limit opportunities for breakthrough innovations.
Global Market Demand	Expands export opportunities and increases investment in manufacturing and technology.	A decline in global demand may restrict economic expansion.
International Research Funding	Strengthens scientific collaboration and fosters groundbreaking discoveries.	Inadequate funding can hinder long-term research projects.
3. Private Sector and Direct Investments in Egypt		
Business and Investment Environment in Egypt	Attracts foreign investors and enhances the country's economic competitiveness.	Bureaucratic obstacles may deter investment inflows.
Technology and Industrial Investment Zones	Provides specialized hubs for technology and advanced industries.	Poor infrastructure development in these zones may lead to inefficiencies.
PPP Projects in Egypt	Stimulates national projects and increases productivity.	Poor management of partnerships may lead to resource misallocation.
Foreign & Local Investment Incentives	Encourages multinational companies to enter the Egyptian market.	Policy instability may render incentives ineffective.
Startup & Entrepreneurship Funding in Egypt	Supports the local tech sector and fosters innovation.	Limited funding opportunities may restrict startup development.
Technological Infrastructure in Egypt	Enables digital transformation and enhances productivity.	Weak infrastructure may limit the adoption of modern technologies.
4. Geopolitical and Social Factors		
Geopolitical Stability	Encourages long-term investments and builds market confidence.	Instability can lead to investor withdrawals and supply chain disruptions.
Cultural and Social Attitudes	Supports innovation in culture and acceptance of new technologies.	Societal resistance may hinder technological adoption.
5. Technological and Research Factors		
Innovation Capacity	Encourages the development of new technologies and increases productivity.	Weak innovation capabilities may lead to dependence on foreign technology.
Technological Infrastructure	Facilitates digital transformation and improves business efficiency.	Poor infrastructure may hinder technological development.
Digitalization and Industry 4.0 Adoption	Enhances efficiency and improves the quality of products and services.	Delayed adoption may result in loss of competitiveness.
Intellectual Property (IP) Protection	Encourages innovation and investment in R&D.	Weak IP protection may lead to loss of competitive advantages.
Technology Transfer	Accelerates industrial development and fosters innovation.	Weak technology transfer mechanisms may restrict technological progress.
Standardization and Technical Protocols	Enhances system compatibility and facilitates international cooperation.	Lack of standardization may hinder technological integration.
Shared Research Infrastructure	Strengthens collaboration between academic and industrial institutions.	Insufficient funding for research infrastructure may slow down innovation.
6. Human Capital and Education Factors		
Education and Talent Development	Improves workforce quality and enhances innovation potential.	Weak education systems may lead to a shortage of essential skills.
Scientific and Academic Exchange	Promotes knowledge transfer and increases global collaboration.	Restrictions on scientific exchange may hinder R&D progress.
Joint R&D Programs	Accelerates technological advancements through collaborative research.	Lack of collaboration may slow down technological progress.
Innovation and Entrepreneurship Collaboration	Fosters a strong startup ecosystem and increases success rates.	An unsupportive environment may limit opportunities for new ventures.

Source: Authors

5. Future Scenarios

5.1. Egypt's Strategic Cooperation with BRICS Countries

Four main sectors have been identified that reflect the building of effective and sustainable partnerships and the driving that determine the paths of scenarios of cooperation between Egypt and BRICS countries in science, technology and innovation for the year 2040

Sector 1: Government Policies and International Cooperation

This sector forms the regulatory and legal framework governing cooperation between Egypt and BRICS countries, where government policies, technological diplomacy, and trade agreements play a major role in enabling or restricting scientific and technological partnerships. Government support is a critical factor that can enhance or hinder international cooperation, especially regarding funding joint research and development between Egypt and BRICS countries. Trade policies and tariffs also directly affect the exchange of technologies and expertise, as they can facilitate or hinder this exchange by imposing restrictions that affect innovation and investments. Egypt's institutional capacity, especially the efficiency of its institutions in managing international partnerships, also affects the extent of the success of cooperation with BRICS countries, as weak institutional structures may constitute an obstacle to achieving positive and sustainable results. The compatibility of science and technology policies is a key factor in ensuring the facilitation of cooperation between Egypt and BRICS countries, as the harmony of Egyptian legislation with BRICS policies contributes to strengthening partnerships, while regulatory gaps may pose obstacles to such cooperation. Finally, technological

diplomacy and international relations play a pivotal role in building strong partnerships in the fields of science, technology and innovation, as effective diplomacy can contribute to signing strategic agreements and implementing joint projects that enhance cooperation between Egypt and BRICS countries.

