

**T.C.  
ISTANBUL AYDIN UNIVERSITY  
INSTITUTE OF GRADUATE STUDIES**



**ASSESSMENT OF LIBYAN ECONOMY THROUGH KEY ECONOMIC  
PERFORMANCE INDICATORS USING TOPSIS METHOD**

**THESIS**

**RIM H MOHAMED ELDINALI**

**Department of Business  
Business Administration Program**

**August 2020**

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**August 2020**

## **DECLARATION**

I hereby declare that all information in this thesis document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results, which are not original to this thesis.

**Rim H Mohamed ELDINALI**

## **FOREWORD**

The Libyan economy has suffered for a long time from an undemocratic political regime, followed by instabilities after the revolution in 2012. Therefore, it is important to understand the factors that are hindering the development and identify the key factors that could assist in the development and growth process. As an oil-rich country, there are a huge potential for Libya to build and expand its economy. The strategic geographic location and the availability of financial means form a great recipe for a successful pursuit. The current research enhanced my understanding for my country's economy and allowed to develop experience in machine-learning techniques that are beneficial in economic planning and management. The outcomes of this research can be the corner stone or a push for a great Libya with a bright future for its citizens.

I would like to thank my thesis advisor Dr. Çiğdem Özarı for support and advice to develop and complete this research. Many thanks to my family for their patience and support.

**December 2019**

**Rim H Mohamed ELDINALI**

## TABLE OF CONTENT

	<u>Page</u>
<b>FOREWORD</b> .....	<b>iv</b>
<b>TABLE OF CONTENT</b> .....	<b>v</b>
<b>ABBREVIATIONS</b> .....	<b>vi</b>
<b>LIST OF FIGURES</b> .....	<b>vii</b>
<b>LIST OF TABLES</b> .....	<b>viii</b>
<b>ABSTRACT</b> .....	<b>ix</b>
<b>ÖZET</b> .....	<b>x</b>
<b>1. INTRODUCTION</b> .....	<b>1</b>
1.1 Research Overview and Significance.....	1
1.2 Aim of Study .....	3
1.3 Research Scope and Thesis Structure.....	3
<b>2. LITERATURE REVIEW</b> .....	<b>5</b>
2.1 Economic Key Performance Indicators (KPIs).....	5
2.1.1 Exportation and importation of goods .....	5
2.1.2 Foreign direct investment (FDI) .....	6
2.1.3 Inflation and foreign currency exchange rate .....	7
2.1.4 Labor force and unemployment .....	9
2.1.5 Oil production and energy imports .....	10
2.1.6 GDP.....	11
2.2 Multi-Criteria Decision-Making Methods and their Applications.....	11
2.3 TOPSIS Technique and its Applications.....	16
2.4 Libyan Economy and Economic Performance Studies .....	22
<b>3. METHODOLOGY AND APPLICATION</b> .....	<b>28</b>
3.1 Methodology Design and Data for Libyan Economy .....	28
3.2 TOPSIS Application and Discussion .....	31
<b>4. CONCLUSIONS</b> .....	<b>38</b>
<b>REFERENCES</b> .....	<b>41</b>
<b>RESUME</b> .....	<b>49</b>

## ABBREVIATIONS

<b>AHP</b>	: Analytic Hierarchy Process
<b>ANP</b>	: Analytic Network Process
<b>CFNAI</b>	: Chicago Fed National Activity Index
<b>DEMATEL</b>	: Decision making trial and evaluation laboratory
<b>ELECTRE</b>	: Elimination and Choice Expressing Reality
<b>EPI</b>	: Economic Performance Index
<b>FDI</b>	: Foreign Direct Investment
<b>GDP</b>	: Gross Domestic Product
<b>HC</b>	: Human Capital
<b>MAUT</b>	: Multi-Attribute Utility Theory
<b>MCDM</b>	: Multi-Criteria Decision-Making technique
<b>MENA</b>	: Middle East and North Africa
<b>MRW</b>	: Mankiw, Romer and Weil model
<b>OECD</b>	: The Organization for Economic Cooperation and Development
<b>PROMETHEE</b>	: Preference Ranking Organization Method for Enrichment Evaluation
<b>SAW</b>	: Simple Additive Weighting
<b>ServQual</b>	: Service Quality
<b>SMART</b>	: Simple multi-Attribute Rating Technique
<b>TOPSIS</b>	: Technique for Order Preferences by Similarity to Ideal Solutions
<b>US</b>	: United States
<b>VAR</b>	: Vector autoregression model

