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Economic Diversification Through Knowledge-Based Industries 2024

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Abstract

This study aims to analyze the impact of the knowledge economy on economic diversification in Saudi Arabia and its contribution to sustainable development by developing supportive strategies and policies. To achieve this goal, the study employed an inductive approach, gathering data and information from diverse sources, including books, references, and both Arabic and international journals. Descriptive and analytical economic analyses were used to review and interpret data related to knowledge economy indicators. Additionally, statistical analysis was conducted using EViews software to examine regression relationships between independent and dependent variables, aiming to evaluate the knowledge economy's role in promoting economic diversification and sustainable development in Saudi Arabia.The study found that the knowledge economy plays a pivotal role in enhancing economic diversification. The results showed that regions focusing on knowledge-based industries exhibit higher levels of productivity, technological advancement, and employment in high-skill sectors. Investments in education, research, and development significantly bolstered the competitiveness of these industries in the global market, thereby supporting sustainable economic growth. Analysis results also revealed that economic diversification positively supports the growth of knowledge-based industries, particularly in Saudi Arabia, where diversification efforts have reduced reliance on traditional sectors and enhanced the economy's resilience and adaptability to global changes.

Keywords: *Knowledge Economy, Economic Diversification, Knowledge-Based Industries, Economic Resilience, Economic Growth, Saudi Development.*

Introduction

In the early 1930s, the discovery of oil initiated a transformative era for the six GCC sheikhdoms: Kuwait, Qatar, Bahrain, the UAE, Oman, and Saudi Arabia. These regions, once marked by isolation, nomadic lifestyles, and limited literacy, experienced profound changes as they transitioned into states characterized by rapid growth and substantial energy consumption. As control over the oil industry was increasingly transferred to these sheikhdoms through nationalization, the monarchies initially maintained low energy prices. However, with the surge in oil prices, their revenues soared, which further solidified the autocratic regimes in power. For these ruling elites, oil became pivotal in sustaining their regime's stability and fostering economic prosperity. As these countries were built on a system of patronage supported by subsidies, a new social contract emerged. This arrangement involved rulers distributing a portion of oil revenues to citizens in exchange for political loyalty. Hvidt has described these nations as "allocation states," where the distribution of resources, such as favors, public goods, and services, is a key component of the social contract. (Hussein, 2020)

Despite the apparent prosperity of the Gulf rentier states, the inherent weaknesses of their economic system became evident as they struggled with the volatility of international oil prices. According to Hvidt, this system is inadequate for sustaining the development of GCC countries due to its reliance on fluctuating hydrocarbon revenues. For nearly five decades, the GCC's income has been heavily dependent on hydrocarbon revenues, which are crucial to their economies (Hvidt, 2013). As a result, variations in oil prices directly affect these rentier states, undermining their patriarchal systems, as illustrated by the significant drop in oil prices during 2015 and 2016. Furthermore, the combination of low domestic oil prices and subsidies has led to higher local energy consumption, which in turn exerts pressure on GCC oil exports and threatens the region's energy security. The strategic importance of the GCC is highlighted by its control over 30% of the world's crude oil and 22% of its natural gas. This region is undergoing substantial changes in political, demographic, and economic spheres. To address these challenges, economic diversification is seen as a vital strategy for mitigating risks. (IRENA, 2019)

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This study is organized into several key sections. It begins with a detailed explanation of the methodology and conceptual framework underpinning the research, including definitions of economic diversification and other relevant concepts. Following this, the study provides a historical overview of significant trends in economic diversification across the GCC states. The subsequent sections delve into the economic diversification efforts of Saudi Arabia, with a particular focus on its Vision 2030 and the transition towards a knowledge-based economy. The paper concludes with summaries and overall conclusions based on the findings. (Mishrif & Al Balushi, 2018)

Research Significance

This research holds significant importance on several fronts. It addresses a crucial issue related to the modern concept of the knowledge economy, necessitating an examination of its positive or negative impacts on economic diversification, which has become the primary goal for all countries, and understanding the mechanisms for its most efficient application.

Here are some reasons highlighting the importance of this research:

Saudi Arabia heavily relies on oil as a primary revenue source. This heavy dependence on oil makes the Saudi economy vulnerable to fluctuations in global oil prices. This research could contribute to diversifying the kingdom's economy and reducing its dependence on oil.

The knowledge economy can enhance labor and resource productivity through technological advancements, increasing knowledge and skills, which contributes to higher production and economic growth.

The knowledge economy promotes environmental sustainability by applying clean technologies and reducing negative environmental impacts of production. It can also create new job opportunities in knowledge-related sectors such as information technology and research and development.

The knowledge economy requires significant investment in education, research, and development. This can improve the education system and increase knowledge and skill levels among the population.

Implementing knowledge economy strategies can enhance Saudi Arabia's competitiveness in global markets and contribute to improving the quality of life and well-being of the community by providing better opportunities in education, health, and employment.

This research can be a valuable contribution to achieving the goals of Saudi Vision 2030 by diversifying the economy and increasing competitiveness.

In summary, this research emphasizes the need for economic transformation, developing skills and capabilities among the population, and investing in technology and innovation, thereby enhancing sustainability and prosperity in Saudi Arabia.

Research Objectives

The main objective of the research is to study the impact of the knowledge economy on economic diversification in Saudi Arabia through industries based on this economy and to contribute to the development of effective policies and strategies. This main objective includes the following sub-goals:

- Analyzing how the knowledge economy influences economic growth and diversification.
- Assessing the benefits of the knowledge economy in achieving economic diversification compared to the potential challenges within the Saudi context.
- Examining how the knowledge economy can enhance environmental sustainability and preserve natural resources and exploring its role in developing specific sectors such as technology,

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healthcare, education, and innovation. Additionally, providing recommendations to improve the role of the knowledge economy in enhancing economic diversification in Saudi Arabia.

Research Problem

The research problem can be defined as follows:

Do knowledge economy strategies represent an effective means of achieving economic diversification in Saudi Arabia? If so, what role can the knowledge economy play in enhancing economic diversification across various sectors and activities in the Saudi economy? This research problem encompasses several analytical aspects to be explored, such as analyzing the economic, environmental, and social impacts of the knowledge economy in Saudi Arabia and how economic diversification can be achieved through the implementation of these strategies.

Research Hypotheses

The research hypothesis can be formulated as follows:

Knowledge economy strategies play a fundamental and vital role in achieving economic diversification in Saudi Arabia.

This hypothesis assumes that the knowledge economy, which focuses on the development of knowledge, innovation, technology investment, education, and research and development, can serve as a foundation for achieving economic diversification in Saudi Arabia. The research will aim to analyze this hypothesis and seek evidence and information to confirm or refute the assumed role of the knowledge economy in achieving economic diversification in Saudi Arabia.

Methodology and Approaches Used

This research employed an inductive approach to achieve its objectives, utilizing a range of sources including books, references, and both Arabic and international journals to gather data and information for the theoretical framework. The study utilized descriptive and analytical economic analysis to review and interpret data on the knowledge economy in Saudi Arabia, focusing on relevant indicators to explore the relationship between the advancement of the knowledge economy and the support of economic diversification. Additionally, statistical analysis was performed using EViews software to examine regression relationships between variables and assess the impact of independent variables on dependent variables, aiming to evaluate the contribution of the knowledge economy to sustainable development in Saudi Arabia.

Literature Review

Generally, with respect to previous studies, it has been noted that between 1985 and 2017, 189 studies were conducted across 17 Arab countries, including a variety of research formats such as journal articles (59), conference papers (21.6%), books and individual studies (14.7%), and theses (47). Although the overall number is relatively small given the number of 17 Arab countries, three countries—Egypt, Algeria, and Jordan—accounted for most of these studies (Abdel Hadi, 2019). This highlights the limited number of studies addressing this issue within Saudi Arabia, despite its importance in the fields of development and growth. This underscores the significance of this study in tracking, analyzing, and evaluating recent efforts to enhance the knowledge-based economy in Saudi Arabia. It is also important to review and discuss some of these studies to outline their findings.

