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Evaluating the Financial Efficiency in the Banking Sector by Adopting Multistage Data Envelopment Analysis: a Practice Study on a Sample of GCC Banks

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DEDICATION

This work is dedicated with love to my family, friends,

and teachers for being with me

at all times.

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I would like to express my utmost gratitude and appreciation to my supervisor, Pr.Saous Cheikh, and Dr. Younes Mouna for their guidance and assistance. Without rieht help and direction, I would have never been able to complete my project on time.

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Abstract

Abstract:

DEA, or data envelopment analysis, is an effective non-parametric mathematical technique for assessing the efficiency ofhomogeneous decision-making units (DMUs). Several writers have used this tool to investigate two-stage processes in which the only inputs to the second stage are all the first stage's outputs. On the other hand, intermediate measurements are the results from the first to the second stage. The current study evaluates the financial efficiency of fifteen (15) GCC Islamic banks during the period 2012–2017. We assumed that banks use Total Assets, Total Equity, and Total Deposits as inputs and ROAE, ROAA, and Net Loans as intermediation variables, Cost to Income Ratio, and Growth of Total Assets as outputs of the second stage in the efficiency calculations of these banks. According to the results, the efficiency level of GCC Islamic banks in six countries was lower in the analysis period. Additionally, the findings demonstrated that the cost efficiency scores of Islamic banks are higher than their productive efficiency scores. There is a significant variance between the efficiency of the first and second stages. The impact of financial efficiency of the first and second stages on overall efficiency was as negative as-0.176 and-0.071, respectively. The impact of centralized efficiency of the first and second stages on centralized efficiency was as negative as-0.018 and-0.2356, respectively. The impact of cost efficiency and productive efficiency on global efficiency was as positive as 0.3636 and 0.7920, respectively. The results also showed that large banks are more efficient than smaller banks because they have the ability to use more specific inputs, better coordinate their resources, and reap the benefits of economies of scale.

Keywords: financial efficiency, Islamic banks, multistage data envelopment analysis, Gulf Cooperation Council (GCC).

الملخص:

DEA، أو تحليل مغلف البيانات، هو تقنية رياضية فعالة غير بارامترية لتقييم كفاءة وحدات صنع القرار المتجانسة DMUs.استخدم العديد من الكتاب هذه الأداة للتحقيق في العمليات ذات المرحلتين حيث تكون المدخلات الوحيدة للمرحلة الثانية هي مخرجات المرحلة الأولى. من ناحية أخرى، فإن المقاييس الوسيطة هي النتائج من المرحلة الأولى إلى الثانية. تقيم الدراسة الحالية الكفاءة المالية لخمسة عشر (15) بنكًا إسلاميًا في دول مجلس التعاون الخليجي خلال الفترة 2012-2017. افترضنا أن البنوك تستخدم إجمالي الأصول وإجمالي حقوق الملكية وإجمالي الودائع كمدخلات و ROAE و ROAA وصافي القروض كمتغيرات وسيطية، ونسبة التكلفة إلى الدخل، ونمو إجمالي الأصول كمخرجات للمرحلة الثانية في حسابات الكفاءة لهذه البنوك. ووفقا للنتائج، كان مستوى كفاءة المصارف الإسلامية في البلدان الست لمجلس التعاون الخليجي منخفضة خلال فترة التحليل. بالإضافة إلى ذلك، بينت النتائج أن درجات كفاءة التكلفة للبنوك الإسلامية أعلى من درجات الكفاءة الإنتاجية. وهناك تباين كبير بين كفاءة المرحلتين الأولى والثانية. وكان تأثير الكفاءة المالية في المرحلتين الأولى والثانية على الكفاءة الإجمالية سلبيابمقدار 0.176- و 0.071- على التوالي. وكان تأثير الكفاءة المركزية في المرحلتين الأولى والثانية على الكفاءة المركزية سلبيا بمقدار 0.018- و 0.2356- على التوالي. وكان تأثير كفاءة التكلفة والكفاءة الإنتاجية على الكفاءة الكلية إيجابيا بمقدار 0.3636 و 0.7920 على التوالي. وأظهرت النتائج أيضًا أن البنوك الكبيرة أكثر كفاءة من البنوك الصغيرة لأن لديها القدرة على استخدام مدخلات أكثر تحديدًا، وتنسيق مواردها بشكل أفضل، وجني فوائد وفورات الحجم.

الكلمات المفتاحية: الكفاءة المالية، البنوك الإسلامية، تحليل مغلف البيانات متعدد المراحل، مجلس التعاون الخليجي.

Table of contents

Content	Page
Dedication	-
Acknowledgment	-
Abstract	I - II
List of Contents	III -IV
List of Tables	V
List of Figure	VI
List of Abbreviation	VII
Introduction	1 - 6
Chapter one: Islamic Banking	7 - 41
Introduction	8
1. Islamic banks	9 - 14
1.1 Definition of Islamic bank	9
1.2 The Emergence of Islamic Banking	10 - 12
1.3 Features of Islamic Banks	12
1.4 pillars of Islamic banking	13
1.5Objectives of Islamic banks	14
2. Islamic finance	15 - 41
2.1 Definition Islamic finance	15
2.2 principles of Islamic finance	16
2.3 Riba	17 - 19
2.4 Islamic financing formulas	20 - 32
2.5 Basic Shariah Principles of Business Contracts	32
2.6 Islamic Banking Risks in Theory	33 - 38
2.7 Challenges of Islamic Banking	38 - 40
Conclusion	41
Chapter two: Financial efficiency	42 - 80
Introduction	43
1. Financial Management	44 - 49
1.1 Definition of financial management	44
1.2 The goal of financial management	45 - 47
1.3 Scope of Financial Management	47 - 49
2. Efficiency and financial efficiency	50 – 60
2.1 Efficiency	50
2.2 Financial efficiency	51
2.3 Financial Efficiency Ratios	53– 55

Table of contents

2.4 Types of efficiency	**55 -60**
3. Data envelopment analysis	**61 – 80**
3.1 New efficiency theory	**61 - 69**
3.2 Advantages of data envelopment analysis	**69**
3.3 Disadvantages of data envelopment analysis	**70**
3.4 Efficiency Measurement Models	**71**
Conclusion	**80**
Chapter three: Literature Reviews	**81 - 114**
Introduction	**82**
1. Review of relevant literature	**83-101**
1.1 Relevant literature reviews of financial efficiency	**83-87**
1.2 Relevant literature reviews of data envelopment analysis	**87-94**
1.3 Relevant literature review of Multi-stage data envelopment analysis	**94-101**
2. Comment on the literature reviews	**102-103**
3. Summary of the related literature	**104-113**
Conclusion	**114**
Chapter four: Empirical Study	**115-158**
Introduction	**116**
1. Method and Tools	**117-124**
1.1Description of sample and variables	**117-119**
1.2 Methodology	**119-124**
1.3 Statistical Tool	**124**
2. Results and Discussions	**125-158**
2.1 Descriptive statistics	**125**
2.2 Variables correlation analysis	**126**
2.3 Financial Efficiency Results	**127-145**
2.4 Statistical Problem	**145**
2.5 Hypotheses Testing	**146-149**
2.6 Discussion	**149-157**
Conclusion	**158**
Conclusion	**159-162**
Bibliography	**163-188**

List of Tables

Number	Title	page
1.3.3	Relevant literature reviews of financial efficiency	**104-105**
2.3.3	Relevant literature reviews of data envelopment analysis	**105-108**
3.3.3	Relevant literature review of Multi-stage data envelopment analysis	**108-113**
4.1.1	Distribution of Islamic banks by countries	**117**
4.1.2	The variables used in the study	**118**
4.2.1	Descriptive statistics	**125**
4.2.2	Correlation Matrix	**126**
4.2.3	First stage financial efficiency score 2012-2017	**128**
4.2.4	Second stage financial efficiency score 2012-2017	**130**
4.2.5	Overall efficiency score of the two-stage process for GCC Islamic banks 2012-2017	**132**
4.2.6	Centralized Results in 2012	**133**
4.2.7	Centralized Results in 2013	**134**
4.2.8	Centralized Results in 2014	**134**
4.2.9	Centralized Results in 2015	**135**
4.2.10	Centralized Results in 2016	**135**
4.2.11	Centralized Results in 2017	**136**
4.2.12	Centralized Efficiency scores of the two-stage process for GCC Islamic banks 12-12-2017	**136**
4.2.13	Global (overall) efficiency Results in 2012	**137**
4.2.14	Global (overall) efficiency Results in 2013	**138**
4.2.15	Global (overall) efficiency Results in 2014	**138**
4.2.16	Global (overall) efficiency Results in 2015	**139**
4.2.17	Global (overall) efficiency Results in 2016	**139**
4.2.18	Global (overall) efficiency Results in 2017	**140**
4.2.19	Global efficiency score of the two-stage process for GCC Islamic banks 2012-2017	**142**
4.2.20	Evolution of efficiency score for GCC Islamic banks over the years 2012 to 2017	**144**
4.2.21	Testing third hypothesis	**146**
4.2.22	Testing fourth hypothesis.	**147**
4.2.23	Testing fifth hypothesis	**147**
4.2.24	Testing sixth hypothesis	**148**
4.2.25	Testing seventh hypothesis	**148**
4.2.26	Testing eighth hypothesis	**149**

List of Figures

Number	Title	page
1.2.1	Different forms of riba	**18**
1.2.2	Islamic financing formulas	**20**
1.2.3	Theoretical risks that Islamic banks confront	**34**
2.3.1	Fundamental models in DEA	**62**
4.1.1	Two-stage process of DMU_j	**120**
4.2.1	Correlation Matrix	**127**
4.2.2	The graph on first stage efficiency for GCC Islamic Banks during the year 2012–2017	**129**
4.2.3	The graph on second stage efficiency for GCC Islamic Banks during the year 2012–2017	**131**
4.2.4	Average first and second stage efficiency of GCC Islamic Banks during the year 2012-2017	**131**
4.2.5	The overall efficiency score of the two-stage process in the GCC Islamic banks during the period 2012–2017	**133**
4.2.6	The Centralized efficiency score of the tow-stage process in the GCC Islamic banks during the period 2012–2017	**137**
4.2.7	The cost efficiency scores in the GCC Islamic banks during the period 2012–2017	**141**
4.2.8	The productive efficiency score in the GCC Islamic banks during the period 2012–2017	**142**
4.2.9	The global efficiency score of the two-stage process in the GCC Islamic banks during the period 2012–2017	**143**

DEA	**D**ata **E**nvelopment **A**nalysis
DMU	**D**ecision **M**aking **U**nit
PPS	**P**roduction **P**ossibility **S**et
M-F	**M**ultiplier **F**orms
E-F	**E**nvelopment **F**orms
CCR	**C**harnes, **C**ooper& **R**hodes
BCC	**B**anker, **C**harnes and **C**ooper
GCC	The **G**ulf **C**ooperation **C**ouncil
RTS	**R**eturns to **S**cale
CRS	**C**onstant **R**eturns to **S**cale
VRS	**V**ariable **R**eturns to **S**cale
IRS	**I**ncreasing **R**eturns to **S**cale
DRS	**D**ecreasing Returns to Scale
ROAA	**R**eturn on **A**verage **A**ssets
ROAE	**R**eturn on **A**verage **E**quity
CTIR	**C**ost **t**o **I**ncome **R**atio
GOTA	**G**rowth of **T**otal **A**ssets
MLR	**M**ultiple **L**inear **R**egression
IFI	**I**slamic **F**inancial **I**nstitution
IB	**I**slamic **B**anks
R	**P**rogramming **L**anguage
RRR	**R**ate of **R**eturn **R**isk
IIFS	**I**nstitutions Offering **I**slamic **F**inancial **S**ervices
SE	**S**cale **E**fficiency
TE	**T**echnical **E**fficiency
PTE	**P**ure **T**echnical **E**fficiency

Introduction

The state of a country's economy is tied directly to the ability of that country to address the needs of large segments of the unemployed, and its strength is derived from the efficiency of its financial institutions, especially banks, which are the backbone of the national economy and one of the most crucial components of the financial sector, and the main pillars of development and economic life. Without a doubt, a country's banking system promotes rapid growth in the various sectors of the economy by promoting capital formation, providing credit facilities, investing in new enterprises, promoting trade, industry, and agriculture, promoting export, and implementing monetary policy. This implies that banks' primary role in economic development is as financial intermediaries. In this capacity, banks aid in the movement of investment capital throughout the market.

There are various banking systems in the world, but the most well-known are conventional banking and Islamic banking, because they symbolize two distinct and opposing methods of banking that have become widely known and influential in the world of finance. The main function of conventional banking can be summed up in one sentence: the bank borrows to lend. They borrow money in the form of deposits and lend it to earn interest. On the other hand, the idea of partnership serves as the foundation of Islamic finance. The depositors and Borrowers all would participate in the Islamic banking framework based on profit-loss sharing. Islamic banks play an important role in the economy as financial intermediaries, mobilizing savings from surplus units and transferring them to deficit units, which require capital to produce goods and services. As a result, they contribute to wealth distribution by effectively allocating financial resources. Moreover, they contribute to the capital of companies and thus help to promote economic activity by offering capital ventures in the production process. The effect of contributing financial resources based on production requirements is said to be more efficient than pure lending. This is expected to have a greater positive effect on economic expansion.

The Middle East, particularly Gulf countries, is a key nerve center of Islamic finance, they have recorded phenomenal growth rates of Islamic banking in terms of the number of Islamic banks and assets growth. But most GCC countries still have entry barriers that limit foreign ownership in the banking sector. Surprisingly, until recently, Oman was the last GCC country to regulate Islamic finance and allow Islamic banks to operate in the country. For example, in December 2012, a significant change to Oman's

banking law permitted Islamic financing products. In Qatar, new banking regulations have recently been implemented. For example, the Qatar Central Bank ordered conventional banks with Islamic activities to shut down their Islamic operations and limit their lending to conventional lending only in 2010. (Saleh, Moradi-Motlagh, & Zeitun, 2020)

The study investigated the GCC countries for several reasons. First of all,several changes are occurring in the GCC region, including the opening of certain markets to foreign competition, the expansion of the private sector, and the increased role of bank lending. (Bitara, Saad, & Benlemlih, 2016). Second, Islamic banks in the GCC work in basically the same manner and deal in comparable items (Olson & Zoubi, 2008) Finally, The GCC member states' economic characteristics share several similarities, such as similar historical and cultural development. Furthermore, due to their unique banking industry structure (Alfadli & Rjoub, 2019)After the oil and gas sector, the banking sector is the second largest contributor to the GDP in most GCC countries (Al-Musalli & Ismail, 2012). Therefore, the GCC countries' primary goal is to improve efficiency in the banking industry by implementing appropriate economic and financial policies.

Accordingly, motivated by the need to determine the efficiency level of GCC Islamic banks this study seeks to evaluate the financial efficiency in GCC countries by adopting multistage data envelopment analysis. Our focus is on 15 Islamic banks operating in the six GCC states from 2012 to 2017.

1. Significance of study:

The significance of this research stems from the fact that it brings to light a significant sector of the global economy, namely Islamic finance. It has an impact on everyone in the world and is a valuable tool for the global economy. It is worth mentioning that,in the banking industry, performance measurement is most beneficial to management, who monitor performance, and to regulators, who monitor financial stability while attempting to detect distress. Additionally, banks and financial institutions are ranked for inclusion in investors' investment portfolios by market experts and investors.

2. Objectives of Study:

The principal objective of the research is to evaluate Islamic banking financial efficiency in GCC nations by adopting multistage data envelopment analysis.

2.1 Specific Objectives:

- knowing the level of Islamic banks' financial efficiency in GCC countries.
- understanding of the most crucial factors affecting the financial efficiency and overall efficiency of the sample under consideration.
- Getting more information about multi-stage data envelopment analysis as a tool for measuring efficiency and the difference between it and traditional data envelope analysis.
- Identify and compare the efficient and inefficient units of the sample under study.

3. Problematic:

It is worth mentioning that the vast majority of the GCC nations are Muslims, so Islamic finance should be studied and developed in these countries. Due to this notion, the current study has been conducted in GCC Islamic banks, and based on what has been mentioned above, the problem of this study has been formulated into the following question:

- What is the extent of Islamic banks' financial efficiency in GCC countries based on a multistage data envelopment analysis approach?

To answer this study question, the following sub-questions are formulated:

1. What is the degree of Islamic banks' financial efficiency in GCC countries?
2. Is there a variation in the degree of financial efficiency of Islamic banks among the six countries?
3. Is there a significant variance between the financial efficiency of the first and second stages?
4. Is there a significant variance between the centralized efficiency of the first and second stages?

5. Is there a significant variance between cost efficiency and productive efficiency?
6. Is there a significant impact of the financial efficiency in the first and second stages on overall efficiency?
7. Is there a significant impact of the centralized efficiency in the first and second stages on centralized efficiency?
8. Is there a significant impact of cost efficiency and productive efficiency on global efficiency?
9. Is there an impact of the bank's size on financial efficiency?

4. Research Hypotheses:

To answer the problem of the study and its sub-questions, the following hypotheses have been elaborated:

H01: The financial efficiency of Islamic banks is lower in GCC countries.

H02: There is a variation in the degree of financial efficiency of Islamic banks among the six countries.

H03: There is a significant variance between the financial efficiency of the first and second stages.

H04: There is a significant variance between the centralized efficiency of the first and second stages.

H05: There is a significant variance between cost efficiency and productive efficiency.

H06: There is a significant impact of financial efficiency in the first and second stages on overall efficiency.

H07: There is a significant impact of centralized efficiency in the first and second stages on centralized efficiency.

H08: There is a significant impact of cost efficiency and productive efficiency on global efficiency.

H09: There is an impact of the size of the bank on financial efficiency.

5. Research Scope:

The research will use Islamic institutions in the GCC as a case study and span the years 2012 to 2017. It will concentrate on assessing overall efficiency and other types of efficiency to pinpoint efficient and inefficient Decision Making Units (DMUs).

6. Limitations of the study:

- One of the noteworthy limitations of the study was that the sample size is small, where exploration of more units in the sample would provide more acceptable results.
- The study period is set at 6 years from 2012 to 2017 and has been limited to this period because there are missing values in some sample banks for the other years.

7. Research Methodology and Tools:

Based on the nature of the problem and to achieve the desired goals, this study relied on the following method:

It relies on the descriptive approach by describing the various information contained in the theoretical literature that discusses the topic of research, through the use of books and magazines, and the views of specialists and experts in this field, in addition to the history approach for recounting the emergence and development of Islamic banks, and the risks they face.

It relied on the analytical method by using multi-stage data envelope analysis to measure financial efficiency, drawing on the R Programming Language, as well as using some statistical tools for hypotheses testing, such as the Wilcoxon signed rank test and multiple linear regression.

8. Research Structure:

This study proceeds as follows:

In sections 1 and 2, we present the theoretical aspect. Section 3 provides the review literature on the related literature. Section 4 explains the data, variables, and the method employed in this and shows empirical findings and hypothesis testing, which are discussed in section 4. Finally, we will summarize our conclusion.

Chapter One:

Islamic Banking

Introduction:

In recent decades, Islamic financial institutions, particularly Islamic banks, have grown in importance as a sector of global financial institutions. Although the concept of Islamic banks gained popularity in the 1960s, the underlying mechanisms and concepts have existed since Islam's inception. Islamic banks play a significant role in providing Islamic financing to those who manage it under Islamic principles. An Islamic bank is a non-interest-bearing institution that fully complies with Islamic laws to promote economic, social, and political solidarity. The Islamic banking industry has been steadily expanding since its inception. One of the reasons Islamic banks have attracted global attention is their consistent increase in activity.

From the above, this chapter was divided into the following two sections:

- The first section, Islamic Banks.
- The second section, Islamic Finance

Chapter One: Islamic Banking

1. Islamic banks.

1.1 Definition of Islamic banks:

There are several definitions offered for Islamic banks:

An Islamic bank is a financial establishment that offers its customers service-free interest. Besides, it prohibits the giving and taking of Riba in all transactions. (Basah & Yusuf, 2013, p. 194)

An Islamic bank is a financial institution that engages in banking, by collecting and using money to frame a complementary Islamic society. And establish a fair distribution of money's role in Islam. This organization conducts its financial work while avoiding dealing with Riba or interest. Because it is forbidden in Islam to do any work that violates sharia principles. (Reguia, 2011, p. 10)

An Islamic bank is a financial institution that adheres to Sharia (Islamic law) principles and puts them into practice through the growth of Islamic economics. (Riptiono, Suroso, & Irma Anggraeni, 2020, p. 365)

According to the definition approved by the OIC's General Secretariat, an Islamic bank is a financial institution that states in its bylaws, policies, and operating procedures that it adheres to Islamic Shariah principles, and forbids the receiving or paying of Riba in any of its transactions.(Sarker, Sultana, & Prodhan, 2017, p. 052)

An Islamic bank is a business that deals with money and offers banking services to facilitate the flow and investment of funds following Islamic principles. (Naif Alotaibi & Asutay, 2015, p. 2)

Yahiya Abdul-Rahman states that traditional banking omits the word "Islamic" (interest), with a new agreement that does not contain the phrase (interest). And that is being organized into a complicated buy-sell arrangement. In which the trader changes ownership to the bank and then the bank sells it to the eventual buyer. (HAILU, 2015, p. 8)

Based on the definitions mentioned above, we can say that an Islamic bank is defined in a variety of ways. And each of them focuses on Sharia compliance.

In simple terms, an Islamic bank is a financial institute operating under the provisions of Islamic Shariah by providing contracts of interest to society without causing any harm to the contracting parties. And we can define an Islamic bank as an organization that avoids dealing with Riba, or interest, as it is forbidden in Islam, and any work that is illegal under sharia principles.

1.2 The Emergence of Islamic Banking:

Islamic banking dates back to the time of the Prophet Muhammad (PBUH). He was a mudarib for his wife Khadijah because she provided all of the capital, which Prophet Muhammad managed. (Martin, 2021)In Egypt in 1963, Bank MYT Ghamir became the first contemporary Islamic bank. Despite being closed down in 1967, Bank Islam MYT Ghamir's attempt served as a model for other Islamic financial institutions. It's believed that the founding of Bank Islam MYT Ghamir opened the door for the founding of Islamic banks. (Dwi Sari, Bahari, & Hamat, 2016) Because of the ongoing collective efforts of Muslim scholars, governments in various Muslim countries have permitted them to establish Islamic banks in various countries. As a result, many Islamic banks sprang up in the 1970s and 1980s. (Abdul Jalil & Rahman, 2010, p. 219)

In 1969, an OIC conference in Kuala Lumpur generated preliminary ideas for the international establishment of Islamic banks. The participants agreed on several points, the first of which was that any profit must be based on the principle of profit and loss sharing; otherwise, the profit would fall under the category of usury, which is forbidden in Islam. Second, it was suggested that an Islamic bank free of the usury system be established as soon as possible and that, in the interim, before the establishment of such a bank, conventional banks be allowed to operate as long as there was an emergency. Furthermore, the Islamic Development Bank (IDB) was founded in 1975 in response to the recommendations of the Islamic Economy Conference in Mecca. IDB played a critical role in meeting the infrastructure financing needs of Islamic countries and actively providing an interest-free guarantee based on the country's capital. Many other countries were inspired to establish Islamic financial institutions as a result of the IDB's establishment. (Wahyudi, Rosmanita, Prasetyo, & Putri, 2015)

There was institutional involvement in the early 1970s. The Egyptian Study in 1972. The First International Conference on Islamic Economics in Mecca in 1976. The International Economic Conference in London in 1977, and the Conference of Islamic

Finance Ministers in Karachi in 1970. These are all outcomes of this involvement. The establishment of the first interest-free banks. And the application of theory to practice was made possible. With the involvement of institutions and governments. (Kettell, 2011, p. 24)

About 35 years after interest-free savings and loan institutions were originally introduced to the Indian subcontinent; Dubai Islamic Bank began operating as the first IFI for the private corporate sector in 1975. IFIs have since expanded globally to include Muslim and non-Muslim nations. Muslims who desired Islamic products and services backed the rapid expansion of IFIs. Today, these institutions provide a diverse range of goods and services, with Islamic "windows," Islamic funds and investment banks, firms of Islamic mortgage, Takaful (Islamic insurance) firms, and Musharakah (profit-sharing) firms (Al Rahahleh, Bhatti, & Misman, 2019, p. 3). Following these early successes, a number of Islamic banks were established in various other Muslim countries beginning in the 1970s. They are as follows: (Wes, 2011-2012, pp. 69-70)

1- The Nasser Social Bank in Cairo 1971;
2- The Islamic Development Bank in Jeddah 1975;
3- The Dubai Islamic Bank in 1975;
4- The Faisal Islamic Bank in Egypt 1977;
5- The Faisal Islamic Bank of the Sudan 1977;
6- The Kuwait Finance House1977 ;
7- The Jordan Financial and Investment Bank 1978;
8- The Bahrain Islamic bank 1979.

In the 1980s, more Islamic banks popped up, including the first Islamic bank to open in a non-Muslim country. The International Islamic Bank of Investment and Development was established in Luxembourg in 1980. In the 1980s, other Islamic banks were established, including: (Venardos, 2006, pp. 61-62)

• The Abu Dhabi Islamic Bank (1980)

• The Qatar Islamic Bank (1981)

• Islamic counters in Pakistan banks (1981)

• The Malaysia Islamic Bank Ltd (1983)

• The Mauritania Islamic Bank (1985)

• The Tanzibar Islamic Bank (1985)

• The Iraq Islamic Bank (1985)

• The Turkey Islamic Bank (1986)

While the banking industry continued to grow (albeit at a slower pace) in the 1990s, non-bank financial institutions received more attention. Other than banks, Islamic financial institutions have begun to emerge in greater numbers. Insurance companies and investment funds are among them. While the Islamic insurance sector has yet to reach its full potential, Islamic investment funds have made significant strides. (Iqbal & Molyneux , 2005)

1.3 Features of Islamic Banks:

Islamic banks have many features. We mention them as follows:(Chalu, 2014, p. 114)

1- Riba (interest) is forbidden in all transactions;
2- Halal (legal/permitted) activities are used to conduct business and make investments;
3- Maysir (gambling) is forbidden, and all transactions should be free of gharar; (speculation or unreasonable uncertainty).
4- The bank pays Zakat to benefit society, and all activities must adhere to Islamic principles;
5- The bank's relationship with its customers is not one of borrower and creditor; rather, it is one of risk and reward sharing; (Komijani & Taghizadeh-Hesary, 2018, p. 4)
6- Islamic banks are expected to contribute to the overall development of society. Although profit is important, it is not the primary goal of finance in Islamic banking. An Islamic bank emphasizes the achievement of socioeconomic goals while adhering to Shariah law. (Komijani & Taghizadeh-Hesary, 2018, p. 5)

1.4 Pillars of Islamic banks:

The following are the five most important pillars of Islamic banking: (Al Rahahleh, Bhatti, & Misman, 2019, p. 5)

1- Prohibition of Riba (Interest): According to Shariah, Muslims are prohibited from engaging in any Riba-related activities, whether paying or receiving interest.
2- Because Riba is prohibited in Shariah, IB operations are based on equity contributions. The borrower (entrepreneur) and the fund provider (investor) are required to split the transaction's profit and risk.
3- Money is regarded as a means of exchange: In Islam, money cannot create more money. It should instead be treated as capital, and any profit or loss should be shared among parties in proportion to their respective investments. All transactions of this nature must be backed by assets.
4- Gharar: Excessive ambiguity and speculation must be avoided, as they lead to Maysir (gambling), which is forbidden.
5- Contract purity: To lower the risk of contract exposure under Shariah, IFI contracts must include full disclosure. This means that strict contract sanctity is essential in IFI transactions.

1.5 Objectives of Islamic banks:

1.5. 1. Social objectives of Islamic banks:

Hamidi and Worthington (2020) developed six categories, each with multiple constructs, to assess the social objectives of Islamic banks, which are as follows: (Irfan, 2021, p. 18)

1. Zakat, Qardh al-hasan, riba, and encouraging spirituality are examples of religious constructs;
2. The environment encompasses concepts such as environmental preservation, green office management, and green financing;
3. Social ends include concepts such as encouraging education, training, quality improvement, and economic empowerment;
4. Governance encompasses concepts such as vision and mission, anti-corruption and anti-fraud measures, proper customer complaint handling, and ethics and staff compliance;
5. Employee management in Islamic banks includes elements such as remuneration, training opportunities, employee education, and equal work opportunities for men and women;

6. Customer orientation includes elements like customer discounts, special financial products for underserved groups and women, and serving underserved areas.

1.5.2. Economic goal of Islamic banks:

The main goal of Islamic banks worldwide is to advertise, foster, and enhance the use of Islamic principles, laws, and traditions in financial banking and business transactions. Its goal is to advertise investment firms, enterprises, and concerns that will engage in business in a manner that is acceptable and in accordance with Islamic principles, laws, and traditions. The following is the economic goal of Islamic banking: (Khan H. , 2017, p. 1008)

1.To provide modern financial services in accordance with Islamic Shariah;

2. Contribute to the growth and prosperity of the economy while adhering to Islamic justice principles;

3.To make resource allocation more efficient;

4. To contribute to economic stability;

5. To ensure that income and resources are distributed fairly.

2. Islamic finance.

2.1 Definition of Islamic finance:

Islamic finance is defined as follows:

The term "Islamic finance" refers to the structure in which all types of financial activities and transactions are conducted under Islamic rules. (Evci & Sharma, 2020)

Warde (2000) defines Islamic finance as Islamic financial institutions that are based, in their objectives and operations, on Quran principles. (Warde, 2000, p. 5)

Islamic finance is also defined as a financial service that is implemented by Sharia principles (or Islamic law). (Gait & Worthington, 2007, p. 4)

Islamic finance is a financial system that adheres to Islamic law, also known as Shariah. The following are the five sources of Shariah:

- **Qur'an**:

The Holy Qur'an, also known as Al-Quran, is the original source of Shariah law. It contains messages that Allah inspired the Prophet (PBUH) to deliver mankind's guidance.

- **Sunnah:**

Sunnah means "custom, habit, or way of life" in Arabic. It refers to the holy Prophet Muhammad's (PBUH) actions, sayings, and utterances. As well as the actions of others who were approved by him, as recorded in the Hadith books.

The hadith comes next in significance to the Quran, which is the second underpinning of Shariah. It is a snippet of data, like a record, account, or story. It fills in as a record of the Prophet's (PBUH) Sunnah, which has been passed down from generation to generationand has become the rules of faith and practice for Muslims.

- **Ijma:**

Al-Ijma, an Arabic word that means "consensus," expresses the agreement or unanimity of Muslim jurists providing legal advice. In actuality, it is a reliable source on legal matters from a third party. In practice, when a legal case arises at a given time and all the ulama of the same time after the Prophet's death (PBUH) agree to render the same

opinion on the case, their agreement is referred to as "Al-Ijma." The decision reached as a result of this consensus becomes law. By analogy, such judgments can serve as a reference for later judgments. "A-Qiyas" (Diomande, 2020, p. 982)

- **Qiyas:**

A Qiyas is a "comparison to determine the equality or similarity of two things." Qiyas is defined as "the extension of a Shariah ruling from one case to another since the effective cause of the new case is the same as the effective cause of the original case. (ALMEZEINI, 2014, p. 28)

- **Ijtihad:**

Ijtihad is the fifth major source of Islamic thought, which is the application of human reason, or aql, to the elaboration and interpretation of Shariah. If there is no clear text in the Qur'an or Sunnah, ijtihad is used.

When the Shariah foundation (Qur'an, Sunnah, and Hadith) is combined with ijma, qiyas, and ijtihad, it forms fiqh, also known as Islamic jurisprudence. Fiqh has played a pivotal role in the global development of Islamic finance and Islamic banking. (ALRIFAI, 2015, p. 98)

2.2 principles of Islamic finance:

The principles of the Islamic worldview and morality are supposed to be reflected in an Islamic economy. The Qur'an and the actions of the Blessed Prophet and Imams are used by Islamic jurists and scholars to derive Shariah laws and the values of an Islamic economic system. The following are the most important Shariah rules for banking and finance, The main tenets of Islamic finance are as follows: (Elasrag, 2011, p. 5)

1- Inability to accept or receive interest;
2- Beyond pure, unfettered profit, capital must serve an ethical and social purpose.
3- Investing in companies that deal with gambling, alcohol, drugs, or anything else considered illegal by Shariah is considered undesirable and prohibited.
4- Transactions involving maysir (speculation or gambling) are prohibited.
5- A preclusion on gharar, or doubt regarding the subject matter and terms of the contract, as well as a prohibition on selling what one does not possess.

The following are the fundamental tenets of Islamic finance that guarantee the stability of the Islamic financial system: (Ardiansyah, Munandar, Fauzi, & Na'imah, 2014, p. 113)

1- Interest is prohibited (riba). Riba means "excess", and it's defined as "any unjustified increase in capital, whether in a loan or a sale."
2- Money is referred to as "potential" capital. That is, money is a medium of exchange, a store of value, and a unit of measurement, not a commodity. Money is a form of power that cannot be used to increase purchasing power unless productive activities are undertaken.
3- Risk sharing is a good idea. With the prohibition of interest, fund suppliers will be treated as investors rather than creditors.
4- The contract's brilliance Contractual obligations and information disclosure are regarded as noble tasks in the system of Islamic finance. With the help of this feature, the dangers of asymmetric information and moral hazard in the workplace should be lessened.
5- In terms of social justice, all transactions that result in inequity or exploitation are prohibited.
6- Trading alcoholic beverages, betting, and gambling are all prohibited as socially destructive activities. (Komijani & Taghizadeh-Hesary, 2018, p. 2)

2.3 Riba:

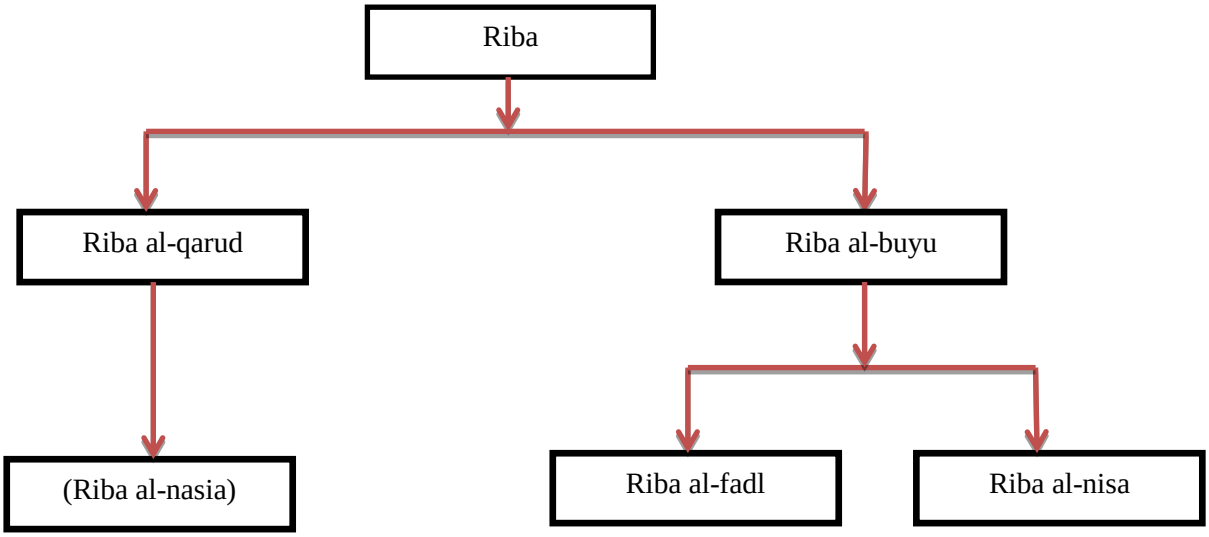
The Qur'an and Sunnah make it clear that riba is forbidden. There are the verses of Al-Quran and Hadith on forbidden riba (see the Holy Qur'an verses 275, 276, and 279 of Surah Al-Baqarah and the Hadith books).

Because riba means "effortless profit" or "surplus value without counterpart," lending on interest adds no value. It only transfers the temporary use of funds from one person to another. (Zulkhibri & Manap, 2019, p. 48)

The prohibition of riba, which most Muslims interpret as interest per se, is the first thing that comes to mind for maximum individuals who are familiar with Islamic finance. Al-Quran and the Sunnah, the teachings of Muhammad the Prophet (peace be upon him), are said to be the foundation for this prohibition of riba. The definition of riba has been

contested and evolving throughout Islamic history, contrary to popular belief, and is frequently the subject of heated debate among Islamic jurists, scholars, and bankers. (Akram & Rashid, 2020, pp. 139-137)

Figure1.2.1. Different forms of riba



Source: (Hassan & Lewis , 2007, p. 43)

The first type is known as "riba al-qarud" or "riba al-nasi'a," while the second is known as "riba al-buyu." Riba al-qarud is associated with usury in the form of loans. Riba al buyu, on the other hand, is associated with usury involving trade. Riba al-buyu, beside that can be divided into two types. The first, "riba al fadl," refers to riba arising from barter or sale, whereas the second, "riba al-nisa," refers to non-simultaneous exchange of equal qualities and quantities of the same commodity.