## LIST OF FIGURES

	<u>Page</u>
<b>Figure 2.1:</b> The Relationship between Unemployment Rate and Inflation.....	<b>8</b>
<b>Figure 2.2:</b> General MCDM Technique Selection and Application Process .....	<b>12</b>
<b>Figure 2.3:</b> Classification of MCDM Techniques Based On Their Data Usage.....	<b>15</b>
<b>Figure 2.4:</b> Contribution of Oil and Non-Oil Production in Libyan Public Budget .	<b>22</b>
<b>Figure 2.5:</b> Per Capita GDP in Libyan Dinars .....	<b>23</b>
<b>Figure 2.6:</b> Log Graph Presenting Human Capital per Labor Force (H/L) In Libya	<b>24</b>
<b>Figure 2.7:</b> The Interrelation between Oil Exportation and GDP in Libya.....	<b>24</b>
<b>Figure 2.8:</b> Best-Fit Graph for Inflation Rate Changes With The Increase Of Oil Prices .....	<b>26</b>
<b>Figure 2.9:</b> The similarity in change profile between the Libyan real GDP and effective exchange rate index .....	<b>26</b>
<b>Figure 2.10:</b> Behavior of GDP, FDI and human capital (HC) in Libya between 2000 and 2015 .....	<b>27</b>
<b>Figure 3.1:</b> Comparison between Export and Import Volumes of Libya from 2009 to 2017 .....	<b>29</b>
<b>Figure 3.2:</b> Foreign Direct Invest in Libya from 2009 to 2017.....	<b>30</b>
<b>Figure 3.3:</b> Labor force and unemployment in Libya from 2009 to 2017 .....	<b>30</b>
<b>Figure 3.4:</b> Performance of the Libyan economy (2009 to 2017).....	<b>36</b>

## LIST OF TABLES

	<u>Page</u>
<b>Table 2.1:</b> A comparison between several MCDM methods (Velasquez & Hester, 2013).....	13
<b>Table 2.2:</b> A compiled literature survey of business administration and management studies that used the TOPSIS techniques .....	18
<b>Table 3.1:</b> Economic Indicators Used For the Evaluation .....	31
<b>Table 3.2:</b> Libyan Economy Data Used For TOPSIS Application (Decision Matrix) .....	31
<b>Table 3.4:</b> Normalized Decision Matrix.....	33
<b>Table 3.5:</b> Weighted Decision Matrix .....	33
<b>Table 3.6:</b> Calculation of Positive and Negative Solutions.....	34
<b>Table 3.7:</b> Separation Measurement from Positive Ideal Solution.....	34
<b>Table 3.8:</b> Separation measurement from negative ideal solution .....	34
<b>Table 3.9:</b> Relative closeness coefficient and order of year from best to worst based on data of the Libyan economy .....	35



## **ASSESSMENT OF LIBYAN ECONOMY THROUGH KEY ECONOMIC PERFORMANCE INDICATORS USING TOPSIS METHOD**

### **ABSTRACT**

The need for economic development and growth gave the research through economic performance indicators a great significance. Considering the limitations of the current equations and models, there is a need for a more complex machine-learning approach to assess economic performance over several years for comparison and precise outcomes. Multi-criteria decision-making techniques (MCDMs) are widely used to compare attributes and select alternative in complex decision-making problems. While the main source of data is often the input of experts from the field, adopting actual economic data can eliminate the uncertainty factor of the MCDM and provide more accurate results. The current study aims to assess the performance of the Libyan economy between the years of 2009 and 2017 using the TOPSIS method in order to understand the factors that contributed into enhancing the economy in the best years. The TOPSIS method is widely used in economic and management applications, as it is helpful in determining the alternative that is the closest to the ideal solution. Through studying the economic factors affecting the Libyan economy between 2009 and 2017, the findings of the research show that 2017 was the best year for economic performance. Prior the late political instability in the country, 2010 is indicated as the second-best year for economic performance with 20.18% enhanced performance from the year before. The worst years for economic performance in Libya were between 2012 and 2014 due to the civil war between the different political and militant powers in the country. However, from 2015 to 2017 a substantial enhancement in the economic performance is observed during a stability period. The current crisis in the country highlighted the impact of oil-dependency on the Libyan economy. Thus, it is understood that adopting oil as the main income of the country increase the vulnerability of the economy and has impacts on the other economic factors, including foreign currency exchange rates.