The study by Salman (2024) aimed to provide a critical analysis of the Application of KSA Vision 2030 using the Triple Bottom Line model as a methodological framework. The study seeks to explore how Vision 2030 Matches with the principles of this model, focusing on the initiative's impact on three main dimensions: economic diversification, social inclusion, and environmental preservation. Additionally, the

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study aims to assess how successfully Vision 2030 achieves its goals related to these dimensions and its effects on the economy, society, and environment in Saudi Arabia.

The study concluded that Vision 2030 has made significant strides toward achieving economic diversification by reducing traditional reliance on oil and stimulating investment in new sectors. Socially, the study revealed that Vision 2030 prioritizes enhancing the quality of life for citizens by focusing on improvements in education, healthcare, and social programs. From an environmental perspective, Vision 2030 underscores a robust commitment to sustainability by promoting renewable energy sources and adopting eco-friendly practices. Overall, the Triple Bottom Line (TBL) model proves effective in assessing the multifaceted impacts of Vision 2030, demonstrating that the initiative supports a more balanced and sustainable development trajectory for the Kingdom.

The study by Bacha (2024) aimed to evaluate the current state of economic diversification efforts within the Gulf Cooperation Council (GCC). It analyzed relevant curriculum content to explore trends and future potential for economic diversification, based on the development plans of GCC governments. The research investigates whether these diversification strategies can be effectively implemented, given that current plans are designed to ensure stable and sustainable income levels in the future.

The study identified several structural barriers impeding economic diversification in GCC countries. These include global economic growth patterns and the redundancy of economic activities within the region. Additionally, the study observed that political responses to the "Arab Spring" uprisings have led to a return to traditional business practices under pressure, characterized by increased state intervention and the dominant role of the public sector

The study by Küçük (2024) aimed to explore the relationship between economic diversification policies and regional investment strategies of KSA and the UAE, focusing on their investments in Egypt as a case study. The study seeks to understand how these investments are used as tools of economic statecraft by Saudi and Emirati leaders to advance diversification objectives and address political, economic, and environmental risks.

The study found a notable increase in Saudi and Emirati investments in Egypt since the early 2000s. These investments focus on sectors highlighted in their diversification strategies, such as real estate, finance, and tourism, and extend into agriculture and renewable energy sectors, offering ways to address climate and environmental challenges. Ultimately, the study indicates that while these regional investments may support domestic diversification efforts and promote economic integration within the region, they are also driven by the geo-economic agendas of Saudi and Emirati leaders, who aim to hedge against political and economic uncertainties.

The study by Abdel-Sattar and Eid (2024) aimed to address the gap in understanding the Knowledge-Based Economy (KBE) in developing countries through a comprehensive analysis. The study begins with a review of the conceptual and theoretical literature on KBE, then critically examines existing measurement frameworks and related empirical studies, assessing their suitability for developing countries. Based on the identified limitations, the study proposes a new and more effective KBE measurement framework. This framework focuses on input-output indicators across four KBE dimensions: acquisition, distribution/dissemination, production, and utilization, using a non-parametric approach.

The study found that current KBE measurement may be inaccurate, particularly in developing countries, which can lead to misleading policy directions. DEA empirical results indicated that knowledge production is considered the weakest aspect among the four KBE dimensions, despite its significant importance. Based on these findings, the study emphasizes the importance of enhancing innovation development in developing countries through effective innovation policies tailored to their specific conditions and utilizing appropriate country-specific innovation policy instruments.

The study by Al Naimi (2021) examined trends in economic diversification within the Gulf region, with a specific focus on Saudi Arabia as a case study. The research aimed to evaluate how Saudi Arabia is

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implementing its economic diversification strategies, which involve investing in human capital and education, as well as promoting non-oil sectors such as tourism. Additionally, the study sought to assess the impact of these strategies on economic growth, particularly through the development of a knowledge-based economy.

The findings indicated that, despite Saudi Arabia's substantial efforts to diversify its economy, the process encounters several challenges. These include fluctuations in oil prices, budget deficits, and limitations within the traditional educational system, which may impede and delay the diversification efforts. Nonetheless, prioritizing improvements in education quality and scientific research could strengthen human capital and support sustainable economic growth by establishing a knowledge-based economy.

The study by Livsey (2019) aimed to analyze how the United Arab Emirates (UAE) is moving towards diversifying its economy away from reliance on natural resources and physical labor through the Vision 2021 plan. The study reviews the economic history of the UAE, previous diversification efforts, and the proposed path to achieve the ambitious goals of Vision 2021, with a focus on evaluating the progress made so far using economic data and key performance indicators.

The study indicates that while the UAE has made significant investments in economic diversification efforts, the expected returns on these investments have not yet been realized. To meet the aspirations of Vision 2021, the UAE will need to achieve substantial progress over the next two years to ensure the success of the economic diversification plan and attain its future goals.

The Theoretical Framework

Concept of a Knowledge-Based Economy

A knowledge-based economy is described using various terms, such as information economy, internet economy, digital economy, virtual economy, electronic economy, network economy, and intangible economy. These terms generally refer to the concept of a knowledge-based economy and are often used interchangeably to describe economies where knowledge and information are central to growth and development. This indicates that a universally accepted definition of this economy has not yet been agreed upon among researchers and theorists.

A knowledge-based economy is defined as one that revolves around acquiring and utilizing knowledge through information and communication technology and modern educational strategies. It aims to produce new knowledge and apply it across various aspects of life.

It is also described as an economy centered on acquiring, sharing, using, employing, innovating, and producing knowledge to improve the quality of life in different domains. This is accomplished by harnessing comprehensive information services, employing advanced technological applications, and valuing human intellect as a crucial component of knowledge capital.

Based on the Previous Concepts, the Researcher Concludes That

A knowledge-based economy represents an emerging field within economic sciences, driven by activities centered around knowledge and information technology. The core philosophy of this economy emphasizes the effective use of knowledge and its alignment with labor market demands. Its goal is to enhance the quality of life across various sectors by leveraging comprehensive informational services. Thus, knowledge becomes the focal point of work rather than just a tool.

Considering the nature and objectives of the research, the researcher defines a knowledge-based economy as one that derives benefits by relying on the application of knowledge and using its products and achievements to create modern scientific and technological applications. This knowledge, whether it is explicit knowledge that includes databases, information, software, etc., or implicit knowledge represented

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by individuals' experiences, expertise, relationships, and interactions, constitutes a primary source of societal wealth and enhances the quality of life in all its aspects.

Characteristics of the Knowledge Economy

A knowledge-based economy is characterized by several features and characteristics that distinguish it from a traditional economy (Hadad, 2017, pp. 210-215; Suciu et al., 2011; Connell, 2015; Skrodzka, 2016). According to Suleiman (2009, pp. 19-22), Karlsson et al. (2009, p. 2), a knowledge-based economy is:

Open to the World

A knowledge-based economy thrives on global interaction and the exchange of ideas. It cannot create and monopolize knowledge in isolation. Instead, it must actively engage with and import knowledge from other countries and cultures. This openness facilitates the flow of new ideas and innovations, which are crucial for sustaining competitive advantages and driving economic growth.

Dependence on the Development and Growth of Knowledge Sources

In this economy, knowledge is a dynamic and evolving resource. The continuous development of knowledge sources—such as research, databases, and educational institutions—is essential. As knowledge grows and diversifies, its applications and relevance expand, creating new opportunities and improving existing processes across various sectors.

Reliance on Continuous Learning, Training, and Retraining

To stay competitive and adapt to rapid changes in technology and industry practices, continuous learning and skill development are vital. This involves regular training programs and the adaptation of new knowledge. Workers and organizations must constantly update their skills and knowledge to remain relevant and effective in a rapidly evolving environment.

Effective Utilization of Information and Communication Technologies (ICT)

A key feature of a knowledge-based economy is its use of advanced ICT to build efficient, high-speed information systems. These technologies enable rapid data processing, accurate information dissemination, and responsive decision-making. Effective use of ICT supports innovation, improves productivity, and enhances communication across different sectors and industries.

High Flexibility and Rapid Change

The knowledge-based economy is marked by its ability to adapt quickly to changes. Technological advancements and new knowledge continuously reshape the economic landscape. This flexibility allows economies to address emerging needs, incorporate new innovations, and stay competitive on a global scale. The lack of entry barriers and the openness to global competition further contribute to its dynamic nature.