2.3.1 Riba al-qarud (Riba al-nasia):

Riba 'al-Nasi'ah is defined as a credit-earning to the lender after a set period of time and a credit increase above the principal. (Bashir, Sultana, Dweikat, & Anwar, 2021, p. 78)The wordnasi'ah is copied from the root nasa'a, which means to delay, wait, ordefer, and refers to the amount of time the borrower is given to pay back the loan in exchange for the "addition" or "premium." As a result, riba al-nasi'ah is the fee for borrowing money(Chapra, 2006, p. 2). Furthermore, Riba al-Nasiah or riba of delay is caused by a delay in exchange due to an excess in one of the counter values, It's an increase in the loan or debt payable's principal. It refers to loan/credit transactions or money lending

with the understanding that the borrower will repay the lender the amount originally lent plus interest at the finish of the period in exchange for the lender giving him time to pay. Riba Al-Nasiah governs all modern banking transactions, including interest. (Ayub, 2007, p. 493)

2.3.2 Riba al-buyu:

Riba al-buyu is divided into two types: Riba al-fadl and Riba al-nisa .

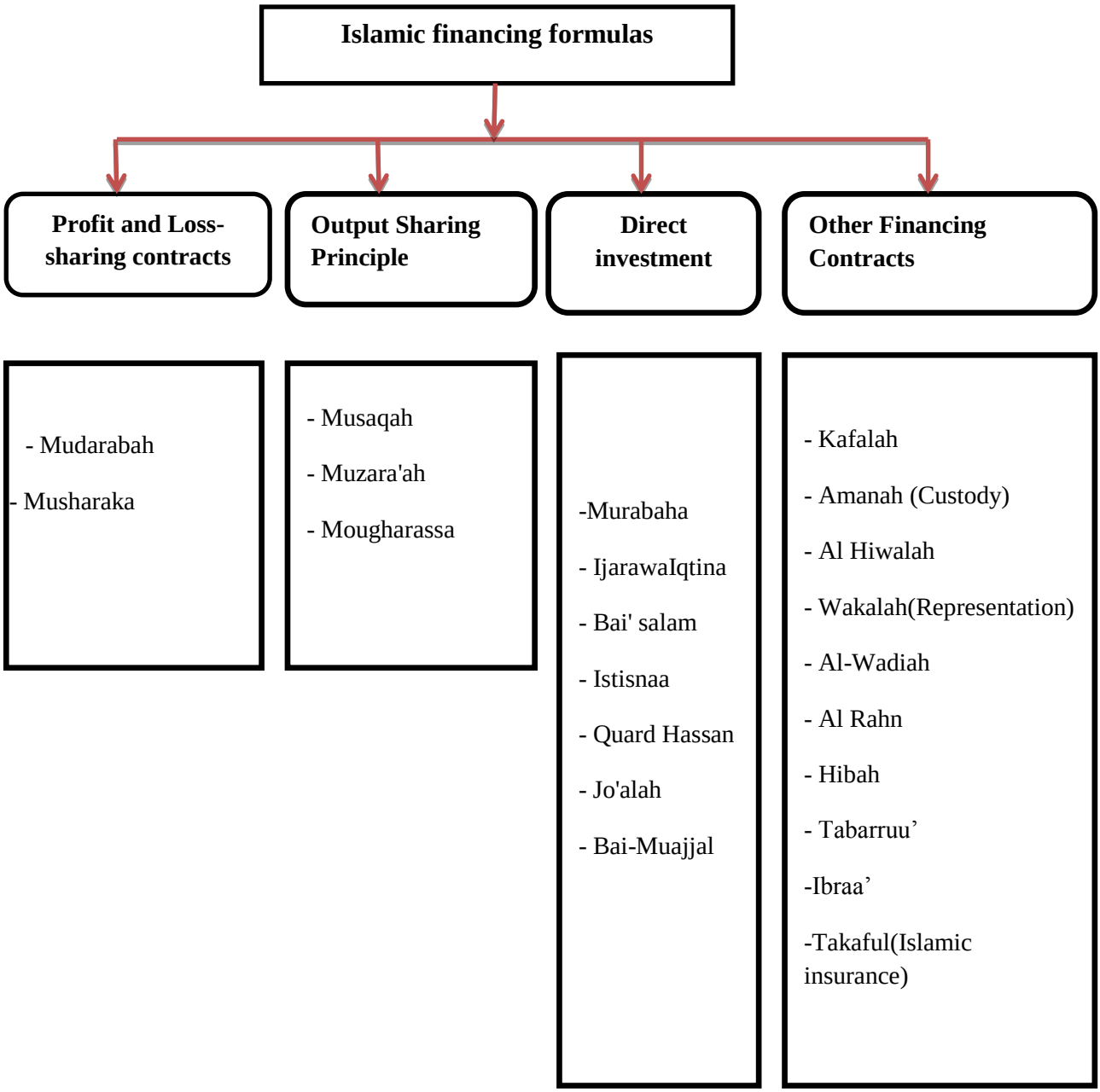
2.3.2.1 Riba al-fadl

Riba Al-Fadl refers to exchange and sale transactions .it is the second way Riba has been used and encouraged in the purchase and sale of commodities between people. It encompasses all spot transactions involving cash payment on the one hand and immediate commodity delivery on the other. Riba al Fadl is based on a Hadith that states that when exchanges of silver, gold, barley, wheat, salt, and dates take place, they must be exchanged spot and equal. Two of the six goods stated in the Hadith around Riba al-Fadl are undeniably commodity money, while the other four staple food items. As a result of gold and silver's characteristics as commodity money, It has been widely assumed that all commodities used as money fall under Riba Al Fadl's sway. (Abdullahi, 2021, p. 3294). Additionally, the quality premium in the trade of inferior commodities for superior goods, such as dates for dates, wheat for wheat, and so on; an excess in the trade of ribawi goods on both sides when dealing with a single genus. (Ayub, 2007, p. 493)

2.3.2.2 Riba al-nisa

"Riba al-nisa" refers to the non-simultaneous exchange of commodities of equal quality and quantity. This distinction between riba and non-riba dates back to pre-Islamic times. Cash, silver, gold, barley, wheat, salt, and dates are all classified as "ribawi" in Islamic law. (Bafra, 2014, p. 76).

Figure 1.2.2 Islamic financing formulas



Source: created by the author

2.3 Islamic financing formulas:

One of the primary functions of a bank is to provide facilities for providing funds to customers who require them. Financing is an extremely important source of revenue for Islamic banks, but it is also the most significant source of business operation risk, namely the emergence of problematic financing because problematic financing not only reduces revenue for Islamic banks, but it also has an impact on their health and, ultimately, harms customers. Islamic banks provide financing that is distinct from conventional bank loans. In Islamic banks, the return on financing is not in the form of interest but rather in other forms determined by the Islamic bank's contracts. These contracts are as follows:

2.4.1 Profit and Loss-sharing contracts:

Profit-and-loss sharing financial institutions are not exposed to a significant risk that all institutions that borrow or lend at interest face: "interest risk." This risk arises from the possibility that interest rates will change in an unfavorable direction for a financial institution.

2.4.1.1 Mudarabah:

A Mudarabah is a profit-sharing and loss-bearing agreement wherein one party provides funding (the financier as principal) and the other party provides effort and management expertise (mudarib or entrepreneur as agent) in order to make a profit. The profit split is decided by mutual agreement (Hussain, Shahmoradi, & Turk, 2015, p. 7). If a Mudarabah venture loses money, the financier bears the entire financial loss unless it is caused by the mudarib's negligence, misconduct, or violation of a contract's terms.The financier is alsomentioned as an "investor," while the managing party is referred to as a "Mudarib," "fund manager," or "commend it." In general, the financier is not supposed to interfere with the Mudarabah administration (Khan & Bhatti, 2008, pp. 45-46)

2.4.1.2 Musharaka:

Musharaka is another approach commonly used by Islamic banks. It's an Arabic word that literally translates to "sharing." According to the Mejella (1329), it is described as a contract for a company on the condition that the capital and its

advantages be shared by at least two people. However, IbnArfa (1984) described it as "a contract among two or more people to carry on a specific business with the intention of sharing profits through joint investment." Another Muslim jurist, Mohammad Akram Khan (1990), characterizes a musharakah, or association, as an agreement between two individuals to begin a business or monetary endeavor for benefit. (Daly & Frikha, 2014)

Every partner in Musharaka has the right to participate in the management and to work for it. However, the partners may agree on the condition that one of them manages the Musharaka and no other partner works for it. In such a case, the "resting" (quiet) accomplice is simply qualified for a benefit to the degree of his venture, and the benefit distribution proportion to him shouldn't surpass the general size of his interest in the business. (Kettell, 2011, p. 14) According to Islamic law, musharaka can take several forms: (BAYDOUN, SULAIMAN, WILLETT, & SHAHUL , 2018, p. 17)

- Musharika al-inan (limited partnership): Contributions of the partners take the form of capital, property, and labor in this type of partnership. A predetermined profit-and-loss-sharing ratio is agreed upon by the partners.

- Musharaka: musharakah is a word that comes to mind when I think of Musharaka. In this case, two or more people pool their resources to invest in a venture. Each partner's management responsibilities are defined.

- A corporation is a business that is possessed by a group of people known as shareholders. The company is a separate legal entity from the shareholders who own it. Financial liability of individual shareholders is limited to the worth of their paid-up shares in the company. It is usually easier for shareholders to sell their stock in the market than it is for other types of business owners. Ordinary shares are legal to own, but Western-style preference shares are prohibited. The basis for this prohibition is the inequality that the preference creates between different owners. Preference shares ensure a minimum return and payment priority in the case of bankruptcy.

2.4.2 Output Sharing Principle:

In this type of contract, the output or product is shared among the contracting parties. Muzara'ah, Musaqat, and Mougharassa are the three most common types of output-sharing contracts.

2.4.2.1 Musaqah:

An agreement in which a garden owner shares his or her produce with another person in exchange for his or her help irrigating the garden. (Ayub, 2007, p. 492) It is also known as "pushing the tree to those who serve it with a portion of its product. (Al-Aifa, 2021, p. 362)

2.4.2.2 Muzara'ah:

Muzara'ah is Arabic for sharecropping, which is a crop partnership wherein one party (the landowner) presents a plot of land to another (the agricultural worker) for the former to plant and maintain in exchange for a common defined part of the crop. In essence, muzara'ah includes the concept of shirkah (partnership). Muzara'ah partnerships are typically concerned with agricultural production, in which two or more parties provide land, labor, and agricultural inputs. They then distribute the product in predetermined percentages. (Bangash, 2020, p. 31)

Muzara'ah is an Arabic term that refers to a farming partnership or a joint planting act. According to the Hanafis, muzara'ah is a contractual contract on farming in exchange for a pre-determined share of crop output. According to Maliki, it is a crop-sharing agreement. (Yahuza , 2018, p. 94)

According to Imam Hanbali, Muzara'ah refers to the transfer of land and the planting of seeds by the land manager, after which the yield from the land (percentage) is calculated and a share is divided between the two parties. Therefore, Muzara'ah refers to agricultural cooperation between landowners and tenants. (Yuspina, Murtib, & Putri, 2020, p. 712).

2.4.2.3 Mougharassa:

In its Legal Standard No. 17 on "Investment Instruments", the Islamic Financial Institutions (IFI) Accounting and Auditing Authority (ICAFA) defined Mougharassa as

"the company that is on the payment of land-no tree-to a man to plant a tree, but the grass and fruits are between them at a certain rate." (Al-Aifa, 2021, p. 370)

2.4.3 Direct investment:

Finance based on profit/loss sharing opens the door to direct investment, where the Islamic bank's primary focus is on the investment's profitability. Close collaboration among the banks and the fund users (project manager) is required in this case to monitor performance and address unexpected issues. The direct investment wouldn't avoid high-risk ventures or support small and miniature endeavors as long as the profits are proportionate to the risk. (Kahf, Ahmed, & Homoud, 1998, p. 5)

2.4.3.1 Murabaha:

Murabahah is certainly not an interest-bearing credit. It is the sale of a commodity at a latertime for a price that includes an agreed-upon profit added to the cost. (Usmani , 1998, p. 73)

A Murabaha contract states that the bank will purchase an asset or goods from a third party and then resell the goods to its client at a profit. The client makes a purchase with either immediate or deferred payment. Some observers compare this type of Islamic finance to a traditional interest-based lending operation. However, one significant variance between murabaha and interest-based lending is that the markup in murabaha is for the services provided by the bank (for example, seeking and purchasing the required goods at the best price), and the markup is not time-limited. (Hassan & Lewis , 2007, p. 52)

2.4.3.2 Ijara wa Iqtina:

Ijara, like a traditional lease, is a sale in which the right to use goods for a set period. Leasing was first used for commerce in Muslim countries and later evolved into a form of finance. An Ijara is anagreement wherein a bank purchases and leases a piece of property or equipment needed by its client in exchange for a rental fee. The lessor is responsible for maintenance and insurance. During a predetermined period, the lessor (that is, the bank) retains ownership of the asset and is responsible for its maintenance, implying that it assumes ownership risk. The lessor has the right to renegotiate the lease's conditions for payment at agreed-upon intervals under an ijara contract (Hassan

& Lewis, 2007, p. 52). the two kinds of Ijara are as following: (Hussain , Qureshi , & Nazir, 2018, p. 121)

- **Ijarah Muntahiya Bi-Tamleek:**

This is a kind of Ijarah contract in which the lessee receives a transfer of title in law. In other words, This is an Ijarah agreementwherein the leased asset has the option to be purchased at the finish of the rent period.

- **Service Ijarah:**

In this kind of financing, the bank purchases a customer's services and then hires the customer to sell those services in the market over time.

Ijarah is a medium-term financing tool that can work on an operating or financial lease basis. It is comparable to a traditional lease in that the owner rents or leases his property or goods to the renter for a set number of months in exchange for a fee. The distinction between the two is that an operating lease returns the estate to the owner at the finish of the rent term, whereas a financial lease transfers the asset to the lessee at the end of the lease term. (Fersi & Boujelbéne, 2016, p. 201)

2.4.3.3 Bai' salam:

A transaction wherein the seller agrees to supply certain items to the customer at a later date in exchange for a fully paid advance price, Although the price is set in cash, the delivery of the purchased goods is delayed. (Usmani , 1998, p. 128)

When a spot payment is made in advance for the future delivery of goods, it is known as "salam" (literally, payment in advance). On the surface, this mechanism appears to go against the very essence of Islamic finance because uncertainty, or gharar, is forbidden in Islamic finance, and surely if you pay for something that has yet to be delivered, there must be some risk of the item not arriving. (Watkins, 2020, p. 71)

Conditions of Salam Contract:

The following are the Salam Contract's basic terms**:** (Dchieche & Aboulaich, 2016, p. 910)

- The full purchase price should be paid to the seller at the time of the sale;

- The quantity and quality of commodities should be precisely specified;

- All product specifications must be stated explicitly;

- The commodity's quantity is agreed upon in clear terms;

- The contract must specify the exact time and location of delivery;

- Salam is not possible in the case of items that need to be delivered on the spot;

- Any party cannot unilaterally terminate the Salam contract. With mutual consent, It can be canceled completely or partially by returning the whole or proportionate amount paid. No penalty can be mentioned in the contract in the event of default.

2.4.3.4 Istisnaa:

Istisna is analogous to the non-participatory mode of financing. Furthermore, it is a special type of sale that is exempt from the specific Fiqh rule (do not sell because it satisfies societal needs that would otherwise be unsatisfied by conventional financing). It is anagreementwherein one party agrees to manufacture or construct something according to specified specifications for a fixed price, which can be paid in one lump sum or installments. The ability to defer both prices and commodities is a distinguishing feature of Istisna. Because of the deferment, Shari'ah scholars do not approve of such a sale contract. However, Istisna is exempt from such restrictions due to its overall economic benefits. (Arshed, Yasmin, & Gulzar, 2020, p. 73)

It is a construction agreement with a progressive funding process wherein one party commits to producing and selling a specific product made to agreed-upon specifications at a predetermined price. (Fersi & Boujelbéne, 2016, p. 200) on a predetermined date, without having to pay the price upfront, or in installments agreed upon by the parties (Bouarar & Mouloudj , 2020, p. 4)

2.4.3.5 Quard Hassan:

Because interest on all types of loans is forbidden in Islam, any loan given following Islamic principles must be a benevolent loan (Qard Hasan), i.e., a loan without interest. It must be granted out of compassion, i.e., to alleviate financial distress caused by a lack of sufficient funds in the face of dire need. Given that banks are profit-driven organizations, it appears that this technique has limited application. Islamic banks, on

the other hand, serve a social purpose. As a result, they make plans to supply Qard Hasan in addition to engaging in income-generating activities. (AHMAD, 1993, p. 49). Quard Hasan loans are benefit loans with no interest charged. However, the lender may charge a commission. It is intended for the less well-off, such as farmers and other small business owners, as well as poor consumers. It can also serve other purposes (Visser, 2009, p. 62)

2.4.3.6 Jo'alah:

A Jo'alah is anagreementwherein one party (the Jo'ala bank or employer) agrees to pay a specific sum of money to the other party (the amel or contractor) in exchange for providing a specific service in keeping with the contract's terms and conditions. (Hosseini, Khaledi, & Gray, 2009, p. 293)

A jo'alah is a contract in which one party (the jaa'el bank or employer) agrees to pay a specific amount of money (jo'al) to the other party (the amel or contractor) in exchange for providing a specific service following the contract's terms and conditions. Istisna'a and jo'alah are two concepts that are similar. Unlike in Istisna'a, where the seller sells a physical item, in Jo'alah the seller sells a service rather than a physical item. All other characteristics of Jo'alah are identical to those of Istisna'a. In a jo'alah deal, a seller will offer a definite service to be provided, whereas the buyer will pay a definite price for this service. It could be challenging in many situations to distinguish whether it is an Istisna'a deal or a jo'alah deal (Sarker A. , p. 17).

2.4.3.7 Bai-Muajjal:

The literal meaning of BaiMuajjal is "deferred or credit sale." It is a kind of contract in which goods are sold on credit, the credit price is agreed upon, and the proceeds are received at the finish of the credit period. (Hussain , Qureshi , & Nazir, 2018, p. 121). It's a type of sale agreementwherein the buyer agrees to take immediate transmission of the goods in exchange for deferring payment of the price until a later date. The customer approaches the bank in order to obtain financing for the purchase of goods. The necessary items are purchased by the bank, which then resells them to the client for a later date and predetermined price. The negotiated price consists of the bank's cost of goods, as well as the bank's profit margin and additional unforeseen expenses. The

customer has to pay the agreed-upon price by the due date. (Salman Syed & Ausaf, 2007, p. 185)

ajil bi-thaminbai (deferred payment financing). Bai bi-thaminajil refers to the credit sale of goods with deferred payment. The bank purchases an existing contract to buy certain goods on a deferred payment schedule at the request of its customer and then sells the goods back to the client at a predetermined price. The bank pays the original supplier upon delivery of the goods, while the bank's customer can repay in a lump sum or over an agreed-upon period. (Hassan & Lewis, 2007, p. 53). "Deferred/credit sales" is the literal translation. This mode is used by Islamic financial institutions to finance their customer needs by supplying the desired commodity. The variance between BaiMuajjaland Murabaha is the cost disclosed. The cost of BaiMuajjal could or might not be revealed. (Hanif & Iqbal , 2010, p. 478).

2.4.4 Other Financing Contracts:

Other Islamic contracts are as follows:

2.4.4.1 Kafalah:

The Arabic word for responsibility, amenability, or suretyship is kafala. It frequently refers to an act in which someone adds himself to another person and makes himself liable to perform the responsibility alongside the person. (Suhaimi, et al., 2016, p. 162) Al kafalah is divided into two types. To begin, al kafalah bi al nafs (guarantee of person) refers to the debtor's or his agent's appearance in a lawsuit. Second, al kafalah bi al mal (guarantee by the property) refers to the debtor or guarantor paying back the loan. (Manan & Kamaluddin, 2010, p. 108)

2.4.4.2 Amanah (Custody):

Amanah (trust) is a crucial aspect of the Islamic personality. It reflects a person's responsibility to his Creator, God. However, God has entrusted the concept of Amanah to humans to spread mercy based on true justice. In the verse (72) surah Al-Ahzab (see the Holy Qur'an), demonstrates the trust command given to mankind (Tekke, İsmail, Adnan, & Othman, 2015, p. 130)

2.4.4.3 Al Hiwalah:

According to the Accounting and Auditing Organization for Islamic Finance Institutions' Shariah Standard No. 7, Hawalah is the transfer of a debt liability from the transferor to the payer. (Suhaimi, et al., 2016, p. 162)

Al hiwalah is Arabic for "to turn over or transfer." "Delay (in debt payment) on the part of a rich man is injustice," says the Prophet (PBUH), "and when one of you is referred to as a rich man, he should follow him" (Abu Hurairah). It is an agreement to transfer debt from one debtor's account to another debtor's account or to make a claim for debt by shifting responsibility from one person to another. (Manan & Kamaluddin, 2010, p. 108)

2.4.4.4 Wakalah (Representation):

Wakalah is an agreement of agency wherein one individual appoints another to perform a specific task on his behalf, usually for a fee. (Said, Ahmad, & Javaid , 1948, p. 132)

The basis of the wakalah contract is subject to four (4) conditions: (Suhaimi, et al., 2016, p. 163)

1. The muwakkil must designate a specific wakil and inform him of his appointment;
2. the wakil (Bank) agent to perform a specific task in areas where delegation is possible, either freely or in exchange for payment;
3. the topic of the wakalah contract must be known to the agent, and assigning someone to complete an unknown task is not allowed;
4. Offer and acceptance can be expressed verbally, in writing, or in any other way that is accepted by customary business practice and does not violate Shariah principles.

2.4.4.5 Al-Wadiah:

The idea of al-wadiah alludes to a trusteeship relationship wherein an individual appoints one more man to protect his guardianship for quite a while. The essential of amanah (trust) shows up here. When a customer deposits money in an Islamic bank, he or she gives the bank permission to use it for profit, and all risks associated with the deposits are transferred to the bank. That is unless the bank cannot control the

damage,all damages caused by the bank during safekeeping are the bank's responsibility. (Yunus, Kamaruddin, & Embong, 2017, p. 217)

2.4.4.6 Al Rahn:

An example of this term is available in the verse (38) surahAl-Mudatsir (see the Holy Qur'an). In Arabic, ar-rahn means "al-tsubut and al-dawam" (fixed and eternal). Some Moslem scholars translate ar-rahn as alhabs (detained). Rahn refers to the holding of a debtor's certain assets as an assurance or security for a loan that the debtor has taken out. The detained properties must have economic value for the detaining creditor to be assured of receiving all or a portion of his receivable back. Simply put, rahn is a kind of loan guarantee or pawning. (Maulidia, 2003, pp. 169-170)

The conditions of rahn in Islam are similar to those of an asset in a sale contract: it must be valuable in the eyes of the Shariah, and it must be existent, identifiable, deliverable, and owned by the pledger. Because the goal of a pledge is to sell a pledged asset if a debtor defaults on a loan, these requirements are necessary. This is only permissible if the subject of the commitment is a legally recognized sale contract. (Hussain & Mahbubi Ali, 2017, p. 197)

Arrahn is divided into two categories: (Lawal, 2016, p. 101)

- Possessory Rahn: A rahn is considered to be possessory if possession of the security's subject is transferred from Al rahin (the debtor) to Al Murtahin (the creditor). For instance, where a pledge or pawn is accepted as security.
- Non- Possessory Rahn: A rahn is considered to be non-possessory when the debtor transfers title to the topic of the security to the creditor. As in the case of a mortgage, the mortgagor transfers the title in the landed property to the mortgagee. As a result, it can be regarded as a proprietary rahn.

2.4.4.7 Hibah:

Hibah comes from the Arabic word "wahaba," which means "to give without thought." Hibah is a gift made to another person during the donor's lifetime in the context of Islamic wealth management planning. Hibah has the advantage that its division is not restricted to any particular distribution, such as a will. Wills are also encouraged in Islam, with a third of the inheritance set aside for non-beneficiaries. (Said & Saad, 2016, p. 19)

Hibah (gift) refers to the free and permanent transfer of ownership of assets. After giving a gift, one cannot take it back unless the person to whom the gift was given consents. (Ayub, 2007, p. 79)

Hibah, gift, and sadaqah are distinct concepts with nearly identical definitions. The distinction is in the purpose of giving. When someone gives something to another person out of appreciation and affection, it is called a gift; when he gives something to gain reward from Allah, it is called sadaqah. To summarize, Eachsadaqahand gift is a hibah, but not every hibah is a gift or sadaqah. (Said & Saad, 2016, p. 19)

2.4.4.8 Tabarruu':

According to the fuqaha, tabarru' is the donation of property for the benefit of others while alive. (Irkhami, 2017, p. 49)

Tabarru': A benefit given by one person to another without receiving anything in return. Tabarru', for example, covers gracious debt repayment at the lender's sole discretion and without any prior condition or inducement for reward. Repaying a debt in excess of the principal without conditions is acceptable and in accordance with the Sunnah of the Prophet Mohammed (PBUH). However,It is a personal decision and cannot be put into place as a system because it would imply that a loan would always yield a profit, making it usurious. (Ayub, 2007, p. 494)

2.4.4.9 Ibraa':

In the literature on Islamic banking and finance, the word "ibra" (rebate) is employed, which refers to Islamic banks providing rebates to customers who meet financial obligations resulting from sale-based agreements before the agreed-upon settlement period. It is a mandub (recommended) action according to Shari'ah, based on the authority of the Quran, verse 280, Surah Al-Baqarah (Trakic, 2013, p. 356)

Ibra' translates to "release," "relief," or "abandonment." Absolution (ibra') is a legal term for an agreementwherein a creditor abandons his claim in favor of the debtor. Ibra's proper subject matter is debt (dayn). A creditor, for example, may exempt the transferee (muhal 'alahi), the guarantor (kafil), or the debtor from paying the debt in part or in full. A person who absolves himself may also waive his right to compensation for the loss of his property. (Saleem, 2016, p. 75)

It is technically defined as "any act by a person to withdraw his rights (to collect payment) from a person who is obligated to repay the amount borrowed from him." (Mohamad & Trakic, 2013, p. 28).

2.4.4.10 Takaful (Islamic insurance):

Takaful is a traditional Islamic insurance policy that also serves as an alternative form of protection for Muslims against the risk of loss due to an accident. It is dependent on the concept that what is uncertain about an individual may cease to be uncertain about a large number of similar individuals. By pooling the risks of many customers, insurance allows each individual to benefit from the law of large numbers. (Zainordin, Selvaraja, Man, & Hoong, 2016, p. 4)

Takaful comes from the Arabic word takaful, which means "Guaranteed to each other." The Aquila system, which was utilized by Muslims in Mecca and Medina, established the groundwork for the mutual assistance insurance known as Takaful, which is based on risk pooling and sharing and has been practiced in various forms for more than 1400 years. Although some Muslim scholars believe that any form of insurance is incompatible with the Muslim faith, others believe that it is necessary, The belief in God, who is the provider and sustainer of all, is based on the following: when a misfortune overtakes them, they say, as in verse 156, Surah Al-Baqarah.

2.5 Basic Shariah Principles of Business Contracts:

While the nature of each type of business contract differs, Sharia's basic principles for dealing with them are nearly identical. The following are the fundamental principles: (Sarker M. , 1999, p. 14)

1- In a partnership, the relationship between the partners is that of a principal and agent;
2- Capital and labor, as well as, in some cases, goodwill and creditworthiness, are jointly responsible for profit creation and share profits;
3- 3- The rights and responsibilities of the partners are largely determined by custom, convention, and usage and are based on the type of joint business;
4- The most important criterion for determining the rights and responsibilities of the partners is the interests of the company;
5- A dormant partner's commitments may be disallowed to bind the firm;

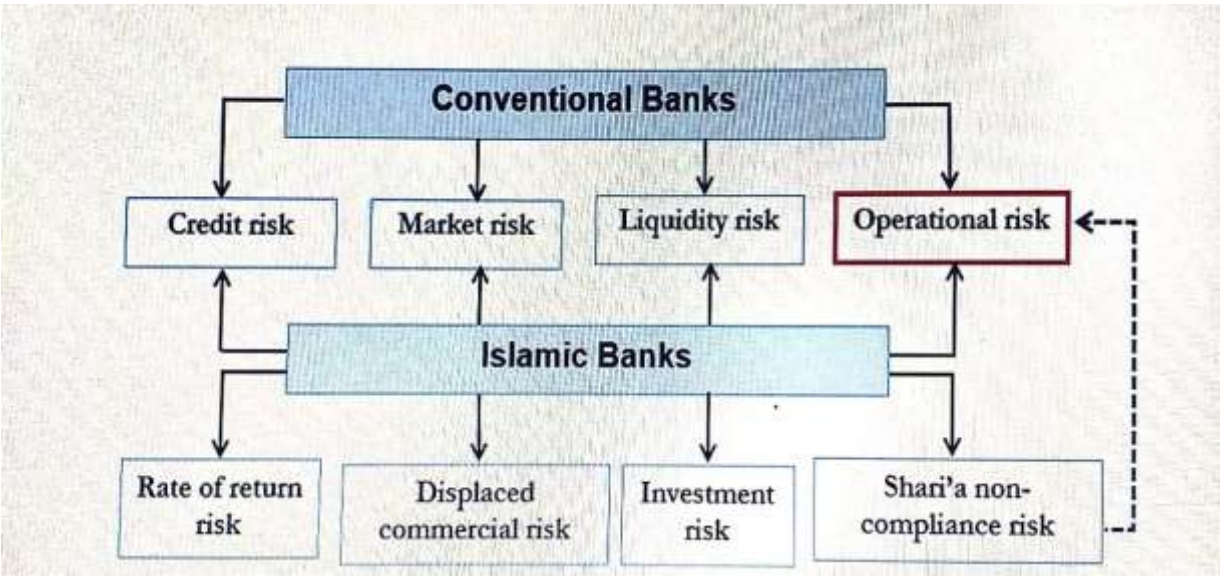
6- The partners would not receive a fixed return for their work other than a share of the profits, but the employees would be paid from the business account;
7- In a joint venture, productivity and profit are calculated using invested capital;
8- Profit proportions aren't always equal to capital proportions;
9- The partner who contributes more labor may be entitled to a larger share of profits, even if his capital contribution is lower;
10- People who join the business solely to profit from it without contributing anything to it or accepting any liability are not entitled to profits by right;
11- No partner has a right to set apart a fixed portion of profits, thus ensuring for himself a sure return;
12- If profits are made, all partners will receive a proportionate share;
13- If there were no profits, no partner would be entitled to an exclusive right to any share.

2.6 Islamic Banking Risks in Theory:

Vaughan (1999) defines risk as "a situation in which there is a chance of deviating from the road leading to the expected or usual result." (Rhanoui & Belkhoutout, 2019, p. 139) .The concept of "risk" in an Islamic financial system is best understood when viewed from two perspectives: the prohibition of gharar (uncertainty) and contract freedom. According to Shariah (Islamic law), gharar is any illegal profit that should be discarded. be excluded based on religion. is concerned with the subject's uncertainty For example, the supplier's contractual obligation is to deliver the subject matter. The issue of the sale is that if he is unable to do so, this amounts to gharar in the contract, which is forbidden in Islam and renders it null and void.

In theory, Islamic banking face two types of risks: include dangers specific to Islamic institutions and risks experienced by mainstream banks. These dangers are depicted in Figure 1 along with their differences.

Figure 1.2.3 theoretical risks that Islamic banks confront



Source:(Rhanoui & Belkhoutout, 2018, p. 113)

2.6.1 Credit Risk:

Credit risk is the chance that a borrower won't pay back a loan in line with the terms of the agreement. Contrary to traditional banks, Islamic banks may have a varied credit risk profile due to their various financing methods. Due to the moral hazard incentives associated with the opportunity to share losses with banks, In PLS (profit-and-loss sharing) financing types, Islamic banks may be subject to greater credit risk. (Safiullah & Shamsuddin, 2018, p. 131) It is the risk that a company or individual will fail to pay the contractual interest or principal on their financial commitments. This type of risk causes panic among investors who have bonds and sukuk in their portfolios. (Ullah Agha & Sabirzyanov, 2015, p. 47)

In the case of Mudarabah investments, the Islamic bank faces an increased credit risk on the funds advanced to the mudarib, in addition to the usual principal-agent issues. Because, The Mudarabah contract's nature does not grant the bank the necessary authority to oversee the mudarib or take part in project management, The bank is unable to be aware of and control how the activities of the mudarib can be accurately monitored, particularly if loss claims are filed, and Islamic banks are vulnerable to credit risk in Murabahah transactions when they have The asset has already been provided to the client, but payment from the client has not yet been received. In

addition, Islamic banks face the risk of losing their whole investment in Musharakah, which may not be recoverable because it is ranked below debt instruments. When it comes to liquidation. (Malim, 2015, p. 67)

2.6.2 Market risk:

Market risk is simply the possibility that an investor will suffer losses as a result of factors affecting the financial market's overall performance in which he is involved. It is also known as systematic risk, and it cannot be eliminated by diversification, but it can be hedged against. (Mohamad, et al., 2018, p. 2082)

Changes in the prices of equity instruments, commodities, fixed-income securities, and currencies cause market risk. As a result, its major components are equity position risk, commodity risk, rate-of-return risk, and currency risk. Each risk component includes a general aspect of market risk as well as a specific aspect of risk that originates in a bank's portfolio structure. Market risk also applies to various derivative instruments, such as options, equity derivatives, and currency and interest rate derivatives, in addition to standard instruments. (Greuning & Iqbal, 2008, p. 156)

2.6.3 Liquidity risk:

The risks are associated with the bank's inability to pay its financial obligations due to a lack of liquidity for short-term operating needs (Al-Sharif , 2018, p. 223) Banks expect liquidity to make up for expected and startling monetary record vacillations as well as to give assets to extension. It refers to The capacity of a bank to handle deposit and other liability redemptions as well as meet demand for funding in the loan and investment portfolio. when a bank can swiftly and affordably get the money it needs (by increasing liabilities, securitizing, or selling assets), it is said to have adequate liquidity potential. Liquidity cost is determined by market circumstances and the market's perception of the borrowing institution's inherent riskiness (Greuning & Iqbal, 2008, p. 150)

The absence of liquid Shariah-compliant instruments exposes Islamic institutions to liquidity risk. Additional issues arise from the Shariah perspective in transforming financial modes into negotiable financial instruments due to the maxim that once a debt

is created, It cannot be transferred to other parties except at par value. Depositor funds,

on the other hand, either has very minimal notice requirements for withdrawal or are callable on demand. As a result, the likelihood of an Islamic bank experiencing a liquidity shortage is quite high inthe case of a sudden increase in the withdrawal of deposits by debtors (Irawati & Puspitasari, 2018, p. 79)

2.6.4 Operational risk:

Risks arising from poor internal controls over operations due to insufficient human resources are referred to as operational risks. Legal risks such as financial fraud and counterfeiting are included in this definition. Al-Sharif (Al-Sharif , 2018, p. 223) defined operational risk as the risk of loss caused by insufficient or failed internal processes, people, and systems, as well as external events. (Safiullah & Shamsuddin, 2018, p. 131)

"Operational risk," also defined as the risk that remains after establishing the funding and systematic risk, includes dangers brought on by internal procedures, people, and systems failing. It also refers to the danger of a change in value as a result of actual losses incurred as a result of insufficient internal processes, people, and systems, or as a result of external events (including legal risk). (Mohamad, et al., 2018, p. 2083)

2.6.5 Rate of return risk:

The rate of return risk is typically connected to total exposures on the balance sheet, where mismatches occur between assets and balances from fund providers occur. It is argued that the RRR is a strategic risk because one of The main duties of the IIFS is to manage Expectations of investment account holders and thus should form part of balance sheet risk management. (Akkizidis & Khandelwal, 2008, p. 104)

Concerning rate-of-return, there are two basic sources of risk. Banking activity includes transactions between depositors and banks, such as bounded and unbounded profit-sharing investment accounts (PSIAs), and banks and debtors, in which the bank expects margin between the chains of activities. The first source is the variance between the anticipated source of funds by PSIA depositors and the actual funding result. Relative rate-of-return risk, also known as displaced commercial risk, is a kind of risk. The second is the variance between the expected and realized results of financing debtors,

where the latter is influenced by the market movement, economic conditions, or inflation. (Wahyudi, Rosmanita, Prasetyo, & Putri, 2015)

2.6.6 Investment risk:

Investment risk arises from willingness of banks to accept the loss of a customer's business, which is financed through profit-sharing-based profit sharing (Firmansyah & Athoillah, 2019, p. 137).On the other hand, this risk arises as a result of the Islamic bank bearing the risk of the debtor's business incurring losses when it is financed through a profit–loss sharing contract, such as mudharabah or musyarakah. The investment risk increases if the profit-sharing basis is the debtor's operating profit or net profit. If the debtor's business fails, the Islamic bank may lose the principal financing it provided to the debtor (Wahyudi, Rosmanita, Prasetyo, & Putri, 2015)

2.6.7 Displaced Commercial Risk:

Displaced commercial risk also suggests that the Islamic bank may be unable to offer competitive return rates when compared to other competitors. This risk arises in such cases when an Islamic bank struggles for a while and is unable to produce sufficient profits to pay its investors and depositors a rate of return that is higher than what should be payable under the actual terms of the investment contract (che arshad, Zakaria, Sulaiman, & Irijanto, 2014, p. 207). This outcome is likely to prompt depositors to withdraw their funds. In order to keep its funding providers and discourage investors from leaving, the Islamic bank would give up all or a portion of its profits to benefit depositors (Rhanoui & Belkhoutout, 2019, p. 141). The rate of return risk, which entails the transfer of deposit-related risk to equity holders, is what causes the displaced commercial risk in Islamic banks.