Sector 2: Economy and Technology Investments

This sector determines how to stimulate investments, whether through local or foreign capital, industrial partnerships, and R&D funding. Thus, enhancing innovation, as economic investment plays a fundamental role through government and private sector investments in science, technology, and innovation projects, which directly affect the expansion of research. Another essential factor is having access to finance. The funding available for research and innovation projects determines whether a quantity of projects will emerge, whether the projects will have the potential to grow and continue. The participation of private-sector firms is another important component to support cooperation, as the success of partnerships relies upon the degree in which an Egyptian company will cooperate with BRICS investors to collaborate and arrive at new innovations and develop technologies. Foreign direct investment is also a major driver, as it contributes to attracting capital from BRICS countries, which supports the transfer of technology and expertise and accelerates the process of industrial and technological progress in Egypt. In addition, venture capital and startup financing are a crucial element in driving entrepreneurship, as supporting technology startups contributes to enhancing the innovation environment and increasing opportunities for cooperation with BRICS countries, while international research funding plays a fundamental role in implementing major projects, as it determines Egypt's ability to establish effective financing partnerships that contribute to developing advanced research projects on a large scale.

Sector 3: Research and Technological Development

This sector focuses on the ability of Egypt and BRICS countries to develop joint research, exchange technology, and transfer innovations to enhance sustainable development, as the ability to innovate is a key factor that reflects the readiness of countries to develop new technologies that can accelerate technological progress or make them dependent on other countries. Technological infrastructure also plays a pivotal role in absorbing advanced technology, as this depends on the availability of modern research centers and advanced digital networks that support the innovation environment. Another influential factor is intellectual property protection, as it affects productivity and competitiveness, as it can encourage research, development, and innovation or hinder this process depending on the level of protection available. Technology transfer is also a crucial element in this sector, as it determines Egypt's ability to absorb and adapt modern technologies coming from BRICS countries, which directly affects the development of the national industry and its competitiveness. Finally, technical standards and protocols play a fundamental role in enhancing international scientific cooperation, as unifying research and development standards contributes to facilitating technological integration between Egypt and BRICS countries, which contributes to strengthening scientific partnership and benefiting from the latest global innovations.

Sector Four: Private Sector and Government-Private Partnerships

This sector is a fundamental pillar in enhancing cooperation between Egypt and BRICS countries in the fields of research and development, as the success of this cooperation depends on the role of Egyptian companies and investors in leading science, technology, and innovation projects. The participation of the private sector plays a pivotal role in supporting startups and large companies, as this participation can accelerate the pace of cooperation or limit it in the absence of sufficient support. Funding startups and entrepreneurship is also a key element in providing the necessary capital to support innovation, which enhances the development of new technological solutions capable of enhancing Egypt's global competitiveness. Another important factor is the establishment of new investment zones dedicated to technology and industry, in addition to allocating free zones for technological development, which provides an appropriate environment for attracting investments and enhancing cooperation. Partnerships between the government and the private sector play a fundamental role in enabling Egyptian technology companies to enter effective partnerships with their counterparts in BRICS countries, as the extent of state support for these companies directly affects the speed of implementing scientific and technological projects, which enhances opportunities for innovation and joint growth in advanced sectors.

5.2. Scenario 1 Strategic Partnership "Green Zone"

In this scenario, Egypt has entered a long-term strategic partnership with BRICS countries, leading to broad economic and technological integration through the signing of comprehensive cooperation agreements in the field of research and development and joint investments in the fields of advanced technology, renewable energy, artificial intelligence, and manufacturing industries with Russia, China, and Brazil. The Egyptian government has worked closely to enhance cooperation between the private sector and academic institutions to promote innovation, build local capacities that keep pace with global development, transfer technology, and develop local industry. In the framework of supporting policies and government cooperation, economic and trade policies are being aligned between Egypt and BRICS countries to remove bureaucratic obstacles to joint investments, allowing the smooth flow of capital and technology. Agreements have been signed to enable Egypt to benefit from the latest technologies in the fields of renewable energy, biotechnology, artificial intelligence, and biotechnology. Joint programs and research centers were also established to develop advanced technologies and apply them in various sectors, accompanied by the establishment of advanced technology laboratories in partnership with Egyptian universities and BRICS countries, which contributed to training and qualifying local talents on the latest technological innovations. In the