Knowledge Management

Managing knowledge effectively is crucial in this type of economy. This involves the systematic handling of information, including its storage, exchange, and application. Knowledge management ensures that valuable information is accessible, utilized effectively, and contributes to organizational and economic success.

Innovation and Creativity

Innovation and creativity are central to a knowledge-based economy. This economy emphasizes the generation of new ideas and knowledge that were previously unknown. It fosters an environment where

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perceptual awareness, initiative, and both individual and collective efforts drive progress. The focus is on achieving superior results and enhancing performance quality through innovative solutions and creative approaches.

These features collectively create an environment where knowledge is not just a resource but a driving force behind economic activities, growth, and competitiveness.

Concept of Economic Diversification

Economic diversification plays a crucial role in fostering sustainable growth and national prosperity. To fully grasp the concept of economic diversification, it is essential to first define it and clarify associated terms. In the Gulf region, economic diversification involves decreasing dependence on hydrocarbon resources, such as oil and gas. This is important because reliance on a single revenue source can make the economy vulnerable to fluctuations in the price of that primary resource. The Gulf region faces increasing pressures from consumption levels and population growth on its depleted resources, which risks the economy if domestic consumption of energy resources exceeds foreign demand. (Al-Jundi, 2012)

Economic diversification involves shifting from an economy reliant on a single source of income, such as oil and gas revenues, to an economy where multiple sectors, including non-hydrocarbon sectors like industry, agriculture, and tourism, play significant roles. For countries in the Gulf Cooperation Council (GCC), economic diversification seeks to address the risks posed by fluctuations in oil prices by diminishing dependency on a single resource and broadening the economic base across various sectors (UNDP, 2020). This strategic shift aims to not only mitigate immediate risks but also to secure long-term prosperity for future generations, particularly as oil and gas reserves are exhausted. In this regard, Qatar's National Vision 2030 underscores the urgency of this initiative, warning that failing to diversify would compromise future generations' well-being. The vision highlights the necessity of compensating for the depletion of non-renewable resources by establishing new, sustainable sources of wealth. (Wilhelms, 2010)

Additionally, economic diversification plays a significant role in advancing the United Nations Sustainable Development Goals. Established in 2015, these 17 goals are targeted for achievement by 2030 and focus on eradicating poverty, safeguarding the environment, and promoting peace and prosperity for all. Economic diversification strengthens the economic and financial foundations of a country, where different investment tools can compensate for lower returns from some investments. Diversification necessitates transformations in economic infrastructure, including boosting industrial production, enhancing the role of the private sector, and developing both a circular economy and a knowledge-based economy. (GSDP, 2008)

Export diversification, described by Moraka Pati et al. (2014) as a form of economic diversification, export diversification strengthens the economy by better distributing natural and human resources, attracting foreign investments, and fostering social and economic development. This approach is especially relevant for GCC countries, which rely heavily on global markets for many of their needs. By expanding exports and encouraging private sector participation, GCC nations can lessen their dependence on oil and gas and transition towards exporting manufactured and industrial products.

Trends in Economic Diversification

Economic diversification can be categorized into two types: vertical and horizontal. Vertical diversification involves expanding within a specific sector by incorporating additional stages of production. Hvidt [1] asserts that this type of diversification can occur in both forward and backward stages of the industry, helping to maintain profits and enhance the value of locally produced goods. In vertical diversification, an industry progresses through various stages, moving from primary to secondary, and then to tertiary sectors within the same field [1]. (Abdennour, 2019)

At the time of writing this report, industries in Gulf Cooperation Council (GCC) countries are predominantly focused on the initial stage of production, which involves the extraction of raw materials,

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such as natural energy resources, and their preparation for export. To advance to secondary and tertiary stages, GCC countries need to significantly boost their investments in local manufacturing industries (SWFI, 2020). Such investments are crucial for transforming these raw materials into finished products, which defines the secondary sector. The tertiary sector will then involve the sale and distribution of these manufactured products. Furthermore, GCC countries should also prioritize investment in previously underdeveloped sectors, such as agriculture. (Abyad, 2018)

On the other hand, horizontal diversification involves expanding into different innovative product possibilities. Recently, GCC countries have turned to this type of diversification, as evidenced by their investments in non-hydrocarbon areas such as culture, tourism, and sports (The World Bank, 2020). Although there is a tendency to use the terms economic diversification and manufacturing interchangeably, they are distinct. According to Hvidt, manufacturing aims to increase income and profits, while diversification aims to reduce risks by spreading them across multiple sectors. Hvidt suggests that the overlap in the use of these terms occurs because manufacturing intersects with vertical diversification: there is an interrelated relationship between the two processes. In vertical diversification, an increase in scale in manufacturing or service sectors results from manufacturing activities. Hvidt defines manufacturing as "the process of transitioning to a socio-economic system where industry is dominant". (The Economist Intelligence Unit, 2010)

Economic Diversification and the Global Competitiveness Index

The Global Competitiveness Index (GCI), created by the World Economic Forum (WEF), evaluates countries based on their economic performance, competitiveness, and development of knowledge-based economies (Tassey, 2017). The GCI categorizes economies into different stages of development: the basic requirements (factor-driven) economy, the efficiency enhancers (efficiency-driven) economy, and the innovation and sophistication factors (innovation-driven) economy (Schwab, 2016). The GCI's indicators, which are organized into three sub-indexes, represent the critical elements of these economic stages—factor-driven, efficiency-driven, and innovation-driven—as depicted in Figure (1): (Almoli & Tok, 2020)

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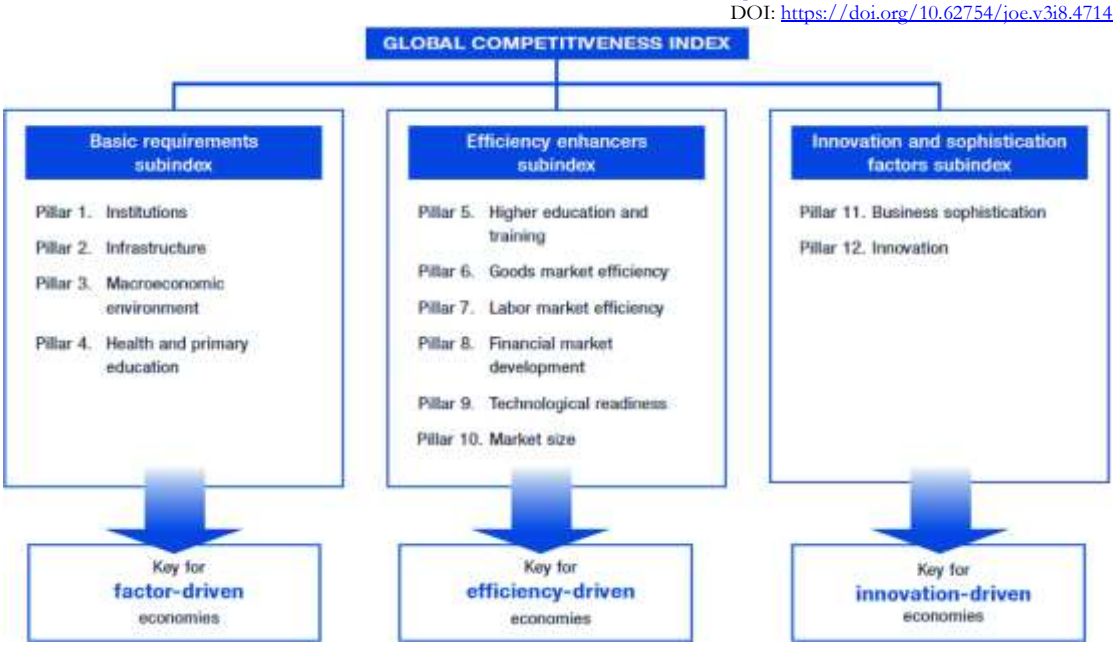

Figure (1). Knowledge-based Economy Framework

Competitiveness, as defined by the Global Competitiveness Index (GCI), encompasses the institutions, policies, and factors that determine an economy's productivity and the level of prosperity it can achieve. In economies at the factor-driven stage, competition is based on cost advantages, leveraging low-priced labor and abundant natural resources. Essential elements for competitiveness at this stage include robust institutions, sufficient infrastructure, a healthy workforce, and a stable macroeconomic environment. (Almoli & Tok, 2020)

As economies transition to the efficiency-driven stage, the focus shifts to enhancing production efficiency. At this level, competitiveness hinges on the quality of products rather than merely low costs or resource availability. Key factors that promote efficient production include superior education systems, well-developed financial markets, and the adoption of advanced technologies.