2.6.8 Sharia non-compliance risk:

Sharia non-compliance risk is a distinct and major part of Islamic banking that results from an Islamic bank's failure to comply with Sharia rules and principles established by the applicable Sharia body in the jurisdiction, which can negatively affect bank income. (Elamer, Ntim, Abdou, & Pyke, 2019). Riba (interest), gharar (uncertainty), ghubn (inequality), ikra (duress), ghalat (error), taghrir (deception), and jahalah are all prohibited in Shariah-compliant financial products (ambiguousness).

These components must be present. Islamic banks have a thorough understanding of it in order to execute effective Shariah risk management. (Omar & Hassan, 2019, p. 22)

Shariah compliance is a continuous process that must be adhered to at all times, and such requirements must pervade the Islamic bank's structure, products, and activities. Islamic banks must ensure that their operations are Shariah compliant on both the fund-raising and financing sides. In extreme cases, failure to follow Shariah rules and principles will expose Islamic banks to reputational and insolvency risks. Because the majority of their fund providers use Shariah-compliant banking services as a matter of principle, customers will lose confidence and trust in the institution, withdrawing their funds and canceling their contracts with the bank. In addition, any income generated by transactions or contracts conducted in a Shariah non-compliant manner will be lost to the Islamic bank because they are now deemed void.

2.7 Challenges of Islamic Banking:

It's no secret that Islamic banks face a variety of difficulties and challenges. Despite Islamic banking's long history and widespread influence in many parts of the world, there are still some issues that stakeholders will have to work through over time.

2.7.1 Banking institutional aspects:

Iqbal, Amad, and Khan (1998) classified Islamic banking challenges into two categories: Islamic banking institutional aspects and Islamic banking operational aspects. The following are the institutional challenges: (Islam & Sultana, 2019, p. 5)

- Islamic banks face a lack of institutional support. The most serious challenge for Islamic finance is establishing a proper institutional framework.
- There is a lack of a suitable legal framework as well as supportive policies.
- There isn't a good supervisory system in place.
- Shortage of Accounting Standards Boards for Islamic finance practicing companies
- A scarcity of equity institutions
- The creation of well-organized secondary financial markets
- The requirement for a market for short-term fund placements.

2.7.2 Banking operational aspects:

The following are the operational challenges**:**(Iqbal, Aḥmad, & Khan, 1998)

2.7.2.1 Profit-sharing finance: Profit-sharing finance has remained a minor part of Operational activities of Islamic banks in practice. From the standpoint of Islamic banks and their clients, there are numerous reasons for this. From the perspective of the banks, it appears that placing funds on a profit-sharing basis has significantly higher costs. Choosing the right project to finance necessitates feasibility studies as well as technical and financial evaluation. Moreover, the cost of such an effort usually outweighs the cost of fixed return placements. Profit-sharing agreements, too, necessitate follow-up and the provision of technical and, in some cases, additional financial assistance to entrepreneurs.

2.7.2.2 financial engineering: The term "financial engineering" refers to the art of designing financial products to meet the needs and preferences of users in terms of risk, maturity, and yield. A "needs approach" to financial engineering is desirable in light of the principles of maslaha and istihsan, of course, within the known principles of Islamic finance. Furthermore, the financial markets are becoming increasingly complex and competitive. Therefore, financial engineering and innovation are required to take advantage of the rapidly changing market environment and to compete effectively.

2.7.2.3 Teaching, training, research, and development: Teaching, training, and research are the backbones of any discipline's development. This is especially true for a young discipline like Islamic banking and finance. Furthermore, there is a severe scarcity of scholars who have even a basic understanding of both Islamic fiqh and modern economics and finance. Similarly, the vast majority of Islamic bank executives are untrained in using Islamic finance (Iqbal , Ahmad, & Khan , 1998, p. 66). Furthermore, many Islamic bank executives are untrained in using Islamic financial instruments. The majority of Islamic bank employees, including managers and financial experts, come from traditional backgrounds and thus lack the necessary Islamic banking expertise.

2.7.2.4 Compliance with Islamic law: Shariah law is founded on the interpretation of the Qur'an, Hadith, and Sunnah. However, Sharia interpretations and applications may differ greatly from one country to the next, from one sect of the religion to the next, or even from one school of thought to the next. As a result, a product may be permissible in one IB institution while being prohibited in another, possibly even within the same city. This may confuse shortly until Sharia standards for the global Islamic financial

market are developed and harmonized (Afshar & Muhtaseb, 2018, p. 251). Because Islamic banks and finance have a religious component, Before a new product is adopted, it has been approved by academics of Shariah. Even after using a new product, Shariah auditing of financial institution operations is critical to confirm that the practice itself complies with Shariah criteria. Shariah boards at various banks may issue different rulings on similar practices, which may cause clients to have doubts. Furthermore, establishing minimum Shariah standards for each type of contract issued by an autonomous body will go a long way toward assuring customers of The "Shariah compatibility" of the arrangements as well as actual operations.

Conclusion:

A bank that specializes in Islamic banking or non-interest banking is known as an Islamic bank. Islamic banks are a moral banking system that operates according to Islamic (Shariah) laws. Interest is strictly prohibited in Islamic banking. It's asset-based financing, and it forbids the trade of elements that Islam forbids.

Islamic finance is a kind of financing that must adhere to Sharia law (Islamic Law). The term can also be used to refer to Sharia-compliant investments. Islamic banks face many challenges by taking this financing. One of the most operational changes is that teaching, training, and research are the backbones of any discipline's development because the vast majority of Islamic bank executives are untrained in using Islamic finance. Therefore, workers, both experienced and inexperienced, must learn and develop to meet the demands of the Islamic banking industry. Universities and colleges should brand and offer courses in Islamic finance. As a result, the graduates will be experts in Islamic finance and related fields.

Chapter Two:

Financial Efficiency

Introduction:

Nowadays, efficiency is a key criterion for assessing economic performance and it reflects success in a broader context. Organizations (e.g., companies, banks, regions, and countries) require high-performing units to meet their objectives, deliver the products and services they specialize in, and gain a competitive advantage. Low performance and failure to meet goals may be perceived as dissatisfying. Furthermore, financial efficiency, if recognized by other organizations, is frequently rewarded with benefits such as improved market position, higher competitive advantage, and improved financial condition. In a broader sense, financial efficiency is a major, but not the only, prerequisite for future economic and social development and success.

Currently, efficiency measurement is a common tool in applied production analysis. In many fields, various types of approacheshave been suggested to measure efficiency. Data envelopment analysis is among the increasingly common methods among these models. Since Charnes, Cooper, and Rhodes' groundbreaking work in 1978, DEA has seen widespread use in a variety of application areas. The main purpose of DEA is to estimate the efficiency frontier and score of decision-making units using mathematical programming (DMUs).

From the above, this chapter was divided into the following three sections:

- In the first section, financial management
- In the second section, financial efficiency
- In the third section: data envelopment analysis

Chapter Two: Financial Efficiency.

1. Financial Management

1.1 Definition of financial management.

Financial management is mostly concerned with analyzing project profitability,planning,cash control, and raising funds, as well as accounting functions relating to profit and tax reporting. An executive who manages one or more of these functions is known as a financial manager. Financial management is considered important in many aspects of any business. As a result, financial managers are involved in almost all major decisions and hold key positions at the heart of all business organizations. (Broyles, 2003, p. 5)

Financial management is the acquisition and effective use of funds to achieve an individual's, corporation's, government's, or non-governmental organization's overall financial goals. Lowering costs is the goal of financial management and other potential risks associated with corporate management. Financial management entails weighing investment risk against potential profit. (Ogbeide, 2021)

Financial management, according to Joshep and Massie, is the operational function of a company that is in charge of securing and efficiently utilizing the funding necessary for effective operations. (Paramasivan & Subramanian, 2009, p. 3)

Financial management has been broadly defined as "the process of planning, acquiring, deploying, and allocating scarce monetary resources among economic units in order to achieve predetermined goals." (JILI'OW, 2016, p. 4)

Financial management, according to McMahon and Davies, is the activity focused on obtaining the funds necessary to finance the company's assets and operations, allocating these limited resources among competing uses, and making sure the money is used wisely and efficiently to meet the company's goals.(Brijlal, Enow, & Isaacs, 2014, p. 342)

According to the above-mentioned definitions, we can define financial management as thetask of the financial manager, who is concerned with the collection of funds from their different sources and exploitation in a manner that achieves the foundation's objectives.

1.2 The goal of financial management:

Financial management's goal is to make money or increase the worth of the owners. If we consider possible financial objectives, we might consider the following: (JILI'OW, 2016, p. 4)

1.2.1 Survive:

Financial management's most important goal is to ensure survival. Therefore, The finance manager must exercise extreme caution when making financial decisions in order to help the corporation survive in the world of competition. A single worse decision could put the company out of business.

1.2.2 Avoiding financial difficulties and bankruptcy:

In corporate finance, the term "financial distress" is frequently applied to describe any situation in which a person's or a company's financial situation makes it difficultto pay their debts, particularly creditor loan payments. Financial distress that persists for an extended period can lead to bankruptcy.

1.2.3 Maximize profits:

Profit is the primary objective of any business venture. A business is also primarily operated for profit which is a term that refers to the procedures used to evaluate a company's efficiency.

1.2.4 Maximize sales or market share:

Profit necessitates sales, just as a corporation's survival necessitates long-term profit. Demand management is a concern of marketing management. Thus, Demand must be managed to govern exchanges or sales. As a result, marketing management's goal is to positively alter sales trends. All businesses, large and small, are concerned with maintaining a sufficient market share to ensure that they can survive and thrive.

1.2.5 Minimize costs:

Financial management aids in locating and utilizing cash in the most cost-effective manner possible.

1.2.6 Beat the competition:

In order to succeed in the future, businesses must stop competing with one another. The competition can only be defeated by giving up on winning. The untapped market potential is what defines blue oceans, demand generation, and the possibility of extremely profitableexpansion.(Kim & Mauborgne, 2005)

1.2.7 Maintain steady earnings growth:

The goals of financial management are to maximize firm value through liquidity, profitability, and growth. Investment decisions, financing decisions, and profit distribution decisions are all made concurrently.(Ojera, 2018, p. 73)

1.2.8 Maximizing firm value (Wealth maximization):

Value maximization refers to increasing the market value of shares. It is also known as shareholder wealth maximization, which, according to modern thinkers, is a key goal of financial management. Moreover,maximizing owner wealth is one of financial management's key goals rather than profit maximization if the price of shares in the market rises.. (Jain, 2011, p. 76) For a firm, maximizing owner wealth is a more important objective than maximizing profit.

- **Liquidity:**

Liquidity is defined in finance as an asset that is liquid if it has one of two basic characteristics: proximity to cash or ease of asset conversion to cash. However, depending on its proximity to liquid, which determines the liquidity of that item or asset, there is a wide range of assets, from liquid to solid. Therefore, liquidity is the capacity of a financial institution to fulfill its cash as well as collateral obligations swiftly and affordably. (Bello, Hasan, & Saiti, 2017, p. 155)

Liquidity is the capacity to provide cash on demand to meet daily needs.(DAHIYAT, 2016, p. 35)**.**

Liquidity is one and only one of the factors taken into account when making investments in order to determine the company's capability of meeting short-term obligations. (Pranata & Pujiati, 2015, p. 170).A firm's optimal level of liquidity ensures that it can meet its short-term obligations, and a profitable business can guarantee proper flow management(M , 2015, p. 3)**.** Liquidity is an important element for the continuation of the enterprise's activity that must be supplied in business in order to gain access to our objective.

- **Profitability:**

Profitability refers to the capacity of a company to make money from sales, total assets, and capital.(Pranata & Pujiati, 2015, p. 174)

The focus on high profitability may deplete adequate liquidity, causing the project's ability to repay its obligations to fail, resulting in the project's bankruptcy. . (G. R & M, 2016, p. 113) The connection between profitability and liquidity can be stated to be dependent on the company's strategies, such as the strategy for managing current assets or net working capital, client and supplier strategies, and product and service development policies.(Pluskota, Bolek, & Wolski, 2020, p. 91)

The profitability of an Islamic bank is the amount of profit it makes from its operations. The profit of a bank is the amount of money it makes after paying taxes and other expenses. (Javaria & Masood, 2020, p. 24). Therefore,profitability is the amount of money the firm makes by exploiting its resources.

1.3 Scope of Financial Management:

Financial management decision-making falls into three categories. Investment, financing, as well as dividend decisions, are examples of these. These three scopes represent three critical areas of financial management.

1.3.1 Financing decisions:

Once the firm has made an investment decision and committed to new investment, it must determine the best way to fund these commitments. Since firms have made new investments on a regular basis, necessitating the need for financing and financial decisions, managers also make decisions pertaining to raising finance from long-term sources called "capital structure" and short-term sources called "working capital." They are classified into two types:

1.3.2 Financial Planning Decisions

Financial planning is the process of combining decisions, actions, and goals with sales forecasts for a company. We need to know what the sales will be in order to calculate cash flows in financial planning. Regression analysis, market surveys, and management forecasts can all be used to forecast sales. (Fabozzi, 2009, p. 373). Financial planners can use policies to reframe financial planning decisions in terms other than personal examples (BAKER & RICCIARDI, 2014, p. 194). For a variety of reasons, income volatility may influence financial planning decisions, one of which is a decreased intrinsic sense of control over one's future. (Peetz, Robson, & Xuereb, 2021, p. 3). Internal controls help reduce errors by defining protocols and procedures to reduce

employee errors and make necessary improvements, thus improving overall performance.

1.3.3 Capital Structure Decisions:

A company's capital structure relates to its long-term financing, which is primarily made up of long-term debt and equity. Choosing the right capital structure is a crucial decision for financial management because it affects the firm's value (Aljamaan, 2018, p. 50). To finance firm assets, the capital structure decision is described as a choice between debt and equity (D'Amato , 2019, p. 218). The capital structure decision is influenced not only by the firm's characteristics but also by the corporate governance, legal framework, and institutional environment in the countries where it operates (Deesomsak, Paudyal, & Pescetto , 2004, p. 20). Industry leverage, profitability, firm size, growth opportunities, asset tangibility, expected inflation, and stock market return are all important factors to consider when deciding on a capital structure (Tongkong, 2012, p. 717). Moreover, the costs and benefits of operating at various leverage ratios could be influenced by institutional characteristics. First, given some deviation, the institutional environment may affect the speed at which a company returns to its long-term capital structure. If a nation's institutional makeup makes issuing debt and equity more expensive, firms in that country will adjust more slowly. Second, the long-term capital structure may be influenced by the country's characteristics. Cheaper debt (equity) financing would result from institutions that protect debt (equity) holders, resulting in higher (lower) leverage (Öztekin, 2015, p. 304). When deciding whether to finance operations with debt or equity, companies must make tradeoffs, and managers must balance the two to find the best capital structure.

1.3.4 Investment decisions:

An investment decision commits current financial resources to a long-term project in the hopes of having more in the future. The investment decision is the most important of the three decision-making areas. One important component of this decision is the allocation of funds to investment ideas whose benefits will be recognized in the future. Because future benefits cannot be predicted with certainty, investment proposals are inherently risky. As a result, they should be assessed in terms of their expected return and the additional risk they pose to the company as a whole. This category of decision-making also includes capital reallocation decisions when an asset no longer justifies the capital invested in it. This includes effective management of current assets, liquidity,

and so on (Joshi, 2021, p. 3). Moreover, investment decisions are based on expectations of investment benefits, which are in turn based on forecasts of future growth and product demand. Future growth projections are based on data such as revenues and earnings. Misstated financial results can hide underlying trends in revenue and earnings growth, in addition to concealing actual performance during the period. As a result, Overstating revenues and earnings has the potential to skew growth expectations among those who are unaware of the error (McNichols & Stubben, 2008, p. 1571)

1.3.5 Dividend decisions:

In corporate terms, the "Dividend Decision" is a decision made by an organization's executives regarding the amount and timing of any money payments made to its investors. The dividend decision is an important part of today's business world. It's a big deal for the company because it could change its capital structure and stock price. In addition, the dividend option may influence the amount of tax collected by investors. (PAVITHRA, SHIVA, & VEERAIAH, 2020) If a dividend decision can maximize the firm's value or the welfare of shareholders, as evidenced by an increase in share prices, it is considered a successful financial decision (Kisman, 2020, p. 3)

Dividend Determinants: There are several elements influencing dividend decisions, both in terms of size and style, which can be summarized as follows: (Wagdi, Salman, & Abouzeid, 2012, p. 12)

1- Legal consideration;
2- Liquidity levels;
3- Homogeneity of ownership;
4- The size of the establishment;
5- Risk levels;
6- Cost structure;
7- Type of sector;
8- The growth stages of the facility life cycle;
9- Stock owning options for management.

2. Efficiency and financial efficiency

2.1 Efficiency:

The microeconomic concept of producer theory gave rise to the concept of efficiency. From the producer's perspective, the theory of the manufacturers attempts to maximize profits or minimize costs. A production frontier curve is described in producer theory as the connection between input and output of the production process. The highest possible output level for any input usage that represents the use of technology by a company or industry is represented by this production frontier curve. (Rusydiana, Marlina, & Rahayu, 2018, p. 567)

Efficiency is referred to as the ability to complete a task with the fewest resources while attaining the best possible outcome. (Kandah, 2017, p. 17)

Efficiency is the ratio of output to input. which means increasing yield to the maximum extent possible while reducing resources (SALEH, 2012, p. 12)

Getting the most out of something is what efficiency is all about. (Lane, 2006, p. 22)

As expressed by Peter Drucker: "Doing the right things the right way is efficiency" (zala, 2010, p. 42)

When comparing the amount of workyield to vitality input, efficiency is the percentage of efficiency in comparison to the contribution of humans and other assets. (Jack P, p. 228)

A system is said to be efficient by the Oxford Dictionary if it can produce the most work with the least amount of money or effort.

Efficiency is the internal process that drives yield and concentrates resources to achieve the best result(Shujat Saleem & -Ud-Din, 2015, p. 81)

Efficiency is a standardized metric that is characterized as the ratio between the ideal input bundle and the actual input bundle, or the actual output bundle to the optimal output bundle. (Simsek, 2014, p. 11). Efficiency encapsulates the concept of producing in the most efficient manner possible, which means that efficiency is focused on using the fewest possible inputs to produce the best possible output. It is dependent on making the most effective application of resources in order to produce the best product at the lowest cost. (Jaouadi & Zorgui, 2014, p. 316)

According to production theory, efficiency denotes the conversion of inputs into outputs, i.e., increasing output from the same inputs or getting the same output from fewer inputs. (Widiarto & Emrouznejad, 2015, p. 7)

Based on the definitions that are mentioned above, efficiency can be defined as the capability of the firm to avoid wasting resources (input) that are utilized to yield a set of goods and services (output). To put it another way, efficiency describes the ability to carry out tasks without wasting time, effort, and funds in order to maximize productivity. It is among the most crucial factors in determining productivity. Simply put, since resources are finite, we have to use them in the best possible manner.

In DEA, the term "efficiency" is a company's capacity to obtain maximum (minimum) outputs (inputs) from a collection of supplied inputs (outputs) (R, Kumar, Singh, Verma, Venkatesh , & Gupta, 2017, p. 83). According to the Pareto-Koopmans definition of efficiency, A DMU is completely efficient. Only when no input or output can be improved without affecting another. (Tone, 2010)

In general, Efficiency is best described in one sentence: it is the ratio of output to input. Efficiency means that using a given number of inputs for a maximum number of outputs or using the minimum number of inputs for a given number of outputs, i.e., more output from the same resources or the same output from fewer resources is efficiency. Additionally, it can be explained as the extent to which an institution can achieve the greatest superiority. Efficiency is expressed as the achievement or the capability to achieve an output or task with a minimum expenditure of input, cost, and time. Furthermore, efficiency means more for less. More output per input. More returns per cost, more production per hour, more investment per resource. The next best thing to getting something for nothing is getting more for less.

2.2 financial efficiency

The two main categories of financial efficiency are financial oversight and resource allocation, Financial efficiency is connected to financial function and defines how financial organizations collect financial resources, allocate them to scarce sectors, and then employ those resources more effectively and efficiently.(M., J., & C.C., 2018, p. 4) Financial efficiency describes a company's overall service quality, operational performance, customer satisfaction, and earning capacity. (Taqi, Ajmal, & Ansari, 2018, p. 15)

The term "financial efficiency" relates to how well the dollars spent on each option generate revenue for the agency. (Hurst, Gaston, Caldwell, & Stokes, 2004, p. B162). In other words, financial efficiency is a metric for how well businesses put their money into higher-yielding investments. As a result, one way to compare investment options is to look at their financial efficiency.

Financial efficiency is the level of functional performance of the financial system (Le, Chuc , & Taghizadeh-Hesary , 2019, p. 2). It is a critical component of the skill set required to work successfully in a money economy (Sibley & Suva, 2010, p. 18). One of the foundational tenets of a competitive and efficient bank is the development of efficient and appropriate financial systems.

At the micro-level, financial efficiency denotes to the accuracy with which an asset is allocated among competing uses over time. (ZALA, 2008-2010, p. 117)

Financial efficiency measures the capability of the company to use its resources to produce a profit and the viability of its delivery, purchasing, estimating, financing, and advertising options. (ZALA, 2008-2010, p. 51)

Financial efficiency denotes to the accuracy with which assets are divided among competing occupations. (Shujat Saleem & -Ud-Din, 2015, p. 81)

The term "financial efficiency" relates to the financial efficiency brought about by the balance of operation costs and benefits (Njuguna & Arnolds, undated, p. 11)

Financial efficiency means a company's financial affairs performing at their best over a time frame during particular technological circumstances. Financial efficiency can show not only how successfully a business allocates resources and pays off debt, but also how well it makes money and how well it can grow in the future. It is a thorough measure of a company's financial health. (Lan, Yang, & Tseng, 2019, p. 2)

According to the definitions given above, financial efficiency is characterized as the company's ability to choose the best investment alternative and make the most effective application of the resources available to do the most with the lowest sum of money.

2.3 Financial Efficiency Ratios:

Financial ratios are a method of analyzing financial statements. Ratios are derived from information obtained from financial reports and are mechanisms for investigating various aspects of an economic entity's economic well-being. The most widely recognized components of financial well-being are liquidity, action, influence, work productivity, and benefit. (Curtis, Hanias, Kourtis, & Kourtis, 2020, p. 328). This ratio describes output and input, so the lower the ratio, the more efficient the region, and vice versa. (Gousario & Dharmastuti, 2015, p. 155)

These financial ratios are commonly regarded as indicators of firm and industry efficiency. Financial ratios can be applied to assess a company's performance and financial situation. They can also be used to analyze trends and compare a company's financial figures to those of its competitors or the business sector in which it operates. Financial ratios are comparisons of some and many financial statement objects. They are used by stock analysts, investors, and company management to compare businesses within a certain industrial sector and to pinpoint internal strengths and shortcomings. Financial efficiency and effectiveness ratios evaluateoperations and profitability of a corporation. There are three main ratios that can be applied to measure the financial efficiency of a business:

2.3.1 The asset turnover ratio:

Asset turnover (total asset turn over) is a ratio that estimates how well the usage of a company's assets supports sales. (Nurlaela, Mursito, Kustiyah, Istiqomah, & Hartono, 2019, p. 298)**.**Asset turnover ratios are calculated to determine the effectiveness of an organization's assets in generating sales revenue. Current assets and fixed assets are the two types of assets that exist. Current assets are either currency or cash substitutes that will be turned into money at the end of the operating or cash cycle. Current assets are assets that are held to carry out basic company activities and have a maximum life of one accounting year. Fixed asset turnover demonstrates how these assets are leveraged to generate revenue. The following is how asset turnover ratios are calculated: (Shrotriya, 2019, p. 79)

Fixed asset turnover ratio = (Sales/Fixed assets)

Current asset turnover ratio = (sales/current assets)

Total asset turnover ratio = (Sales/Total assets)

The greater the value of the ratios, the more effectively assets are leveraged to generate sales.

2.3.2 The stock turnover ratio:

A stock turnover ratio is a comparison of the price of items sold to the average stock or inventory. Every business must keep a certain number of finished goods on hand. However, the inventory level should not be too high or too low. It assesses the capacity of a business to manage its inventory efficiently. This ratio establishes a link between the price of items sold and the average stock level. The Stock Turnover Ratio indicates how many times the company sold the value of its stocks during the fiscal year. It is calculated as follows: (Ramananda, 2012, p. 99)

Stock Turnover Ratio = Cost of goods Sold/ Average Stock

Cost of goods sold = Opening stock + Purchases + Direct expenses – Closing Stock

Or

Cost of goods sold = Sales – Gross Profit

Average stock = (Opening stock + Closing stock)/2

The stock turnover ratio is the ratio of a material's annual consumption divided by its mean inventory, i.e., the items are divided into three categories: (Devarajan & Jayamohan, 2016, p. 565)

A. Fast moving (F): items with a stock turnover ratio greater than three.
B. Slow moving (S), items with a stock turnover ratio of 1 to 3.
C. Non-moving (N): items with a stock turnover ratio less than one.

2.3.3 The debtor day's ratio:

The debtor day ratio measures the typical time it takes a business to obtain payment (trade receivables) from consumers for invoices sent to them. (Muli, 2019, p. 10). The debtor-day ratio measures how long it takes trade debtors to cover their debts and

indicates whether they are given too much credit. Creditor Day is the average time it takes a company to pay off its debts to trade suppliers. It's similar to the debtor's day ratio in that it shows whether a company is taking advantage of all available trade credit. This ratio reflects general debt and credit collection issues, as well as the financial situation of large corporations (K.N, 2012, p. 373). This ratio shows how long it takes on average for a company to collect debts owed to it by customers who bought goods on credit. The following formula is employed to compute: (Krishnakumar)

The Debtor Days Ratio= debtors/ sales turnover

Efficiency ratios are non-balancing-sheet ratios. These ratios are important in determining the Inventory turnover efficiency of the business, sales, assets, accounts receivables, or payables. It also has to do with a company's capacity to fulfill both immediate and long-term commitments. This is due to the point that if they are not paid on time, how will you be paid on time (Krishnakumar)

2.4 Types of efficiency:

2.4.1 X-efficiency:

In his seminal work Allocative efficiency vs. "X-efficiency (Leibenstein, 1996), Harvey Leibenstein presented the idea of X-efficiency in 1966. X-efficiency is the formal definition of the extent to which a group of inputs achieves the maximum level of output possible with those inputs (Bevir, 2007, p. 260). This means that if an organization produces as much output as it can from a predetermined set of resources, it is X-efficient.

X-efficiency, according to Leibenstein, is a significant source of increased output (Leibenstein, 1996, p. 406). According to Berger, Hunter, and Timme (1993), X-efficiencies account for 20% or higher of banking costs. When accurately estimated, however, product mix and scale inefficiencies typically account for no more than 5% of the costs. (Berger, Hunter, & Timme, 1993, p. 222)

The X-efficiency method attempts to quantify the amount of waste and friction in the manufacturing process. Scale efficiency and scope efficiency are two concepts related to X-efficiency. (Kisaka, Sheila, & Mangobe, 2014, p. 103)

2.4.2 Scale efficiency:

The ratio of marginal product to average product is defined as scale elasticity, also known as "degree of scale economies". In the single-input/output case, if an output y is produced by an input x, the scale elasticity is defined as follows: (Tone, 2017, p. 288)

$$\varepsilon = \frac{d_y}{d_x} / \frac{y}{x}$$

With the overall CCR and BCC models calculated, the item scale efficiency can be calculated. According to the formula, The definition of scale efficiency is the difference between the pure technical efficiency score and the total technical efficiency score for DMUs as determined by the CCR model (measured by the BBC model). Scale efficiency calculated in this way indicates the level of an object's efficiency in comparison to the optimum, allowing for the most efficient use of inputs**.**(BARAN & GÓRECKA, 2015)That is, management's ability to select the optimal volume of resources in order to determine the overall size and thus select the appropriate products to meet the expected production level.

Scale efficiency refers the degree of typical productivity that a company can achieve when operating at the right scale size. This is the point at which average productivity reaches its maximum level. (Taib, Saleem, & Shahril, 2018, p. 4) Because scale efficiency is concerned with the choice of output level, the key question becomes whether firms operate under decreasing, increasing, or CCR (Van, 1995, p. 31)). Moreover, scale efficiency refers to taking advantage of scale economies by operating near the production frontier. (Pasiouras, 2008, p. 305)). Thus, the unit's capabilities to operate at the right return to scale are measured by scale efficiency. (Hasan & Kale, 2011, p. 895)

2.4.3 Economic efficiency (cost or Productive efficiency):

The relationship between aggregate benefits and costs to the individuals concerned is referred to as economic efficiency. The Pareto Optimality, Kaldor-Hicks, Cost-Benefit, and Wealth Maximization criteria are among the most widely used efficiency criteria. (

Marciano & Ramello, 2019, p. 637)The definition of economic efficiency is the efficiency with which dollars invested in each alternative produce societal benefits. The present net value (PNV) is thesize of economic efficiency. (Hurst, Gaston, Caldwell, & Stokes, 2004, p. B162)Economic efficiency is the most important criterion for economists when evaluating policies and programs, overall economic efficiency is achieved when members of society maximize their utility given the economic resources available. (Productivity Commission, 2013, p. 2) One of the requirements of economic efficiency is that businesses operate at thecheapest possible cost. (Rao, 1989, p. 167)The goal of achieving economic efficiency, is demonstrated as the maximization of production value. (BERTRAND, 2015, p. 416)

The ratio of the lowest cost (calculated using x* and actual prices) to the observed cost is utilized to calculate total economic efficiency (EE). This can be expressed mathematically as: (Zongli, Yanan, Feifan, Hui, Yongming , & Xinhua, 2016, p. 4)

$$EE_i = w_i{}'x_{i*} / w_i{}'x_i$$

That EE_i is the ratio of the lowest cost to the observed cost.

In the DEA model, economic efficiency is calculated by the multiplication of technical and allocative efficiency.

EE = TE*AE

2.4.4 Technical efficiency:

Efficiency analyses can be traced back to Knight (1933), Debreu (1951), and Koopmans (1961). (1951). Koopmans (1951) defined technical efficiency, and Debreu introduced the initial step of "coefficient or resource utilization" (1951). (Khan, 2015, p. 25) Technical efficiency is the capacity to generate as much output as possible from a specified collection of inputs. (Farrell, 1957, p. 254) Furthermore, technical efficiency indicates producers' decisions to distribute the resources at their disposal to produce the greatest amount of output from the inputs provided, or to utilize the fewest possible inputs in order to achieve a specific level of outputs. As a result, technical efficiency analysis can be classified either as input- or output-oriented. (Daidone & D'Amico , 2008, p. 2)On the other hand, technical efficiency is related to the production of outputs given some inputs: a production plan is technically efficient if it is possible to produce

more outputs with the same inputs or the same outputs with fewer inputs. (Favero & Papi, 1995, p. 386) The technical efficiency of a given firm is expressed as the proportion of its mean production (in original units) to the corresponding mean production if the firm effect was zero. (Battese & Coelli, 1988, p. 389)If a corporation is technically efficient, it produces the most output from the lowest number of inputs, such as labor, capital, and technology.(Adegoke & Funke Iyabo, 2016, p. 63)

2.4.5 Allocative efficiency (price or scope efficiency):

The term "Allocative efficiency" describes a capacity of business to stay on the same production possibility curve by using the least expensive combination of inputs and available technology. (Khan, 2015, p. 25)When a bank is able to allocate inputs in such a way that the cost of producing a specific volume of output is kept to a minimum, this is referred to as allocating efficiency.

Allocative efficiency is a firm's ability to choose the ideal input combination for a given input cost. (Badunenko, Fritsch, & Stephan, 2008, p. 1094)The ratio of the DMU's minimum costs to creating a specific number of outputs is used to determine allocation efficiency. (Watkins, Hristovska, Mazzanti, Wilson, & Schmidt, 2014, p. 90)Allocation efficiency measures the departure of the firm's input mix from the input combination that reduces costs. (Oum & Zhang, 1995)

According to the standard (multiplicative) Farrell approach, cost efficiency (CE) stems from technical efficiency (TE) and allocative efficiency (AE). Farrell quantified and thus explained what these phrases meant in the following way: (Aparicioa, Pastor , & Zof, 2017, p. 346)

$$\underbrace{\frac{C(y,w)}{C(x)}}_{CE} = \underbrace{\frac{1}{D_i(y,x)}}_{TE}.AE,$$

Where:

$C(x) = \sum_{i=1}^{m} w_i, x_i$ is the cost at x, $D_i(y,x) = \sup\{\delta > 0 : x/\delta \in (y)\}$ which is the distance input function.

Allocation efficiency is calculated by dividing cost efficiency by technical efficiency.

AE = CE/TE.

2.4.6.Revenue efficiency:

Revenue refers to the efficiency with which a bank sells its outputs. Maximum revenue is obtained on account of efficiently producing the output bundle. In reality, revenue efficiency is made up of efficiency at both a technical and allocation level, both of which are related to managerial factors and are frequently associated with regulatory factors.(Sufian, Kamarudin, & Noor, 2014, p. 53)Rather than bank size, factors particular to the bank or other unrelated variables impact revenue efficiency.(Asongu & Odhiambo, 2019, p. 22)

Revenue efficiency measures how successfully a bank is likely to function financially in comparison to other banks generating the same set of results during the same period. Similarly, profit efficiency measures how well a bank is predicted to perform financially in comparison to other banks that are providing the same set of outputs during the same period.(KHALED I., MOHAMAD, ARIFF, & HASSAN, 2008, p. 26)

The revenue efficiency index is defined in DEA as the proportion of optimal revenue to actual revenue, that is, $RE_o = \frac{p^t y^*}{p^t y_o} = \frac{\sum_{r=1}^{s} p_r y_r^*}{\sum_{r=1}^{s} p_r y_{ro}}$

If this index equals one or more than one, the DMUo is allegedly revenue efficient; otherwise, it is allegedly revenue inefficient. (Ghiyasi, 2017, p. 260)

2.4.7 P**rofit efficiency:**

The ratio between the real profit of a bank and the maximum level that could be achieved by the most efficient bank is known as profit efficiency. (Maudos, Pastor, Pe´rez, & Quesada, 2002, p. 38)

A bank's profit efficiency is the ratio of its actual profit to the maximum profit that a bank operating under optimum practices might generate at the same input prices. and output prices or output quantities. (Assaf, Berger, Roman, & Tsionas, 2016, p. 5)

Profit efficiency is calculated by dividing each DMU's observed profit by the maximum profit possible when compared to other efficient DMUs. (Mahdavi, Ghayouri, & Alipour, 2012)

2.4.8 Operational efficiency:

Operationalefficiency isthe level at which changes in the cash conversion cycle, operating expenses to sales revenue ratio, total debt to total assets ratio, total asset turnover, operating cash flow, operating risk, and firm size affect the company's future performance. (Gill, Singh, Mathur, & Mand, 2014, p. 259)

A bank's operational efficiency is associated with a variety of factors such as operational cost-effectiveness, productivity, customer service, priority sector lending, credit deployment in rural and underserved areas, and deposit mobilization. (ZALA, 2008-2010, p. 44)

Operational efficiency requires two things: (Allen & Rai, 1996, p. 656)

1. Optimization of the output mix to fully use any scale and scope economies.
2. The input mix's optimization to prevent both excessive input use (technical X-inefficiency) and non-optimal relative input proportions (allocative X-ineffficiency).

3. Data envelopment analysis (DEA)

3.1 New efficiency theory

The proposed Efficiency Theory (EF) is based on the universal algorithm known as the "brute force" approach. Brute Force (BF) is a method for solving difficult computational problems that consider every possible solution. BF is an extremely inefficient method of problem-solving and is generally regarded as inapplicable in practice to instances of difficult problems of non-trivial size. It is an incredible as well as an unappreciated reality that the simplest algorithm to discover, understand, and implement also generates the most precise (rather than approximate) solutions to the collection of all challenging complex mathematical problems. (Yampolskiy, 2011)

The new efficiency theory or, as it is known, "data envelopment analysis" came from the intellectual roots of DEA in economics and can be traced back to the early 1950s. In literature, Debreau and Koopmans offered it for the first time in 1951 (Simsek, 2014, p. 11), as well as Farrell's (1957) influential 'The Measurement of Productive Efficiency.' Farrell was heavily influenced by Koopmans and Debreu's technical efficiency measure and proposed that a firm's Technical efficiency can be broken down into two components: pure technical efficiency (TE), which reflects the ability of a business to maximize output from a specific set of inputs under a given technology; and allocative efficiency (AE), which reflects a firm's ability to use its inputs in optimal proportions, given their respective costs. See (Farrell, 1957, p. 254)

The DEA technique is a nonparametric approach to determining the efficiency of a group of DMUs, such as business firms, financial institutions, government agencies, and non-profit organizations, and identifying the sources and amounts of inefficiency in each input and output for each DMU. There are many definitions and models. In terms of efficiency measurement, the most interesting approach is DEA, and researchers have used different DEA models for the performance evaluation of bank branches. In addition, there are many approaches to fully rankingboth effective and ineffective DMUs. They are as follows:

3.1.1 Traditional DEA models

For different types of measuring requirements, there are different DEA models for assessing efficiency. Traditional DEA models calculate technical (radial) efficiencies by

using assumptions. where each performance measure's status of output and input is known. Traditional DEA models assume that the data related to performance measures is non-negative, that technical (radial) efficiency is required, and that each performance measure's input or output status is known. (Tavana, Izadikhah, Tolood, & Roostaee, 2021, p. 3).The basic classical DEA models that have the ability to estimate efficiency are as follows:

- **The variable returns to scale(VRS):**

The return to scale in VRS can be increasing, constant, or decreasing. In terms of efficiency, the following options are available for return to scale:(Fenyvesa, Tarnóczia, & Zsidóa , 20015, p. 425)

- **The constant returns to scale(CRS):**

Changes in either the input or output result in a proportionally proportional change in the other. It's the abbreviated CRS (constant return to scale).