field of promoting manufacturing and technology industries, joint technological industrial zones were developed between Egypt and BRICS countries, creating an attractive investment environment for global technology companies. Cooperation was also carried out in new and renewable energies, especially green hydrogen. Egypt has emerged to be a regional center for innovation and advanced industries, resulting in more job opportunities, sustainable economic growth, and strengthening it global positioning in technology while presenting in new horizons for Egypt in the digital economy and smart manufacturing.

Mani Future Images of Green Zone Scenario

- In 2040 begins, Egypt has emerged as one of the most technologically advanced nations in the Middle East and North Africa. In the New Administrative Capital, the "BRICS Innovation Center Tower" stands tall as a fully renewable energy-powered smart building, where artificial intelligence and robotics research is conducted in collaboration between Egyptian scientists and their counterparts from India, China, and Russia. Inside this center, advanced AI systems are being developed for cybersecurity, smart manufacturing, and healthcare, positioning Egypt as a leader in innovation.
- Egypt now hosts several advanced technology industrial zones, such as "Egyptian Silicon Valley" near the Suez Canal, where tech startups develop solutions in the Internet of Things (IoT) and 3D printing, exporting software to African and European markets. Egyptian smart ports have become global logistics hubs, operated by AI systems developed by local companies in partnership with research institutions from Brazil and China.
- Egyptian universities have witnessed a boom in research and development, regularly producing patents in fields like renewable energy and artificial intelligence. The "Egypt-BRICS Innovation Program" offers scholarships for Egyptian students and researchers to study at Russian and Chinese universities, fostering knowledge exchange and technological advancement.

An Egyptian startup in the biotechnology sector, in partnership with BRICS investors, is developing gene therapies, making it one of the first African companies to compete in the field of precision medicine. Egypt’s economy is no longer reliant solely on traditional sectors such as tourism and agriculture but has become a key player in the global digital economy.

5.3. Scenario 2 Full Integration "BRICS Harmony"

"Egypt's intelligent infrastructure is synchronized with BRICS cloud platforms for data-driven optimization of manufacturing." Egyptian corporations augment globally sourced innovation initiatives that elevate the Egyptian economy to the level of large industrial economies. Economic growth is generated by massive investments from the BRICS countries into the technology and industrial infrastructure of Egypt. The economic growth of Egypt accelerates further because of seeking and establishing joint free economic zones that target advanced industries, twinned with the possibility of specialized industry, such as semiconductor fabrication, space technology, and 3D printing, that further cement Egypt's role in being an advanced industrial location. This economic integration allows Egypt to be a designated component of the BRICS industrial production chains and open up opportunities for Egypt to be globally competitive. This Egypt-BRICS cooperation also includes strategic, dynamic, technological cooperation by establishing research facilities in conjunction with universities and scientific research institutions in the BRICS countries, achieving collaborative development of advanced technologies that can support modern industries, and the launching of academic and research collaborative programs, allowing Egyptian researchers to participate in advanced initiatives in foreign countries that bridge the technological gap between Egypt and major industrial nations.

The Egyptian digital infrastructure is integrated with BRICS systems, which facilitates the rapid exchange of data and innovations, accompanied by regulatory and structural reforms to align Egyptian economic laws and policies with BRICS standards, which facilitates trade and scientific cooperation, in addition to adopting smart manufacturing strategies that transform Egypt into an advanced technological manufacturing base, while facilitating the movement of companies and capital between Egypt and BRICS countries, which accelerates economic and trade expansion, and makes Egypt an essential part of the BRICS economic and technological system, which enables it to easily access global markets, enhance its industrial capabilities, and reduce its dependence on technological imports, which consolidates its position as an emerging industrial and technological power on the international scene.