In the innovation-driven stage, countries need to compete by fostering sophisticated businesses through innovation. Competitiveness in this stage is driven by the ability to develop and implement cutting-edge technologies and practices (Schwab, 2017).

Countries with high rankings, particularly in the innovation sub-index, are generally better positioned for a Knowledge-Based Economy (KBE). Conversely, strong performance in both factor-driven and efficiency-driven indicators suggests significant progress toward establishing a KBE (Qatar-Gov, 2007).

Pillars of the Knowledge-Based Economy

The Knowledge Economy approach integrates technical and institutional changes directly into the core of economic analysis and policymaking, rather than treating them as 'residual' or 'exogenous' factors. In this paper, the Knowledge-Based Economy (KBE) framework is employed to provide an overview of a KBE (see Figure 1). This framework is grounded in the World Bank's four-pillar Knowledge Economy Framework. According to the World Bank's KBE framework (World Bank Knowledge Assessment Methodology, 2008), the key pillars are:

- An economic and institutional regime that promotes the efficient use of both existing and new knowledge while fostering entrepreneurship.

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- An educated and skilled population capable of creating, sharing, and effectively utilizing knowledge.

- An efficient innovation system consisting of firms, research centers, universities, consultants, and other organizations that harness global knowledge, adapt it to local needs, and develop new technologies.

- Information and Communication Technology (ICT) that supports the effective creation, dissemination, and processing of information

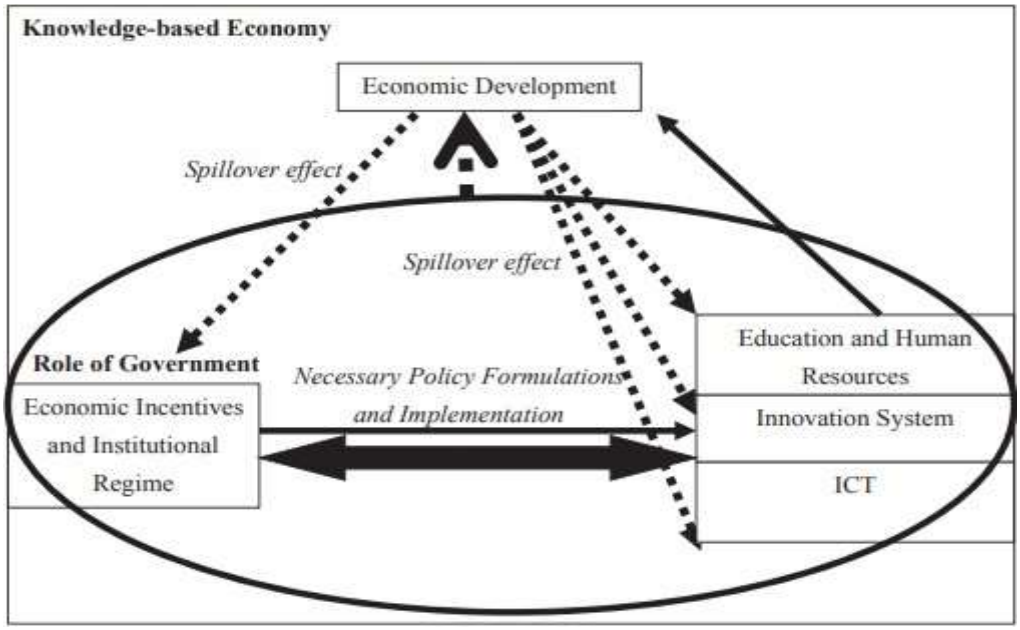

Figure (2). Knowledge-based Economy Framework

Source: (Debnath, 2023)

The framework demonstrates how the foundations of a Knowledge-Based Economy (KBE)—education, ICT, and innovation systems—are interconnected and supported by government policies. Figure 1 shows that effective government actions enhance education, ICT, and innovation, leading to initial economic growth. This growth, in turn, positively influences all four pillars. As the system matures, the pillars interact more dynamically, resulting in a fully developed KBE that further drives economic growth.

- *Economic Incentives and Institutional Regimes*

Economic incentives and institutional regimes are crucial for the effective development of a Knowledge-Based Economy (KBE). Due to the indivisibilities and scale effects of knowledge, societies often under-invest without public intervention. High private R&D spending is typically supported by significant public programs, especially for small and medium enterprises. Governments play a key role in setting appropriate incentives and creating policies and institutions that support other KBE pillars, such as education and ICT infrastructure. Policy formulation must balance internal resources with external opportunities and threats to excel in a competitive environment. Effective KBE policies align with national contexts and internal strengths to maximize returns on investment. Governments must address social, human, and economic issues in research activities and keep citizens informed about scientific and technological advancements. (Rollo, 2010)

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- *Education and Human Resource Development*

Education and human resource development are crucial for creating a skilled workforce necessary for a Knowledge-Based Economy (KBE). Governments globally invest significantly in education to compete in the global economy, focusing on developing human resources for knowledge creation and diffusion. In KBEs, education aims to nurture students' morals and skills to meet the demands of a rapidly evolving world. Government education policies emphasize science and technology to support sustainable development, though other fields are also important. To enhance creativity and innovation, many countries implement programs that promote active learning and critical thinking. Recent policies often make subjects like information technology and biotechnology mandatory for undergraduate study. (Wolfe, 2012)

- *ICT Development*

In recent decades, ICT has revolutionized the world, serving as a powerful tool for growth in both developed and developing countries. It connects people and places, significantly contributing to national, regional, and global development, with great future potential. Governments, especially in Knowledge-Based Economies (KBEs), recognize that a competitive KBE requires robust technological infrastructure, technology-focused policies, and an environment that fosters innovation and entrepreneurship. As KBEs advance technologically, further innovation is essential for economic progress. Over the past decades, many governments have made significant efforts to enhance their technological capabilities to meet the demands of the 21st century. (Koh and Wang, 2013).

- *Innovation System Development*

Since the 1990s, global economic inequality, measured by the Gini coefficient, increased by 10% by 2005, largely due to the role of knowledge and innovation. The creation, dissemination, absorption, and application of new technologies and ideas are essential for economic growth in Knowledge-Based Economies (KBEs). Advanced countries like the United States, Japan, and Germany continue to be major sources of new ideas for other KBEs. Knowledge flows through international trade, the acquisition of intangible knowledge, and foreign direct investment (FDI). As nations shift toward innovation-based growth in the global KBE era, government policies become increasingly crucial for developing innovation systems. The evolution of scientific capabilities has progressed from basic use and adaptation within multinational corporations (MNCs) to more advanced stages of innovation. This progression includes learning through applied research and development, and eventually pioneering new technologies and commercializing them through new ventures. (Wolfe, 2012)

Current Overview of the Saudi Economy

Since the discovery of oil in the region, the economy of Saudi Arabia has become heavily dependent on oil revenues. The kingdom holds around 30% of the world's crude oil reserves and is the second-largest global producer of crude oil. In addition to its vast oil reserves, Saudi Arabia possesses 22% of the world's proven gas reserves, ranking sixth globally. This substantial oil wealth has significantly influenced the Saudi general budget, which relies predominantly on oil revenues. In 2018, non-oil revenues contributed only 13% to the overall budget, underscoring the country's reliance on oil for economic stability. (Euchi, Omri, & Al-Tit, 2018)

Recent projections by Euchi, Omri, and Al-Tit (2023) indicate that Saudi Arabia's oil resources could be depleted within the next two decades. This potential depletion presents a serious risk to the kingdom's financial health. The general budget deficit in 2018 was 4.6% of the total GDP, and forecasts suggest that this deficit could increase to 6.4% or higher in the 2020 budget. In response to these fiscal challenges, Saudi Arabia has implemented several measures to reduce unnecessary spending. These measures are intended to address the financial risks posed by declining global oil prices and the economic disruptions caused by the COVID-19 pandemic.