**Keywords:** economic performance indicators; Libya; TOPSIS

## LİBYA'NIN EKONOMİK PERFORMANSININ TOPSIS YÖNTEMİYLE DEĞERLENDİRİLMESİ

### ÖZET

Ekonomik gelişme ve büyüme ihtiyacı, ekonomik performans göstergeleriyle araştırmaya büyük önem verdi. Mevcut denklem ve modellerin sınırlarını göz önünde bulundurarak, karşılaştırma ve kesin sonuçlar için ekonomik performansı birkaç yıl boyunca değerlendirmek için daha karmaşık bir makine öğrenme yaklaşımına ihtiyaç vardır. Çok kriterli karar verme teknikleri (MCDM'ler), nitelikleri karşılaştırmak ve karmaşık karar verme problemlerinde alternatif seçmek için yaygın olarak kullanılmaktadır. Temel veri kaynağı çoğu zaman alandaki uzmanların girdisi olsa da, gerçek ekonomik verilerin benimsenmesi MCDM'nin belirsizlik faktörünü ortadan kaldıracaktır ve daha doğru sonuçlar sağlayabilir. Mevcut çalışma, ekonomiyi en iyi yıllarda arttırmaya katkıda bulunan faktörleri anlamak için 2009-2017 yılları arasında TOPSIS yöntemini kullanarak Libya ekonomisinin performansını değerlendirmeyi amaçlamaktadır. TOPSIS yöntemi, ekonomik ve yönetim uygulamalarında yaygın olarak kullanılır, çünkü ideal çözüme en yakın olan alternatifi belirlemede yardımcı olur. 2009-2017 yılları arasında Libya ekonomisini etkileyen ekonomik faktörleri inceleyerek yapılan araştırmanın bulguları, 2017'nin ekonomik performans için en iyi yıl olduğunu göstermektedir. Ülkedeki geç siyasi istikrarsızlıktan önce, 2010, bir önceki yıla göre% 20,18 artırılmış performansla ekonomik performans için en iyi ikinci yıl olarak gösterilmektedir. Libya'daki ekonomik performans için en kötü yıl, ülkedeki farklı siyasi ve militan güçler arasındaki iç savaş nedeniyle 2012 ile 2014 arasındaydı. Ancak, 2015 ile 2017 arasında bir istikrar döneminde ekonomik performansta önemli bir artış gözlenmektedir. Ülkedeki mevcut kriz, petrole bağımlılığın Libya ekonomisine etkisini vurguladı. Dolayısıyla, petrolü ülkenin ana geliri olarak kabul etmenin ekonominin kırılabilirliğini arttırdığı ve döviz kurları dahil olmak üzere diğer ekonomik faktörler üzerinde etkisi olduğu anlaşılmaktadır.

**Anahtar Kelimeler:** ekonomik performans göstergeleri; Libya; TOPSIS

## **1. INTRODUCTION**

### **1.1 Research Overview and Significance**

Key performance indicators are used in economic studies to investigate or test a certain phenomenon and suggest the suitable recommendations for development. Several methods have been suggested to provide an indication of the performance of a specific economy, such as the economic performance index EPI (Khramov and Lee, 2013) and Chicago Fed National Activity Index (CFNAI) (Evans, Liu, & Pham-Kanter, 2002). Different studies have considered several performance indicators; however, the majority of research had a consensus on indicators like the GDP, FDI, inflation and unemployment (Tampakoudis, et al., 2014; Alzaidy, et al., 2017; Gungor and Ringim, 2017; Kargi, 2014), while other studies included economy-specific indicators, such as oil production, expatriate population and foreign exchange rates (Radda, et al., 2015; Barguellig, et al., 2018; Lowell & Findlay, 2001). Therefore, it is important to include the common economic indicators in the performance assessment, while ensuring that the economy-specific indicators are considered and highlighted.

Furthermore, the method of assessment is one of the important factors that determines the accuracy of the final results, response and economic measures. Equations were widely invented and used for that purpose (Wilson & Briscoe, 2004). Nonetheless, machine learning solutions and algorithms have not been utilized for that purpose, despite their proven success in solving complex decisions in different domains, including economy and management. Multi-criteria decision making (MCDM) methods are a group of solutions that can be used in order to determine the most influential factors, the interrelations between these factors and/ or the measures that can be implemented for best and desired outcomes (Jayant & Sharma, 2018). The logical sequence of MCDMs allows for breaking down the problem into parts and steps; simplifying the

problem and providing a mathematical model that can be implemented to reach precise conclusions (Singh & Malik, 2014).