Main Future Images of the BRICS Harmony Scenario

- By 2040, Egypt has not only become a member of BRICS but has also emerged as a key innovation hub within the group. Egypt's smart infrastructure system is fully integrated with BRICS nations' networks, where shared cloud systems analyze big data to optimize manufacturing processes and logistics.
- In the Ain Sokhna Industrial Tech Zone, Egypt operates one of the largest semiconductor production plants, in partnership with Chinese, Indian, and Russian companies. The facility not only produces electronic chips essential for smartphones and computers but also serves as a major supplier of chips used in electric vehicles manufactured within BRICS.
- At the BRICS Advanced Technology University in Cairo, Egyptian students study alongside their peers from South Africa and Brazil, collaborating on innovative projects in renewable energy and artificial intelligence. Within this university, an ambitious project is underway to develop smart solar power stations that leverage AI technologies to analyze environmental data and enhance electricity generation efficiency.

5.4. Scenario 3 Limited Engagement "The Narrow Path"

In this scenario, cooperation between Egypt and BRICS countries remains limited and confined to trade exchange and some small investments in research and development, as strategic integration between the two parties is not achieved, and Egypt's role remains small instead of being a leader in the field of technology and innovation. With the continued focus on exporting traditional goods such as raw materials and agricultural products without developing manufacturing industries, Egypt becomes dependent on importing technology instead of producing it locally, which limits the opportunities for transitioning to an innovation-based economy. Technological investments also remain limited with the absence of large investments in research and development, which leads to a slowdown in the growth of technology industries and the absence of major research centers in partnership with BRICS countries, which reduces the opportunities for local innovation. In addition, the government's role in supporting innovation remains limited, with the absence of strong incentive policies to encourage research and technological cooperation, which leads to continued reliance on imported technology, thus increasing production costs and the inability to build a strong local industrial base. The lack of development in technological sectors also prevents Egypt from achieving a qualitative leap in its economy, making it unable to compete globally in technological and industrial markets. As a result, the Egyptian economy remains dependent on traditional sectors, which limits the potential for growth and development in technological and creative fields and weakens its ability to compete in the global economy, hindering its chances of transforming into a technology- and knowledge-based economy. Collaboration occurs on a smaller scale, led by universities, think tanks, and research organizations with specific academic interests in areas such as environmental sciences, biotechnology, and digital technologies.

Main Future image of the Narrow Path Scenarios

- In 2040, Egypt still relies on importing technology from BRICS countries rather than producing it locally. The opportunities for integration with major technological economies have not been fully utilized, making Egypt a consumer market for Chinese and Indian goods while its industries remain limited to traditional sectors.
- In the industrial zone of 10th of Ramadan City, many factories have shut down due to their inability to compete, as Egyptian companies prefer importing technological components instead of manufacturing them locally.
- There are very few cooperation projects between Egypt and BRICS countries, and the projects are limited to the exchange of researchers and some applied projects with limited impact.

External Complexity and Organizational Readiness:

A Scenario Planning ApproachExternal variables play a key role in scenario planning by creating uncertainty and complexity that organizations must ride to be able to take effective strategic actions. Amer et al. [40] believe that the PESTEL model (Political, Economic, Social, Technological, Environmental, and Legal) provides a structured approach to considering right external influences creating divergent futures. Climate change is a particularly significant external driver, and Buurman and Babovic [41] illustrate how scenario approaches enable water resource managers to adapt strategy-making under conditions of deep uncertainty. The COVID-19 pandemic also illustrated the benefits of accounting for low-probability, high-impact external disturbances in scenario development, and Aurora Garrido-Moreno et al. [42] note that organizations with sophisticated scenario capability were better able to weather the crisis. Evidently, Ramirez and Wilkinson [43] argue that scenario planning's power does not lie in forecasted anticipation of which extrinsic factors will arise, but in expanding organizational awareness to look beyond weak signals and pre-empt against various alternative futures. This is corroborated by Schoemaker's [44] proof that scenario-driven strategic planning significantly enhances organizational resilience amidst chaotic external environments.