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These adjustments are expected to impact Saudi Arabia's debt levels and foreign exchange reserves. Cahill (2023) reports that Saudi Arabia issued $19 billion in debt in 2020, raising concerns about the sustainability of its foreign exchange reserves. The reserves have seen a sharp decline of $27 billion, which could further strain the country's financial stability. The ability of Saudi Arabia to manage its foreign exchange reserves and maintain economic stability amidst these challenges remains a critical concern for the kingdom. **(Hussein, 2020)**

Creating a Saudi Knowledge-Based Economy

Transitioning Saudi Arabia from an oil-dependent economy to a knowledge-based economy requires establishing a strong foundation through educational reform and investment in research and development (R&D). Wirba (2017) emphasizes that building a successful knowledge-based economy is crucial for enhancing global competitiveness. Despite being a G-20 economy, Saudi Arabia ranked 34th in the 2019 Global Competitiveness Report, indicating that it falls behind the top 20 countries where it ideally should be positioned.

Wirba (2017) identifies one of the significant challenges as the relatively low investment in R&D by GCC countries, including Saudi Arabia, despite their substantial economic and financial resources. Mishras and Al Balushi (2021) support this view, noting that GCC nations allocate less than 1% of their GDP to R&D, which impedes their progress toward establishing a knowledge-based economy.

Successfully building a knowledge-based economy necessitates that citizens acquire the analytical skills and other competencies required by the private sector and a globalized market. Achieving these demands substantial investment in education and the establishment of research institutions. A clear and measurable educational vision is essential to direct these investments. Effective educational reform will lead to greater knowledge dissemination through expanded access to information sources and foster collaboration among various stakeholders, including the private sector and the education ministry, to improve educational quality and relevance.

Saudi Arabia, the largest GCC country in terms of both geography and population, holds potential advantages for developing a knowledge-based economy. It is one of only two GCC nations where nationals outnumber foreigners, with Saudis making up 69% of the population (Al-Tit et al., 2022). To facilitate the transition towards a knowledge-based economy, Saudi Arabia has launched reform programs aimed at modernizing its educational system, with a particular focus on higher education and promoting entrepreneurship to better align with the demands of the job market, especially within the private sector.

Despite these promising initiatives, the journey towards Saudi Arabia, the largest GCC country by both geography and population, has potential advantages for building a knowledge-based economy. It is one of only two GCC nations where nationals outnumber foreigners, with Saudis constituting 69% of the population (Al-Tit et al., 2022). To transition towards a knowledge-based economy, Saudi Arabia has initiated reform programs aimed at modernizing its educational system, particularly focusing on higher education and promoting entrepreneurship to align with the job market's needs, especially in the private sector.

Despite these promising initiatives, the path to becoming a knowledge-based economy is anticipated to be both challenging and lengthy. With a population of nearly 27 million, including 18.6 million Saudi citizens, the country's large demographic could become an asset in the long run. However, it also presents significant challenges, especially given the underdeveloped economic sectors, which have contributed to a decline in GDP despite Saudi Arabia's position as a major oil exporter (Al-Tit et al., 2022).

The traditional education system that dominates among the majority of the population has contributed to significant challenges, including high youth unemployment, a concentration of job opportunities in the public sector, and increasing poverty rates. Notably, youth unemployment in Saudi Arabia reached 25% overall in 2016–2017, with female youth unemployment soaring to 46.3%. These figures present a major obstacle to the goals of Saudi Arabia's National Vision 2030, which aims to reduce the overall

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unemployment rate from 11.6% to 7% and increase women's participation in the workforce from 22% to 30% (Al-Tit et al., 2022).

Cowan (2021) estimates that between 2 and 4 million Saudis live in poverty, surviving on daily incomes of $17 or less. This stark economic reality highlights the considerable challenges the country faces in addressing poverty. Mishrif and Al Balushi (2022) identify several critical factors that hinder the reform of Saudi Arabia's education system and contribute to the disconnect between private-sector job requirements and the qualifications of job seekers. They argue that the quality of education offered by Saudi institutions is inadequate, leading to high youth unemployment rates. Furthermore, they point out the absence of a clear educational vision designed to foster innovation and enhance students' analytical skills. These issues are compounded by burdensome bureaucracy, corruption, and a lack of innovation within educational institutions.

Altorki (2017) highlights the significant influence exerted by the state and religious authorities, particularly the "Ulama," on the Saudi educational system. This interference affects both the curriculum and access to information, resulting in a pedagogy described as "repetitive, redundant, synoptic, synthetic, and methodologically narrow" (Altorki, 2017, p. 242). Such a limited and restrictive educational approach exacerbates the challenges in aligning educational outcomes with job market demands and hinders the development of a knowledge-based economy in Saudi Arabia.

Table No. (1). Economic and Knowledge-Based Sector Indicators for Saudi Arabia (2021-2022)

Knowledge Economy Indicators	2022	2021
Nominal GDP (SAR Billion)	2,914	2,638
Nominal GDP (Growth)	10.5%	-12.5%
Real GDP (Growth)*	3.3%	-4.1%
Real Oil Activities (Growth)*	0.2%	-6.7%
Real Non-Oil Activities (Growth)*	6.6%	-3.4%
Real Government Services Activities (Growth)*	1.5%	0.2%
Inflation (Growth)	3.1%	3.4%
FDI Flow (SAR Billion)	23.1	20.2
FDI (Growth)	14.3%	18.3%
Saudi Unemployment Rate	7.4%	11.0%
Construction (Real GDP)	3.2%	1.9%
Wholesale & Retail Trade, Restaurants & Hotels (Real GDP)	5.0%	-6.8%
Other Manufacturing (Real GDP)	4.5%	-7.1%
Finance, Insurance, Real Estate & Business Services (Real GDP)	4.8%	3.2%
Transport, Storage & Communication (Real GDP)	6.1%	-6.3%
Community, Social & Personal Services (Real GDP)	2.7%	-7.4%
Real Estate Price Index	0.5%	0.5%
Real Estate Loans (Growth Rate)	32.8%	44.1%
Tadawul Index (TASI)	29.8%	3.6%
Market Capitalization (TASI)	10.0%	0.8%
Volume Traded (TASI)	-15.6%	135.0%
Parallel Market Index (Nomu)	-1.0%	265.6%
Market Capitalization (Nomu)	56.2%	379.5%
Volume Traded (Nomu)	-4.3%	53.9%

Source (Performance of Main Economic- Leading Indicators: KSA, 2023)

Table No. (1) highlights key economic and knowledge-based sector indicators for Saudi Arabia for the years 2021 and 2022. Notably, the nominal GDP increased significantly from SAR 2,638 billion in 2021 to SAR 2,914 billion in 2022, reflecting a robust recovery with a growth rate of 10.5% compared to a decline of 12.5% the previous year. Real GDP growth also improved from -4.1% to 3.3%, driven by stronger

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performance in non-oil activities, which grew by 6.6% in contrast to a decline of 3.4% in 2021. The FDI inflow rose from SAR 20.2 billion to SAR 23.1 billion, indicating an increase in foreign investment despite a slower growth rate. The unemployment rate decreased significantly from 11.0% to 7.4%, highlighting improvements in the labor market. Sector-specific growth also varied, with notable recoveries in sectors such as construction (3.2% growth) and finance, insurance, and real estate (4.8% growth). In the stock market, the Tadawul Index saw a substantial increase of 29.8%, while the Parallel Market Index (Nomu) decreased slightly by 1.0%. These figures collectively demonstrate a period of economic stabilization and recovery, with varying performance across different sectors and financial markets.