Each MCDM method have been applied in several studies that investigated their strengths, weaknesses, possible applications and the accuracy of their results. While some MCDMs are known for their ability to determine the relative importance of attributes versus each other, such as AHP, MCDMs like TOPSIS are known for an approach that calculates the most ideal solution, the worst solutions and compare the available alternatives to them. Therefore, the utilization of TOPSIS in economic and management studies allowed researchers and practitioners to handle decision-making in human resources, supply chain management, marketing, business processes and strategy management (Velasquez & Hester, 2013). The conventional form of MCDMs depend on input from experts to evaluate attributes and alternatives based on their experience. Several models have been created to enhance the accuracy and precision of the results, such as stochastic and fuzzy models (Triantaphyllou, et al., 1998). However, a few studies have considered attributes that are based on actual data, such as economic indicators that are presented in the current study.

Following acquiring the necessary data and constructing the initial decision matrix between the attributes and the alternatives for the TOPSIS method, a normalized decision matrix is calculated. Weights are incorporated into the normalized decision matrix to consider the difference in effect amongst the attributes and to produce the weighted decision matrix. Ideal positive and negative solutions are calculated, as well as the separation measures between the weighted decision matrix elements and the ideal solutions. Finally, a relative closeness coefficient for each alternative is calculated indicating its closeness from the ideal solutions (Hwang & Yoon, 1981).

The case study in the current research is performed on the performance of the Libyan economy. Concerned literature observed the high dependency of the Libyan economy on oil production as the main product and source of income (Ali, 2011) , which hindered development besides lack of national development plans, processes and systems (Triki, 2017). The fluctuating oil market affected the Libyan economy with instability and influenced other factors, such as exchange rates, GDP and employment, as well as growth and development

(Yahia & Metwally, 2007). In the late years of instability on the political and security levels, the high dependency on oil exports had severe impacts on the country, especially during the civil war between 2012 and 2014 (Bhattarai & Taloba, 2017). Foreign currency exchange rates were also one of the most unstable economic factors in the selected years of the current study. Thus, oil production and exchange rates are emphasized in the application of the TOPSIS method.

## **1.2 Aim of Study**

The main aim of this research is to assess the performance of the Libyan economy between the years of 2009 and 2017 using the TOPSIS method in order to understand the factors that contributed into enhancing the economy in the best years. A good understanding of the key economic indicators, the status of the Libyan economy during the study period and the TOPSIS method is necessary in order to achieve the main aim. Therefore, the following objectives are set for the research:

- Study the key economic indicators that are used for the assessment of the performance a country's economy.
- Understand the factors affecting the Libyan economy performance and the drawbacks that are hindering growth and development.
- Study the TOPSIS method in terms of its mathematical model, as well as its applications and developments in the literature.
- Apply the TOPSIS method for the evaluation of the performance of the Libyan economy between the years of 2009 to 2017.
- Determine the best and worst years for the economic performance in Libya, in addition to the factors that can affect it.
- Provide recommendations for policy and economy strategic planning for the enhancement of the development and growth pace for Libya.

## **1.3 Research Scope and Thesis Structure**

The current research is mainly concerned with the economic performance of Libya in the years of instability between 2009 and 2017. The TOPSIS method is

used as an MCDM mathematical model that can assist the researcher to determine the best and worst economic conditions experienced by the country. Nine key economic performance indicators are considered in the research, which are exportation, importation, labor force, unemployment rate, inflation (GDP deflator), net secondary income, exchange rates and oil production. The thesis report presents the outcomes of the research and it is divided into four chapters:

- Introduction: a highlight of the significance of the study, the aim of the research and the scope of the investigation.
- Literature review: a survey from literature sources for the most important economy performance indicators, the MCDM methods with emphasis on TOPSIS, and the status and performance of the Libyan economy.
- Methodology and Application: An explanation of the used method and an application on the data from the Libyan economy, in addition to a discussion to the research outcomes.
- Conclusions: a summary of the research outcomes and recommendations for policy and planning for the Libyan economy.

## **2. LITERATURE REVIEW**

### **2.1 Economic Key Performance Indicators (KPIs)**

There is no single economic performance indicator that can measure the economic status and development in a country, despite the different attempts to create equations that can provide an insight using input factors, such as Gross Domestic Product (GDP) and budget deficit. Khramov and Lee (2013) proposed a model called the economic performance index (EPI) that is based on four main economic inputs; inflation rate, unemployment rate, budget deficit and GDP. Other more comprehensive systems were used, such as the Chicago Fed National Activity Index (CFNAI) that considers eighty-five indicators. It includes measurement of different sectors within the economy and studies have shown the probability of its benefit in predicting recessions through changes in the economic indicators (Evans, Liu, & Pham-Kanter, 2002). This section explores several economic indicators that are used as inputs to evaluate the economic performance of a country.