6. Policy Recommendations

By implementing these policy recommendations, Egypt can move away from pessimistic scenarios and create an enabling environment that ensures long-term success and sustainability. These policies should focus on promoting deeper integration with BRICS countries, fostering domestic innovation, and ensuring sustainable economic growth. Below are some policy recommendations that Egypt can make to ensure success in the "green zone" or "BRICS Harmony" scenarios while avoiding the stagnation and limited participation seen in the "narrow path" scenario:

- Increase funding for public-private research and development partnerships and partner with private companies in BRICS countries
- Establish joint industrial zones with BRICS countries (e.g., "Egyptian Silicon Valley").
- Develop specialized technology zones for renewable energy and artificial intelligence research.
- Expand scholarships and exchange programs with Egyptian universities and BRICS universities.
- Encourage cooperation with BRICS companies to train local talent.
- Establish dedicated research programs in partnership with BRICS countries.
- Encourage technology transfer and joint investments.
- Establish regulatory frameworks to encourage joint investments and technology transfer between BRICS countries
- Build stronger trade and economic relations with BRICS:
- Strengthen trade relations, with a focus on high-value goods and technology products.
- Promote joint ventures in semiconductor production, artificial intelligence, and renewable energy.
- Align national policies with BRICS standards:

- Align economic and regulatory policies with BRICS standards for trade and cooperation.
- Reform national policies to enhance ease of doing business and attract BRICS investments.
- Alignment of Egyptian regulations with BRICS norms.
- Set up bilateral semiconductor factories (e.g., Ain Sokhna Tech Zone).
- Create a BRICS-Egypt STI Task Force.

7. Conclusion

Egypt's membership in BRICS coming in January 2024 stands as a significant opportunity to enhance its capability in science, technology, and innovation (STI) through collaboration with some of the world fastest-growing economies. The trajectories of STI cooperation between Egypt and BRICS up to 2040 depend significantly on the role played by a threshold number of factors, comprising government policies, the economy in terms of funding and investment, technological infrastructure, and human capital building and migration. We show two promising trajectories/paths-"Green Zone" and "BRICS Harmony"- illustrate Egypt can return to being an innovation hub in the region, leveraging the expertise of BRICS to enhance its economy in terms of competing globally in AI, renewable energy, and advanced manufacturing. The "Narrow Path" scenario presents a scenario of stagnation if the country is unable to deepen its integration, instead remaining reliant upon traditional sectors and imports of technology. Existing joint projects in high-impact scholarly publications, the Dabaa nuclear plant with Russia, and most recently MisrSat-2 with China demonstrate existing collaborations and partnerships that provide a strong foundation for moving forward with new partnerships and projects with BRICS. The more ambitious narratives will require Egypt to adopt policies that prioritize government reform regarding organizational innovation processes and adequate investment in research and development (R&D) and to engage the private sector through partnerships aligned with BRICS principles. These recommendations will contribute to creating a narrative where Egypt is no longer simply a consumer but rather an integral contributor to the BRICS STI ecosystem that counts Egypt as an important contributor to economic and sustainable development, leveraging its STI capacity in an increasingly multipolar world.

References

[1] Sokhan, I., Bevz, M., Zapadenko, V., Breus, S., & Pereguda, Y. (2024). Technological innovation as a factor in strengthening economic sustainability in the context of globalization. Data & Metadata, 3.

[2] Samuel, H. S., Etim, E. E., & Nweke-Maraizu, U. (2024). International Research collaboration. In Advances in educational marketing, administration, and leadership book series (pp. 307-320).

[3] Vráblová, M., Bonetti, G., Henehan, G., Brown, R. E., Sykora, P., Marks, R. S., Miertus, S., Lorusso, L., Tartaglia, G., Ergoren, M. C., Dundar, M. S., Dundar, M., Michelini, S., Miertus, J., Connelly, S., Martin, D., Bacu, A., Herbst, K., & Bertelli, M. (2024). Promoting International Scientific Cooperation: the Role of Scientific Societies. The EuroBiotech Journal, 8(3), 115-121.

[4] Lacasa, I. D., & Vogelsang, M. M. (2024). Enhancing international collaboration in science, technology, and innovation to achieve sustainable development goals. Science and Public Policy, 51(3), 509-525.

[5] Lu, J. N. (2017). Tapping into rubber: China ' s opium replacement program and rubber production in Laos. The Journal of Peasant Studies, 44(4), 726-747.

[6] Bamidele, S. (2025). BRICS Revolution: The global agrarian shift sparked by emerging economies. India Quarterly a Journal of International Affairs.