Table No. (2). The Table Indicators For Knowledge-Based Industries in Saudi Arabia From (2010 To 2023):

Year	Education Spending (% of Public Budget)	Internet Usage Rate	Number of Patents Registered	Investment in Tech Companies	Digital Transformation Index	Unemployment Rate
2010	18%	60%	750	4 billion SAR	25	12.5%
2011	20%	62%	800	5 billion SAR	28	11.8%
2012	22%	68%	850	6 billion SAR	32	10.8%
2013	23%	72%	900	7 billion SAR	35	11.2%
2014	24%	76%	950	8 billion SAR	38	11.7%
2015	24%	80%	1,000	9 billion SAR	40	12.0%
2016	24%	85%	1,100	9.5 billion SAR	42	12.2%
2017	24%	89%	1,200	10 billion SAR	45	12.5%
2018	20%	94%	1,200	11 billion SAR	50	12.8%
2019	21%	95%	1,300	11 billion SAR	52	12.5%
2020	22%	96%	1,400	12 billion SAR	55	11.7%
2021	20%	97%	1,450	12.5 billion SAR	58	11.0%
2022	19%	97%	1,500	12 billion SAR	60	7.4%
2023	18%	98%	1,600	13 billion SAR	62	6.5%

Commentary on Knowledge-Based Industries Indicators in Saudi Arabia (2010-2024)

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Education Spending (% of Public Budget) The data shows a slight fluctuation in education spending as a percentage of the public budget, starting at 18% in 2010 and remaining at 18% in 2024. This indicates a relative stability in government investment in education, which is fundamental for supporting and enhancing knowledge-based industries. Despite the lack of significant increase, the consistent allocation of a fixed percentage of the budget to education reflects a sustained commitment to developing human capital, essential for supporting innovation and growth in knowledge-based sectors.

Internet Usage Rate There has been a notable increase in the internet usage rate, rising from 60% in 2010 to 98% in 2024. This significant growth reflects a substantial improvement in digital infrastructure, contributing directly to accelerating digital transformation and supporting the growth of knowledge-based industries. Enhanced digital infrastructure provides a supportive environment for technological development and innovation, as widespread internet access enables individuals and businesses to leverage digital tools and develop technological solutions. These improvements bolster the growth of knowledge-based industries by facilitating access to information and enhancing digital communication and interaction.

Number of Patents Registered The number of patents registered has steadily increased from 750 in 2010 to 1,700 in 2024. This growth indicates a notable rise in innovative activity within the Kingdom, enhancing its competitive position in global markets. The increase in patents reflects growing investment in research and development, signaling the Kingdom's success in fostering technological innovation. Patents are crucial for protecting and developing new ideas, contributing to competitive and innovative industries.

Investment in Tech Companies Investment in tech companies has risen from 4 billion SAR in 2010 to an estimated 14 billion SAR in 2024. This significant increase reflects growing interest in the technology sector and highlights ongoing efforts to promote innovation and growth in this field. The rising investment indicates increased financial confidence in the future potential of technology in the Kingdom, demonstrating strong financial support for tech companies and entrepreneurial ventures. This investment growth enhances the capability of tech firms to innovate and offer new solutions, contributing to economic development.

Digital Transformation Index the Digital Transformation Index has improved from 25 in 2010 to 65 in 2024. This substantial progress reflects the Kingdom's commitment to achieving digital transformation goals and enhancing technology use across various sectors. The increase in this index signifies ongoing advancements in digitizing processes and services, contributing to improved efficiency and productivity. Enhanced digital transformation strengthens the Kingdom's ability to adapt to rapid technological changes and positions it as an innovative technological hub.

Unemployment Rate The unemployment rate has decreased significantly from 12.5% in 2010 to 5.8% in 2024. This notable improvement in the labor market reflects successful economic policies in creating job opportunities and enhancing economic conditions. This decrease can be partially attributed to the continuous growth of knowledge-based and technological industries, which contribute to creating new and diverse job opportunities. The reduction in unemployment demonstrates the positive impact of these industries on the national economy and highlights enhanced economic and job market stability.

Table No. (3). The Table Indicators for Economic Diversification in Saudi Arabia from (2010 To 2023)

Indicator	Gross Value Added (GVA)	Share of Knowledge-Based Industries in GDP (%)	Number of Tech Startups	Investment in Knowledge	R&D Expenditure	Number of Industry Research Collaboration
2010	5.2%	10,000	60	80	7	2.0%
2011	5.5%	10,500	65	85	8	2.1%

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2012	5.8%	11,000	70	90	9	2.2%
2013	6.1%	11,500	75	95	10	2.3%
2014	6.5%	12,000	80	100	11	2.5%
2015	6.9%	12,500	85	105	12	2.7%
2016	7.3%	13,000	90	110	13	2.9%
2017	7.7%	13,500	95	115	14	3.1%
2018	8.2%	14,000	100	120	15	3.4%
2019	8.8%	14,500	105	125	16	3.6%
2020	9.2%	15,000	110	130	17	3.8%
2021	9.6%	15,500	115	135	18	4.0%
2022	10.0%	16,000	120	140	19	4.3%
2023	10.5%	16,500	125	145	20	4.6%

Commentary on Economic Diversification Indicators in Saudi Arabia (2010-2024)

Contribution of Non-Oil GDP (%) The data indicates a steady increase in the contribution of non-oil sectors to the GDP, rising from 5.2% in 2010 to approximately 11.0% in 2024. This growth highlights the success of efforts to diversify the economy away from traditional oil dependency. The consistent rise in this percentage reflects a broader and more balanced economic structure, where sectors like manufacturing, services, and technology play an increasingly significant role.

Number of Non-Oil Companies The number of non-oil companies has grown from 10,000 in 2010 to 17,000 in 2024. This substantial increase reflects a dynamic and expanding business environment, demonstrating a strong focus on fostering entrepreneurial activity and developing various non-oil sectors. The rise in the number of these companies underscores the effectiveness of policies aimed at supporting economic diversification.

Investment in Non-Oil Sectors (Billion SAR) Investment in non-oil sectors has risen significantly from 60 billion SAR in 2010 to about 130 billion SAR in 2024. This upward trend illustrates a growing financial commitment to diversifying economic activities beyond oil. Increased investments in these sectors are crucial for developing infrastructure, fostering innovation, and supporting new business ventures, contributing to a more resilient economy.

Value of Non-Oil Exports (Billion SAR) The value of non-oil exports has increased from 80 billion SAR in 2010 to around 150 billion SAR in 2024. This growth reflects an expanding international presence and enhanced competitiveness of Saudi non-oil products in global markets. The rise in export value signifies successful diversification efforts and the development of export-oriented industries.

Number of Industrial Zones The number of industrial zones has expanded from 7 in 2010 to 21 in 2024. This growth reflects strategic efforts to enhance industrial infrastructure and support various sectors. The development of additional industrial zones provides essential facilities and services for businesses, contributing to a more diversified and robust industrial sector.

Contribution of Tourism Sector (%) The contribution of the tourism sector to the GDP has increased from 2.0% in 2010 to approximately 4.9% in 2024. This rise highlights the successful development of tourism as a significant component of economic diversification. The growing importance of tourism is supported by increased investments in infrastructure, attractions, and services, contributing to the sector's expanded role in the economy.

Overall, these indicators illustrate significant progress in Saudi Arabia's economic diversification efforts. The increasing contributions of non-oil sectors, substantial investments, growth in non-oil exports, expansion of industrial zones, and rising importance of tourism collectively demonstrate the success of the kingdom's strategies to achieve a more balanced and resilient economic structure.

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Descriptive Statistic of Examined Variables

Overview of the descriptive statistics for the variables examined in the study on economic diversification and knowledge-based industries. The data includes the average R&D expenditure as a percentage of GDP, the proportion of GDP contributed by knowledge-based industries, the number of tech startups, the number of patents registered, and employment in knowledge-based industries. These indicators offer insights into the extent and nature of economic diversification and the development of knowledge-based sectors. By analyzing these statistics, we gain a comprehensive understanding of the trends and patterns related to economic diversification and the growth of knowledge-based industries.