- **The decreasing returns to scale (DRS):**

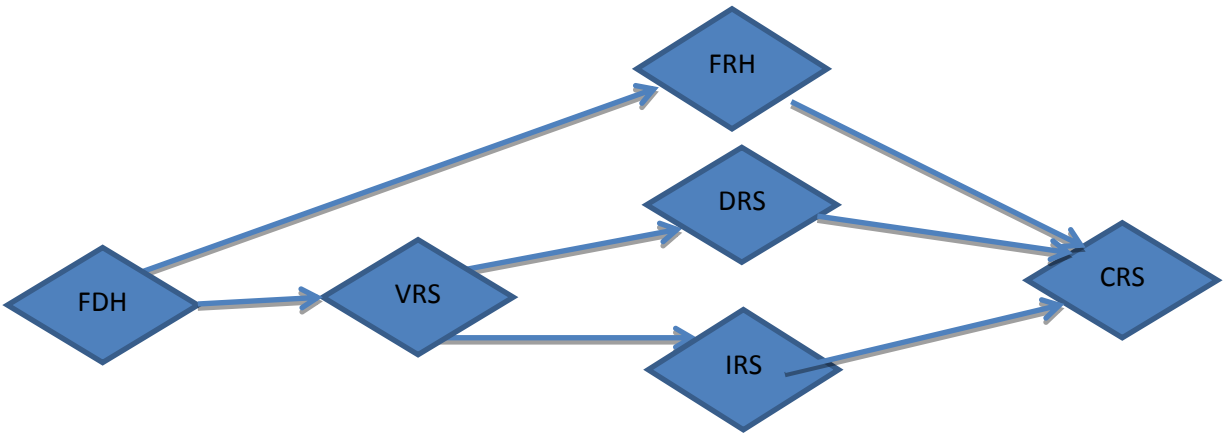
Increasing the input may result in a proportionally lower increase in output. It's the abbreviated DRS (decreasing returns to scale).

- **The increasing returns to scale(IRS):**

Alterations to the input cause a larger increase in the output. It's the abbreviated IRS (increasing return to scale).

Non-convex models include Free Disposal Hull (FDH) and Free Replicability Hull (FRH) in DEA. The following is a partial ranking of technologies from smaller to larger (as indicated by arrows below)(see figure.1): (Bogetoft & Otto, 2011, p. 89)

Figure 2.3.1 fundamental models in DEA



Source: (Bogetoft& Otto, 2011, p. 89)

The smallest technology set is FDH. Because we've "filled in the gaps," (VRS) is now larger. We get a larger set, permitting some scaling, either (DRS) (It broadens the set for low input values) or (IRS) (This broadens the technology's application for huge input values). We determine our most advanced technology, the (CRS) technology, by allowing for complete rescaling and convexity. The FRH is smaller than FDH and larger than CRS, but it is comparable to the others.

- **Directional distance function:**

Over the last two decades, the directional distance function (DDF) as an expanded DEA approach has drawn the interest of academia and has undergone substantial research. However, choosing the proper direction to calculate the separation between the ineffective DMU and the effective production frontier is a challenge during the use of DDF. (Yanga, Wei, Li, Huangb , & Chenb, 2018)DDF calculates the size of an input or output vector in a predetermined direction from itself to the technology frontier. DDF is more general than Shephard's distance functions or McFadden's gauge function because this direction can differ from the radial direction out of the origin (Chambers, Chung, & Färe, 1998). Moreover, DDF is adaptable because it accepts a wide range of direction vectors. Negative data is allowed in more pragmatic, managerially oriented benchmarking models. (Kerstens & Van de Woestyne, 2011)

- **Multiplier models:**

Envelopment models use multiplier models, which are dual linear programming problems. When data is available, linear multiplier models have the advantage of being easily scaled up to include sectorial detail**.** (Robinson, et al., 2021, p. 17)The methodology of multiplier models is simple and has a number of flaws, such as calculating average effects rather than marginal effects and ignoring the price and income effects due to increased demand for goods and services. (Getzner, 2003, p. 186)

3.1.1 New DEA models:

Traditional DEA approaches compare the efficiency of decision-making units (DMUs), but they do not allow for ranking, particularly among the most efficient. Non-radial models, super-efficiency models, fuzzy models, and other models are among the techniques used to address this problem. Various models for improving scores have been proposed; they are as follows:

- **Non-radial models:**

Given that most production processes have multiple inputs and outputs, radial DEA modeling does not provide information on the efficiency of specific inputs or outputs that intervene in the process (depending on the model's orientation). Färe, Grosskopf, and Lovell (1994) developed a series of non-radial DEA models that measure individual input reductions (increases in outputs) to individual outputs. In other words, this model provides a measure of efficiency for each of the process variables. The main advantage of using this type of indicator is that it permits us to pinpoint the specific inputs on which to act to improve the effectiveness of the unit under consideration. (Hernández-Sancho, Molinos-Senante, & Sala-Garrido, 2011) The non-radial DEA models have some unique characteristics. However, determining the returns of the set of optimal points to scale is not a problem. (Krivonozhko, Førsund, & Lychev, 2014, p. 93). An important property of the non-radial measure is that no differentiation between measures take into account both inputs and outputs while projecting, which differs from the radial measure. The non-radial model has a methodological advantage in this regard. (Krivonozhko, Førsund, & Lychev, 2012). They are as follows:

- **Additive:**

the additive DEA model proposed by (Charnes, Cooper, Golany, Seiford, & Stutz, 1985), combines both input and output orientations in a single approach, whereas the BCC and CCR models are either input or output-oriented. It handles output deficits and excessive inputs concurrently and is not dependent on the dataset's coordinate system. (Stiakakis & Sifaleras, 2013) The additive model's weakness is that it does not directly show the return. Only if the intended unit has BCC efficiency and dual variables equal to zero is it additively efficient (Karami, Ghasemy Yaghin, & Mousazadegan, 2021).On other hand, To evaluate decision-making units, an additive model is used. DMU is only effective according to the additive model when its goal function's optimal value is zero. (Khodabakhshi , Gholami , & Kheirollahi, 2010, p. 1249).

- **Preference structure:**

While calculating relative efficiency, the decision maker's (DM) preference structure and value judgments are absent from the original DEA model, with little to no involvement from the DM (Lotfi, Jahanshahloo, Soltanifar, Ebrahimnejad, &

Mansourzadeh, 2010). It is critical to consider the decision-making unit's or the decision-makers choice for potential adjustments to various inputs and outputs.By defining a set of "desire weights" that describe the relative attractiveness of future changes to current input and output levels, weighted non-radial CCR models were built.The DEA/preference structure approach offers a newway to eliminate DMUs that appear to be efficient but have unrealistic weightings. To put it another way, the approach allows certain inputs to be increased and certain outputs to be decreased. The preference structure is shown to generate fixed weights or areas that make some virtual multipliers invalid, leading to preferred input and output targets for each DMU. To ensure comparability, the approach provides a DMU-specific scalar efficiency score in addition to the preferred target. (ZHU, 1996)

- **SBM efficiency:**

Tone (2007) proposed a non-radial model called SBM (slacks-based measure) by Tone in 2001, which uses the term "slacks'' to represent the input surpluses and output deficits (Tone K. , 2001). The DEA model with slack-based measures (SBM) is utilized to register relative productivity, information, and results and focuses on the different dynamic units (DMUs) because of their best companions or efficient frontier. Moreover, the SBM model posits n decision-making units, with each decision-making unit composed of three elements: desirable output, unacceptable output, and input. (Liu, Hu, & Tang, 2016, p. 3)It provides a scalar measure of efficiency that includes all inefficiencies identified by the additive model. It is invariant about the unit of measurement of each input and output item, but not for the dataset's coordinates. (Stiakakis & Sifaleras, 2013)

- **Super-efficiency models:**

When a DMU under evaluation is not included in the reference set of envelopment models, the resulting DEA models are referred to as super-efficiency DEA models. The super-efficiency DEA models are built on a reference technology made up of all other DMUs (Krivonozhko, Førsund, & Lychev, 2014, p. 197). The super-efficiency method involves removing the scoring unit from the dual linear program and analyzing the alteration in the Pareto Frontier. (Marins, da Silva, Miranda, & Montevechi, 2019). Moreover, the super-efficiency DEA approach has the ability to detect influential observations as well as identify extremely efficient DMUs. (Zhu , 2009, p. 205).In

super-efficiency models, we first subtract DMUo from the production possibility set (PPS) and then compute its efficiency regarding the new PPS. Allow DMUo to become an extremely efficient unit. A vertex of the PPS is removed by removing DMU. As a result, the new PPS is smaller than the old one, and DMUo is not included in the new PPS. However, if DMUo is inefficient, non-extremely efficient, or weakly efficient, then removing DMUo from the PPS results in the new PPS being the same as the old one, because these DMUs are not a vertex of the PPS and thus no hyperplane is removed. As a result, the situation of these DMUs to the new PPS is the same as it was concerning the old PPS. That is, they are both within the PPS, on the strong supporting hyperplane and the weak supporting hyperplane. (Hadi-Vencheh & Esmaeilzadeh, 2013)

- **Radial super-efficiency:**

Andersen and Petersen (1993) created a radial super-efficiency model that allows efficient DMUs to have efficiency scores greater than one while the efficiency scores of inefficient DMUs remain unchanged (Guo, Lee , & Lee, 2016, p. 3). Radial super-efficiency compares the efficiency and super-efficiency of inefficient and efficient DMUs using the same model, so that the efficient DMU's super-efficiency score is greater or equal to one. (Lee , 2021)

- **A slacks-based measure of super-efficiency:**

Tone (2002) offered a slacks-based measure (SBM) of super-efficiency(Tone K. , 2002), while Fang et al. (2013) created a slack-based variant of the Tone-proposed Super SBM, a super-efficiency model alternative to the SBM. However, the projection found using SBM of super-efficiency is strongly Pareto efficient, whereas the projection found using the Super SBM model may not be. (Fang , Lee, Hwang , & Chung, 2013)

- **Additive super-efficiency:**

Additive super-efficiency is introduced in (Du , Liang , & Zhu, 2010) To rank efficient DMUs, this super-efficiency DEA model is used. There are two kinds of additives. The first super-efficiency model is unit-invariant, while the second is not. (Du , Wang, Chen , Chou, & Zhu, 2014) In a single model, the additive DEA model determines inefficiency in each input and output. As the DMUo's score for additive efficiency, It is demonstrable that the fall efficiency score is monotonically lowering in input/output

slacks, unit-invariant, and between 0 and 1. Only if and when the efficiency score is one, DMUo is allegedly additive efficient, implying that all optimal slacks are zero. (Premachandra , Chen , & Watson, 2011)

- **non-radialsuper-efficiency:**

(Chena & David Shermanb, 2004)developed a non-radial super-efficiency DEA (NRSE-DEA) approach that provides improved insights into the ranking of efficient DMUs. The slack in radial methods is eliminated by a gradual series of proportional modifications to the inputs (outputs). Furthermore, they demonstrate how value judgments are implicitly incorporated into the super-efficiency evaluation through this incremental application. As a result, potential inefficiencies in the radial super-efficiency ratings are eliminated.

3.1.2.3 Fuzzy DEA models:

Traditional DEA models are restricted to sharp inputs and outputs, which are not always available in real-world applications. In real-world problems, however, outputs and inputs are frequently imprecise or uncertain. As a result, Fuzz was presented in DEA to deal with ambiguity and imprecise input-output data. As a result, it was increased to fuzzy DEA (FDEA). Fuzzy sets, often known as fuzzy numbers, can be used in FDEA to represent imprecision and uncertainty in inputs and outputs. Many researchers have made efforts to prove that FDEA can handle fuzzy output and fuzzy input data. (Emrouznejad & Tavana, 2014, p. 123)

- **The fuzzy DEA methods:** Fuzzy set theory applications in DEA are often classified into six groups: (Izadikhah & Khoshroo, 2018, p. 597)
- **The Tolerance Approach:** The tolerance approach was one of the first fuzzy DEA models developed by Sengupta and improved upon by Kahraman and Tolga.
- **The Fuzzy Rankin Approach:** Guo and Tanaka were the first to develop the Fuzzy Rankin Approach. They introduced a fuzzy CCR methodology in which fuzzy constraints, such as fuzzy inequalities and fuzzy equalities, were converted by establishing a possible level

into sharp constraints and employing the fuzzy number comparison method.

- **The Fuzzy Random Type-2 Fuzzy Set**: Qin et al. developed the fuzzy random/type-2 fuzzy set in 2009. This DEA approach with type-2 fuzzy outputs and inputs was developed to deal with linguistic and numerical uncertainties in fuzzy membership functions.

- **The α-level Based Approach:** Girod was used for the very first time to develop the fuzzy BCC and FDH approach, which is radial efficiency measures.
- **The Fuzzy Arithmetic:**hat Wang and colleagues pioneered they proposed two fuzzy DEA models that use fuzzy arithmetic to generate fuzzy inputs and outputs**.**
- **The Possibility Approach:**Guo et al. proposed the possible approach. It constructs fuzzy DEA models using possibility and necessity measurements. The possibility approach treats the FDEA model's fuzzy constraints as fuzzy events, and the FDEA model is transformed into a possible linear programming problem using the possible measures of the fuzzy events. (Emrouznejad & Tavana, 2014, p. 119)

3.1.2.4.Other models:

- **Malmquist index:**

The Malmquist productivity index, created by Malmquist in 1953, is a unit of measurement of total factor productivity growth for a bank or decision-making unit. The Malmquist index computes ratios of a certain value (rate of increase/decrease) between two periods to assess the change in productivity between the two data points. It is determined as the sum of DEA-derived catch-up or recovery terms and frontier-shift or innovation terms (Bahadji & Saous, 2021, p. 6).

- **Profit model:**

Profit efficiency models are designed so that the amounts of change in outputs and inputs are proportional to their prices. Numerous models have been constructed in this field. (S. Tohidnia & Tohidi , 2019, p. 2)

- **Cross-efficiency :**

Cross-efficiency is usually depicted as a two-step procedure. The first phase is the phase of self-evaluation, during which the DEA scores are computed using a constant returns-to-scale formula (CRS). Multipliers from the first phase are implemented on every peer DMU in the second phase to produce a so-called "cross-evaluation score" for each of those DMUs. (Zhu, 2015, p. 24)

- **Two-stage model:**

The two-stage DEA is a model that assesses the efficiency of DMUs with a two-stage internal structure, in which the basic inputs are changed into intermediate outputs or intermediate measures (Jianfeng, 2015, p. 2). The indicators of the two-stage DEA approach are classified as inputs, intermediates, and outputs. The first stage's outputs are used as intermediate inputs for the second stage (LIU, LIU, YANG , & PAN, 2020)

One of the main limitations of traditional DEA models is that they treat the manufacturing process as a black box in which the input variables are transformed to give the output variables. Although revealing without imposing the structure of the transformation process is among the benefits of DEA, in some applications, a more structured model is required for better application. The banking industry is a prime example of this situation. Because it is a highly complex sector, an improved DEA model is ideal for incorporating this manufacturing process. (Henriques, Sobreiro, Kimura, & Mariano, 2020, p. 5)

3.2 Advantages of data envelopment analysis:

Due to its various benefits, DEA is a well-liked tool for efficiency evaluation, which are listed below:(Lehmann, Warning, & Weigand, 2002, p. 4)

1. The function relating inputs to outputs in DEA requires very little structure;

2. DEA enables the investigation of multiple outputs at the same time. It is critical to note that no relationship between multiple outputs is required;
3. DEA computes a relative efficiency rating for every unit individually based on the entire set of units under consideration. The weights assigned to outputs and inputs are determined endogenously for each firm's equations;
4. The DEA model not only identifies inefficiency but also its causes;
5. One advantage of DEA is the ability to set benchmarks as DMU improvement targets that are inefficient. (Yousefi, Shabanpour, Fisher, & Saen, 2016, p. 2);
6. Establishes a standard for inefficient and efficient DMUs.
   (Guo, Hu, Shi, & Bilan, 2020, p. 4)pointed out some DEA advantages that are as follows:
7. There is no need to consider the functional connection between output and input, no need to estimate parameters ahead of time, no need to make any weight assumptions, and as much as possible, avoid subjective factors;
8. DEA can highlight the adjustment values of related indicators of ineffective decision-making units, giving decision-makers a point of reference;
9. Mainly used to issues involving several inputs and outputs.

3.3 Disadvantages of data envelopment analysis:

Like any other scientific model, it has a number of disadvantages which need to be acknowledged when using DEA:(Gitonga, 2013, p. 17)

1. Because DEA is a deterministic rather than a statistical method, it produces results that are sensitive to variable measurement error;
2. It compares efficiency to the best in the sample, so comparing scores from two different studies isn't necessary;
3. The linear program formulations obtained for each DMU under investigation make manual solving very time consuming and tedious;
4. In the event that input and output variables have a strong correlation, DEA's ability to evaluate will be harmed. (Guo, Hu, Shi, & Bilan, 2020, p. 4)
5. One major disadvantage of the DEA approach is the assumption that the frontier was constructed without any measurement errors. This approach ignores the

impact of measurement errors and other statistical noise, which can cause measurement results to deviate. (Guo, Hu, Shi, & Bilan, 2020, p. 4);

6. Traditional DEA models do not allow for the ranking of DMUs, particularly those that are efficient. In DEA, it's also possible that some of the inefficient DMUs perform better overall than some of the efficient ones. This is due to the problem of DEA's unrestricted weight flexibility. (Talluri, 2000, p. 9);

7. In determining DMU efficiency scores, all DEA models allow for unrestricted weight flexibility. Units can attain relatively high efficiency by using inefficient input and output weights. (Yılmaz & Yurdusev, 2011, p. 673).

According to Wagenvoort and Schure, the literature on frontier analysis mentions two major criticisms of using mathematical programming techniques: (Bank, 1999, p. 7)

8. First and foremost, the methods are extremely sensitive to outlier observations. Only one observation can cause the frontier to shift. This observation, however, could be the result of a measurement error, which would overstate the industry's technological capacity;

9. Second, any observation that is beneath the frontier is considered inefficient.

to achieve meaningful results in DEA, you must have access to assertive resources such as :

1- We can't compare DMUs that differ in these aspects because DEA considers the same strategic goals and objectives for each firm's DMUs;

2- Input and output variables have to be selected very carefully. However, information on various outputs and inputs is readily available. However, some of these data are inaccessible, and some businesses are unwilling to share information;

3- The total number of DMUs compared cannot be less than a specific number. By lowering the number of DMUs, we would enhance the proportion of effective DMUs.

3.4 Efficiency Measurement Models:

3.4.1 Non-parametric Models:

- **Data Envelopment Analysis:**

Making units' relative efficiency based on a variety of output and input data. The expression "relative" is critical because an institution that the DEA identifies as an efficient unit in one

data set might be considered wasteful when contrasted with another informational collection. (Yeh, 1996, p. 981)In other words, efficiency estimates are considered relative rather than absolute because they can change as the set of firms changes, and a firm that was efficient can become inefficient and vice versa.

Charnes, Cooper, and Rhodes introduced data envelopment analysis for the first time. (CHARNES, COOPER , & RHODES , 1978) which was derived from Farrell's seminal work on peer decision-making unit performance evaluation in the presence of multiple outputs and inputs (M. J. Farrell, 1957) The DEA approach also makes it easier to figure out why DMUs fail. Empowering managers to recognize which DMUs should be the focus of their observations, to introduce change that will improve the organization's overall efficiency. (Miragaia, Ferreira, Carvalho, & Ratten, 2019, p. 7)This non-parametric approach does not necessitate a detailed specification of the production function form or the weights of differentoutputs and inputs, but it can provide explicit information on the unit's efficiency in comparison to specific efficiency units used as comparators. (Yang, Lin, & Chen, 2014)

- **A Decision-Making Unit (DMU):** is any entity that uses input to generate any type of output. The "ability of the DMU to obtain output from a specified collection of inputs" is referred to as relative technical efficiency.
- **Form:** The ideas of relative efficiency and production possibility set are used to simulate the multiplier forms (M-F) and envelopment forms (E-F) of conventional DEA models (PPS). (Peykani, Hosseinzadeh Lotfi, Sadjadi, Ebrahimnejad, & Mohammadi, 2021, p. 4)
- **Orientation:**

The efficiency or performance of DMUs in DEA is measured in three directions. They are as follows: (Peykani, Hosseinzadeh Lotfi, Sadjadi, Ebrahimnejad, & Mohammadi, 2021, p. 4)

- **The input-oriented (I-O) models:** The proportional reduction of inputs is fixed in the input-oriented (I-O) models.
- **The output-oriented models:** The output-oriented (O-O) models consider the possibility of a proportionate rise in outputs while keeping the inputs constant.
- **Non-oriented methods**: In non-oriented (N-O) DEA models, the inputs are reduced while the outputs are increased.

The weights v_i μ_r and are assigned to "i" the input and "r" the output in the models below. In the functional, the subscript "0" refers to the entity under consideration, but in the constraints, it retains its original subscript. (Joro & Korhonen, 2015, p. 16)

Input-oriented model:

$$max\ h_0 = \frac{\sum_{r=1}^{s} \mu_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

s.t.

$$\frac{\sum_{r=1}^{s} \mu_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1,\ j=1,2,...,n$$

$$\mu_r, v_i \geq 0, r = 1,2,...,s, i = 1,2,...,m$$

Output-oriented model:

$$min\ f_0 = \frac{\sum_{i=1}^{m} v_i x_{i0}}{\sum_{r=1}^{s} \mu_r y_{r0}}$$

s.t.

$$\frac{\sum_{i=1}^{m} v_i x_{ij}}{\sum_{r=1}^{s} \mu_r y_{rj}} \geq 1,\ j=1,2,...,n$$

$$\mu_r, v_i \geq 0, r = 1,2,...,s, i = 1,2,...,m$$

There is a third option, represented by the additive and SBM models, which cope with input excesses and output shortages concurrently in such a way that maximizes both. (COOPER, SEIFORD, & TONE , 2007, p. 115)

- **Returns to Scale:** Data envelopment analysis employs common methods. CRSand VRSmethods are used.

The main difference between the BCC and CCR models is that the BCC model is more adaptable and assumes VRS, in contrast to the CCR model's assumption of CRS.IRS and DRS are the two models that comprise VRS.

In the following manner, a particular DMU's many outputs and inputs are linearly combined into a single 'virtual' output and input:(Widiarto & Emrouznejad, 2015, p. 9)

$$Virtual\ output = u_1 y_1 + \ldots + u_r y_r = \sum_{r=1}^{s} u_r y_r$$

$$Virtual\ Input = v_1 x_1 + \ldots + v_i x_i = \sum_{i=1}^{m} v_i x_i$$

$$Efficiency = \frac{Virtual\ output}{Virtual\ intput} = \frac{\sum_{r=1}^{s} u_r y_r}{\sum_{i=1}^{m} v_i x_i}$$

- **Efficient Frontier:** referred to as "frontier line" is the line connecting the most efficient points. Because an efficient frontier envelope other data points, it is referred to as "DEA" (R, Kumar, Singh, Verma, Venkatesh , & Gupta, 2017, p. 82)
    - The frontier line depicts the unit's performance in comparison to others.
    - The deviation of points from the frontier line may be used to determine the efficiency of other units. The efficiency of other units is measured in terms of the efficient frontier serves as a reference point.

      There are non-convex DEA models: (Klumpp & Loske, 2021, p. 852)

1. Deprins, Simar, and Tulkens proposed a non-convex Free Disposal Hull in 1984.
2. Tulkens introduced the non-convex Free Replicability Hull (FRH) in 1993, and Agrell and Tind offered it in 2001.
3. Agrell and Tind suggested the non-convex Elementary Replicability Hull (ERH) in 2001.

- **Free Disposal Hull (FDH):**

Free Diposal Hull is a term that was first used in 1978 by Mac Fadden in his paper "cost revenue and profit functions." (Aliyu, 2018, p. 3). FDH was suggested by DEPRINS, SIMAR, and TULKENS (1984) and TULKENS (1986, 1993) this paper serves as a fresh, non-parametric, deterministic reference technology for the assessment of productive efficiency. (BORGER, KERSTENS, MOESEN , & VANNESTE, 1994) We make no extant assumptions about the impact on the size, and we don't even assume that we can make linear interpolations (convex combinations) between two points when we use the Free Disposability Hull (FDH). (AGRELL & BOGETOFT, 2009, p. 37)

FDH can assess efficiency by contrasting the unit under observation with the actual unit. (Safari, Jafarzadeh, & Fathi, 2020, p. 207) Only strong free disability in inputs (i.e., positive monotonicity) and outputs are imposed by FDH (i.e., nestedness of input requirement sets). (Borger, Ferrier, & Kerstens, 1998, p. 429) The technical efficiency FDH of DMU is assessed in relation to the set's free disposability frontier (free disposal hull) as follows: (Souza, Gomes, & Alves, 2017, p. 97)

$$\psi = \left\{ (x,\ y) \in R_{+}^{3+1},\ y \leq \sum_{j=1}^{n} \gamma_j\ y_j, x \geq\ \sum_{j=1}^{n} \gamma_j x_j, \sum_{j=1}^{n} \gamma_j = 1, \gamma_j\ \in\ \{0,\ 1\},\ j\ =\ 1 \ldots n \right\}$$

The input-oriented FDH efficiency measure is given by

$$\hat{\theta}(x_\tau,\ y_\tau) =\ Min\left\{ \theta;\ y_\tau\ \leq\ \sum_{j=1}^{n}\ \gamma_j\ y_j\ ,\ \theta\ x_\tau\ \leq\ \sum_{j=1}^{n} \gamma_j x_j, \sum_{j=1}^{n} \gamma_j = 1, \gamma_j\ \in\ \{0,\ 1\} \right\}$$

The output-oriented FDH efficiency measure is given by

$$\hat{\lambda}(x_\tau,\ y_\tau) =\ Max\left\{ \lambda; \lambda y_\tau\ \leq\ \sum_{j=1}^{n}\ \gamma_j y_j\ ,\ x_\tau \geq \sum_{j=1}^{n} \gamma_j x_j, \sum_{j=1}^{n} \gamma_j = 1, \gamma_j\ \in\ \{0,\ 1\} \right\}$$

The FDH model was first presented as a DEA model with VRS, with binary activity variables that excluded linear combinations of observed production plans.(Leleu, 2006, p. 341)

It is worth mentioning that, unlike the CCR and BCC models, the FDH model does not make use of the convexity assumption. As a result, because this model is discrete, an inefficient DMU's efficient target point is simply designated as an example of those DMUs that have been observed. As a result, the efficiency analysis is carried out about the other specified DMUs rather than a hypothetical efficiency border. This has the benefit of giving an inefficient DMU's attainment goal—provided by its efficient target point—more credibility than it would have otherwise had for CCR and BCC models. (Abbasi, Jahanshahloo, Rostamy-Malkhlifeh, & Hosseinzadeh Lotfi, 2014, p. 2)

- **Free Replicability Hull (FRH):**

In his 1993 article ON FDH EFFICIENCY ANALYSIS: SOME METHODOLOGICAL ISSUES AND APPLICATIONS TO RETAIL BANKING, COURTS, AND URBAN TRANSIT, Henry Tulkens introduced FRHas **an** expansion of FDH (Tulkens, 1993). Integer replications of observations are supported by the model. The binary condition is replaced by the integrality condition. Mixed integer programming is used to solve the program. (Magáthová, 2002, p. 36)

The free replicability approach takes into account DMU combinations that are integers. Let x^j y^j and indicate the vectors for the output and input of the j th DMU. Consider a certain DMU with input vector x^0 and output vector y^0. Let j = 0, ... , n, i.e. we have n + 1 DMUs. Let θ, be λ_j variables, j = 0, ... , n. (Ehrgotta & Tind, 2009)

The free replicability approach can then be expressed as follows.:(Ehrgott & Tind, 2008, p. 4)

$$min \quad \theta$$

$$s.t. \quad \theta x^0 - \sum_{j=0}^{n} x^j \lambda_j \geq 0$$

$$\sum_{j=0}^{n} y^j \lambda_j \geq y^0$$

$$\lambda_j \geq 0 \; and \; integer \; (j = 0, \ldots, n)$$
$$\theta \qquad free.$$

FDH is a modified version of FRH (free replicability hull). Higher efficiency scores and cost norms are obtained using VRS (variable returns to scale). The production function of the firm determines whether to use DRS (decreasing returns to scale) or IRS (increasing returns to scale). (BATCHIMEG, 2017, p. 22)

- **Elementary Replicability Hull:**

Replicability relates to the skill of obtaining consistent results across studies addressing the same scientific question, each of which has collected its data. Individual integer replications of individual observations are allowed in the ERH (Elementary Replicability Hull) model, but their combinations are rejected. The following is the condition for the vector: (Magáthová & Lukáčik, 2002, p. 36)

$$\forall h \forall j \neq h \lambda_h \lambda_j = 0, \lambda_h \in Z_+$$

3.4.2 Parametric Models:

- **Stochastic Frontier Approach:**

Aigner, Lovell, and Schmidt (1977) and Meeusen and van der Broeck (1977) were the first papers to use SF analysis (1977). The standard presentation of the SF model starts with a production function (f) that connects output (q) to the utilization of various inputs (x) through a set of unknown but estimable parameters (β). (Soto & Vásquez, 2011, p. 16)In the classic stochastic frontier technique, where the frontier function is the same for each business, we estimate inefficiency relative to the frontier for all data. (Kumbhakar & Tsionas, 2011, p. 10)Modeling of the departure from the efficient border is done using a compound error term. The compound error term is the product of a normally distributed noise term and an asymmetrically distributed "inefficiency" component, both of which are always negative. The negative component represents firm deviations from the efficientborder caused by inefficient production structure, whereas the normally distributed term represents random deviations from the efficient frontier caused by factors such as data measurement errors. The stochastic frontier model, in its most general form, can be written as: (Dudu, Cakmak, & Öcal, 2015, p. 51)

$$y = F(x;\beta)\exp(\mathrm{v}-\mathrm{u})$$

Where,

$$v \sim \mathrm{N}(0,\sigma_v^2)$$

$$u \sim \left|\mathrm{N}(0,\sigma_u^2)\right|$$

SFA has the advantage of allowing the residual to be decomposed into two terms: statistical noise and the inefficiency effect. As a result, SFA generates a stochastic frontier. In terms of drawbacks, it necessitates an a priori determination of a specific functional form, which determines the contour of the efficient frontier and a probability distribution for the efficiency levels of banks. When the contour is inconsistent with the data, the stochastic process is biased inductively by the chosen functional form, which could significantly impair the outcomes. (Silva, Tabak, Cajueiro, & Dias, 2016)

- **Thick Frontier Approach:**

In order to address some of their concerns with the SFA method, Berger and Humphrey (1991) developed the thick frontier analysis, or TFA, as an alternative. Berger and Humphrey argued in their article that the normal-half normal specification of the composed error term, which is commonly assumed in stochastic frontier estimation, suggests that the majority of the observations should be clustered towards maximum efficiency. Berger and Humphrey contended that, at least for bank cost data, the cost distribution has a thicker tail than the normal-half normal frontier model allows. To address this issue, Berger and Humphrey proposed a thick frontier, which is a frontier based solely on the lowest quartile of average costs in each of several size categories. (Caudill, 2002, p. 310). This method begins with sorting the data on average costs. It then calculates two "thick-frontiers," one for the lowest and one for the most expensive quartile of firms. These regressions are carried out independently for each year in the sample. The average inefficiency of the top firm's quartile is then calculated by comparing the two thick frontiers. (Bank, 1999, p. 9).

- **Distribution Free Approach:**

Berger developed the DFA (1993). This method assumes that cost differences due to inefficiency are stable over time, whereas random errors vary and tend to zero over time. The idea of a firm-effect of efficiency underpins the long-term stability of each bank's inefficiency. Berger (1993) states that good management maximizes long-term profitability

by keeping expenses low over extended periods of time., though costs may vary from trend due to luck and management error." Managers of firms do not influence their efficiency from one year to the next by preferring a long-term perspective. All of the variations are due to chance or measurement errors. (ALSALKHADI, 2012, p. 17)

The distribution-free method is employed to determine the best quantities that maximize the projected profit for the company when the stochastic demand distribution is unknown. (Raza, 2013). In order to create a lower bound prediction of the revenue function, $\tilde{\pi} = \tilde{\pi}(\tilde{p}, \tilde{q})$ the following relationships must be used to minimize the function: (Raza, 2013).

$$min\{q, D\} = q - E_{\xi}[q - D] +$$
$$E_{\xi}[q - D]^{+} = q - E_{\xi}(D) + E_{\xi}[D - q] +$$
$$E_{\xi}[D - q]^{+} = E_{\xi}(D) - q + E_{\xi}[q - D] +$$

To maximize the above-mentioned function, we require the following: (Alfares & Elmorra, 2005, p. 467)

Lemma 1.

$$E(D-Q)^{+} \leq \frac{\left[\sigma^2+(Q-\mu)^2\right]^{1/2} - (Q-\mu)}{2}$$

Lemma 2.

$$E(Q-D)^{+} \leq \frac{\left[\sigma^2+(\mu-Q)^2\right]^{1/2} - (\mu-Q)}{2}$$

Conclusion:

Financial management is the most important function in any organization. Owners and business managers, in particular, bear the burden of being aware of management decisions that affect cash flow and profits. The significance of financial management stems from how it decides a company's growth and success. Financial managers are accountable for keeping track of all firms' spending, developing a budget for all firm activities, and ensuring that all expenses are within the budget. This helps them to fix the issue if the cost exceeds the anticipated amount by taking all required actions.

Efficiency denotes the highest level of performance achieved by using the smallest number of inputs to produce the greatest number of outputs. That means reducing the number of unneeded resources spent to create a given output, including personal time and energy, to increase efficiency. That is important for both managers and employees. Efficiency is considered one measure of success for a firm by how many people deal with it. However, efficiency should never be used as the sole criterion for making critical decisions like financing, investment, and dividend decisions.

Chapter Three:

Literature Reviews

Introduction:

The review of the literature is based on relevant previous studies from several countries that have different types of markets (developed, developing, and emerging) relating to the concept of financial efficiency, data envelopment analysis, and multistage data envelopment analysis. By adopting multistage DEA for the period from 2012 to 2017, our study will address a gap in evaluating financial efficiency in GCC Islamic banking from the above, this chapter was divided into the following three sections:

- In the first section, "Review of relevant literature"
- In the second section, we will comment on the literature reviews.
- In the third section, a summary of the related literature.

Chapter Three: Literature Reviews

1. Review of relevant literature

Existing studies in this area are categorized into three gatherings. The first set includes studies that assess financial efficiency using different models. The second set includes studies that evaluate the efficiency by utilizing data envelopment analysis. The third set includes studies that measure efficiency using multistage data envelopment analysis.

1.1 Relevant literature reviews of financial efficiency:

Financial efficiency assesses the capacity of a business to generate net income from its resources and the viability of its delivery, purchasing, estimating, and financing. In the present study, we used multistage DEA to evaluate efficiency in GCC Islamic banks. While there is no lack of literature on DEA in banking, the same cannot be said about financial efficiency. No literature has yet been used on the financial efficiency of GCC Islamic banking. Relevant literature reviews of financial efficiency are as follows:

(Kablan, 2012) aimed to evaluate the efficiency of the microfinance institutions in the West African Economic and Monetary Union following the changes made to the sector. The study used DEA to measure social efficiency from one viewpoint and financial efficiency from the other viewpoint. The sample of the study consisted of 104 MFIs that provided financial statements to BCEAO from 2002 to 2006. The findings indicated that there is financial efficiency improvement at the expense of social efficiency. MFIs that place a strong emphasis on outreach are less efficient. Reforms also have a negative impact on social efficiency while having favorable effects on financial efficiency. Indeed, the implementation of prudential ratios and accounting rules caused MFIs to prioritize their intermediation role.

For the study **(Gill, Biger, & Mand, 2013)** which explored the links between changes in corporate leverage, changes in financial efficiency, and changes in the determination of dividends by Indian businesses for the period 2009–2012, a sample of all 500 largest businesses were chosen. The study used a co-relational and non-experimental research design. The findings discovered that changes in corporate leverage create changes in financial efficiency, and changes in corporate leverage and financial efficiency generate changes in dividend decision-making in

Indian enterprises. The data also suggested that corporate leverage and financial efficiency have a factor in determining the proportion of dividends to pay.

(Owolabi & Ajayi, 2013) conducted a comparative analysis on the financial efficiency of Nigerian banks before and after mergers and acquisitions to achieve increased financial efficiency from 2002 to 2009 for a sample of three Nigerian banks. The information gathered was analyzed using the t-test statistic at the 5% level of significance with the assistance of the statistical package for social science (SPSS) by using gross earnings, profit after tax, and net assets of the selected bank as indices to determine financial efficiency by comparing mergers and acquisitions before and after the indices for the period under review. It was discovered that the period following mergers and acquisitions was more financially efficient.