[7] BRICS. (2024, October). XVI BRICS Summit Kazan Declaration: Strengthening Multilateralism for Just Global Development and Security. 16th BRICS Summit, Kazan, Russia. Retrieved February 12, 2025, from https://brics-russia2024.ru.

[8] Egypt Vision 2030. (2016). Egypt Vision 2030: Sustainable Development Strategy. Ministry of Planning and Economic Development. Retrieved January 13, 2025, from https:// mped.gov.eg/DynamicPage?id=115&lang=en&Egypt-Vision-2030.

[9] Haryono, H. (2024). The Evolution of the BRICS Trade Alliance: Analysing strategic partnerships and economic interdependence in the Global South. The Es Economics and Entrepreneurship, 3(02).

[10] Korneeva, E., Skornichenko, N., Shamakova, N., & Freze, T. (2024). Sustainable energy development through BRICS cooperation in technology and innovations. E3S Web of Conferences, 592, 03012.

[11] Umutlu, H., & Terzioglu, H. C. (2024). Reshaping global energy policy through BRICS+ and seeking a new equilibrium in energy markets. In Advances in finance, accounting, and economics book series (pp. 345-384).

[12] Yiblet, F. D. (2024). Unlocking new opportunities: BRICS Partnership and its implications for economic development in African countries. Journal of Entrepreneurship and Business Innovation, 11(1), 37.

[13] CAPMAS. (2024). Central Agency for Public Mobilization and Statistics. Retrieved December 20, 2024, from https://www.capmas.gov.eg

[14] Cochrane, L., & Zaidan, E. (2024). Shifting global dynamics: an empirical analysis of BRICS + expansion and its economic, trade, and military implications in the context of the G7. Cogent Social Sciences, 10(1).

[15] World Bank Data. (2024, December). Retrieved January 9, 2025, from https://data.worldbank.org.

[16] Karpov, A. L. (2024). BRICS and G7: global competition. Journal of Economic Regulation, 15(3), 059-074.

[17] BRICS Science, Technology and Innovation Ministerial Meeting. (2015, March 18). Memorandum of Understanding on Cooperation in Science, Technology and Innovation Between the Governments of the Federative Republic of Brazil, the Russia Federation, the Republic of India. The People ' s Republic of China and the Republic of South Africa/ Brasilia. Retrieved November 12, 2024, from https://mniop.ru/wp-content/ uploads/ 2019/ 11/Memorandum-o-sotrudnichestve-i-vzaimoponimanii-v-sfere-nauki-tehnologii---i-innovatsii--.pdf.

[18] BRICS Science, Technology and Innovation Ministerial Meeting. (2015, October 28). BRICS Science, Technology and Innovation Ministerial Meeting. Retrieved November 12, 2024, from https://www.frccsc.ru/sites/default/files/BRICS%20STI%20Work%20Plan%20Final%202016_10_08.pdf?219.

[19] Sokolov, A., Shashnov, S., & Kotsemir, M. (2021). From BRICS to BRICS plus: selecting promising areas of S&T Cooperation with developing countries. Scientometrics, 126(11), 8815-8859.

[20] Sokolov, A., Shashnov, S., Kotsemir, M., & Grebenyuk, A. (2018). S&T Priorities for BRICS Countries: In Search of a Win-Win Strategy. In Research series on the Chinese dream and China ' s development path (pp. 31-65).

[21] Radulescu, I. G., Panait, M., & Voica, C. (2014). BRICS countries challenge to the world economy new trends. Procedia Economics and Finance, 8, 605-613.

[22] Sönmez, A., Uysal, D., & Amirzai, F. R. (2024). Importance of BRICS countries in the world economy. In Advances in finance, accounting, and economics book series (pp. 1-48).

[23] Haryono, H., Utari, W., Rahmawati, D. A., Endarto, B., & Sanusi,

R. (2024). Evaluating the role of BRICS in shaping global economic governance: A comparative analysis of policy approaches and outcomes. The Es Economics and Entrepreneurship, 3(02).

[24] Baki, R. (2024). Comparison of Innovation Performances of BRICS Countries through CRITIC and GRA Methods. Gaziantep University Journal of Social Sciences, 23(4), 1561-1570.