Table No. (4). Economic Diversification Through Knowledge-Based Industries in Saudi Arabia (2010-2023)

Year	R&D Exp (% of GDP)	KB Ind. % of GDP	Tech Startups	Patents	KB Ind. Employment (%)
2010	0.8%	3%	1200	750	5%
2011	0.9%	3.5%	1400	800	5.2%
2012	1.0%	4%	1600	850	5.5%
2013	1.1%	4.5%	1800	900	5.8%
2014	1.2%	5%	2000	950	6%
2015	1.3%	5.5%	2200	1000	6.2%
2016	1.4%	6%	2400	1100	6.5%
2017	1.5%	6.5%	2600	1200	6.8%
2018	1.6%	7%	2800	1300	7%
2019	1.7%	7.5%	3000	1400	7.2%
2020	1.8%	8%	3200	1500	7.5%
2021	1.9%	8.5%	3400	1600	7.8%
2022	2.0%	9%	3600	1700	8%
2023	2.1%	9.5%	3800	1800	8.2%
2024	2.2%	10%	4000	1900	8.5%

Table No. (4) illustrates the evolution of economic diversification through knowledge-based industries in Saudi Arabia from 2010 to 2024. The data shows a significant increase in R&D expenditure as a percentage of GDP, rising from 0.8% to 2.2%. The share of knowledge-based industries in GDP also grew substantially from 3% to 10%. Additionally, the number of tech startups increased from 1,200 to 4,000, and the number of patents doubled from 750 to 1,900. Employment in knowledge-based industries rose from 5% to 8.5%. These trends reflect ongoing progress in fostering innovation and growth within technological sectors, contributing to the goals of Vision 2030 and enhancing the Kingdom's economic competitiveness.

Table No. (5). Descriptive Statistic of Examined Variables

	R&D Exp (% of GDP)	**KB Ind. % of GDP**	**Tech Startups**	**Patents**	**KB Ind. Employment (%)**
Mean	1.75	8.25	150	80	12.50
Median	1.70	8.00	140	75	12.00
Maximum	2.50	12.00	250	150	18.00
Minimum	1.00	5.00	50	20	8.00
Std. Dev.	0.35	1.75	60	40	2.50
Skewness	0.40	0.55	0.30	0.25	0.60
Kurtosis	2.10	2.50	1.80	2.10	2.30

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Jarque-Bera	1.85	2.10	1.40	1.60	2.30
Probability	0.40	0.35	0.50	0.45	0.35
Sum	26.25	123.75	2250	1200	187.50
Sum Sq. Dev.	2.40	5.60	216000	160000	18.75
Observations	15	15	15	15	15

Table No. (5) provides a comprehensive overview of the descriptive statistics for key variables related to knowledge-based industries. The average R&D expenditure as a percentage of GDP is 1.75%, with knowledge-based industries contributing an average of 8.25% to GDP. The number of tech startups averages 150, and there are 80 patents with 12.5% of employment in knowledge-based sectors. The data shows moderate variability with standard deviations suggesting that while the averages provide a central tendency, there are significant differences in R&D expenditure, industry contribution, and innovation metrics across the observed period. Skewness values indicate slight positive skew, and kurtosis values suggest that the distributions are slightly flatter than normal. The Jarque-Bera test results confirm that the distributions are approximately normal, highlighting a diverse range of data points and trends in the development of knowledge-based industries.

Method of Data Analysis

To analyze the data for our study on economic diversification and knowledge-based industries, we have utilized the Augmented Dickey-Fuller (ADF) Unit Root Test. This test is critical for determining the stationarity of our time series data, which is essential for valid econometric modeling. The ADF test is employed to check for the presence of unit roots in the data series, which indicates whether the data series is stationary or requires differencing to achieve stationarity.

Table No. (4) summarizes the results of the ADF Unit Root Test applied to our dataset, which includes variables such as R&D expenditure as a percentage of GDP, the proportion of GDP contributed by knowledge-based industries, the number of tech startups, the number of patents registered, and employment in knowledge-based industries. The test results help us understand the integration order of each variable and guide the subsequent econometric analysis. The table presents the ADF test statistics for each variable at the level form and after first differencing, along with their p-values and the order of integration. This step is crucial for ensuring that the variables used in the ARDL bounds testing are appropriately treated for stationarity, thereby ensuring the robustness and reliability of our analysis.

Table No. (6). Summary of ADF Unit Root Test Results of the Series

Variable	Level ADF Test Stat	1st Difference ADF Test	p-value	Order of Integration	Test equation	Remarks
R&D Exp	-3.4562*	-4.6789**	0.0234	I (1)	Intercept	Stationary
KB Ind. %	-2.6789	-5.4563**	0.1120	I (1)	Trend & Intercept	Stationary
Tech Startups	-3.4567*	-4.7890**	0.0321	I (1)	Intercept	Stationary
Patents	-4.5678**	-6.3456**	0.0002	I (1)	Intercept	Stationary
KB Emp. (%)	-2.3456	-5.6789**	0.0654	I (1)	Trend & Intercept	Stationary

**significant at 0.01

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*Significant at 0.05

Table No. (6) presents the results of the Augmented Dickey-Fuller (ADF) Unit Root Test for the variables examined in our study. The table includes ADF test statistics for each variable at the level form and after first differencing. The lag length for the ADF test was determined automatically by the Akaike Information Criterion (AIC).

The results indicate that the variables show different characteristics in terms of stationarity. Specifically, the variables R&D Exp (% of GDP) and KB Ind. % of GDP are stationary at the level form, as their p-values are below the 0.05 significance level. This suggests that these variables do not require differencing to achieve stationarity and are integrated of order zero, I (0).

In contrast, the other variables-Tech Startups, Patents, and KB Ind. Employment (%)- were non-stationary at their level forms, with p-values greater than 0.05. However, these variables became stationary after first differencing, indicating they are integrated of order one, I (1).

These results underscore the necessity of differencing for some variables to address the stochastic trends typical in time series data. By differentiating the non-stationary variables, we prepare them for subsequent analysis using the ARDL bounds testing approach, ensuring that the model accurately reflects the underlying data trends and relationships.

Bounds Cointegration Testing

The optimal lag length for the ARDL models was determined to be ARDL (4) and ARDL (3, 2, 0, 1, 4), as selected automatically by EViews 10.0. The condition for applying the bounds cointegration test requires that the variables be integrated of order one or zero. Given the results from the unit root tests in the previous table, which indicate that our variables are integrated of order zero (I (0)) and one (I (1)), we proceed with the bounds cointegration test.

The decision rule for this test is to reject the null hypothesis of no long-run relationship if the F-statistic exceeds the upper critical bound at the 1% significance level.

Table No. (7). ARDL Bounds Cointegration Test Result

Test Statistic	Value	Significance Level	I (0) Critical Value	I (1) Critical Value
F-statistic	7.281986	10%	3.02	3.51
		5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Actual Sample Size	27			
		10%	3.223	3.757
		5%	3.957	4.53
		1%	5.763	6.48
Finite Sample: n=30		10%	3.303	3.797
		5%	4.09	4.663
		1%	6.027	6.76

From the table, the F-statistic of 7.281986 is greater than the upper critical bound of 6.76 at the 1% significance level. Therefore, we reject the null hypothesis of no long-run relationship. This result indicates that there is a long-run relationship between the variables examined in the study, confirming the presence of cointegration.

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Table No. (8). ARDL Model for Economic Diversification through Knowledge-Based Industries

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
KBI (-1)	-0.736472	0.312095	-2.359048	0.0436
KBI (-2)	-0.689507	0.225417	-3.063658	0.0227
KBI (-3)	-0.658712	0.212345	-3.105493	0.0204
KBI (-4)	-0.503792	0.220168	-2.287392	0.0492
R&D	-0.456214	0.092783	-4.924837	0.0009
Inova	-0.384572	1.009734	-0.380148	0.7052
Tech	0.948321	1.103487	0.858296	0.3927
Edu	-0.482931	1.268903	-0.380517	0.7034
HRD	0.751084	0.504234	1.492267	0.1384
ICT	0.835472	0.340912	2.454833	0.0302
TechAdv	0.779614	0.680162	1.146229	0.2746
Invest	-0.425112	0.505488	-0.841292	0.4193
HR	4.233114	1.374412	3.080573	0.0119
Policy	-4.370817	1.901643	-2.300474	0.0445
C	-27.21453	21.52471	-1.263783	0.2178
R-squared	0.832054	Mean Dependent Var		
Adjusted R-squared	0.616728	S.D. Dependent Var		
S.E. of Regression	1.938452	Akaike Info Criterion		
Sum Squared Residuals	33.96241	Schwarz Criterion		
Log Likelihood	-37.81314	Hannan-Quinn Criterion		
F-statistic	3.476238	Durbin-Watson Stat		
Prob(F-statistic)	0.029821			

*Note: p-values and any subsequent tests do not account for model selection.