(Zhang , Feng , Xu , & Jiao, 2014) developed a dynamic stochastic frontier model to assess financial efficiency in regions and gave an empirical evaluation of the model using panel data from 62 Chinese counties from 2001 to 2010. The variables of the research included FEVA, labor, and assets. The findings revealed a gradient variation in China's regional financial efficiency. Because of rising economies, financial efficiency is particularly high in the Pearl River Delta area, the Yangtze River Delta area, and the area surrounding the Bo Sea, and relatively poor in the Northeast, Central, and Western areas. It is difficult for The financial efficiency of emerging economies to reach the Pareto optimum completely through the immature market.

(Yildirim, 2015) Data Envelopment Analysis and the Malmquist Index were used to calculate the total factor productivity change. The survey included 17 Islamic banks from Turkey and Malaysia. The levels of financial efficiency of these banks were discovered between 2010 and 2014. The study employed total assets and total equities as inputs and total deposits and net profit/loss as outputs. According to the findings, in both Turkey and Malaysia, 50% of all these Islamic banks meet the CCR value for technological productivity. In other words, 50% of all these Islamic banks can make good use of their total assets and total equity. It was discovered that the Technical Efficiency Change (EFFCH) The value of Islamic banks was never documented to be more than one for any period. The Islamic banks were discovered to be unlikely to reach the production limit.

(Zouhaier, 2015) used a panel data model to investigate the connection between the level of financial efficiency, competitiveness, and profitability of Islamic banks for a sample of 29 selected Islamic banks during the eight years from 2005 to 2012. The study attempted to precisely measure the importance of financial efficiency (costs, profits, capitalization, and liquidity) on Islamic bank profitability. The results showed that cost efficiency, as represented by the CTIR and NIER ratios, has a favorable influence on Islamic banking profitability. The two OPIR and REP ratios, which approximate efficiency profit, have a favorable influence on Islamic banking profitability. The EA's capitalization ratio has a detrimental influence on Islamic bank profitability. The liquidity ratio has a positive impact on the profitability of Islamic banks. The inflation rate, as a proxy for the macroeconomic environment, has a favorable effect on profitability of Islamic banks.

(Liu, Hu, & Tang, 2016) employed the DEA super efficiency SBM model to gauge regional financial efficiency and experimentally investigate the regional effects of fiscal decentralization in China's 281 prefecture-level cities from 2003 to 2012. The study used financial efficiency as a dependent variable, whereas the independent variables were decentralization of fiscal expenditures and revenue decentralization. The calculated results revealed that regional financial efficiency has considerable spatial spillover effects due to space-time dependence and time inertia. The symmetry between decentralization of revenue and expenditures determines the positive boost of fiscal decentralization's impact on financial efficiency in the local region. Furthermore, the spatial impacts of revenue decentralization on fiscal expenditure and financial efficiency in nearby regions are inconsistent. Fiscal revenue decentralization has a greater detrimental impact on the financial efficiency of neighboring regions than fiscal spending decentralization.

(Hu , Zhang, & Chao, 2018) investigated financial efficiency and economic development in China using a sample of 30 regions during the period 2005–2013. The DEA approach was used. The study used mechanism number, financial practitioner, and total assets as input variables. In contrast, deposits and loans are output variables. The findings indicated that Economic growth is only encouraged by financial efficiency once it reaches a particular level (financial threshold). When it crosses the threshold, It boosts the accumulation's capacity and distribution of financial resources. Rapid financial Development may offer a more favorable financial environment and

enhanced circumstances for economic growth, promoting the Chinese economy's continual improvement.

(Sin, 2019) also calculated a firm's financial efficiency by taking into account both input and acquisition capital. The study used a three-dimensional DEA approach for a sample of 33 Korean car parts manufacturers. The input variables were total assets, total capital, sales, EBITDA, and net income. Whereas the output variables were sales, EBITDA, net income, borrowings, and total debt, the results revealed that when compared to the capital acquisition, there are many ineffective businesses. Meanwhile, management performance was inefficient when compared to input assets; nonetheless, certain firms were productive in terms of capital procurement. As a result, when assessing a company's efficiency, efficiency techniques as well as measurement metrics that account for both input and acquisition capital are essential. As a result, when assessing a company's efficiency and efficiency techniques, it is vital to use measurement values that account for both input and acquisition capital.

(Wang, Yang, Chiu, & Lin, 2020) analyzed the impact of digital finance on financial efficiency by using panel data for a sample that consisted of 30 administrative provinces in China during the period 2011–2017. The study used the number of financial organizations and financial personnel as input variables, and loan balances, premium income, amount of securities trading, digital financial inclusion index, and financial assets as outputs. The findings demonstrated that digital banking has marginally enhanced financial sector efficiency, although there are considerable variances in the influence of China's provincial efficiency. Although financial sector efficiency favorably corresponds while digital financial efficiency benefits underdeveloped regions, digital finance disadvantages them. The eastern region's financial industry has a much greater efficiency score than the non-eastern zone. The growing influence of digital finance on financial sector efficiency is greater in the east of the region than in the non-eastern zone.

(RIBEIRO, NOGUEIRA, LINHARES , & da SILVA, 2020) used panel data to investigate the factors that affected the financial efficiency of Portuguese municipalities from 2008 to 2016. The determinants were grouped into three groups: sociodemographic, political, and budgetary. The model's dependent variable is a financial efficiency index. The findings indicated that political factors had little effect on municipal financial efficiency. In terms of sociodemographic

variables, it has been discovered that location, purchasing power index, tourism, and unemployment rate all have an impact on municipal financial efficiency. Tax income and financial independence are budgetary drivers that have a favorable impact on municipal financial efficiency. Staff expenditure has a negative effect on it.

(Yu & Li, 2021) evaluated the financial efficiency of interprovincial industrial companies in China dynamically and measured the levels of major impacts on the financial efficiency of quantitative data about Chinese interprovincial industrial firms from 2007 to 2019. The study used the Malmquist Index model. It selected total assets, employment, total water consumption, and total energy consumption of interprovincial industrial enterprises as inputs. whereas, the profit of industrial enterprises, total industrial output, industrial wastewater discharge, industrial waste gas discharge, and the total amount of industrial solid waste as the output indicators. According to the findings, there is a rather large financial efficiency gap among industrial enterprises in different Chinese provinces. The main element influencing the increase of financial efficiency in Chinese industrial businesses is technological change, with technical efficiency having a minimal impact. The findings found that indicated that enterprise efficiency analysis, primary business costs, the national capital, the number of R & D employees, total liabilities, as well as operating profit, all have an important effect on the financial efficiency of Chinese industrial businesses.

1.2 Relevant literature reviews of data envelopment analysis:

There are many studies about DEA and its application in several sectors, such as business firms, financial institutions, government agencies, and non-profit organizations. The main function of DEA is to estimate relative efficiency among identical decision-making units that have the same processing procedure to produce equivalent results by using similar inputs. Relevant literature reviews of data envelopment analysis are as follows:

(Tahir, Baka, & Haron , 2009) Used the DEA approach to investigate the technical efficiency, breakdown of pure technical efficiency, and scale efficiency of local and overseas Islamic banks from a few Southeast Asian nations. Over the period 2006–2014, the sample included 29 Malaysian Islamic banks, including native and international, Indonesia, and Brunei. The study utilized Total Deposits, Total Labor, and Total Capital as inputs, whereas Total Loans and Total

Investment were outputs. The findings demonstrated that native Islamic banks outperformed their foreign bank counterparts in terms of efficiency. Furthermore, native Islamic banks have better levels of efficiency in all three efficiency measures, which is consistent with the home-field advantage theory.

(Moussawi & Obeid, 2010) proposed a DEA method for assessing the successful operation of GCC Islamic banks from 2005 to 2008. The study used Total Deposits, Total Fixed Assets, Interest Expenses, Personnel Expenses, and Other Operating Expenses as inputs, whereas Total Earning Assets and Net Commissions Revenue were outputs, by applying this method to a sample of 23 Islamic banks. The findings revealed that technical and allocative inefficiencies increased bank costs by 14 and 29 percent, respectively, and that both internal and external factors appear to play a significant role in the evolution of the efficiency scores of Islamic financial institutions present in the GCC.

(Ajlouni, Hmedat, & Hmedat, 2011) also looked into the factors that influenced the relative efficiency of Jordanian banks for a sample of 11 commercial banks from 2005 to 2008. They also looked into the factors that influence such efficiencies, such as the size and capitalization of the bank. It used two inputs (total deposits and total expenses (interest and non-interest expenses)) and two outputs (total loans and net investments). The results revealed that the average efficiency score of the sample banks is substantial and steady throughout time. Another significant finding is that larger banks outperform smaller and medium-sized banks based on relative efficiency.

(Tahir, Bakar, & Haron, 2011) Utilized Data Envelopment Analysis to explore technical and scale efficiencies to investigate the efficiency of Islamic banks in four regions: Africa, the Middle East, Central Asia, Europe, and the Far East between 2003 and 2008. It used total deposits and overhead expenses as input and total loans and earned assets as output. According to the results, the average efficiency of Islamic banks fell from 0.746 in 2003 to 0.544 in 2008. Pure technical inefficiency has contributed significantly to overall inefficiency of Islamic banks. Based on a series of parametric and non-parametric tests, there are considerable variations in efficiency between sizes but not between regions. Large banks are more effective than small and medium-sized banks.

(Srairi, Kouki, & Harrathi, 2012) used data envelopment analysis to estimate the efficiency of 25 GCC Islamic banks from 2003 to 2009. The study used employee expenses, other operating expenses, and loan loss provisions as inputs, while net interest income and other operating income were as outputs. The findings revealed that efficiency measures, particularly pure technical as well as technical efficiency, increased during the research period but remained low when compared to conventional banks. The inefficiency of Islamic banks can be attributed to sheer technical inefficiency rather than scale inefficiency. Small and big banks are more effective than medium-sized banks regarding total technical efficiency. Furthermore, they research the connection between efficiency of Islamic banks and the performance of their stock. According to the empirical findings, changes in share returns are favorably correlated with pure technical efficiency and technical efficiency, whereas changes in scale efficiency do not affect stock performance.

(Onour, 2012) used DEA and bootstrap simulation to investigate the impact of some critical financial ratios on the technical efficiency performance of thirty-six GCC banks from 2006 to 2008. The study utilized salaries, wages, and deposits as inputs and loans and net incomes as outputs. The results indicated that the drop in the technological efficiency of GCC banks during the worldwide financial crisis was caused by a simultaneous drop in scale efficiency and pure technical efficiency. In 2008, the average output loss due to scale inefficiency (a reduction in scale operations below the ideal level) was estimated to be 16%, up from 5% in 2007. The size of the bank is inversely related to scale efficiency, implying that a subpar operation size is a primary cause of scale inefficiency in GCC banks.

(Zeitun, Abdulqader, & Alshare, 2013) DEA from the GCC was utilizedto com assess the effectiveness of 65 conventional and Islamic banks from 2002 to 2010.The study used total fixed assets, total assets, total deposits, personnel expenses, and total equity as inputs and total loans, net income, and total other earnings as outputs, the empirical findings showed that the proposed input variables are significantly related to the output variables. The input and output combinations influence the efficiency scores of both regular and Islamic banks. Three out of five DEA models produced using the Constant Return to Scale and Variable Return to Scale processes show Islamic banks to be significantly less efficient than regular banks. The efficiency status of these banks is not significantly different from the other two DEA outcomes.

(Johnes, Izzeldin, & Pappas, 2014) The study utilized financial ratio analysis as well as data envelopment analysis to assess the effectiveness of the GCC region's Islamic and conventional banking systems from 2004 to 2007. The study utilized deposits and short-term funding, general and administrative expenses, equity as inputs, and other earning assets and total loans as outputs. The findings revealed that the two methods complement one another. According to the FRA, Islamic finance is less cost-effective but more income and profit-efficient than the conventional system. Bootstrapped tests confirm the significance of these differences. According to the DEA, average efficiency of Islamic banks is significantly lower than that of conventional banks. A breakdown of the efficiencies demonstrated that working under Islamic laws (i.e., the banking system itself) accounts for the efficiency disparity rather than poor management. Productivity expansion has been modest, which is attributable to inefficient banks' slow adaptation to technological advancements.

(Kamarudin, Nordin, Muhammad, & Hamid, 2014) applied the DEA method to examine the cost, revenue, and profit efficiency levels of 74 banks (47 conventional and 27 Islamic banks) in the GCC countries from 2007 to 2011. The study used deposits and labor as inputs, while loans and income were as outputs. The results found that revenue efficiency appears to be the primary factor influencing whether profit efficiency is low or high. In essence, higher revenue efficiency only has a favorable influence on higher profit efficiency levels in Islamic banks. The results revealed that profit efficiency is lower than cost efficiency as a result of the higher revenue efficiency; hence increasing revenue efficiency levels will not have an impact on profit efficiency conventional banks. Additionally, statistically, significant cost differences exist, in revenue, and profit efficiency among Islamic and conventional banks in GCC countries. The study's results are anticipated to greatly advance knowledge of how the conventional and Islamic banking sectors operate in the GCC, the bank's specific management, and policymakers. That could make things easier for future directions for the sustained competitiveness of GCC conventional and Islamic banking activities.

(Rajput, Chopra, & Oberoi , 2014) used DEA to measure and compare efficiency ratings of PSBs, FBs, and private sector banks active in India between 2008 and 2013. The study used deposits, the number of employees, operating expenses, and investments as inputs, whereas the return on assets, interest income, and non-interest income together as net profits as outputs. The

results revealed that there is a consistent increase in the net profits of PSBs and private banks in comparison to foreign banks. In terms of efficiency scores, foreign banks have shown significant improvement. Indian banks must strengthen their technical orientation in order to continue their efforts to minimize the percentage of NPAs and increase their profitable efficiency as soon as possible. They must also be alert to potential acquisition opportunities.

(Sillah & Harrathi, 2015) employed data envelopment analysis to develop efficiency measures for both traditional and Islamic banks and to undertake means tests to compare the efficiency of bank types in GCC nations (28 conventional banks and 20 Islamic banks) from 2006 to 2012. The study used total deposit, general expenses, fixed assets, and equity as inputs, while total loans and investments as outputs. The results revealed that there was no evidence of a difference in efficiency between the two sorts of banks, and based on the supposition of a variable return to scale, conventional banks were found to be more efficient than their Islamic counterparts at two points in time, 2009 and 2010, following the 2008 financial crisis. In Saudi Arabia, Kuwait, and Qatar, the two bank types are the same for within-country efficiency comparisons. Traditional banks are more effective than their Islamic counterparts in Bahrain and the UAE. According to the Malmquist productivity analysis, there is no evidence of technological improvements in banking operations.

(Islam & Kassim, 2015) used Data Envelopment Analysis to compare the efficiency of traditional andIslamic banks in Bangladesh and examined 25 commercial banks, seven of which are Islamic and eighteen of which are conventional, from 2009 to 2013. The study utilized three inputs (Total Deposits, Fixed Assets, and Personnel Expenses) and three outputs (Total Loan, Other Earning Assets, and Off-Balance Sheet Items). The results revealed that Islamic banks are efficient in technology, but their scale efficiency is inadequate, implying that scale inefficiency is the primary inefficient source in Islamic banks. In opposition to that, traditional banks are found to be purely technically inefficient, but their scale efficiency is satisfactory.

(Kamarudin, Sufian, Nassir, & Anwar, 2015) investigated the pure technical efficiency, technical efficiency, and scale efficiency of GCC banks using DEA. PTE and SE are both potential factors influencing the efficiency of GCC banks from 2007 to 2011. The study used assets and deposits as inputs and income and loans as outputs. The findings revealed that GCC banks operate on an optimal scale. Nonetheless, the results were tainted by managerial

inefficiency in resource utilization, even though TE, or managerial efficiency, increased to 83.6 percent in 2011. Furthermore, smaller banks (the 21 smallest) were more likely than larger banks (the 22 largest) to operate at CRS or rising returns to scale.

(Aghimien , Kamarudin , Hamid, & Noordin, 2016) Utilized Data Envelopment Analysis to examine the pure technical efficiency, technical efficiency, and scale efficiency of GCC banks. PTE and SE are two potential variables that could affect how effectively the GCC banks operate. 43 GCC banks in total were monitored for the duration of this investigation, which ran from 2007 to 2011. The study used deposit and total assets as inputs, with income and total loans as outputs. The results revealed that many GCC banks are operating within an optimal scale of efficiency. Nevertheless, the results also indicated ineffective resource management on the part of management. The results also revealed that smaller banks, the 21 smallest, typically operate at CRS or increasing returns to scale, in contrast to the 22 largest banks, which typically function at CRS or falling returns to scale.

(Bahrini , 2017) who assessed and analyzed technological efficiency of Islamic banks in the Middle East and North Africa region from 2007 to 2012, using the bootstrap DEA method. The Islamic banks sampled (33 banks) were based in the MENA region. The study used labor, fixed assets, and total deposits as inputs, whereas the investment portfolio and total loans were the outputs. The main findings revealed that the main cause of total technical inefficiency was pure technical inefficiency, not scale inefficiency. This result was verified for all MENA Islamic banks and the two subsamples: GCC banks and GCC Islamic banks. Furthermore, GCC Islamic banks maintained consistent efficiency levels between 2007 and 2008, the height of the worldwide financial crisis, and the immediate aftermath (2009–2010). However, in the last two years of the review time frame,the technical efficiency of all MENA Islamic bank boards diminished (2011-2012). As a result, they advise MENA Islamic bank leaders to focus on enhancing their management procedures as opposed to growing their businesses. Intending to ensure the expansion of MENA Islamic banking, we also urge MENA financial authorities to implement some financial and regulatory measures.

(Hafez & Halim, 2019) used the DEA model to investigate the efficiency of two different banking systems operating in Egypt (Islamic versus conventional banks) for a sample of 35 banks was used to examine technical efficiency before and following the financial crisis from

2009 to 2017, The study used total deposits and assets as inputs, while income and total loans were used as outputs. The results revealed that conventional banks outperformed traditional banks with Islamic windows and Islamic banks before the financial crisis, and scale technical efficiency outperformed pure technical efficiency when analyzing traditional banks and traditional banks with Islamic windows. Pure efficiency is superior to scale efficiency in Islamic banks. Following the financial crisis, The technical efficiency of all banks has decreased. However, due to better management, Islamic banks now perform better than both traditional banks and traditional banks with Islamic windows in terms of pure technical efficiency.

(Alsharif , 2020) The DEA model and Tobit regression analysis were used to examine bank efficiency from 2005 to 2013 for a sample of 73 GCC commercial banks, while also taking into account the effect on banks listing status and ownership type efficiency. The study used deposits, fixed assets, and personal expenses as inputs, whereas other earning assets and loans were used as outputs. The findings demonstrated that all GCC nations agree that conventional GCC banks are significantly more effective than Islamic GCC banks. Additionally, it was shown that generally speaking, and across all GCC nations, state-owned GCC banks perform better than private GCC banks. However, banks listed by the GCC were less effective than GCC unlisted banks. Furthermore, scale inefficiency was the primary inefficient source in GCC banks, with GCC banks exhibiting a decreasing return to scale. As a result, GCC policymakers and regulators should oppose any expansionary strategy in the banking sector.

(Khokhar, Hassan, Khan, & Amin, 2020) used data envelopment analysis to examine and compare the performance of 63 GCC banks (21 Islamic and 42 conventional) at two tiers from 2010 to 2016. Each country is subjected to an industry-level analysis in the first tier, followed by an individual bank-level analysis in the second tier. The study utilized capital, assets, and deposits as inputs, whereas investment, advances, and income were outputs, and discovered that, in terms of efficiency, Islamic banking is on par with, if not better than, conventional banking. Banking in Bahrain and Saudi Arabia, in particular, is among the best, whereas there is no room for improvement in the UAE's banking industry. Lack of standardization in products and plans, as well as a lack of caution in decision-making, governance, and operations, may be to blame for this subpar performance. At the bank level, many Islamic banks perform better than traditional banks. Most studies on the MENA and GCC focus on development factors and indicators, in addition to the expansion of the banking business in general.

(Samad, 2021) used Bootstrap DEA to assess the 90% estimate of the confidence interval of the bias-corrected overall technical efficiency, bias-corrected pure technical efficiency, and bias-corrected scale efficiency of GCC Islamic banks between 2014 and 2016. The study used Emexpse, CAP, and deposits as inputs, while earning assets and loans were outputs. The results revealed that the bias-corrected pure technical efficiency (PTEBC) and bias-corrected scale efficiency (SE) were found to be 91 percent and 59.8 percent, respectively, and thus PTEBC dominated the OTBBC at 82.4% and the SE at 59.8 percent of the GCC Islamic banks. Moreover, the DRS was the source of the inefficiency of the GCC's Islamic banks, except for Qatar's Islamic banks. GCC banks were inefficient because they were governed by the IRS or DRS. The primary source of inefficiency was DRS in all three efficiencies.

(Alsharif, 2021) DEA was employed on all publicly traded Saudi Arabian banks to assess the effectiveness of Saudi Arabian banks and look into how they related to stock performance over the period 2006–2018. The study used fixed assets, personnel expenses, and deposits as inputs and other earning assets and loans as outputs. The findings demonstrated that Although Saudi banks are more technically efficient, their price efficiencies are less stable. Furthermore, stock performance is positively correlated with improvements in bank efficiency. However, these positive relationships with modifications to scale and profit efficiency measures are only statistically significant, indicating payment from investors paying close attention to future dividends and profitability of the bank.

1.3 Relevant literature review of Multi-stage data envelopment analysis:

In the literature, there are a large number of DEA models for modeling banking efficiency and performance. Researchers have used various DEA models to evaluate the bank's performance branches. In the present study, we selected a version called multistage-DEA to assess the efficiency of GCC Islamic banks. Relevant literature reviews of multi-stage DEA are as follows:

(AKIN , KILIÇ, & ZAĐM, 2009) used two-stage DEA to investigate the efficiency of the Turkish banks from 2002 to 2007 for a sample of thirty-one banks that operated continuously during this period. The number of employees, interest expenses, non-interest expenses, and total deposits was determined as inputs in the research model, and total credits, interest revenue, and

non-interest revenue were determined as outputs. The goal of this analysis is to use a collection of explanatory variables such as size, ownership type, and ethnicity to examine differences in efficiency scores and whether or not the company is publicly traded. The findings revealed that efficiency levels did not differ noticeably between 2002 and 2007. In 2005 and 2006, the efficiency scores were at an all-time high. Smaller banks outperform larger banks in expressions of efficiency. Banks become less efficient as they grow in size. The results of the regression analysis demonstrated that all of the explanatory variables have a substantial impact on the efficiency levels of banks, and the size of banks has a negative influence on their efficiency levels. Banks that are publicly traded are more effective than those that are not. Banks with foreign ownership perform better than their domestic competitors. State-owned banks are also less effective than private banks.

(Paradi , Rouatt , & Zhu, 2011) used a two-stage DEA method to evaluate the effectiveness of operational components across various dimensions. The efficiency ratings from stage one were combined using a Slacks-Based Measure model to provide a composite performance indicator for each unit. An example of this strategy is provided by data analysis from a big Canadian bank with 816 branches that operate across three market sizes and five geographical regions, using both BCC and CCR input-oriented models from the three dimensions of production, Intermediation, and profitability. The results showed that medium and small branches were effective in terms of productivity and profitability. X-Large branches are the most efficient in the intermediation dimension, and the large branch group is discovered to be relatively inefficient in all three dimensions. These findings imply that the efficiency gains from a mergers and acquisitions strategy based on potential cost savings may be offset by increased operational complexity.

(Lotfi, Eshlaghy, shafiee, Saleh, Nikoomaram, & Seyedhoseini, 2012) used a two-stage DEA approach to assess the general effectiveness of bank branches of a large commercial bank in Iran in terms of profitability, efficiency, and effectiveness. In the first phase (profitability efficiency), personal expenses, equipment expenses, and operational expenses were determined as inputs, while non-operational income and the sum of deposit commissions were determined as intermediate variables. In the second phase (effectiveness), net income was identified as an output. The study revealed the significance of profitability, efficiency, and effectiveness in the

overall effectiveness of Iranian bank branches. It's important to understand how profitability, efficiency, and effectiveness relate to one another. Without these connections, we are unable to have a greater understanding of the performance as a whole.

(Wang & Lu, 2014) used a two-stage DEA method to assess the impact of marketing and profit-oriented activities on The cost-effectiveness of Taiwanese banks. From 2008 to 2011, information was obtained from 37 Taiwanese banks. Operating expenses, employees, and fixed assets were used as inputs in the first stage of "marketability efficiency," while ATM usage, deposits, charges, and commissions were used as intermediation variables. The second stage, "profitability efficiency," used interest revenue and other revenue as output. The empirical findings demonstrated that the average efficiency score of banks at the profitability stage is greater than that of the marketability stage banks', and that technical efficiency differs significantly from both operating scale and pure technical efficiency in terms of rankings; scale efficiencies differ greatly from operating scale and pure technical efficiency rankings, and scale efficiencies differ greatly from rankings based on operating scale and pure technical efficiency.

(Qamruzzaman & Jianguo, 2016) The DEA multistage approach was used to identify the financial efficiency level of banks in Bangladesh from 2011 to 2015, taking into account both output and input orientation methods under the VRS and CRS models for each year over five years. The study looked at 24 private commercial banks out of 30 that are publicly traded on the stock exchange. It used five inputs (deposit, loan, total assets, total assets, investment, and capital) and three outputs (namely, return on assets, return on equity, and net profit margin). According to the results, the overall level of technical efficiency decreases in both the VRS and CRS assumptions. At the firm level, approximately 62 percent of banks are performing efficiently under CRS, and 75 percent of banks are performing efficiently both in the input and output orientations under Variable Returns to Scale. This entails assessing the level of technical efficiency, as the banking industry as a whole is inefficient.

(Kong, Fu, & Yu, 2017) applied to evaluate Taiwanese bank efficiencies both at the operational stage and profitability stage in banking activities based on a data set consisting of 35 domestic banks in Taiwan for the period 2007–2010. In the operational stage, it used operational expenses, loanable funds, and capital stock as inputs as well as investments, performing loans, nonperforming loans, and service revenues as outputs. In the profitability stage, we used

investments and performing loans as inputs, as well as interest income and investment revenue as outputs. The results demonstrated that in the direction of the two-stage DEA approach, operational efficiency was lower than profitability efficiency. Numerous banks made too many performing loans, which should be reduced by independent banks more than by the subsidiary banks of financial holding firms. The ratio of investments to loans and the proportion of nonperforming loans to performing loans had no significant impact on efficiency.

(Gulati & Kumar, 2017) A two-stage network data envelopment analysis was used to calculate the overall bank efficiency and its decomposition in intermediation and operating efficiencies during the period 2011–2013. The study sample consisted of 46 banks. In stage one (the intermediation stage), banks used fixed assets, employees, and loanable funds (deposits plus borrowings) to produce the intermediate outputs of advances and investments. Those advances and investments are used to generate non-interest income and net-interest income in stage two (the operating stage) of the manufacturing process. According to the empirical findings, operating inefficiency is the primary source of overall bank inefficiency in India's banking sector,The intriguing result is that public-sector banks outperform private banks in terms of efficiency in the intermediation stage of the production process, whereas private banks are more effective in stage two. Finally, according to the bootstrapped truncated regression's findings, bank size, liquidity position, and directed lending all play a role in explaining Variations in the efficiency of intermediation and intermediation cost, whereas inter-bank operating efficiency differences are influenced by profitability and income diversification.

(Farandy, Suwito, & Dabutar, 2017) used the two-stage DEA method to calculate the effectiveness of Indonesian Islamic and commercial banks from 2011 to 2014 by examining elements that influenced the degree of efficiency for a sample of 10 Indonesian Islamic commercial banks. Two methods were used (the nonparametric DEA method in the first phase and the Tobit model in the second phase). In the first phase, funds, total assets, and labor costs were used as inputs, and financing and operating income were used as outputs. The DEA score was the dependent variable used to assess an Islamic commercial bank's efficiency. The independent variables used are assets, capital adequacy ratio, return on assets, the number of bank branches, and non-performing financing. The results showed that while CAR and NPF do

not have a statistically significant impact on efficiency, the variables' assets, number of bank branches and ROA have a substantial impact on the efficiency of commercial and Islamic banks.

(Fernandes, Stasinakis , & Bardarova, 2018) A two-stage DEA was utilized to evaluate the efficiency of peripheral European domestic banks and study the influence of bank-risk variables on their performance from 2007 to 2014. A Malmquist Productivity Index is used with Data Envelopment Analysis to obtain bank efficiency scores for a sample of five nations. Then, in order to get bias-corrected scores and ascertain whether modifications to the financial environment have distinct effects on the efficiency of banks, a double bootstrapped truncated regression is used. The analysis accounts for the crisis of the sovereign debt period and different levels of financial development in the countries under study. The study used interest expenses and operating expenses as inputs and total income, capital, liquidity, profit, credit, and size as outputs. The findings discovered that credit risk and liquidity are found to negatively affect productivity of banks, whereas capital and profit risk have a favorable effect on their performance. The crisis date is found to amplify these effects, whereas bank-risk variables have a greater impact on bank efficiency when lower levels of financial development are observed.

(PALECKOVA, 2019) used a two-stage DEA to determine the factors that influence cost-effectiveness in Slovak and Czech commercial banks from 2005 to 2015, and The sample included 28 commercial banks (16 Czech and 12 Slovak). In the first phase, the relative cost-efficiency was estimated using an input-oriented model with a variable return to scale. It used inputs and their prices as well as one output and its price, with deposits, the number of employees, and fixed assets as inputs. Variable costs are interest expenses, other operating expenses, and personal expenses, in that order. Total loans were chosen as outputs, and their price was interest income. and used panel data analysis to estimate the cost efficiency determinants in the two countries in the second phase. The findings discovered that larger banks with higher liquidity risk and lower net interest margin values were more efficient. It supports the cause of inefficiency identified by the DEA model: banks were highly cost-efficient. throughout the period of economic growth when inflation was lower.

(Yonnedi & Panjaitan, 2019) aimed to empirically examine the change in efficiency and productivity of 26 regional development banks (BPDs) in Indonesia from 2011 to 2016. By using Multi-stage DEA to calculate the MPI and the efficiency score to calculate total factor

productivity change, the level of efficiency of BPDs was examined using three approaches: intermediation, operation, and the asset approach. The following variables were chosen: In the first phase, it used third-party funds, interest expenses, and non-interest operating expenses as inputs, whereas loans made, non-interest income, and interest incomes were generated as output. In the second stage, it used interest expense and non-interest operating expenses as inputs, whereas non-interest income and interest income were generated as outputs. In the third stage, they used labor expenses, cost of funds, and fixed asset expenses as inputs, whereas loans provided investment or placement as an output. The multi-stage DEA results demonstrated a considerable variation in the number of efficient BPDs when the three techniques were used, based on changes in efficiency at both the scale and the growth. The findings discovered that BPDs should spend more money on technology to increase firm efficiency.

(Fukuyama, Matousek, & Tzeremes, 2020) A two-stage model was used to examine the cost inefficiency levels of Turkish banks from 2007 to 2016 for a sample of 25 commercial banks. The study used total fixed assets and the number of employees as discretionary inputs. In addition, total deposits as well as labor quality profiles (human capital) were used as intermediate inputs, with three outputs. The first output (desired output) is trading securities. The second output (undesired output) is non-performing loans (NPLs), and the third output is net loans (desired output). The findings demonstrated that the levels of cost inefficiency are primarily determined by the ability of a bank to regulate its degrees of allocative inefficiency. The empirical evidence suggests that foreign banks outperform domestic banks, while analyzing cost performance, bank ownership arrangements are significant. Finally, the global financial crisis harmed ability of banks to reduce their levels of cost inefficiency. However, post-crisis findings showed Turkish banks have started to recover from the negative effects of crisis, primarily by strengthening their allocative efficiency.

(Dutta, Jain, & Gupta, 2020) used a two-stage DEA method to measure the performance of 43 non-banking finance companies (NBFC) about India from 2014 to 2018, calculating super-efficiencies in the first phase and regressing the same on exogenous factors in the second phase. The study's overarching goal is to fill a void in the NBFC domain. Total assets and employee costs were chosen as input variables, and interest income, non-interest income, and operating profit were chosen as output variables. The findings revealed that size, income diversity, and

ROA have a substantial impact on efficiency scores, while ROE has no significant impact. According to MPI analysis, there has not been much improvement in the productivity index of 0.89 percent, and only 10 NBFCs have an MPI of more than 1%, highlighting the lack of consolidation in the NBFC industry.

(Ravanshad, Amiri, Salari, & Khodadadi, 2020) utilized a fuzzy multi-objective programming technique with a two-stage DEA method to analyze the performance of businesses in Tehran in order to look into the connection between managerial skill and firm performance. The study used the total liability ratio and total equity ratio as first stage inputs; return on equity and return on assets as intermediation variables; and book-to-market equity ratio and earnings-to-price ratio as the second stage outputs. The findings indicated that there exists a positive connection between management ability and consistent performance. It means that managerial ability is directly related to company performance. In this sense, the company's performance improves by increasing its managerial ability to better utilize resources and, as a result, increase overall efficiency.

(Wasiaturrahma, Sukmana, Ajija, Salama, & Hudaifah, 2020) used the DEA approach to examine the efficient performance of rural banks, both conventional and Islamic, in Indonesia, specifically,Bank Pembiayaan Rakyat Syariah and Bank Perkreditan Rakyat. In the production stage, they used interest/margin/profit sharing from the third-party fund, allowance for making assets expenses, administrative and general expenses, non-operational expenses, and other expenses as inputs, whereas we received interest/margin/profit sharing from loans disbursed and other revenue as outputs. In the intermediation stage, they used capital, savings, time deposits, and bank loans as inputs, whereas loans and financing were disbursed as outputs. The findings showed that although BPRS and BPR are effective in production, they are nonetheless ineffective as intermediaries. The results demonstrate that, while manufacturing is efficient, intermediation is not for BPR or BPRS. Additionally, the Tobit estimate revealed that location and capital adequacy ratio have a positive effect on these two effectiveness outcomes (CAR). These rural banks that operate in cities are more productive than others. Furthermore, in expressions of intermediation and production, both Islamic and traditional rural banks are more effective than the larger capital.

(Moutinho , Vale, Bertuzi , Bandeira, & Palhares , 2021) A two-stage DEA method was used to evaluate 58 Iberian banks' performance and look at the connection between that performance and the banks' intellectual capital (IC) efficiency over the period 2013–2016. The study used total operating expenses, the number of employees, and fixed assets as inputs, whereas total net loans and advances, total deposits, and net interest income as outputs. The findings discovered that banks can significantly increase their efficiency by improving their resource management practices; the relationship between IC's efficiency and the scores obtained in the first phase was then inferred using fractional regression. overall performance of Iberian banks is primarily based on the effectiveness of their human capital. This study emphasizes how crucial IC measurement is in assisting bank managers in making more efficient decisions.

(Jelassi & Delhoumi, 2021) used a two-stage DEA to explain and investigate the potential determinants of technical efficiency with a non-radial and radial bootstrap DEA for a sample of ten commercial banks in Tunisia (three largest publicly-owned conventional banks and seven largest private banks) from 1995 to 2017. The study used an input-oriented approach for the radial technique and the Range Adjusted Measure for the non-radial technique (RAM). First, estimates of technical efficiency were evaluated using the input-oriented and RAM model approaches. The impact of the number of potential factors on technical effectiveness was then estimated using the double bootstrap regression technique on a list of potential determinants. It used three inputs (labor, financial capital(deposits), and physical capital and four outputs (the bank’s portfolio, loans, interbank loans, and off-balance sheet commitments). The findings demonstrated that the majority of the profitability measures were insignificant to technical efficiency, implying that Tunisian banks were operating in a low-competitive environment. The input-oriented and RAM approaches produced somewhat comparable results. We discovered that the return on equity, expense-to-income ratio, loan-to-deposit ratio, and growth rate have no bearing on Tunisian banking technical efficiency. Banking technical efficiency rises with capitalization and inflation but falls with size, the number of bank branches, the management-to-staff ratio, and the loan-to-asset ratio. The post-revolution reforms centered on enforcing good governance and banking supervision rules, as well as restructuring public banks.

2. Comment on the literature reviews

2.1 Similarities and differences between previous studies.

2.1.1 For relevant literature reviews of financial efficiency:

- There are very few studies concerned with financial efficiency in the banking sector.
- Most studies used a sample from different sectors. While only two studies address the financial efficiency in Islamic banks like our study.
- Most studies used the DEAapproachto measure financial efficiency. Certain of these studies used the Panel data, except for two studies that used different models.
- The study of **(Gill, Biger, & Mand, 2013)** differs from the remainder of the studiesbecause it used a co-relational and non-experimental research design model.
- The study of **(Owolabi & Ajayi, 2013)**differs from the remainder of the studies because it used the t-test statistic to calculate financial efficiency.

2.1.2 For relevant literature reviews of data envelopment analysis:

- There are very few studies that used the comparative formula to compare performance between conventional and Islamic banks. While only one study **(Rajput, Chopra, & Oberoi , 2014)**compares the efficiency of public and private banks. And the study **(Tahir, Baka, & Haron , 2009)**between Domestic and international Islamic banks.
- All studies used the DEAapproach to measure different types of efficiency.
- Some studies assess the efficiency of GCC countries and the other in one country study **(Islam & Kassim, 2015)** or combination among different regions like the study**(Tahir, Bakar, & Haron, 2011)**in four geographic areas: Central Asia, Europe, and the Middle East, Africa, and the Far East.

2.1.3 For relevant literature reviews of multistage data envelopment analysis:

- There are a large number of previous studies models that have examined multistage DEA modeling in different areas.
- There is only one study that used multistage DEA in the bank sector to evaluate financial efficiency.
- There are very few studies concerned with financial efficiency in the banking sector.