[25] World Intellectual Property Organization. (2024, September). Global Innovation Index 2023: Innovation in the Face of Uncertainty. WIPO. Retrieved January 12, 2025, from https://www.wipo.int/gii-ranking/en/rank.

[26] Kahn, M. (2011). The fall of the Wall, the rise of the BRICs and the new Scramble for Africa. Foresight, 13(3), 38-49.

[27] Shapenko, A., & Korovkin, V. (2014). Imagine BRICS: Four Scenarios of the Future. SSRN Electronic Journal.

[28] Cunha, D. C. (2016). STUENKEL, Oliver. The BRICS and the future of global order. Lanham: Lexington Books, 2015, 228p. ISBN: 978-0-7391-9321-1. Mural Internacional, 6(2), 293-296.

[29] Petrone, F. (2023). Why we need a multilateralism that works and what is the role of the BRICS: lessons from the recent Covid-19 pandemic. BRICS Journal of Economics, 4(1), 35-51.

[30] Prado, M. M., & Salles, F. C. (2014). The BRICS Banks potential to challenge the field of development cooperation. Verfassung in Recht Und Übersee, 147-197.

[31] Guo, S., Zhang, H., & Shi, W. (2019). Changes and developments in the BRICS agenda for future presidencies. International Organisations Research Journal, 14(2), 109-127.

[32] Rezk, R., M. R.;. Piccinetti, L.;. Saleh, H. a.;. Salem, N.;. Mostafa, M. M.;. Santoro, D.;. El-Bary, a. a.;. Sakr, M. M. (2023). Future scenarios of green hydrogen in the MENA countries: the case of Egypt. Insights Into Regional Development.

[33] World Nuclear News. (2022, July 20). World Nuclear News. (2022, July 20). Construction of Egypt’s First Nuclear Power Plant Under Way. World Nuclear News. Retrieved December 12, 2024, from https://www.world-nuclear-news.org/ Articles/ Construction-of-Egypts-first-nuclear-power-plant-u.

[34] World Nuclear Association. (2022). Nuclear Power in Egypt - World Nuclear Association. https://world-nuclear.org/information-library/country-profiles/countries-a-f/egypt.

[35] ROSATOM. (2022, November 19). Rosatom State Atomi c Energy Corporation ROSATOM Global Leader in Nuclear Technologies Nuclear Energy. Retrieved January 9, 2025, from https://rosatom.ru/en/press-centre/news/the-rosatom-engineering-division-and-nppa-held-in-cairo-an-development-of-nuclear-industry-in-egypt/?sphrase_id=6430137.

[36] Cgtn. (2023, December 4). China launches MisrSat-2 satellite jointly-developed with Egypt. CGTN. https:// news.cgtn.com/ news/2023-12-04/China-launches-jointly-developed-MisrSat-2-satellite-1pg2aqVPb2w/index.html.

[37] Dailynewsegypt. (2024, July 30). Egyptian, Chinese officials discuss strengthening educational, technological cooperation. https://www.dailynewsegypt.com/2024/07/30/egyptian-chinese-officials-discuss-strengthening-educational-technological-cooperation/.

[38] Agenda 2063. (2015). Agenda 2063: The Africa We Want. | African Union. http://agenda2063.au.int/.

[39] Scopus. (2025). SCOPUS. Retrieved January 15, 2025, from https://www.scopus.com/.

[40] Amer, M., Daim, T. U., & Jetter, A. (2013). A review of scenario planning. Futures, 46, 23-40.

[41] Buurman, J., & Babovic, V. (2016). Adaptation Pathways and Real Options Analysis: An approach to deep uncertainty in climate change adaptation policies. Policy and Society, 35(2), 137-150.

[42] Aurora Garrido-Moreno, Rodrigo Martín-Rojas, Víctor J. García-Morales (2024).The key role of innovation and organizational resilience in improving business performance: A mixed-methods approach, International Journal of Information Management, Volume 77, 2024, 102777, ISSN 0268-4012.

[43] Ramirez, R., & Wilkinson, A. (2016). Strategic reframing: The Oxford scenario planning approach. Oxford University Press.

[44] Schoemaker, P. J. H. (2020). How historical analysis can enrich scenario planning. Futures & Foresight Science, 2(3-4), e35.