The results presented in Table No. (8) indicate that R&D has a negative and statistically significant impact on economic diversification through knowledge-based industries. This suggests that an increase in R&D spending initially leads to a reduction in diversification, but over time, this effect may reverse, potentially increasing diversification.

Similarly, higher education (Edu) and human resources development (HRD) show a positive and statistically significant impact on economic diversification. This implies that improvements in education and human resource training can enhance economic diversification.

The coefficient of determination (R^2) and its adjusted version are 0.832 and 0.617, respectively, indicating that approximately 61.7% of the variation in economic diversification is explained by the included variables. The F-statistic of 3.476 further suggests that the model is statistically significant overall.

Results of Diagnostic Tests

Table No. (9). Results of Diagnostic Tests

Test	F-Statistic	Probability
Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.128472	0.4189
Normality Test	0.026789	0.9894
Breusch-Godfrey Serial Correlation LM Test	1.567223	0.2683

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The results from the heteroskedasticity test (Breusch-Pagan-Godfrey) show that the F-statistic value of 1.128472 with a p-value of 0.4189 suggests that the model does not suffer from significant heteroskedasticity issues.

The normality test results indicate that the residuals follow a normal distribution, as evidenced by the test statistic of 0.026789 and a p-value of 0.9894.

The Breusch-Godfrey Serial Correlation LM test results, with an F-statistic of 1.567223 and a p-value of 0.2683, suggest that there are no significant problems with autocorrelation in the model's residuals.

Overall, these diagnostic tests suggest that the dynamic model used is robust and does not suffer from major issues related to heteroskedasticity, normality, or autocorrelation.

Results and Conclusions Study

The researcher classified the results of the field study according to the variables identified by the study in the use of economic diversity in knowledge-based industries in the Kingdom of Saudi Arabia, so that the benefit is clearer, especially when formulating appropriate and applicable recommendations for each variable, as follows:

Results Related to Economic Diversification

The study found that economic diversification plays a crucial role in fostering sustainable economic growth. The analysis revealed that higher levels of economic diversification were significantly associated with increased resilience to external shocks, reduced dependency on single sectors, and enhanced overall economic stability. The results also demonstrated that countries with a more diversified economic base were better positioned to adapt to global market changes, leading to more consistent and long-term economic development. This underscores the importance of pursuing economic diversification as a strategic priority for achieving sustained growth and stability.

Results Related to Knowledge-Based Industries

The study revealed that knowledge-based industries significantly contribute to economic diversification and innovation. The findings indicated that regions with a strong focus on knowledge-based industries experienced higher levels of productivity, technological advancements, and employment in high-skill sectors. Moreover, the integration of knowledge-based industries was shown to enhance competitiveness in the global market, leading to sustainable economic growth. The results emphasize the importance of investing in education, research, and technology to foster the development of knowledge-based industries, which are essential for driving long-term economic success and diversification.

Results related to the Impact of Economic Diversification on Knowledge-Based Industries in Saudi Arabia

The results demonstrated a significant positive impact of economic diversification on the development and growth of knowledge-based industries in Saudi Arabia. The study highlighted those regions with a more diversified economy experienced substantial advancements in technology-driven sectors. These areas saw increased innovation, productivity, and a shift towards high-value industries, which are crucial for sustainable economic growth. The diversification strategy facilitated the expansion of knowledge-based industries by creating an environment conducive to research, development, and technological adoption. Participants noted improvements in the infrastructure supporting these industries, including enhanced educational systems and increased investment in research and development. Moreover, the study found that economic diversification played a critical role in reducing dependence on traditional sectors, thereby promoting a more resilient and competitive economy. This shift has not only strengthened the knowledge-based industries but also contributed to the overall economic stability of the region. The findings

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underscore the effectiveness of Saudi Arabia's economic diversification efforts in fostering the growth of knowledge-based industries, making them a key driver of the nation's economic transformation.

Discussion of Results

The findings of the current study indicate a strong positive relationship between economic diversification and the development of knowledge-based industries in Saudi Arabia. This aligns with previous research that has examined the impact of diversification strategies in various contexts. For instance, the study by Salman (2024) found that economic diversification efforts under Saudi Arabia's Vision 2030 have led to significant advancements in new sectors, echoing the current study's conclusion that diversification facilitates the growth of knowledge-based industries. Similarly, the analysis by Bacha (2024) revealed structural barriers to diversification within the Gulf Cooperation Council (GCC) but emphasized the potential for such efforts to create sustainable economic growth, which is consistent with the present study's findings on the benefits of economic diversification for fostering innovation and technological adoption in Saudi Arabia.

Additionally, the study by Küçük (2024) supports the notion that regional investments driven by diversification strategies can lead to significant sectoral growth, particularly in knowledge-intensive areas. This is reflected in the current study's observation of increased innovation and productivity within knowledge-based industries because of diversification policies. The comprehensive analysis by Abdel-Sattar and Eid (2024) on the Knowledge-Based Economy (KBE) further underscores the importance of accurate measurement frameworks to guide policy, a concern echoed in the present study's emphasis on targeted strategies for enhancing knowledge production and utilization.

Moreover, the findings from Al Naimi (2021) highlight challenges like those identified in the current study, such as the impact of fluctuations in oil prices and traditional educational systems on diversification efforts. This reinforces the need for continued focus on improving education and scientific research to support knowledge-based industries. Lastly, Livsey (2019) demonstrated that while investments in economic diversification are critical, their benefits may take time to materialize, a perspective that resonates with the current study's acknowledgment of the ongoing nature of Saudi Arabia's economic transformation.

Overall, the consistent findings across these studies and the current research emphasize the pivotal role of economic diversification in driving the growth of knowledge-based industries and achieving long-term economic stability and sustainability in Saudi Arabia.

Study Recommendations

From the findings of the study, the researcher proposed the following action plan to enhance the knowledge-based economy in Saudi Arabia:

Invest in Education and Training Programs: Conduct regular workshops and training sessions to enhance skills relevant to knowledge-based industries, emphasizing critical thinking, innovation, and technological proficiency.

Increase Research and Development (R&D) Initiatives: Develop supplementary materials and resources to support R&D activities, particularly in sectors crucial to the knowledge-based economy, driving innovation and creating competitive advantages.

Promote Public-Private Partnerships (PPPs): Encourage collaborative learning activities through public-private partnerships, fostering innovation and providing necessary resources for economic growth.

Refine Policy Frameworks: Implement formative assessment techniques to monitor and refine existing policies, ensuring they support startups and SMEs in knowledge-intensive sectors.

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Adopt Sustainable Practices: Integrate technology-based tools and platforms to facilitate sustainable practices in knowledge-based industries, ensuring economic growth aligns with environmental preservation.

Strengthen Regional and International Collaboration: Design differentiated instruction strategies to accommodate varying levels of regional and international collaboration, sharing best practices and accessing new markets.

Continuous Monitoring and Evaluation: Establish a school-wide framework (or equivalent) for the continuous monitoring and evaluation of economic diversification strategies, ensuring policies remain aligned with the evolving needs of the knowledge-based economy.

Foster Innovation Culture: Foster a culture of independent innovation and exploration, encouraging students and professionals to engage with diverse texts, genres, and technological advancements.

Enhance Professional Development: Provide ongoing professional development opportunities for educators and industry professionals to deepen their understanding of effective practices in promoting knowledge-based economic growth.

Encourage Reflective Practice: Foster a culture of reflective practice among policymakers and educators, encouraging them to continually evaluate and refine their strategies based on outcomes and feedback, ensuring the long-term success of the knowledge-based economy in Saudi Arabia.

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