- All studies used two-stage or multistage stage DEA to estimate efficiency by using different DEA models in each stage.

2.2 Research gap addressed by the current study:

There are many features that the current study has compared to previous studies. This study varies from the previous studies in several ways, such as:

1- This research is first, to the best of our knowledge, to evaluate GCC Islamic banks' financial efficiency by adopting multistage DEA for the period from 2012 to 2017.
2- The present study is an important framework for future studies, which sheds light on the financial efficiency of Islamic banks in the GCC and provides options on how best to move forward.
3- This study contributes to the research on evaluating financial efficiency in the banking sector. It will most likely support earlier research on this topic and add to the body of knowledge. Its findings are expected to have an important effect on regulators and policymakers, Islamic banking, investors, and other stakeholders.

2.3 aspects of benefit from previous studies:

1- The current study has benefited from all previous studies in arriving at an accurate formulation of the title of the study:" **Evaluating the financial efficiency in the banking sector by adopting multistage data envelopment analysis: A practice study on a sample of GCC banks"**
2- Previous studies have helped to identify the appropriate approach to this study.
3- The previous studies have also helped to select the input and output variables.

3. Summary of the related literature.

Table 3.3.1 Relevant literature reviews of financial efficiency

Author	Method	Objective
(Kablan, 2012)	DEA	Aimed to evaluate the social and financial efficiency of microfinance institutions in West Africa from 2002 to 2006.
(Gill, Biger, & Mand, 2013)	co-relational and non-experimental research design	Explored the links between changes in corporate leverage, changes in financial efficiency, and changes in Indian enterprises' dividend decision-making for the period 2009–2012
(Owolabi & Ajayi, 2013)	the t-test statistic	Conducted a comparative analysis of the financial efficiency of Nigerian banks before and after mergers and acquisitions to achieve increased financial efficiency from 2002 to 2009
(Zhang , Feng , Xu , & Jiao, 2014)	Panel Data	Developed a dynamic stochastic frontier model to assess financial efficiency in regions and gave an empirical evaluation of the model using panel data from 62 Chinese counties from 2001 to 2010.
(Yildirim, 2015).	DEA, MI	Discovered Islamic banks' financial efficiency in Turkey and Malaysia between 2010 and 2014.
(Zouhaier, 2015)	Panel Data	Examined the connection between the level of financial efficiency, competitiveness, and Islamic banks'profitability for a sample of 29 selected Islamic banks from 2005 to 2012.
(Liu, Hu, & Tang, 2016)	SBM-DEA	Measured regional financial efficiency and experimentally investigated the regional effects of fiscal decentralization in China's 281 prefecture-level cities from 2003 to 2012.
(Hu , Zhang, & Chao, 2018)	DEA	Examined financial efficiency and economic development in China using a sample of 30 regions during the period 2005–2013.
(Sin, 2019)	DEA	Calculated the financial efficiency by taking into account both input and acquisition capital for a sample of 33 Korean car parts manufacturers.
(Wang, Yang, Chiu, & Lin, 2020)	Panel Data	Analyzed the impact of digital finance on financial efficiency by using panel data for a sample that consisted of 30 administrative provinces in China from 2011 to 2017.

(RIBEIRO, NOGUEIRA, LINHARES , & da SILVA, 2020)	Panel Data	investigate the factors that affected the financial efficiency of Portuguese municipalities from 2008 to 2016.
(Yu & Li, 2021)	MI	Evaluated the financial efficiency of interprovincial industrial companies in China dynamically and measured the levels of major impacts on the financial efficiency of quantitative data about Chinese interprovincial industrial firms from 2007 to 2019.

Table. 3.3.2 Relevant literature reviews of data envelopment analysis

Author	Inputs and outputs	Objective
(Tahir, Baka, & Haron , 2009)	**Inputs:** - Total Deposits - Total Labor - Total Capital **Outputs:** - Total Loans - Total Investment	investigated the technical efficiency, breakdown of pure technical efficiency, and scale efficiency of local and overseas Islamic banks from a few Southeast Asian nations. Over the period 2006–2014
(Moussawi & Obeid, 2010)	**Input:** - Total deposits, - Total Fixed Assets - Interest Expense - Personnel Expenses - Other Operating Expenses **Outputs:** - Total Earning Assets - Net Commissions Revenue	Assessed the successful operation of GCC Islamic banks from 2005 to 2008.
(Ajlouni, Hmedat, & Hmedat, 2011)	**Inputs:** - Total deposits - Total expenses (interest and non-interest expenses) **Outputs:** - Total loans - Net investments	looked into the factors that influenced the relative efficiency of Jordanian banks for a sample of 11 commercial banks from 2005 to 2008
(Tahir, Bakar, & Haron, 2011)	**Inputs:** - Total deposits - Overhead expenses **Outputs:** - Total loans	Explore technical and scale efficiencies to investigate Islamic banks' efficiency in four regions: Africa, the Middle East, Central Asia, Europe, and the Far East between 2003 and

	- Earning assets	2008.
(Srairi, Kouki, & Harrathi, 2012)	**Inputs:** - Employee expenses - Other operating expenses - Loan loss provision **Outputs:** - Net interest income - Other operating income**.**	Estimate the efficiency of 25 GCC Islamic banks from 2003 to 2009.
(Onour, 2012)	**Inputs:** - Salaries - Wages - Deposits **Outputs:** - Loans - Net incomes	Examined the impact of some crucial financial ratios on the technical efficiency performance of thirty-six GCC banks from 2006 to 2008.
(Zeitun, Abdulqader, & Alshare, 2013)	**Inputs:** - Total fixed assets - Total assets - Total deposits - Personnel expenses - Total equity **Outputs:** - Total Loans - Net income - Total other earnings	Compared the effectiveness of 65 Islamic and conventional banks in the GCC from 2002 to 2010.
(Johnes, Izzeldin, & Pappas, 2014)	**Inputs:** - Deposits - Short-term funding, - General - Administrative expenses, - Equity **Outputs:** - Total loans - Other earning assets	Assessed the effectiveness of Islamic and traditional banking systems in the GCC from 2004 to 2007.
(Kamarudin, Nordin, Muhammad, & Hamid, 2014)	**Inputs:** - Deposits - Labor **outputs:** - Loans - Income	Examined the cost, revenue, and profit efficiency levels of 74 banks (47 conventional and 27 Islamic banks) in Gulf Cooperative Council (GCC) countries from 2007 to 2011.
(Rajput, Chopra, & Oberoi , 2014)	**Inputs:** - Deposits, - Investments, - Operating expenses, - The number of employees	Measured and compared the efficiency scores of PSBs, FBs, and private sector banks active in India between 2008 and 2013.

	Outputs: - The return on assets - Interest income, and non-interest income together as Net Profits	
(Sillah & Harrathi, 2015)	**Inputs:** - Total deposit - Equity - Fixed assets, and - General expenses **Outputs:** - Total loans - Investments	Compared the efficiency of the two bank types in GCC nations (28 conventional banks and 20 Islamic banks) from 2006 to 2006.
(Islam & Kassim, 2015)	**Inputs:** - Total Deposits, - Fixed Asset, - Personnel Expenses) **Outputs:** - Total Loan - Other Earning Assets - Off-Balance Sheet Items	Compared the efficiency of traditional and Islamic banks in Bangladesh and examined 25 commercial banks, seven of which are Islamic and eighteen of which are conventional, from 2009 to 2013.
(Kamarudin, Sufian, Nassir, & Anwar, 2015)	**Inputs:** - Assets - Deposits **Outputs:** - Loans - Income	Investigated the pure technical efficiency, technical efficiency, and scale efficiency of GCC banks from 2007 to 2011.
(Aghimien , Kamarudin , Hamid, & Noordin, 2016)	**Inputs:** - Total assets - Deposit **Outputs:** - Total loans - Income	Examined the pure technical efficiency, technical efficiency, and scale efficiency of GCC banks. 43 GCC banks in total were monitored for the duration of this investigation.
(Bahrini , 2017)	**Inputs:** - Labor - Fixed Assets - Total deposits **outputs:** - Total Loans - Investment Portfolio	Assessed and analyzed technological efficiency of Islamic banks in the Middle East and North Africa region from 2007 to 2012.
(Hafez & Halim, 2019)	**Inputs:** - Total deposits - Assets as input **Outputs:** - Total loans - Income	A sample of 35 banks was used to examine technical efficiency before and following the financial crisis from 2009 to 2017.

(Alsharif , 2020)	**Inputs:** - Personal expenses - Fixed assets - Deposits **Output:** - Loans - Other earning assets.	Examined bank efficiency from 2005 to 2013 for a sample of 73 GCC commercial banks.
(Khokhar, Hassan, Khan, & Amin, 2020)	**Inputs:** - Deposits - Assets - Capital **Outputs:** - Investment - Advances - Income	Examined and compared the performance of 63 GCC banks (21 Islamic and 42 conventional) at two tiers from 2010 to 2016.
(Samad, 2021)	**Inputs:** - Emexpse - CAP - Deposit **Outputs:** - Earning assets - Loans	Assessed the 90% estimate of the confidence interval of the bias-corrected overall technical efficiency, bias-corrected pure technical efficiency, and scale efficiency of the GCC's Islamic banks from 2014 to 2016 after bias correction.
(Alsharif, 2021)	**Inputs:** - Personnel expenses - Fixed assets - Deposits Outputs: - Loans and - Other earning assets	Assessed the effectiveness of Saudi Arabian banks and looked into how they related to stock performance over the period 2006-2018.

Table 3.3.3. Relevant literature review of Multi-stage data envelopment analysis

Author	Input and output indexes	Objective
(AKIN , KILIÇ, & ZAĐM, 2009)	**Inputs:** - Number of employees - Interest expenses. - Non-interestexpenses. - Total deposit. **Outputs:** - Total credits. - Interest revenue. - Non-interest revenue.	Examined the efficiency of the Turkish banks from 2002 to 2007 for a sample of thirty-one banks.
(Paradi , Rouatt , & Zhu, 2011) 1.	**Inputs:** (Theintermediary model). - Cash balances,	evaluated the effectiveness of operational components across various dimensions for a Canadian bank with 816 branches that

	- Fixed assets/accruals - Other liabilities - Net non-performing loans - Loan loss experience. **Outputs:** - Wealth management - Homeowner mortgages - Consumer lending - Commercial loans - Commercial deposits - Consumer deposits **Inputs: (**Profitability model) - Employee expense - Occupancy/computer expense - Loan losses - Cross charges - Other expenses - Sundry. **Output:** - Commissions - Consumer deposits - Consumer lending - Wealth management - Home mortgages - Commercial deposits - Commercial loans.	operate across three market sizes and five geographical regions.
(Lotfi, Eshlaghy, shafiee, Saleh, Nikoomaram, & Seyedhoseini, 2012)	**In the first stage:** (profitability efficiency) - Personal expenses. - Equipment expenses. - Operational expenses **Intermediate variables:** - Non-operational income. - The sum of deposits. **In the second stage:** (effectiveness) - Net income.	They assessed the general effectiveness of bank branches of a large commercial bank in Iran in terms of profitability, efficiency, and effectiveness.
(Wang & Lu, 2014)	**Inputs:** the first stage of "marketability efficiency" - Employee - Fixed assets - Operating expenditure **intermediation variables:** - ATM usage, - Deposits, - Charges - Commission	Assessed the impact of marketing and profit-oriented activities on the cost efficiency for a sample consisting of 37 Taiwanese banks from 2008 to 2011.

	Outputs: The second stage, "profitability efficiency" - Interest revenue - Other revenue	
(Qamruzzaman & Jianguo, 2016)	**Inputs:** - Deposit - Loan - Total assets - Investment - Capital **Outputs:** - Return on assets - Return on equity - Net profit margin	Identify the financial efficiency level of banks in Bangladesh from 2011 to 2015.
(Kong, Fu, & Yu, 2017)	**In the operational stage:** **Inputs:** - Operational Expenses, - Loanable Funds, and - Capital Stock **Outputs:** - Investments, - Performing Loans, - Nonperforming Loans, - Service Revenues **In the profitability stage**: **Inputs:** - Investments - Performing Loans - **Outputs:** - Investment Revenue - interest income	Evaluated Taiwanese bank efficiencies both at the operational stage and profitability stage in banking activities based on a data set consisting of 35 domestic banks in Taiwan for the period 2007–2010.
(Gulati & Kumar, 2017).	**The input of stage one:** (Intermediation stage) - Fixed assets, - Employees, and - Loanable funds (deposits plus borrowings) **Intermediate outputs:** - Advances - Investments. **The output of stage two:**(Operating stage) - Net interest income - Non-interest income in stage two	Measured the overall bank efficiency and its decomposition in intermediation and operating efficiencies during the period 2011–2013.

(Farandy, Suwito, & Dabutar, 2017)	**Inputs:** - Funds, - Total assets, and - Labor costs **Outputs:** - Financing - Operating income	Measured the effectiveness of Indonesian Islamic commercial banks from 2011 to 2014 by examining elements that influenced the degree of efficiency for a sample of 10 Indonesian Islamic commercial banks.
(Fernandes, Stasinakis , & Bardarova, 2018)	**Inputs:** - interest expenses - Operating expenses **Outputs:** - Total income - Capital R - Liquidity R - Profit R. - Credit R - Size	Analyzed the efficiency of peripheral European domestic banks and studied the influence of bank-risk variables on their performance from 2007 to 2014.
(PALECKOVA, 2019)	**Inputs:** - Deposits. - Fixed assets. - The number of employees. **Outputs:** - Total loans	Determined the factors that influence cost-effectiveness in Slovak and Czech commercial banks from 2005 to 2015. The sample included 28 commercial banks (16 Czech and 12 Slovak).
(Yonnedi & Panjaitan, 2019)	**In the first stage,** **Inputs:** - Third-party funds, - Interest expense, - Non-interest operating expenses **Outputs:** - Loans made, - Interest income - Non-interest income **In the second stage:** **Inputs:** - Interest expense - Non-Interest Operating Expenses **Outputs:** -Non-Interest Income, and - Interest income as output.	Aimed to empirically examine the change in efficiency and productivity of 26 regional development banks (BPDs) in Indonesia from 2011 to 2016.

	In the third stage: **inputs:** - Labour Expenses, - Cost of Funds, and - Fixed Asset Expenses **Outputs:** - Loans provided, - Investment / Placement	
(Fukuyama, Matousek, & Tzeremes, 2020)	**The intermediate inputs:** - Total deposits - The labor quality profile (human capital) - outputs. **The first output (desired output):** - trading securities **The second output (undesired output):** - non-performing loans (NPLs) **the third output is (desired output):** - Net loans	Examined the degrees of cost-efficiency of Turkish banks from 2007 to 2016 for a sample of 25 commercial banks.
(Dutta, Jain, & Gupta, 2020)	**Inputs:** - Total assets and - employee costs were chosen as **Outputs:** - interest income, - non-interest income, and - operating profit	Measured the performance of 43 non-banking finance companies (NBFC) in relation to India from 2014 to 2018.
(Ravanshad, Amiri, Salari, & Khodadadi, 2020)	**The first stage inputs:** - Total liability ratio and - Total equity ratio **Intermediation variables:** - Return on asset - Return on equity **The second stage outputs:** - Book-to-market equity ratio (B/M) - Earnings to price ratio (E/P)	Analyzed the performance of businesses in Tehran in order to look into the connection between managerial skill and firm performance.

(Wasiaturrahma, Sukmana, Ajija, Salama, & Hudaifah, 2020)	**in the production stage:** **Inputs:** - Interest/margin/profit sharing from the third-party fund - Expenses for Allowance for Earning Assets - Administrative and General Expenses - Non-operational expenses, - other expenses **Outputs:** - Receipt of interest/margin/profit sharing from loans disbursed, - other revenue **In the intermediation stage:** **Inputs:** - capital - savings - time deposits - bank Loans **Outputs:** - Loans/financings disbursed as	Analyzed the efficiency performance of rural banks, both Islamic and conventional, in Indonesia, precisely,Bank Pembiayaan Rakyat Syariah and Bank Perkreditan Rakyat.
(Moutinho , Vale, Bertuzi , Bandeira, & Palhares , 2021)	**Inputs:** - Total operating expenses, - The number of employees, - Fixed assets **Outputs:** - Total net loans - Advances - Total deposits, and - Net interest income	Evaluated 58 Iberian banks' performance and looked at the connection between that performance and the banks' intellectual capital (IC) efficiency over the period 2013-2016.
(Jelassi & Delhoumi, 2021)	**Inputs:** - Labor - Physical capital - Financial capital(deposits) **Outputs:** - Bank’s portfolio - Loans - Interbank loans - Off-balance sheet commitments).	investigate the potential determinants of technical efficiency with a non-radial and radial bootstrap DEA for a sample of ten commercial banks in Tunisia from 1995 to 2017.

Conclusion:

This chapter has offered the most important previous studies on the subject of the current study during various periods in many countries and regions, as well as comments on them, and describes the main characteristics of the current study and the aspects of the current study benefiting from the previous studies. In addition, a summary of the linked literature through this chapter, we have seen that the majority of the studies on financial efficiency found that financial efficiency increases in advanced economies and decreases in non-advanced economies.

Data envelopment analysis is among the most popular and is used to evaluate various applications in banks, sports, insurance, agriculture, etc. Many studies of DEA revealed that internal and external factors appear to have a substantial impact on the evolution efficiency scores of Islamic banks. The importance of liquidity, profitability, efficiency and effectiveness in overall performance and the relationships between these three factors are critical. Without these connections, the inability to advance a better understanding of the overall performance remains. The following chapter presents the methodology, results, and a discussion of the results.

Chapter Four:

Empirical Study

Introduction:

After considering past studies, the identification of financial efficiency, and the most important data envelope analysis models, we are trying in this chapter to evaluate the GCC Islamic banks' financial efficiency by adopting multistage data envelopment analysis during the period (2012–2017), with a sample of 15 banks. In this chapter, the methodology of this study is presented, along with information about the analysis approach, models used, the data collection, sample, results, and discussion of the results of the study. In addition, it outlines the major findings of this study and provides conclusions and recommendations.

The GCC hopes to rebuild its competitiveness and economic performance by increasing its growth potential and productivity. The DEA method's performance analysis can be used to assess the financial efficiency of Islamic banks in the countries under consideration.

And that's why this chapter is divided as follows:

- In the first section, Method and Tools
- In the second section, Results and Discussions

Chapter four: Empirical Study (evaluating the efficiency of GCC Islamic Banks)

1. Method and Tools

1.1 Description of sample and variables:

1.1.1 Description of the study sample.

Our sample relates to six countries: Bahrain, Saudi Arabia, the United Arab Emirates, Kuwait, Oman, and Qatar. The cluster of these countries is called the Gulf Cooperation Council (GCC). We chose the GCC area for its great interest in Islamic banking. The Islamic financial market in the Arab world has been focused more on the GCC countries, which account for 41% of global Shariah-compliant assets (Alharbi, 2015, p. 21). The data was collected from annual reports of banks. Therefore, our sample contains 15 Islamic banks and covers six countries for the sample period begins from 2012 to 2017 due to the data available under Table 4.1.1.

Table.4.1.1 Distribution of Islamic banks by countries

Country	Bank code	Number of Islamic banks per country
Bahrain	B01 B02 B03 B04 B05	- Al Salam Bank-Bahrain B.S.C. - ABC Islamic Bank (E.C.) - Al Baraka Banking Group B.S.C. - Bahrain Islamic Bank B.S.C. - Kuwait Finance House B.S.C.
Saudi Arabia	B06 B07	- Liquidity Management Center BSC - Bank Albilad
United Arab Emirates	B08 B09 B10	- Abu Dhabi Islamic Bank PJSC - Dubai Islamic Bank PJSC - Emirates Islamic Bank PJSC
Kuwait	B11	- Warba Bank
Oman	B12 B13	- Alizz Islamic Bank S.A.O.G. - Bank Nizwa SAOG
Qatar	B14 B15	-Qatar Islamic Bank (Q.P.S.C) -Qatar International Islamic Bank
Total		**15**

Source: Researcher's preparation

1.1.2 Description of variables:

We use a two-stage data envelopment analysis in order to appraise the financial efficiency of GCC Islamic banks. In this model, the first stage's outputs serve as the second stage's inputs, in addition to the second stage's outputs and the first stage's inputs. First-stage outputs are sent to the second stage as intermediate measures. We assume that banks using Total Assets, Total Equity, and Total Deposits as inputs in the first stage (Yildirim, 2015) have taken the same input variables. ROAE, ROAA, Net Loans as intermediation variables, Cost to Income Ratio, and Growth of Total Assets as outputs of the second stage in the efficiency calculations of these banks.

Table.4.1.2: The variables used in the study

	Input variables	**Intermediation variables**	**Output variables**
2012-2017	1- Total Assets**(X1)** 2- Total Equity**(X2)** 3- Total Deposits**(X3)**	1- ROAA**(Z1)** 2- ROAE**(Z2)** 3- Net Loans**(Z3)**	1- CTIR**(Y1)** 2- GOTA**(Y2)**

Source: Researcher's preparation

- **Total Assets:** consists of all asset accounts minus all contra asset accounts, such as loan reserve and the accumulated depreciation.
- **Total equity:** Total equity is equal to total assets minus total liabilities. It is also the total of all equity accounts minus any equity distributions made to shareholders, such as dividends, stock repurchases, or other cash payments.
- **Total Deposits:** the depositor on demand for the total amount of funds deposited with the MFI. Any current, checking, or savings account that is payable on demand is included in this category. Time deposits, which have a fixed maturity date, are also included.
- **Return on Average Assets:** (ROAA) Net income after taxes as a percentage of the average total assets book value is a metric for determining the profitability of a bank's assets. Otherwise, the bank can make do with what it has according to the return on average assets (ROA). Companies, banks, and other financial institutions typically use it as a means of evaluating their performance.
- **Return on Average Equity:** (ROAE) net profit after taxes as a percentage of total equity book value the performance of a bank during an exercise is measured by its return on average equity (ROAE). In situations where the capital

value has shifted significantly over the year, an estimate of the average return on equity can give a more realistic representation of a bank's profitability.

- **Net Loans:** The total amount of all gross loans less loan loss reserves is referred to as net loans.
- **Cost to Income Ratio (CTIR):** The net income ratio calculates the bank's overhead or operating costs as a percentage of income before provisions are made. Wages are a significant cost component of this report. It is a banking industry indicator that is defined as the proportion of operating expenses (staff costs, depreciation, amortization, and provisions on tangible and intangible assets, as well as other external services) divided by net banking income. It assesses a bank's operational efficiency.
- **Growth of Total Assets(GOTA):** Total asset growth is the increase in the proportion of the bank's asset balance.

1.2 Methodology:

1.2.1 Network systems:

Networks are systems that have multiple processes that are connected together (Shahroudi, Taleghani, & Mohammadi, 2012). There are several types of network structures: structure into two stages: Structure in general, two stages; Structures in series and parallel Structure mix; Structure that is hierarchical A network system's dynamic structure and nine approaches independent method; System distance measurement method; Process distance measurement method; Factor distance measurement method A Slacks-based measurement strategy ratio-form approach to system efficiency; ratio-form approach to process efficiency; An approach based on game theory; an approach based on values (Kao, 2014).

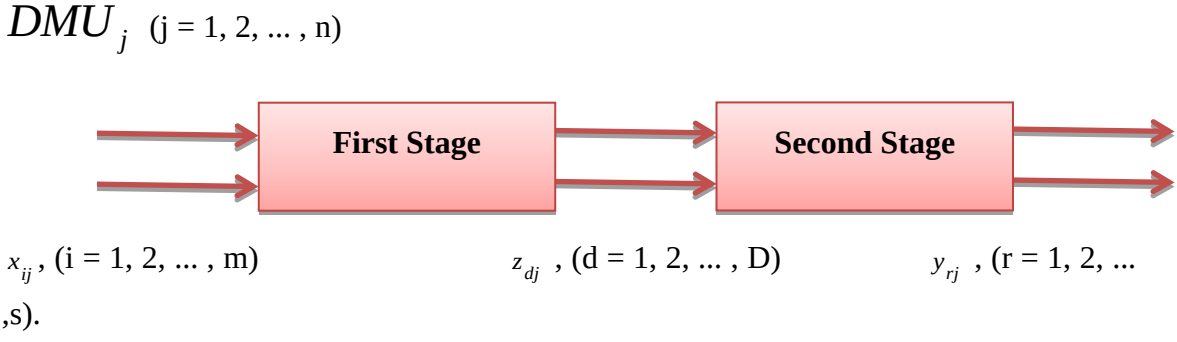
The DMU is treated as a "black box" in DEA models, which distinguishes network and traditional DEA approaches. Inputs arrive and outputs leave, with no regard for the steps in between. As a result, providing specific information about inefficient areas within individual DMUs to individual DMU managers is challenging, if not impossible (SEXTON & LEWIS, 2003). The network DEA, on the other hand, has multiple structures to properly assess efficiency.

The centralized model approach and two-stage structure were used in this study, and these procedures will be discussed. The second stage only receives the intermediate metrics as independent inputs, which means it has no other independent inputs.

1.2.2 Two-stage DEA Model:

Traditional DEA models serve as a black box in performance evaluation from a production standpoint, converting inputs into outputs while the actual conversion process is rarely modeled (Mahmoudabadi & Emrouznejad, 2019). When a two-stage manufacturing technique is used, traditional efficiency models, Data envelopment analysis, for example, can only assess the efficiency of a single stage.(CHEN & ZHU, 2004) devised an efficiency model for determining the productive frontier of a two-stage manufacturing process connected by intermediate measures, and assume each DMUj (j = 1, 2, ... , n) has m inputs x_{ij} , (i = 1, 2, ... , m) to the first stage and D outputs z_{dj}, (d = 1, 2, ... , D) from that stage. These D outputs are then used as intermediate measures as inputs to the second stage. The second stage's outputs are y_{rj} , (r = 1, 2, ... ,s). The above two-stage structure is shown in Figure 1.

Figure 4.1.1 Two-stage process of DMU_j



In the literature, two kinds of two-stage DEA models have been identified:

Model of closed-system DEA: The intermediate outputs remain constant from one stage to the next, implying that the first stage's outputs are the second stage's inputs.

Open-system DEA model: The intermediate outputs of one stage are not all used in the subsequent stage in the open-system DEA model, which means that the first stage's outputs are used as partial inputs in the second stage.

1.2.3 Centralized Model:

(Liang, Cook, & Zhu, 2008) proposed the following model for evaluating the overall system and subsystem efficiencies, based on (CCR) assumption, the efficiency for the first stage a E_j^1 nd the second E_j^2 stage DMU_j, can be calculated by the following:

$$E_j^1 = \frac{\sum_{d=1}^{D} w_d z_{dj}}{\sum_{i=1}^{m} v_i x_{ij}}, v_i, w_d \geq 0 \quad (1)$$

$$E_j^2 = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{d=1}^{D} \tilde{w}_d z_{dj}}, u_r, \tilde{w}_d \geq 0$$

They refer to this as a centralized model, and they propose an efficiency decomposition in which The overall efficiency of the two-stage process is determined by the efficiencies. The centralized approach is characterized by letting wd = ˜wd, and the efficiencies of both stages are evaluated concurrently. The results of centralized models are identical to the results of applying the standard DEA model to the two stages separately. Because the connection between the two stages is cooperative, this model can be called a cooperative model.

since: wd = ˜wd, then $E_j^1 \bullet E_j^2$ becomes $\frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$ Therefore, the centralized model can be presented as:(Zhu, 2011)

$$E_o^{Centralized} = \text{Max } E_o^1 \bullet E_o^2 \quad \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$$

$$s.t \quad (2)$$

$$E_o^1 \leq 1 and E_o^2 \leq 1 and w_d = \tilde{w}_d$$

Model (2) can be transformed into the linear program shown below:

$$E_o^{Centralized} = Max \sum_{r=1}^{s} u_r y_{ro}$$

$$s.t.$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{d=1}^{D} w_d z_{dj} \le 0,\ j = 1,2,...n, \qquad (3)$$

$$\sum_{d=1}^{D} w_d z_{dj} - \sum_{i=1}^{m} v_i x_{ij} \le 0,\ j = 1,2,...n,$$

$$\sum_{i=1}^{m} v_i x_{io} = 1,$$

$$w_d \ge 0, d = 1,2,...,D; v_i \ge 0, i = 1,2,...,m; u_r \ge 0, r = 1,2,...,s$$

Assume the above model (3) yields a unique solution, which gives The overall efficiency of the two-stage process. The efficiencies for the first and second stages, respectively, are obtained.

$$E_o^{1.Centralized} = \frac{\sum_{d=1}^{D} w_d^* z_{do}}{\sum_{i=1}^{m} v_i^* x_{io}} = \sum_{d=1}^{D} w_d^* z_{do} \qquad (4)$$

$$E_o^{2.Centralized} = \frac{\sum_{r=1}^{s} u_r^* y_{ro}}{\sum_{d=1}^{D} w_d^* z_{do}}$$

If we denote the bestfit to model (4) $E_o^{Centralized}$ then we have $E_o^{Centralized} = E_o^{1.Centralized} \bullet E_o^{2.Centralized}$. Note that optimal multipliers from the model (4) may not be unique, meaning that $E_o^{1.Centralized}$ and $E_o^{2.Centralized}$ may not be unique.

their models can also be used to test whether $E_o^{1.Centralized}$ $E_o^{2.Centralized}$ and, obtained from model (3), are unique. The maximum possible value $E_o^{1.Centralized}$ can be determined via: (Cook , Liang , & Zhu, 2010)

$$E_o^{1+} = Max \sum_{d=1}^{D} w_d z_{do}$$

$$s.t.$$

$$\sum_{r=1}^{s} u_r y_{ro} = E_o^{Centralized} \quad (5)$$

$$\sum_{d=1}^{D} w_d z_{dj} - \sum_{i=1}^{m} v_i x_{ij} \le 0,\ j = 1,2,...n$$

$$\sum_{i=1}^{s} u_r y_{rj} - \sum_{d=1}^{D} w_d z_{dj} \le 0,\ j = 1,2,...n$$

$$\sum_{i=1}^{m} v_i x_{io} = 1,$$

$$w_d \ge 0, d = 1,2,...,D; v_i \ge 0, i = 1,2,...,m; u_r \ge 0, r = 1,2,...,s$$

This produces the smallest number of $E_o^{2.Centralized}$, namely $E_o^{2-} = E_o^{Centralized} / \mathrm{E}_o^{1+}$ the maximum of $E_o^{2.Centralized}$ can be calculated via the following linear program;

$$\mathrm{E}_o^{2+} = Max \sum_{r=1}^{s} u_r y_{ro}$$

$$s.t. \quad (6)$$

$$\sum_{r=1}^{s} u_r y_{ro} - E_o^{centralized} \sum_{i=1}^{m} v_i x_{io} = 0$$

$$\sum_{r=1}^{s} u_r y_{rj} \sum_{d=1}^{D} w_d z_{dj} \le 0,\ j = 1,2,...n$$

1.2.4 Global (overall) efficiency:

Where θ_o^{Global} is the overall (global) efficiency level of the two-stage process for DMU_o DMUo. Assuming that model (1) yields a unique solution, the efficiencies for the first and second stages are respectively given next: (Wanke & Barros , 2014)

$$\theta_o^{1.\text{Cost\_}efficiency} = \sum_{d=1}^{D} w_d^* z_{do}$$

$$\theta_o^{2.Productive\_efficiency} = \frac{\sum_{r=1}^{s} u_r^* y_{ro}}{\sum_{d=1}^{D} w_d^* z_{do}}$$

Because a unique solution was assumed, the following relationship can be expressed:

$$\theta_o^{Global} = \theta_o^{1.\text{Cost\_}efficiency} \bullet \theta_o^{2.Productive\_efficiency}$$

That is, the sum of the individual efficiency levels for each stage equals the overall efficiency level.

1.3 Statistical Tool: Wilcoxon signed rank test and simple linear regression

1.3.1 Wilcoxon signed-rank test:

It is a factual hypothesis and a non-parametric test that looks at the distinction in values between two matched examples. (such as subjects before and after treatment, husbands and wives, etc.) to determine whether they are likely to come from the same distribution. The test assumes that all pairs are independent, random draws from an ordinal distribution.. (Couch, Kazan, Bray, & Groce, 2018)

Wilcoxon signed-rank test was used in this study to confirm the hypothesis (H1). the hypothesis is that H1 there is a significant variance between the efficiency of the first and second stages**.**

1.3.2 Multiple linear regression:

Regression analysis is a statistical technique for determining the relationship between variables that have a cause-and-effect relationship. The main goal of univariate regression is to figure out how independent and dependent variables are related. Multiple linear regression (Uyanık & Güler, 2013) is a regression model with one dependent variable and multiple independent variables. The Multiple Linear Regression (MLR) modeling method is among the statistical models that use observational data to establish a relationship between independent and dependent variables connected to linear equations. (Çerçi & Hürdoğan, 2020)

2. Results and Discussions

After presenting the results, we turn next to a discussion of the results divided into four parts. First, we calculate descriptive statistics. Secondly, assess the correlation between variables of the study. Thirdly, we examine the efficiency results of Multistage DEA and compare the scores across the countries. Finally, the last part of our discussion focuses on the evolution of efficiency scores for GCC Islamic banks over the years 2012 to 2017.

- **Descriptive statistics:**

Table 4.2.1 shows the descriptive statistics of the eight variables for the sample period 2012-2017. From statistical analysis, the average of inputs for Total Assets (X1), Total Equity (X2), and Total Deposits (X3) scored an increase during the whole period and the standard deviation. It means that the GCC Islamic banks have evolved rapidly, which suggests that the size of the banks has increased rapidly. The input variables had a big gap between the maximum and minimum values. The intermediation variables ROAA (Z1), ROAE (Z2), and Net Loans (Z3) scored an increase, except for ROAA (Z1). ROAE (Z2) scored a decrease in 2016. For outputs, CTIR (Y1) variable score increased from 2012 to 2013 and then down rapidly after that. GOTA (Y2) variable scores increased and decreased during the sample period.

Table 4.2.1 Descriptive statistics

	X1	**X2**	**X3**	**Z1**	**Z2**	**Z3**	**Y1**	**Y2**
2012								
Max	98611.2	13051.0	73393.50	23.500	3.260	55182.70	549.81	84.00
Min	101.2	58.8	0.36	0.000	0.000	3.96	20.27	0.00
Mean	25169.6	3137.4	18914.51	7.171	1.079	14450.20	102.63	20.78
St.Dev	34276.2	4344.37	25564.88	7.22464	0.994692	19794.06	138.037	23.91051
2013								
Max	113288.40	13672.7	81750.60	20.480	2.400	61747.60	574.95	81.48
Min	99.72	63.0	1.09	0.000	0.000	3.96	22.52	0.00
Mean	28692.74	3433.3	21746.74	7.920	1.094	16462.75	120.50	17.76
St.Dev	39293.77	4629.497	29568.01	6.57196	0.808957	21980.33	180.9542	19.56655
2014								
Max	123887.4	14171.7	96285.20	23.220	2.300	73976.6	398.46	79.670
Min	119.6	67.5	20.36	0.000	0.000	12.2	24.92	0.000
Mean	32580.8	3700.0	25709.57	9.429	1.194	20083.8	84.26	20.481
St.Dev	44001.3	4968.23	34741.38	7.63516	0.836948	27392.16	96.3960	21.14254

2015								
Maximum	149897.5	15447.5	114694.0	26.89	2.710	97219.6	177.55	111.280
Minimum	183.4	71.0	90.6	0.000	0.000	14.5	25.39	0.000
Mean	38144.4	4042.9	30494.4	10.05	1.234	25034.3	59.81	19.883
St.Dev	52495.5	5444.02	41811.9	8.14765	0.807932	34905.39	41.3584	28.28666
2016								
Max	174970.5	19923.2	132794.9	23.150	2.430	114967.6	141.02	51.01
Min	132.7	52.0	90.6	0.000	0.000	12.4	23.61	0.00
Mean	41610.0	4580.4	32457.9	8.096	0.9313	27354.1	59.81	15.67
St.Dev	58504.68	6361.123	45909.22	7.617665	0.8013013	39044.44	32.13753	18.02105
2017								
Max	207337.0	21534.5	162058.6	162058.6	2.340	133334. 2	113.12	57.330
Min	149.4	54.1	90.6	0.000	0.000	23.9	26.56	0.000
Mean	45801.7	4896.2	36141.0	9.997	1.249	29598.7	52.53	16.091
St.Dev	65459.6	6853.02	51446.15	6.40519	0.611011	42577.69	22.9218	17.92921

Source: Researcher's preparation based on R version 4.1.3

- **Variables correlation analysis.**

As mentioned in chapter two, one of the disadvantages of DEA is that if the output and input variables have a strong correlation, DEA's ability to evaluate will be harmed. Therefore, before conducting the efficiency test, it would be best to look at the autocorrelation of variables to see the degree of a linear relationship between them. The following are the outcomes of the correlation matrix of the variables:

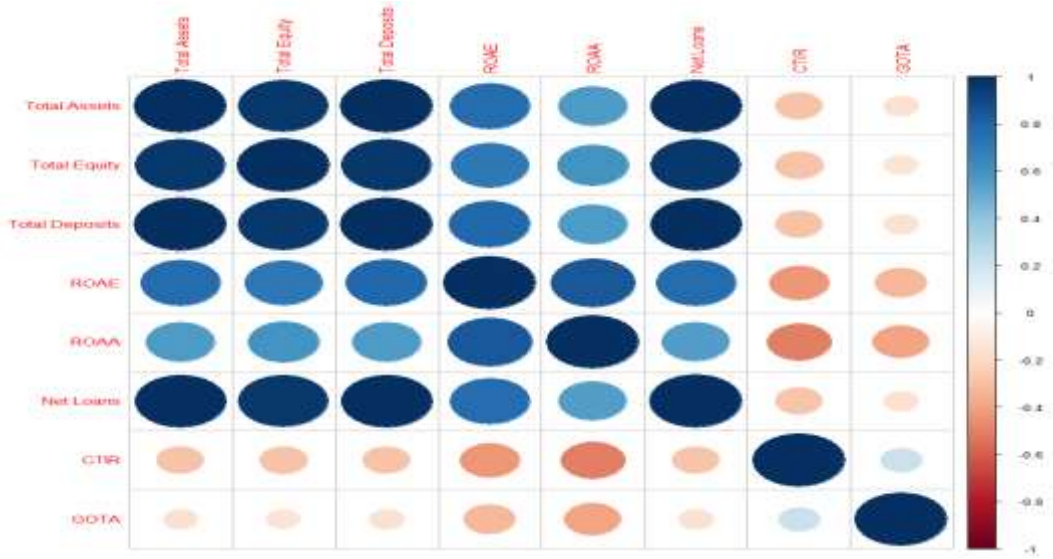
Table 4.2.2 Correlation Matrix

	Total Assets	**Total Equity**	**Total Deposits**	**ROAE**	**ROAA**	**Net Loans**	**CTIR**	**GOTA**
Total Assets	1.00							
Total Equity	0.97	1.00						
Total Deposits	1.00	0.96	1.00					
ROAE	0.77	0.72	0.78	1.00				
ROAA	0.56	0.60	0.57	0.85	1.00			
Net Loans	1.00	0.96	1.00	0.76	0.56	1.00		
CTIR	-0.28	-0.28	-0.28	-0.44	-0.50	-0.28	1.00	
GOTA	-0.15	-0.15	-0.16	-0.33	-0.39	-0.15	0.22	1.00

Source: Researcher's preparation based on R version 4.1.3

The outcomes of the correlation matrix show that the correlation coefficients vary from 0.97 to -0.50. The variables that are highly positively correlated are located on the upper right and also the lower left since this is the symmetric representation. The variables that are negatively correlated are concentrated on the upper left or lower right portion of the figure. There is a relationship among the input variables. As well as for intermediation variables and output variables, that means there is no autocorrelation problem. (See figure 2.1.4)

Figure 4.2.1 Correlation Matrix



Source: R-4.1.3 program outcome.

- **Financial Efficiency Results:**

This study uses the input-oriented DEA multistage model for efficiency measurement. When this model is solved for each choice point, total efficiency measures will be obtained for each decision point. When these metrics are equal to one, they reflect efficiency; when they are less than one, they represent inefficiency.

Table 4.2.3 shows the first stage financial efficiency score 2012-2017.In the GCC Islamic Banking sector, Liquidity Management Center (BSC) and Alizz Islamic Bank S.A.O.G. operated on the 100% efficient frontier during the periods 2012–2017; Warba Bank operated on the efficiency frontier in 2013 and 2017, and Bank Nizwa SAOG operated on the efficiency frontier in 2012. According to the average efficiency of countries, we found that Saudi Arabia had an average efficiency of 0.5061 and Bahrain had an average efficiency of 0.4048. Qatar and the United Arab Emirates had lower

scores, namely 0.0094 and 0.0090. This result confirmed previous research (Khokhar, Hassan, Khan, & Amin, 2020) found that banking in Bahrain and Saudi Arabia, in particular, is among the best. There is no room for improvement in the UAE's banking industry. This low performance may be due to a lack of product and scheme standardization, as well as a lack of prudence in governance, operations, and decision-making. A previous study of (Samad, 2021)revealed that Qatar Islamic banks demonstrated the highest level of efficiency among GCC banks. Kuwait and Oman had higher scores, namely 0.9120 and 0.9056. That means the financial efficiency in GCC Islamic banks is lower.

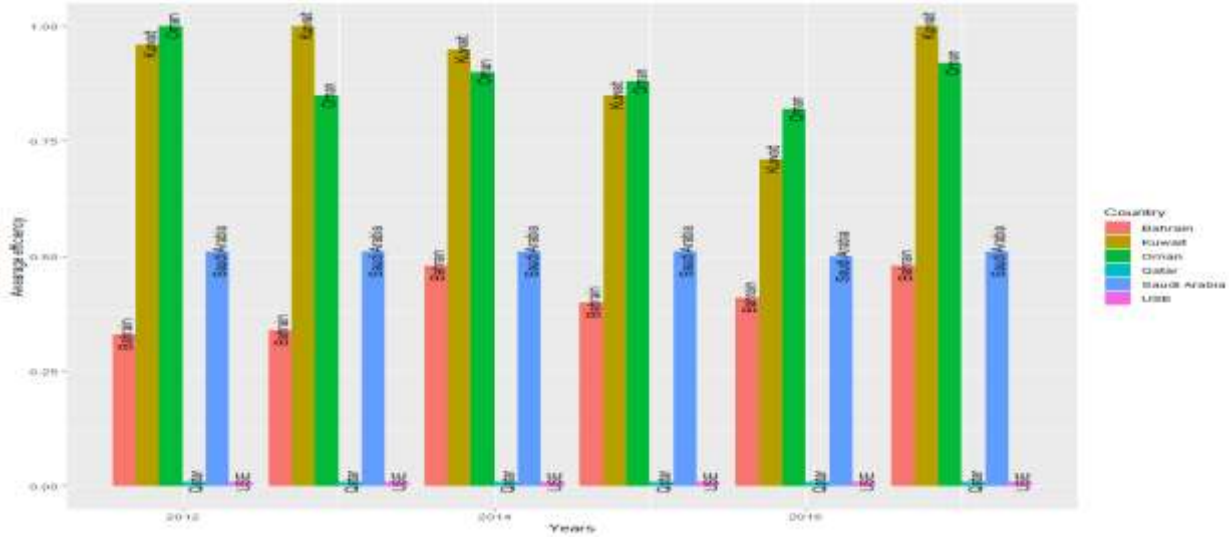
Table 4.2.3 The first stage financial efficiency score 2012-2017

Bank	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Frequency of efficiency**
B01	0.282	0.342	0.467	0.245	0.248	0.376	0
B02	0.320	0.310	0.8143	0.772	0.935	0.929	0
B03	0.029	0.033	0.036	0.037	0.033	0.033	0
B04	0.842	0.847	0.870	0.716	0.581	0.587	0
B05	0.154	0.171	0.198	0.228	0.251	0.457	0
Bahrain	0.3254	0.3406	0.4771	0.3996	0.4096	0.4764	0.4048
B06	1.000	1.000	1.000	1.000	1.000	1.000	6
B07	0.013	0.013	0.016	0.012	0.009	0.01014	0
Saudi Arabia	0.5065	0.5065	0.508	0.506	0.5045	0.50507	0.5061
B08	0.008	0.009	0.009	0.008	0.006	0.006	0
B09	0.005	0.005	0.005	0.005	0.003	0.005	0
B10	0.022	0.015	0.016	0.015	0.010	0.010	0
United Arab Emirates	0.01167	0.009667	0.0100	0.009333	0.006333	0.0070	0.0090
B11	0.960	1.000	0.949	0.849	0.714	1.000	2
Kuwait	0.960	1.000	0.949	0.849	0.714	1.000	0.9120
B12	1.000	1.000	1.000	1.000	1.000	1.000	6
B13	1.000	0.694	0.806	0.767	0.762	0.838	1
Oman	1	0.8470	0.9030	0.8835	0.8810	0.9190	0.9056
B14	0.004	0.004	0.008	0.005	0.004	0.004	0
B15	0.011	0.014	0.020	0.014	0.012	0.013	0
Qatar	0.00750	0.0090	0.014	0.00950	0.008	0.00850	0.0094
Average	0.469	0.452	0.477	0.428	0.421	0.486	0.457

Source: DEA Frontier outcomes

Figure 4.2.2 shows the average efficiency of the first stage for GCC Islamic banks for each country during 2012–2017. We can see that the Islamic banking sectors of Kuwait and Oman have higher efficiency on average, Bahrain and Saudi Arabia have medium efficiency, and those of Qatar and the USE have lower efficiency.

Figure 4.2.2 The graph on first stage efficiency for GCC Islamic Banks during the year 2012–2017



Source: R-4.1.3 program outcome.

Table 4.2.4 shows the Second stage financial efficiency score 2012-2017. In the GCC Islamic Banking sector, Alizz Islamic Bank S.A.O.G. operated on the 100% efficient frontier during the periods 2012–2017; Liquidity Management Center (BSC) operated on the efficiency frontier during the period 2014–2017; Warba Bank operated on the efficiency frontier in 2012, 2013, and 2017; Bank Nizwa SAOG operated on the efficiency frontier during the period 2013–2014, and Al Salam Bank-Bahrain B.S.C. operated on the efficiency frontier in 2014. According to the average efficiency of countries, we found that Kuwait, Bahrain, the United Arab Emirates, and Qatar had lower average efficiency scores of 0.5867, 0.5457, 0.4314, and 0.3955, respectively. Oman and Saudi Arabia had higher scores, namely 0.7591 and 0.6987. This result is confirmed by a previous study of(Alsharif, 2021) that found Saudi banks are more technically efficient, but their price efficiencies are more volatile. Furthermore, changes in bank efficiency are related to stock performance in a positive way. And also, we can see that the financial efficiency improved from stage one to stage two.

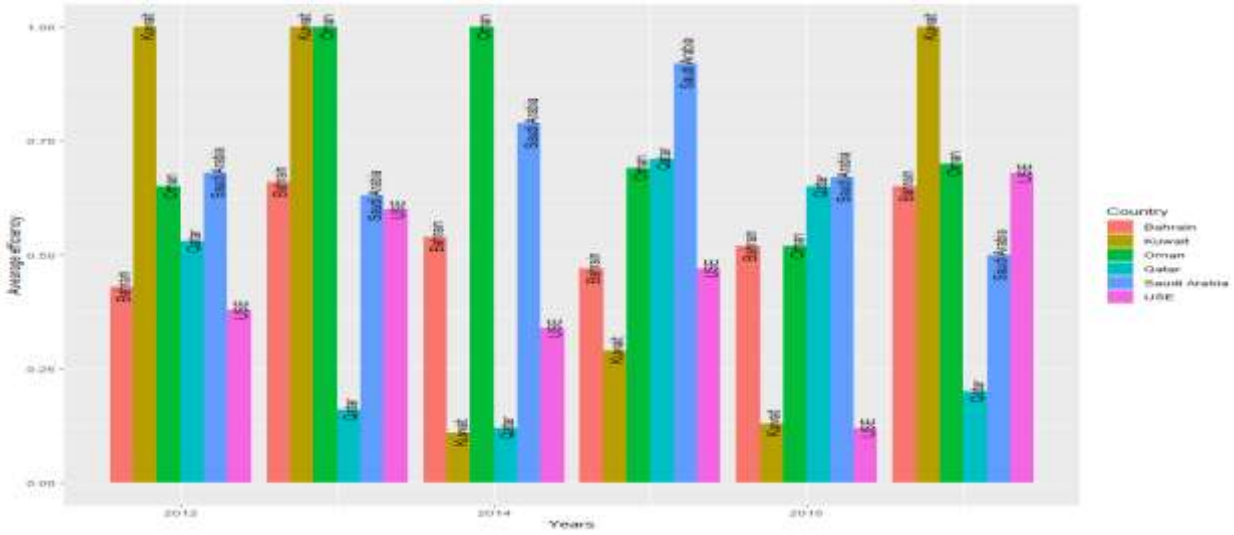
Table 4.2.4 the second stage financial efficiency score 2012-2017.

Bank	2012	2013	2014	2015	2016	2017	Frequency of efficiency
B01	0.244	0.637	1.000	0.943	0.798	0.720	1
B02	0.683	0.813	0.368	0.639	0.360	0.060	0
B03	0.323	0.896	0.094	0.281	0.620	0.965	0
B04	0.747	0.299	0.913	0.427	0.282	0.743	0
B05	0.174	0.675	0.347	0.044	0.535	0.740	0
Bahrain	0.434	0.664	0.544	0.466	0.519	0.645	0.5457
B06	0.630	0.879	1.000	1.000	1.000	1.000	4
B07	0.732	0.372	0.570	0.849	0.345	0.008	0
Saudi Arabia	0.6810	0.6255	0.7850	0.9245	0.6725	0.504	0.6987
B08	0.370	0.821	0.468	0.842	0.087	0.538	0
B09	0.444	0.785	0.509	0.147	0.049	0.829	0
B10	0.315	0.192	0.048	0.416	0.225	0.680	0
United Arab Emirates	0.3763	0.5993	0.3417	0.4683	0.1203	0.6823	0.4314
B11	1.000	1.000	0.105	0.287	0.128	1.000	3
Kuwait	1.000	1.000	0.105	0.287	0.128	1.000	0.5867
B12	1.000	1.000	1.000	1.000	1.000	1.000	6
B13	0.294	1.000	1.000	0.375	0.039	0.401	2
Oman	0.647	1	1	0.687	0.5195	0.700	0.7591
B14	0.285	0.071	0.013	0.426	0.729	0.259	0
B15	0.771	0.245	0.232	0.992	0.578	0.145	0
Qatar	0.5280	0.1580	0.12250	0.7090	0.6535	0.2020	0.3955
Average	**0.611**	**0.675**	**0.483**	**0.590**	**0.436**	**0.622**	0.569

Source: DEAFrontier outcomes

Figure 4.2.3 shows the average efficiency of the second stage for GCC Islamic Banks for each country during 2012-2017. We can see that the Islamic banking sectors of Kuwait and Oman have higher efficiency on Average. Kuwait on the efficiency frontier in 2012, 2013, and 2017. Oman on the efficiency frontier in the period (2013-2014) while those of Bahrain, Saudi Arabia, Qatar, and the USE scored inefficiency during the whole period.

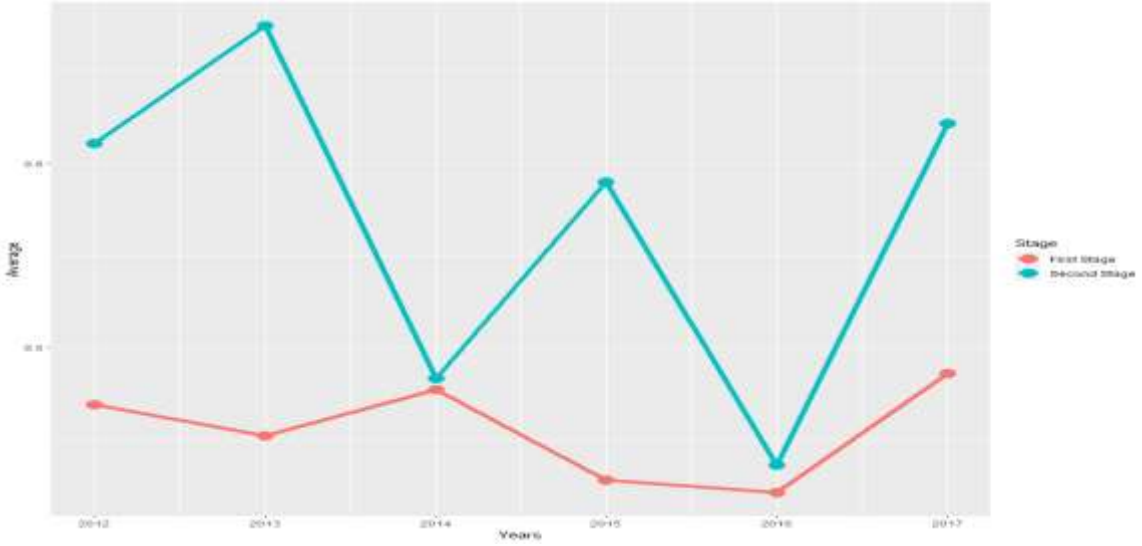
Figure 4.2.3 the graph on second stage efficiency for GCC Islamic Banks during the year 2012–2017



Source: R-4.1.3 program outcome.

Figure 4.2.4 presents the average first and second-stage efficiency of GCC Islamic banks during 2012–2017. We can note that the average efficiency in both stages is negatively and positively changing from one year to another. The average efficiency of the second stage is higher than the first stage during the research period. This means that the efficiency increased in the second stage, especially in 2013 and 2016.

Figure 4.2.4 Average first and second stage efficiency of GCC Islamic Banks during the year 2012-2017



Source: R-4.1.3 program outcome.

Table 4.2.5 reveals that overall efficiency of GCC Islamic banks declined significantly during the whole period. Only two banks existed out of the 15 banks that scored centralized efficiency: Liquidity Management Center BSC in 2015 and Alizz Islamic Bank S.A.O.G. in 2015 and 2016. This decline was mainly caused by the increase in their financial inefficiency.

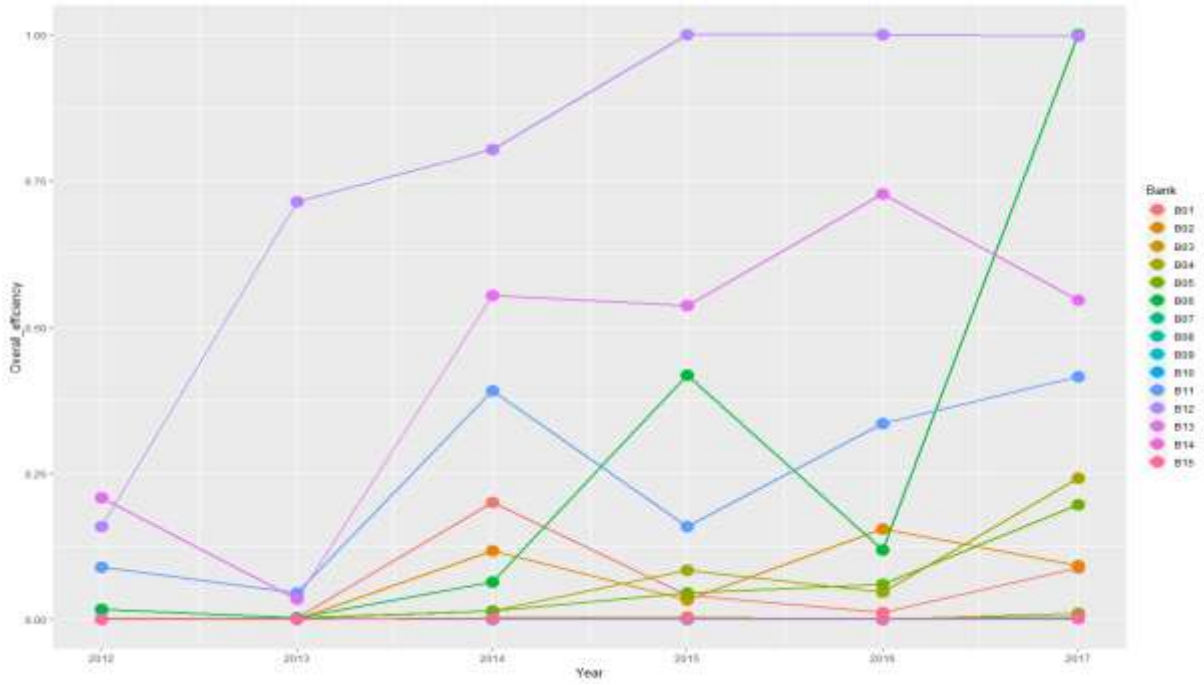
Table 4.2.5 overall efficiency score of the two-stage process for GCC Islamic banks 2012-2017

Banks	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Frequency of efficiency**
B01	0.001	0.003	0.201	0.042	0.012	0.088	0
B02	0.001	0.000	0.118	0.033	0.155	0.093	0
B03	0.000	0.000	0.003	0.004	0.000	0.011	0
B04	0.001	0.003	0.015	0.085	0.047	0.242	0
B05	0.000	0.001	0.015	0.045	0.0560	0.197	0
B06	0.017	0.003	0.065	0.418	0.120	1.000	1
B07	0.000	0.000	0.003	0.002	0.001	0.004	0
B08	0.000	0.000	0.000	0.001	0.000	0.002	0
B09	0.000	0.000	0.000	0.000	0.000	0.001	0
B10	0.001	0.000	0.000	0.001	0.002	0.003	0
B11	0.089	0.045	0.392	0.159	0.335	0.416	0
B12	0.159	0.713	0.804	1.000	1.000	0.997	2
B13	0.207	0.035	0.555	0.537	0.728	0.547	0
B14	0.000	0.000	0.001	0.001	0.001	0.001	0
B15	0.000	0.000	0.002	0.001	0.001	0.003	0
Average	0.032	0.054	0.145	0.155	0.164	0.240	
Standard deviation	0.066	0.183	0.247	0.285	0.303	0.350	

Source: DEAFrontier outcomes

To add more depth to this analysis, we present Figure 4.2.4, which illustrates the evolution of overall efficiency in GCC Islamic banks during the period 2012–2017. We can note that Alizz Islamic Bank S.A.O.G. scores the highest level of efficiency in our sample study. Except in 2012 and 2017, Bank Nizwa SAOG and Liquidity Management Center BSC are more efficient than it. In our sample study, Al Baraka Banking Group B.S.C., Abu Dhabi Islamic Bank PJSC, and Qatar International Islamic Bank scored the smallest level of efficiency in our sample study.

Figure 4.2.5 The overall efficiency score of the two-stage process in the GCC Islamic banks during the period 2012–2017



Source: R-4.1.3 program outcome.

The Centralized Results:

Table 4.2.6 Centralized Results in 2012

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.001	14	0.420	0.001
B02	0.001	5	1.000	0.001
B03	0.000	3	1.000	0.000
B04	0.001	9	0.828	0.001
B05	0.000	13	0.452	0.001
B06	0.018	15	0.279	0.063
B07	0.000	7	0.867	0.000
B08	0.000	4	1.000	0.000
B09	0.000	8	0.847	0.000
B10	0.001	6	1.000	0.001
B11	0.090	11	0.448	0.201
B12	0.159	2	0.159	1.000
B13	0.208	1	1.000	0.208
B14	0.000	10	0.777	0.000
B15	0.000	12	0.680	0.000

Source: DEAFrontier outcomes

Table 4.2.7 Centralized Results in 2013

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.003	14	0.389	0.008
B02	0.000	2	1.000	0.000
B03	0.000	4	0.967	0.000
B04	0.003	7	0.836	0.004
B05	0.001	12	0.462	0.002
B06	0.003	15	0.190	0.018
B07	0.000	6	0.893	0.000
B08	0.000	3	1.000	0.000
B09	0.000	10	0.738	0.000
B10	0.000	5	0.914	0.000
B11	0.046	11	0.616	0.074
B12	0.714	1	0.714	1.000
B13	0.035	13	0.170	0.208
B14	0.000	8	0.774	0.000
B15	0.000	9	0.754	0.000

Source: DEAFrontier outcomes

Table 4.2.8 Centralized Results in 2014

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.201	5	0.441	0.457
B02	0.118	4	1.000	0.118
B03	0.003	7	0.968	0.003
B04	0.015	11	0.879	0.017
B05	0.015	15	0.519	0.029
B06	0.065	8	0.083	0.784
B07	0.003	9	0.912	0.003
B08	0.000	6	1.000	0.000
B09	0.000	13	0.882	0.000
B10	0.001	10	0.905	0.001
B11	0.392	3	0.930	0.422
B12	0.804	1	0.804	1.000
B13	0.555	2	0.721	0.770
B14	0.001	12	0.890	0.001
B15	0.002	14	0.821	0.002

Source: DEAFrontier outcomes

Table 4.2.9 Centralized Results in 2015

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.042	14	0.545	0.077
B02	0.033	6	1.000	0.033
B03	0.004	12	0.931	0.004
B04	0.085	5	0.934	0.092
B05	0.046	15	0.511	0.090
B06	0.418	3	0.418	1.000
B07	0.002	11	0.948	0.002
B08	0.001	7	1.000	0.001
B09	0.000	9	0.960	0.000
B10	0.001	10	0.955	0.001
B11	0.159	4	1.000	0.159
B12	1.000	1	1.000	1.000
B13	0.537	2	0.997	0.539
B14	0.001	8	0.994	0.001
B15	0.001	13	0.875	0.001

Source: DEAFrontier outcomes

Table 4.2.10 Centralized Results in 2016

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.012	15	0.510	0.024
B02	0.155	5	1.000	0.155
B03	0.000	10	0.921	0.001
B04	0.047	7	0.872	0.054
B05	0.060	14	0.500	0.120
B06	0.119	4	0.119	1.000
B07	0.001	11	0.918	0.001
B08	0.000	9	0.926	0.000
B09	0.001	8	0.926	0.001
B10	0.002	12	0.882	0.002
B11	0.335	3	1.000	0.335
B12	1.000	1	1.000	1.000
B13	0.728	2	0.962	0.757
B14	0.001	6	0.978	0.001
B15	0.001	13	0.872	0.001

Source: DEAFrontier outcomes

Table 4.2.11 Centralized Results in 2017

Bank	$E_o^{Centralized}$	Rank	$E_o^{1.Centralized}$	$E_o^{2.Centralized}$
B01	0.088	11	0.490	0.179
B02	0.093	7	1.000	0.093
B03	0.011	10	0.785	0.014
B04	0.242	5	0.816	0.297
B05	0.197	6	0.728	0.270
B06	1.000	1	1.000	1.000
B07	0.004	13	0.724	0.005
B08	0.002	14	0.725	0.002
B09	0.001	9	0.853	0.001
B10	0.003	15	0.589	0.005
B11	0.416	4	1.000	0.416
B12	0.997	2	0.997	1.000
B13	0.547	3	1.000	0.547
B14	0.001	12	0.753	0.001
B15	0.003	8	0.859	0.003

Source: DEAFrontier outcomes

Table 4.2.12 revealed that Centralized efficiency of GCC Islamic banks declined significantly. For the whole period, only two banks existed out of 15 banks that scored centralized efficiency: Liquidity Management Center BSC in 2015 and Alizz Islamic Bank S.A.O.G. in 2015 and 2016.

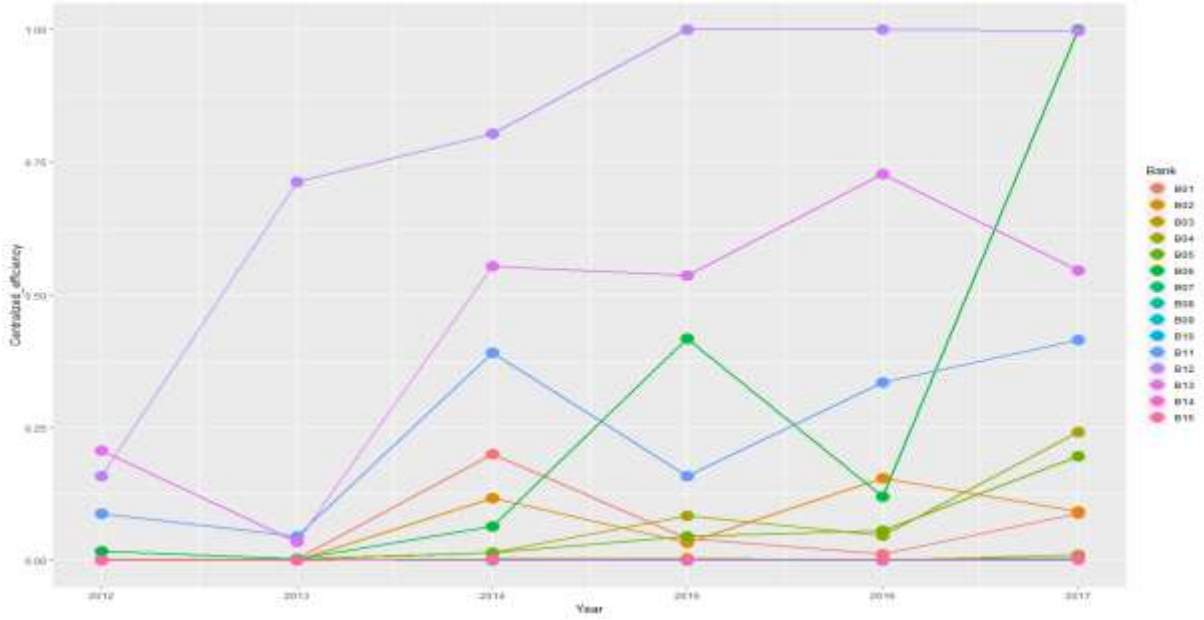
Table 4.2.12 Centralized Efficiency scores of the two-stage process for GCC Islamic banks 12-12-2017

Bank	2012	2013	2014	2015	2016	2017	Frequency of efficiency
B01	0.001	0.003	0.201	0.042	0.012	0.088	0
B02	0.001	0.000	0.118	0.033	0.155	0.093	0
B03	0.000	0.000	0.003	0.004	0.000	0.011	0
B04	0.001	0.003	0.015	0.085	0.047	0.242	0
B05	0.000	0.001	0.015	0.046	0.060	0.197	0
B06	0.018	0.003	0.065	0.418	0.119	1.000	1
B07	0.000	0.000	0.003	0.002	0.001	0.004	0
B08	0.000	0.000	0.000	0.001	0.000	0.002	0
B09	0.000	0.000	0.000	0.000	0.001	0.001	0
B10	0.001	0.000	0.001	0.001	0.002	0.003	0
B11	0.090	0.046	0.392	0.159	0.335	0.416	0
B12	0.159	0.714	0.804	1.000	1.000	0.997	2
B13	0.208	0.035	0.555	0.537	0.728	0.547	0
B14	0.000	0.000	0.001	0.001	0.001	0.001	0
B15	0.000	0.000	0.002	0.001	0.001	0.003	0
Average	0.032	0.054	0.145	0.155	0.164	0.240	0
Standard deviation	0.066	0.183	0.247	0.285	0.303	0.350	0

Source: DEAFrontier outcomes

To add more depth to this analysis, we present Figure 4.2.6, which illustrates the evolution of Centralized efficiency in GCC Islamic banks during the period 2012–2017. We can note that Alizz Islamic Bank S.A.O.G. scores the highest level of efficiency in our sample study. Except in 2012, 2013, and 2014, Bank Nizwa SAOG is more efficient than it was in 2012. In our sample study, Al Baraka Banking Group B.S.C., Abu Dhabi Islamic Bank PJSC, and Qatar International Islamic Bank score the smallest level of efficiency in our sample study.

Figure 4.2.6 The Centralized efficiency score of the two-stage process in the GCC Islamic banks during the period 2012–2017



Source: R-4.1.3 program outcome.

Global (overall) efficiency Results:

Table 4.2.13 Global (overall) efficiency Results in 2012

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost}\_efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.000	14	0.560	0.001
B02	0.001	4	1.000	0.001
B03	0.000	7	1.000	0.00
B04	0.001	10	0.831	0.001
B05	0.000	15	0.462	0.001
B06	0.016	3	1.000	0.016
B07	0.000	6	0.867	0.000
B08	0.000	8	1.000	0.000
B09	0.000	9	0.847	0.000
B10	0.001	5	1.000	0.001

B11	0.090	12	0.448	0.201
B12	0.159	2	0.159	1.000
B13	0.208	1	1.000	0.208
B14	0.000	11	0.777	0.000
B15	0.000	13	0.680	0.000

Source: DEAFrontier outcomes

Table 4.2.14 Global (overall)efficiency Results in 2013

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost\_}efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.003	13	0.503	0.005
B02	0.000	4	1.000	0.000
B03	0.000	6	0.967	0.000
B04	0.003	2	1.000	0.003
B05	0.001	14	0.462	0.002
B06	0.003	3	1.000	0.003
B07	0.000	8	0.893	0.000
B08	0.000	5	1.000	0.000
B09	0.000	11	0.738	0.000
B10	0.000	7	0.914	0.000
B11	0.046	12	0.616	0.074
B12	0.714	1	0.714	1.000
B13	0.035	15	0.170	0.208
B14	0.000	9	0.774	0.000
B15	0.000	10	0.754	0.000

Source: DEAFrontier outcomes

Table 4.2.15 Global (overall)efficiency Results in 2014

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost\_}efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.187	6	0.455	0.410
B02	0.118	4	1.000	0.118
B03	0.003	9	0.968	0.003
B04	0.015	7	1.000	0.015
B05	0.015	15	0.519	0.029
B06	0.059	5	1.000	0.059
B07	0.003	10	0.912	0.003
B08	0.000	8	1.000	0.000
B09	0.000	13	0.882	0.000
B10	0.001	11	0.905	0.001
B11	0.392	3	0.930	0.422
B12	0.804	1	0.804	1.000
B13	0.555	2	0.721	0.770
B14	0.001	12	0.890	0.001
B15	0.002	14	0.821	0.002

Source: DEAFrontier outcomes

Table 4.2.16 Global (overall)efficiency Results in 2015

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost\_}efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.041	14	0.560	0.074
B02	0.033	6	1.000	0.033
B03	0.003	12	0.933	0.003
B04	0.085	5	1.000	0.085
B05	0.045	15	0.531	0.085
B06	0.412	3	1.000	0.412
B07	0.001	11	0.953	0.001
B08	0.001	7	1.000	0.001
B09	0.000	9	0.964	0.000
B10	0.001	10	0.957	0.001
B11	0.159	4	1.000	0.159
B12	1.000	1	1.000	1.000
B13	0.318	2	0.999	0.318
B14	0.001	8	0.994	0.001
B15	0.001	13	0.881	0.001

Source: DEAFrontier outcomes

Table 4.2.17 Global (overall)efficiency Results in 2016

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost\_}efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.006	15	0.666	0.008
B02	0.155	4	1.000	0.155
B03	0.000	10	0.921	0.001
B04	0.045	6	1.000	0.045
B05	0.060	14	0.500	0.120
B06	0.119	5	0.119	1.000
B07	0.001	11	0.918	0.001
B08	0.000	9	0.926	0.000
B09	0.001	8	0.926	0.001
B10	0.002	12	0.882	0.002
B11	0.335	3	1.000	0.335
B12	1.000	1	1.000	1.000
B13	0.717	2	0.963	0.744
B14	0.001	7	0.978	0.001
B15	0.001	13	0.872	0.001

Source: DEAFrontier outcomes

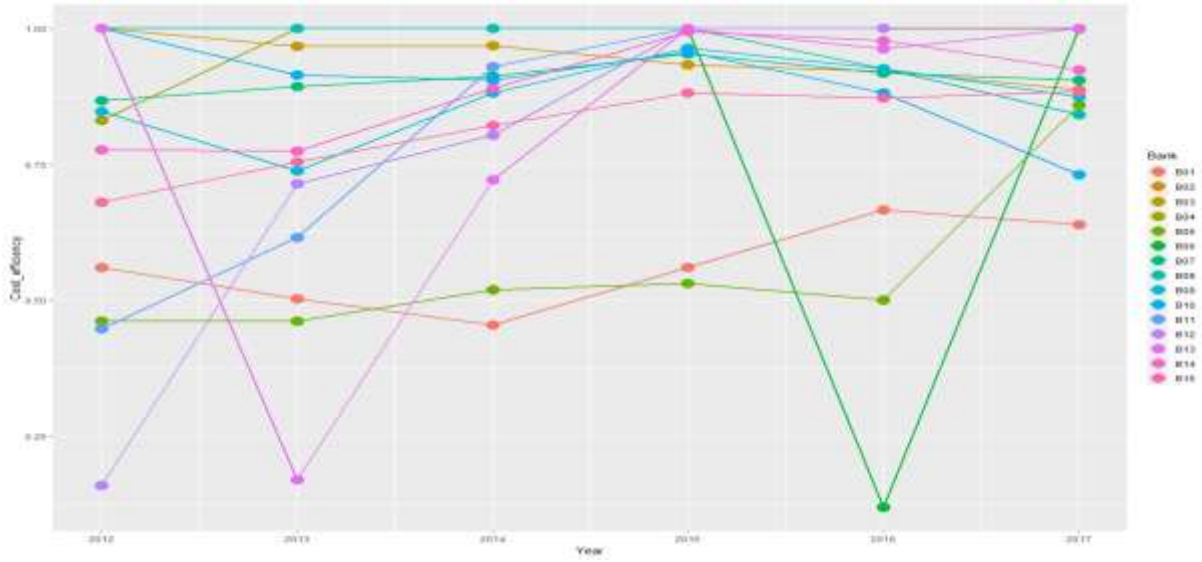
Table 4.2.18 Global (overall)efficiency Results in 2017

Bank	θ_o^{Global}	Rank	$\theta_o^{1.\text{Cost\_}efficiency}$	$\theta_o^{2.Productive\_efficiency}$
B01	0.066	14	0.639	0.104
B02	0.093	6	1.000	0.093
B03	0.001	10	0.887	0.001
B04	0.193	5	0.999	0.193
B05	0.131	7	0.859	0.153
B06	1.000	1	1.000	1.000
B07	0.001	9	0.905	0.001
B08	0.000	13	0.841	0.000
B09	0.000	12	0.874	0.000
B10	0.000	15	0.731	0.000
B11	0.416	4	1.000	0.416
B12	0.959	2	1.000	0.959
B13	0.547	3	1.000	0.547
B14	0.000	8	0.924	0.000
B15	0.000	11	0.884	0.001

Source: DEAFrontier outcomes

Through **figure 4.2.7,** we note that Abu Dhabi Islamic Bank PJSC scores the highest level of efficiency in our sample study. Except in 2016 and 2017, Warba Bank and Alizz Islamic Bank S.A.O.G. are more efficient than it. In our sample study in 2012, 2013, and 2016, respectively, Alizz Islamic Bank S.A.O.G., Bank Nizwa SAOG, and Liquidity Management Center BSC scored the smallest levels of efficiency in our sample study.

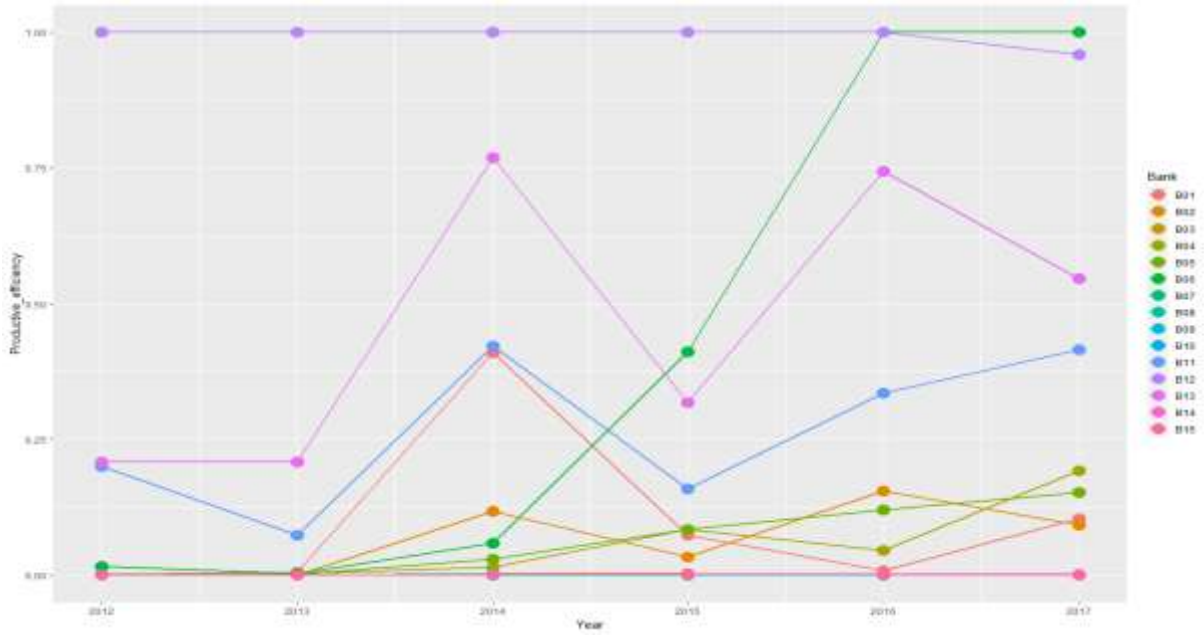
Figure 4.2.7 The cost efficiency scores in the GCC Islamic banks during the period 2012–2017.



Source: R-4.1.3 program outcome.

Through figure 4.2.8, We note that Alizz Islamic Bank S.A.O.G. scores the highest level of efficiency in our sample study. Except in 2017, Liquidity Management Center BSC has greater efficiency than it. The Islamic banks of the United Arab Emirates and Qatar scored the smallest levels of efficiency in our sample study during the whole period.

Figure 4.2.8 The productive efficiency score in the GCC Islamic banks during the period 2012–2017.



Source: R-4.1.3 program outcome.

Table 4.2.19 reveals that the global efficiency of GCC Islamic banks declined significantly during the whole period. Only two banks existed out of 15 banks that scored global efficiency; Liquidity Management Center BSC in 2017 and Alizz Islamic Bank S.A.O.G. in 2015 and 2016.

Table 4.2.19 global efficiency score of the two-stage process for GCC Islamic banks 2012-2017

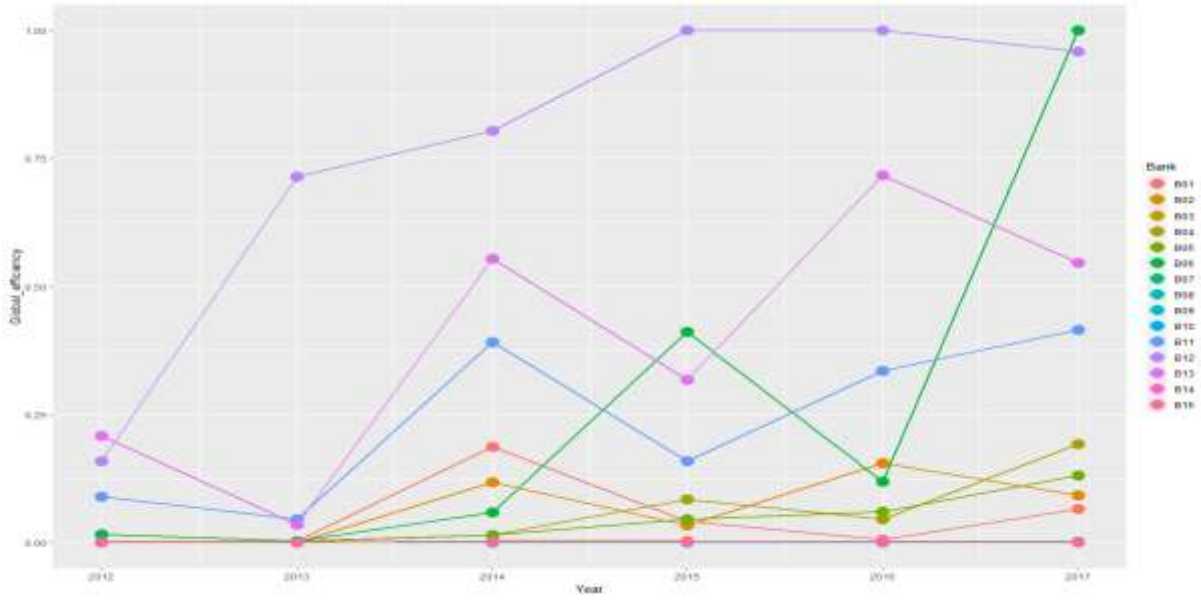
Banks	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Frequency of efficiency**
B1	0.000	0.003	0.187	0.041	0.006	0.066	**0**
B2	0.001	0.000	0.118	0.033	0.155	0.093	**0**
B3	0.000	0.000	0.003	0.003	0.000	0.001	**0**
B4	0.001	0.003	0.015	0.085	0.045	0.193	**0**
B5	0.000	0.001	0.015	0.045	0.060	0.131	**0**
B6	0.016	0.003	0.059	0.412	0.119	1.000	**1**
B7	0.000	0.000	0.003	0.001	0.001	0.001	**0**
B8	0.000	0.000	0.000	0.001	0.000	0.000	**0**
B9	0.000	0.000	0.000	0.000	0.001	0.000	**0**
B10	0.001	0.000	0.001	0.001	0.002	0.000	**0**
B11	0.090	0.046	0.392	0.159	0.335	0.416	**0**
B12	0.159	0.714	0.804	1.000	1.000	0.959	**2**
B13	0.208	0.035	0.555	0.318	0.717	0.547	**0**
B14	0.000	0.000	0.001	0.001	0.001	0.000	**0**
B15	0.000	0.000	0.002	0.001	0.001	0.000	**0**
Average	**0.031**	**0.053**	**0.143**	**0.140**	**0.162**	**0.227**	
Standard deviation	**0.066**	**0.183**	**0.246**	**0.269**	**0.301**	**0.346**	

Source: DEA Frontier outcomes

From the overall efficiencies, we can see that the calculated overall efficiencies are almost the same. Similar results are accompanied by similar phenomena in the efficiencies of stage one and stage two.

Through figure figure 4.2.9, We observe that the Liquidity Management Center BSC scores the highest level of efficiency in our sample study in 2017. Alizz Islamic Bank S.A.O.G. scored increased levels of efficiency during the research period. Saudi Arabia, the United Arab Emirates, and Qatar score the smallest level of efficiency in our sample study.

Figure 4.2.9 The global efficiency score of the two-stage process in the GCC Islamic banks during the period 2012–2017



Source: R-4.1.3 program outcome.

Table 4.2.20 Evolution of efficiency score for GCC Islamic banks over the years 2012 to 2017.

Code	Total Assets	2012	2013	2014	2015	2016	2017	Count banks (%)			Count banks in no.		
		RTS						CRS	IRS	DRS	CRS	IRS	DRS
B1	942.2	Irs	Irs	Drs	Drs	Irs	Irs	0	0	0	0	0	0
B2	1,066.80	Irs	Irs	Irs	Irs	Irs	Irs	83.3	83.33	100	5	5	6
B3	19,055.10	Irs	Drs	Drs	Drs	Drs	Drs	0	0	0	0	0	0
B4	832.8	Irs	Irs	Irs	Irs	Drs	Irs	33.3	33.33	33.33	2	2	2
B5	1,473.50	Irs	Drs	Drs	Irs	Drs	Irs	0	0	0	0	0	0
B6	213.6	Irs	Irs	Irs	Irs	Drs	Irs	50	83.33	50	3	5	3
B7	29,777.50	Irs	Drs	Drs	Drs	Drs	Irs	0	16.66	16.66	0	1	1
B8	86,083.80	Irs	Irs	Irs	Irs	Drs	Irs	0	0	33.33	0	0	2
B9	98,611.20	Irs	Irs	Irs	Irs	Drs	Drs	0	0	50	0	0	3
B10	37,263.80	Irs	Irs	Irs	Irs	Drs	Irs	0	0	0	0	0	0
B11	223.45	Crs	Crs	Irs	Irs	Irs	Irs	16.7	16.66	16.66	1	1	1
B12	101.24	Crs	Crs	Crs	Crs	Crs	Crs	16.7	66.66	16.66	1	4	1
B13	148.37	Crs	Crs	Crs	Crs	Irs	Irs	16.7	16.66	16.66	1	1	1
B14	73,192.10	Drs	Irs	Irs	Drs	Drs	Drs	0	0	33.33	0	0	2
B15	28,559.00	Drs	Drs	Drs	Drs	Drs	Drs	0	0	16.66	0	0	1

Source: R-4.1.3 program outcome.

As previously stated in Chapter two, a bank may operate at CRS or VRS, where CRS means that an increase in inputs results in a proportionate increase in outputs, and VRS means that an increase in inputs results in a disproportionate increase in outputs. Furthermore, a bank operating at VRS could also be operating at DRS or IRS. Thus, DRS defines an increase in inputs as a lower increase in outputs than IRS defines an increase in inputs as a higher increase in outputs.

According to table 4.2.18, only ABC Islamic Bank (E.C.) seems to have dominated the efficiency frontier DRS at the 100 percent level compared with other GCC banks. The findings show that Islamic banks typically operate at 50 percent DRS, 33.33 percent DRS, or 16.66 percent DRS. And the findings show that Islamic banks typically operate at 83.33 percent IRS, 66.66 percent IRS, 33.33 percent IRS, or 16.66 percent IRS. These findings are similar to those of previous studies by, for example, **(Zeitun, Abdulqader, & Alshare, 2013)** indicated that Variable Return to Scale (VRS) procedures result in three out of five DEA models, indicating that Islamic banks are significantly less efficient than conventional banks.

The findings show that Islamic banks typically operate at 83.33 percent CRS, 50 percent CRS, 33.33 percent CRS, or 16.66 percent CRS. These findings are similar to those of previous studies by, for example, **(Zeitun, Abdulqader, & Alshare, 2013)** found that the Constant Return to Scale (CRS) procedures result in three out of five DEA models, indicating that Islamic banks are significantly less efficient than conventional banks.

- **Statistical Problem**

We wanted to know if there is a significant variance between the efficiency score of the first and second stages during the period 2012-2017 So, we randomly selected 15 Islamic banks in GCC states by using two stage DEA model. The efficiency score calculated by the DEA ranges from 0 to 1. If the efficiency scores of the banks equal one, the banks are efficient. If the efficiency scores are less than one, the bank is inefficient.

- **Hypotheses Testing:**
  - **Testing third hypothesis:**

The alternative hypothesis is that H1 there is a significant variance between the efficiency of the first and second stages. That means the second stage'sfinancial efficiency is higher than the first stage, they have been shown below:

$$H_0 : \mu_1 \geq \mu_2$$
$$H_1 : \mu_1 < \mu_2$$

To test this hypothesis, the tables below show the outcomes of the first hypothesis test.

Table 4.2.21 testing third hypothesis

Stage	Median	Test Statistics	P-value	Decision	Interpretation
First stage	-0.2160575	815	0.000302	Reject H0	Significant
Second stage					

Source: R-4.1.3 program outcome.

Since P- value = 0.0003 is less than the level of significance (a)= 0.05 we rejected Ho. therefore accept the alternative hypothesis H1 “the financial efficiency of the second stage is higher than the first stage”

- **Testing fourth hypothesis:**

The alternative hypothesis is that H1 there is a significant variance between the efficiency of the first and second stages which means H1 the centralized efficiency of the first stage is higher than the second stage.

$$H_0 : \mu_1 \leq \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

Table 4.2.22 testing fourth hypothesis

Stage	Median	Test Statistics	P-value	Decision	Interpretation
$E_o^{1.Centralized}$	0.6914447	3638.5	2.899e-13	Reject Ho	Significant
$E_o^{2.Centralized}$					

Source: R-4.1.3 program outcome.

Since P- value =2.899e-13 is less than the level of significance (a)= 0.05 we rejected Ho. therefore accepting the alternativehypothesisH1 the centralized efficiency of the first stage is higher than the second stage.

- **testing fifth hypothesis:**

The alternative hypothesis is that H1 there is a significant variance between the efficiency of the first and second stages that means H1 the cost efficiency is higher than productive efficiency

$$H_0 : \mu_1 \leq \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

Table 4.2.23 testingthe fifth hypothesis

Stage	**Median**	**Test Statistics**	**P-value**	**Decision**	**Interpretation**
$\theta_o^{1.\text{Cost\_}efficiency}$	0.7798737	3725	1.786e-14	Reject Ho	Significant
$\theta_o^{2.Productive\_efficiency}$					

Source: R-4.1.3 program outcome.

Since P- value =1.786e-14 is less than the level of significance (a)= 0.05 we rejected Ho therefore accept the alternative hypothesis H1 the cost efficiency is higher than productive efficiency.

- **Testing sixth hypothesis:**

the null hypothesis is that There is a non-significant impact of financial efficiency in the first and second stages on overall efficiency and the alternative hypothesis is that there is a significant impact of financial efficiency in the first and second stages on overall efficiency, they have been shown below:

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 \neq \mu_2$$

To test this hypothesis, the tables below show the outcomes of the first hypothesis test.

Table 4.2.24 testing sixth hypothesis

Efficiencies	**Estimate**	**Std Err**	**t-value**	**P-value**	**Decision**	**Interpretation**
First stage	-0.176	0.2241	-0.918	0.291	Reject H1	Non-significant
Second stage	-0.071	0.3507	-0.203	0.840		

Source: R-4.1.3 program outcome

From table **4.2.24**, we observe that the impact of financial efficiency in the first and second stages on overall efficiency was as negative as-0.176 and-0.071, respectively, which is non-significant and therefore rejects the alternative hypothesis" There is a significant impact of financial efficiency in the first and second stages on overall efficiency "

- **testing seventh hypothesis:**

Table 4.2.25 testing the seventh hypothesis

Efficiencies	**Estimate**	**Std Err**	**t-value**	**P-value**	**Decision**	**Interpretation**
$E_o^{1.Centralized}$	-0.018	0.095	-0.114	0.105	Reject H1	Non-significant
$E_o^{2.Centralized}$	-0.2356	0.1396	-1.687	0.095		

Source: R-4.1.3 program outcome

From table **4.2.25**, we observe that the impact of centralized efficiency in the first and second stages on centralized efficiency was as negative as-0.018 and-0.2356, respectively, which is non-significant and therefore rejects the alternative hypothesis" There isa significantimpact of centralized efficiency in first and second stages on centralized efficiency "

- **testing the eighth hypothesis:**

Table 4.2.26 testing eighthhypothesis

Efficiencies	Estimate	Std Err	t-value	P-value	Decision	Interpretation
$\theta_o^{1.Cost\_efficiency}$	0.3636	0.0442	8.230	0.000	Reject Ho	Significant
$\theta_o^{2.Productive\_efficiency}$	0.7920	0.0302	26.241	0.000		

Source: R-4.1.3 program outcome.

From table **4.2.26**, we noted that the impact of cost efficiency and productive efficiency on global efficiency was as positive as 0.3636and 0.7920, respectively, which is significant and therefore accepts the alternative hypothesis" There is a significant impact of cost efficiency and productive efficiency on global efficiency "

2.6 Discussion:

Efficiency Measurement System R Programming and DEA Frontier software were used for measuring the efficiency and hypotheses testing.

H01: The financial efficiency of Islamic banks is lower in GCC countries.

The financial efficiency of Islamic banks is lower in GCC countries which means the financial efficiency in GCC Islamic banks is lower This implies that Islamic banks are affected by many internal and external factors (Yu & Li, 2021) indicated that enterprise efficiency analysis, primary business costs, the national capital, the number of R & D employees, total liabilities, as well as operating profit, all have an important effect on the financial efficiency of Chinese industrial businesses. Moreover (RIBEIRO, NOGUEIRA, LINHARES , & da SILVA, 2020) discovered that location, purchasing power index,

tourism, and unemployment rate all have an impact on municipal financial efficiency; Tax income and financial independence are budgetary drivers that have a favorable impact on municipal financial efficiency. Staff expenditure has a negative impact on it. As well as (Hafez & Halim, 2019) found that The pure technical efficiency of Islamic banks has improved as a result of management quality and outperformed both conventional banks and conventional banks with Islamic windows (Zhang , Feng , Xu , & Jiao, 2014)revealed that the immature market makes it difficult for The financial efficiency of emerging economies to fully reach the Pareto optimum.(Sillah & Harrathi, 2015) Indicated thatthere is no evidence of technological improvements in banking operations in GCC banks, that's why they need to increase technological improvements that will likely decrease the cost and increase the return of banks hence increasing the financial efficiency. As(Rajput, Chopra, & Oberoi , 2014) indicated that Indian banks need to improve their technological orientation to continue their efforts to reduce the percentage of NPAs to augment their profitable efficiency soon.

Principles of Islamic banks commit suppliers and customers to the same principles by making such rules part of contractual relations. Working on these Islamic principles is more dangerous, leading to a lower level of efficiency.(Johnes, Izzeldin, & Pappas, 2014)Indicated that the average efficiency of Islamic banks is significantly lower than that of conventional banks, a breakdown of the efficiencies demonstrated that working under Islamic laws (i.e., the banking system itself) accounts for the efficiency disparity rather than poor management This result is consistent with earlier studies of (Samad, 2021) The banks in the GCC countries were inefficient because they were governed by the IRS or DRS. The primary source of inefficiency was DRS. As well as (Alsharif , 2020) Found that all GCC nations agree that conventional GCC banks are significantly more effective than Islamic GCC banks. Additionally, it was shown that generally speaking and across all GCC nations, state-owned GCC banks perform better than private GCC banks. However, banks listed by the GCC were less effective than GCC unlisted banks. Furthermore, scale inefficiency was the primary inefficient source in GCC banks.

H02: There is a variation in the degree of financial efficiency of Islamic banks among the six countries.

Looking at these six countries, there is a difference in the degree of financial efficiency in both stages among the six countries. These are given in Table1.2.4 and Table2.2.4 average efficiency was computed for each of these countries. this result indicated that the difference in financial efficiency is explained by the level of deposit, growth of assets, return of bank, and Cost to Income Ratio .this result confirmed the previous study of (Farandy, Suwito, & Dabutar, 2017) revealed that the variables of assets, number of bank branches, and ROA have a substantial impact on the efficiency of Islamic commercial banks, While CAR and NPF do not have a statistically significant impact on efficiency. and (Dutta, Jain, & Gupta, 2020) found that Size, Income Diversity, and ROA have a substantial impact on efficiency scores, while ROE has no significant impact.In addition, (Jelassi & Delhoumi, 2021) discovered that the return on equity, expense-to-income ratio, loan-to-deposit ratio, and growth rate have no bearing on Tunisian banking technical efficiency. as well as **(Sin, 2019)** revealed that numerous inefficient businesses exist when compared to procurement capital. Meanwhile, management performance was inefficient when compared to input assets; nonetheless, certain firms were productive in terms of capital procurement; As a result, when assessing a company's efficiency, efficiency techniques and measurement values take both input and acquisition capital into account are essential. As a result, when assessing a company's efficiency, efficiency techniques as well as measurement metrics that account for both input and acquisition capital are essential. And (Gulati & Kumar, 2017) Indicated that variations in intermediation efficiency are explained by bank size, liquidity position, directed lending, and intermediation cost, whereas inter-bank operating efficiency differences are influenced by profitability and income diversification. As previously stated, GCC Islamic banks must develop their technology in order to improve their performance. (Yu & Li, 2021) there is a rather big financial efficiency gap among Chinese interprovincial industrial businesses. The main element influencing the increase of financial efficiency in Chinese industrial businesses is technological change, with technical efficiency having a minimal impact. And (Wang, Yang, Chiu, & Lin, 2020) exposed that digital banking has marginally enhanced financial sector efficiency, although there are considerable variances in the influence of

China's provincial efficiency. Although financial sector efficiency favorably corresponds while digital financial efficiency benefits underdeveloped regions, digital finance disadvantages them. The eastern region's financial industry has a much greater efficiency score than the non-eastern zone. The growing influence of digital finance on financial sector efficiency is greater in the east of the region than in the non-eastern zone. As well as (Tahir, Baka, & Haron , 2009) demonstrated that native Islamic banks outperformed their foreign bank counterparts in terms of efficiency. Furthermore, native Islamic banks have better levels of efficiency in all three efficiency measures, which is consistent with the home-field advantage theory.

H03: There is a significant variance between the financial efficiency of the first and second stages.

Our study found that there is a significant variance between the financial efficiency of the first and second stages the financial efficiency of the second stage is higher than the first stage. This result confirmed a previous study of(Kablan, 2012) that indicated that there is an increase in financial efficiency at the expense of social and financial efficiency. MFIs that place a strong emphasis on outreach are less efficient. Reforms also have a negative effect on social efficiency while having a beneficial influence on financial efficiency. and (Islam & Kassim, 2015) also revealed that Islamic banks are technically efficient, but their scale efficiency is inadequate, implying that scale inefficiency is the primary source of inefficiency in Islamic banks. The variation between the efficiency of the two stages makes a world of difference that might impact overall efficiency. Thus, the management must increase their financial efficiency to access the optimal levels in both stages.

H04: There is a significant variance between the centralized efficiency of the first and second stages.

Our study found that there is a significant variance between centralized efficiency of the first and second stages which means the centralized efficiency of the first stage is higher than the second stage This result confirmed the previous study of(Yonnedi & Panjaitan, 2019) the multi-stage DEA revealed a significant difference in the number of efficient BPDs using the three approaches, depending on the increase in efficiency change and scale efficiency change. According to its findings, BPDs should invest more in technology to increase firm efficiency.

H05: There is a significant variance between cost efficiency and productive efficiency.

The Cost and productivity levels have been calculated. for each DMU using the two-stage DEA approach and found that the cost efficiency is higher than production efficiency. this result confirmed with previous study of (Yildirim, 2015) discovered that the Technical Efficiency Change (EFFCH) The value of Islamic banks in Turkey and Malaysia was never documented to be more than one for any period. The Islamic Banks were discovered to be unlikely to reach the production limit.(Johnes, Izzeldin, & Pappas, 2014) Productivity growth has been slow, which can be attributed to inefficient banks' slow adaptation to technological advancements. According to (Wang & Lu, 2014) showed that the mean efficiency score of banks during the profitability period is greater than that of the marketability stage banks', and that technical efficiency differs significantly from both operating scale and pure technical efficiency in terms of rankings; scale efficiencies differ greatly from operating scale and pure technical efficiency rankings, and scale efficiencies differ greatly from rankings based on operating scale and pure technical efficiency.

The Islamic banks with a higher ROA tend to seek riskier, less liquid investment opportunities to generate profits, resulting in low levels of productivity (Fernandes, Stasinakis , & Bardarova, 2018) indicated that Liquidity and credit risk are found to negatively affect productivity of banks.

H06: There is a significant impact of financial efficiency in the first and second stages on overall efficiency.

The impact of financial efficiency in the first and second stages on overall efficiency was as negative as-0.176 and-0.071, respectively, which is non-significant and therefore rejects the alternative hypothesis" There is a significant impact of financial efficiency of first and second stages on overall efficiency "This decline in overall efficiency was mainly caused by the increase of their financial inefficiency. to increase their financial efficiency, they have to gather more financial resources, allocate them to resource-scarce sectors, and then use those resources more effectively and efficiently to increase the overall efficiency as pointed out (Moutinho , Vale, Bertuzi , Bandeira, & Palhares , 2021) banks can significantly increase their efficiency by improving their resource management practices.

The global performance of Iberian banks is primarily based on the effectiveness of their human capital. In addition, (Wasiaturrahma, Sukmana, Ajija, Salama, & Hudaifah, 2020) revealed that location and capital adequacy ratio has a positive effect on these two effectiveness outcomes (CAR). These rural banks that operate in cities are more productive than others. Furthermore, in terms of production and intermediation, both Islamic and traditional rural banks are more effective the with larger capital. Moreover (Ravanshad, Amiri, Salari, & Khodadadi, 2020)indicated that there exists a positive relationship between management ability and consistent performance. It means that managerial ability is directly related to company performance. In this sense, the company's performance improves by increasing its managerial ability to better utilize resources and, as a result, increase overall efficiency. As well as found out (Owolabi & Ajayi, 2013) demonstrated that the period following mergers and acquisitions was more financially efficient. This result is consistent with earlier studies of (Liu, Hu, & Tang, 2016) The calculated results demonstrated that regional financial efficiency has considerable spatial spillover effects due to time inertia and spatial dependence.

financial efficiency distributes economic growth via increasing sources of banks and improving productivity as pointed out in previous research of (Hu , Zhang, & Chao, 2018) that financial efficiency promotes economic growth only when it reaches a particular level (financial threshold). When it crosses the threshold, it increases the capacity for the accumulation and distribution of financial resources. Rapid financial development can give a superior financial environment and enhanced circumstances for economic growth, promoting the Chinese economy's continual improvement. Moreover (Gill, Biger, & Mand, 2013)changes in corporate leverage create changes in financial efficiency, and changes in corporate leverage and financial efficiency generate changes in dividend decision-making in Indian enterprises. The data also suggested that corporate leverage and financial efficiency have a factor in determining the proportion of dividends to pay.As well as (Zouhaier, 2015) indicated that the liquidity ratio has a positive impact on the profitability of Islamic banks. The inflation rate, as a proxy for the macroeconomic environment, has a favorable effect on profitability of Islamic banks.

H07: There is a significant impact of centralized efficiency in the first and second stages on centralized efficiency.

The impact of centralized efficiency of first and second stages on centralized efficiency was as negative as-0.018 and-0.2356, respectively, which is non-significant and therefore rejects the alternative hypothesis" There is a significant impact of centralized efficiency in first and second stages on centralized efficiency "lower centralized efficiency has a negative impact on centralized efficiency. this result is consistent with earlier studies of (Bahrini , 2017) revealed that pure technical inefficiency, rather than scale inefficiency, was the primary source of overall technical inefficiency. as well as(Kong, Fu, & Yu, 2017) found that Many banks made too many performing loans, which should be reduced by independent banks more than by financial holding company subsidiary banks. the ratio of investments to loans and the ratio of nonperforming loans to performing loans had no significant impact on efficiency. And contrasted with a previous study of (Lotfi, Eshlaghy, shafiee, Saleh, Nikoomaram, & Seyedhoseini, 2012) revealed the significance of profitability, efficiency, and effectiveness in the overall performance of Iranian bank branches. It's important to understand how profitability, efficiency, and effectiveness relate to one another. Without these connections, we are unable to have a greater understanding of the performance as a whole.

H08: There is a significant impact of cost efficiency and productive efficiency on global efficiency.

Cost efficiency is the ratio of the cost to the output and Productivity efficiency is about making the best possible use of resources. In our study, we found that the impact of cost efficiency and productive efficiency on global efficiency was as positive as 0.3636and 0.7920, respectively, which is significant and therefore accepts the alternative hypothesis" There is a significant impact of cost efficiency and productive efficiency on global efficiency " this result confirmed with the previous study of (Fernandes, Stasinakis , & Bardarova, 2018) found that capital and profit risk have a beneficial influence on their performance. bank-risk variables have a greater impact on bank efficiency when lower

levels of financial development are observed and (Kamarudin, Nordin, Muhammad, & Hamid, 2014)found that revenue efficiency appears to be the primary factor influencing whether profit efficiency is low or high. In essence, higher revenue efficiency only has a favorable influence on higher profit efficiency levels in Islamic banks. The results revealed that profit efficiency is lower than cost efficiency as a result of the higher revenue efficiency, hence increasing revenue efficiency levels will not have an impact on profit efficiency of conventional banks. To increase the productive efficiency of GCC Islamic banks should be working on decreasing the cost of the product (Fukuyama, Matousek, & Tzeremes, 2020) indicated that cost inefficiency levels are primarily determined by a bank's ability to control its allocative inefficiency levels.

Lower technology has the role of increasing costs, which in turn leads to a decline in productivity of banks as pointed out (Moussawi & Obeid, 2010) revealed that technical and Allocative inefficiencies increased bank costs by 14 and 29 percent, respectively. As well as (Qamruzzaman & Jianguo, 2016) found that The overall level of technical efficiency is decreasing under both the CRS and VRS assumptions. This entails assessing the level of technical efficiency, as the banking industry as a whole is inefficient.

H09: There is an impact of the size of the bank on financial efficiency.

As you know, the size of the bank is related to the size of its assets. It is frequently argued that large banks are more efficient than smaller banks because they can use more specialized inputs, better coordinate their resources, and reap the benefits of economies of scale. Economists have demonstrated that larger banks are better positioned to achieve the optimal mix and scale of output. In our study, according to Table.9, we found that large-sized banks are less efficient than small banks. As the bank grows, it becomes less efficient which means GCC Islamic banks lack the managerial and technical abilities to manage their operations. This conclusion differed from earlier research (Ajlouni, Hmedat, & Hmedat, 2011) found that larger banks outperform smaller and medium-sized banks based on relative efficiency. as well as(Tahir, Bakar, & Haron, 2011) found thatthere are considerable variations in efficiency between sizes but not between regions. Large banks are more efficient than small and medium-sized banks.and(PALECKOVA, 2019) revealed

That larger banks with higher liquidity risk and lower net interest margin values were more efficient. In addition, (Paradi , Rouatt , & Zhu, 2011) revealed the efficiency of small and medium branches in the production and profitability dimensions. X-Large branches are the most efficient in the intermediation dimension, and the large branch group is found to be relatively inefficient in all three dimensions. Moreover, (Jelassi & Delhoumi, 2021) revealed that Banking technical efficiency rises with capitalization and inflation but falls with size, number of bank branches, management-to-staff ratio, and loan-to-asset ratio.

This result is confirmed with a previous study of (AKIN , KILIÇ, & ZAĐM, 2009)Smaller banks outperform larger banks in terms of efficiency. Banks become less efficient as they grow in size. And the size of banks has a negative influence on their efficiency levels. Banks that are publicly traded are more effective than those that are not. Foreign-owned banks operate more successfully than their domestic counterparts. Furthermore, state-owned banks are inefficient compared to non-state banks, As for the study of(Srairi, Kouki, & Harrathi, 2012)found that large and small banks are more efficient than medium banks.

utilization of resources is important for maintaining productivity. If the banks do not interested in this task, deliverables will be delayed, and costs will rise. (Kamarudin, Sufian, Nassir, & Anwar, 2015) and (Aghimien , Kamarudin , Hamid, & Noordin, 2016) revealed that many GCC banks are operating within an optimal scale of efficiency. Nevertheless, the results also indicated ineffective resource management on the part of management. The results also revealed that smaller banks, the 21 smallest, typically operate at constant returns to scale or increasing returns to scale, in contrast to the 22 largest banks, which typically function at constant returns to scale or falling returns to scale. As well as (Onour, 2012) found that the size of the bank is inversely related to scale efficiency, implying that a subpar operation size is a primary cause of scale inefficiency in GCC banks.

Conclusion:

Data Envelopment Analysis is a prominent method for comparing the efficiency of similar units by taking into account a variety of input and output factors. The multi-stage DEA model can express the dependency, with the outputs from the previous stage serving as inputs for the subsequent stage. The multi-stage DEA model assesses the efficiency of each stage as well as the overall efficiency of the operations.

The overall efficiency results indicate that inefficiency is small across 15 Islamic banks in the GCC region. This is really low when compared to many previous studies. Therefore, the GCC Islamic banks must work to increase work by entering new markets and encouraging the spirit of competition with foreign countries to develop the Islamic financial industry.

Conclusion

In this study, the two-stage DEA centralized mode lproposed by Liang, Cook, and Zhu (2008) was used to evaluate the financial efficiency of (15) GCC Islamic banks from 2012 to 2017.To make a comparative analysis between the efficiency scores of the first and second stages to determine the banks that operate more efficiently and to test the hypotheses and answer the questions of the study found in the introduction.

Traditional DEA models assume that industrial processes include only one stage. These models treat each decision-making unit as a "black box." Inputs enter and output exit without taking the intermediate step into account in calculating the relative efficiency of a set of production systems. While two-stage DEA applies to DMUs that are produced in two phases, assessing the proficiency for each stage, with the result of the principal stage turning into the contribution to the subsequent stage. The goal of efficiency measurement is to identify problem areas so that the proper resources can be used to boost performance. An issue that is of greater concern to the inefficient DMUs is what factors cause the inefficiency. Two-stagedata envelopment analysis can detect inefficiencies that the one-stage DEA model misses. In addition, it can also distinguish those that are inefficient in the first stage from those that are inefficient in the second stage. The results of the theoretical and analytical framework are presented as follows:

1. **The result of the theoretical framework**

- According to Shariah, the concept of Islamic Finance forbids the fixed or acceptance of specific interest or fees, which is known as Riba.
- The Islamic concept emphasizes profit that accepts risk and demonstrates fairness, honesty, avoidance of hoarding, and avoidance of that which is an integral part of Sharia law.
- Islamic banks face many challenges by taking this financing.
- Workers, both experienced and inexperienced, must learn and develop to meet the demands of the Islamic banking industry.
- Universities and colleges should brand and offer courses in Islamic finance.
- The most crucial function in every firm is financial management.
- Particularly owners and business managers bear the burden of being aware of management decisions that affect Profits and cash flow.
- The significance of financial management stems from the reality that it determines a company's growth and success.

- The financial managers are concerned with keeping track of all business expenses.
- If costs go beyond the allocated sum, financial managers take every required action to make things right.
- Efficiency refers to the highest level of performance achieved by using the fewest number of inputs to produce the greatest number of outputs which means Reducing the number of superfluous resources used to produce a given output, including personal time and energy, to increase efficiency.
- Efficiency should never be used as the sole criterion for making critical decisions like these Financing, Investment, and Dividend decisions.

2. The result of the analytical framework

The result of the study can be summarized as follows:

- The financial efficiency of Islamic banks is lower in GCC countries.
- Results reveal that on average, the financial efficiency of GCC Islamic banks is found to be equal to 0.457 in the first stage and 0.569 in the second stage.
- The financial efficiency improved from the first stage to the second stage.
- Banks must rethink and place a strong emphasis on improving financial efficiencies to facing the pressures of competition.
- Principles of Islamic banks commit suppliers and customers to the same principles by making such rules part of contractual relations. Working on these Islamic principles is more dangerous, leading to a lower level of efficiency
- There is a variation in the degree of financial efficiency in both stages among the six countries.
- There is a significant variance between the efficiency of the first and second stages.
- the financial efficiency of the second stage is higher than the first stage.
- the centralized efficiency of the first stage is higher than the second stage.
- The cost efficiency is higher than production efficiency.
- The impact of financial efficiency in the first and second stages on overall efficiency was as negative as -0.176 and-0.071, respectively, which is non-significant. That means there is a non-significant impact of financial efficiency in the first and second stages on overall efficiency.

- the impact of centralized efficiency of the first and second stages on centralized efficiency was as negative as-0.018 and-0.2356, respectively, which is non-significant. That means there is a non-significant impact of centralized efficiency in the first and second stages on centralized efficiency.
- The impact of cost efficiency and productive efficiency on global efficiency was as positive as 0.3636and 0.7920, respectively, which is significant. That means there is a significant impact of cost efficiency and productive efficiency on global efficiency.
- Results also show that large Banks are more efficient than smaller banks because they have the ability to use more specific inputs, better coordinate their resources, and reap the benefits of economies of scale.

3. Recommendations:

- Although the study focuses on the financial sector, there is ample need to generalize the study to other knowledge-intensive industries such as industries, universities, and hospitals.
- It is recommended that the generalizability would be more effective for future researchers by increasing the sample size and the period of study.
- There is ample need for future researchers to explore more DEA practices to compare these practices and determine which ones are the most capable of measuring the company's performance.
- Overall, I would recommend Algeria to independently investigate the viability of Islamic banking for its financial system. In order to do this, it may be necessary to perform market research, consult with industry experts, and assess the potential advantages and risks of Islamic banking.

4. Future research:

Future research should look into how the results might be applied in broader contexts than the GCC Islamic banks. Important firms, for example, industry sectors from different countries, should also be used. And our proposed framework could also be used in the future for performance evaluation in other regions such as North Africa, Maghreb countries, and Middle Eastern countries.

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