#### **2.1.1 Exportation and importation of goods**

Exportation and importation activities are defined as goods that produced within or outside the country and removed or entered into the custom area of the country, respectively (Kartikasari, 2017). The volume of exports and imports have been correlated to economic growth in several case studies in different countries. The main economic growth indicator that was used in these studies is the country's GDP (Bakari & Mabrouki, 2017). The correlation and impact between these indicators is expected, since the total exports and total imports of a country are key determinants of the gross domestic product (GDP) (Uddin & Khanam, 2017).

Khan, et al. (2012) and Hye (2012) found correlations between the change in GDP and the change in the exportation and importation volumes in the Pakistani and Chinese economies, respectively. Albiman and Suleiman (2016) found that

exportations and importation volumes have impacts on determining the country's GDP in Malaysia. Nonetheless, Ajmi, et al. (2013) and Abugamea (2015) showed results that did not imply any correlation or impact between GDP and the volumes of exports and imports in the South African and Palestinian economies. The aforementioned studies have based their conclusions on data of several years; ranging between 37 to 100 years.

### **2.1.2 Foreign direct investment (FDI)**

The International Monetary Fund (IMF) and the Organization for Economic Cooperation and Development (OECD) define foreign direct investment as the initial and long-lasting business relationship between a direct investor and an investment enterprise, where capital transactions occur by transferring funds from overseas to the local economy. The IMF restricts its definition to the condition of the foreign investor owning a minimum of 10% of the enterprise's capital and a maximum of 50% to become an associate. Moreover, the enterprise is considered a subsidiary of a foreign investment if the foreign investment exceeds 50% (Duce & de Espana, 2004).

FDI is stated if the foreign investor acquires a controlling stake at the holding company at the host economy. The choice of the investment is based on market demands and feasibility for the industry and the product at the host market, which then determines the type of FDI to be horizontal: establishing an affiliated company in the new market to produce a final product in it, vertical: establishing an affiliated company in the new market to produce an intermediate product in it driven by production costs, or complex: a mixture between the horizontal and the vertical types. The types of FDI clarify the motivations of the investors to create affiliations in foreign countries, which is mainly driven by cost, market investment opportunities and market consumption demands (Alfaro & Chauvin, 2020).

The positive impacts of increasing FDI in an economy are suggested to enhance economic growth, GDP, and regenerate confidence in the market by other investors to enter the local economy (Alfaro & Chauvin, 2020). Owusu-Antwi, et al. (2013) studied the Ghanaian economy twenty-three years for the effects of FDI on macroeconomic indicators. The results of the study show that the



impacts on all factors were significant with a total R square value of 0.947 at the regression analysis. The macroeconomic factors studied included exchange rates, inflation, trade openness, GDP, while the availability of natural resources, open attitude towards investment and infrastructure contributed into simulating more FDI into the country's economy (Owusu-Antwi, et al., 2013).

Alzaidy, et al. (2017) studied the impact of the financial development on the economic growth for thirty-nine years, with the mediating effect of FDI on their relationship. The authors found that FDI increased the positive effect of financial development, especially with FDI spill overs. Ibrahim, et al. (2019) researched 46 African economies over thirty-six years and found that FDI is simulated into the economy if the country financial sector is developed and adequate information, communication and technology infrastructures are implemented. Djordjevic, et al. (2015) studied the relationship between FDI and each of unemployment rates, GDP and export volume in Croatia over fifteen years and found that a 1% increase in FDI would reduce unemployment in the country by 31%, while FDI was positively correlated to increasing GDP and export volume. Gungor and Ringim (2017) confirmed that FDI is considered one of the main drivers and predictors of economic growth.

### **2.1.3 Inflation and foreign currency exchange rate**

Inflation is identified in the economy through either the continuous rise in the price levels of goods or services, or the reduced value of a currency against worldwide currencies. Monitoring inflation is performed over an extended period of time over several months. The usual cause of inflation is the increase in the quantity of money printed in comparison with the national output, which is a measurement taken by central banks to close government budget deficits, to resist high exchange rates against influential exchange currencies, such as the American dollar, or according to the economic theory, when unemployment is reduced (Labonte, 2011).

Despite the conceptual understanding of inflation in relation with other financial variables, some research showed that inflation rates did not increase significantly with the increase of money supply. Such as case is shown through the case study of Tabi and Ondoa (2011), who studied the Cameroonian

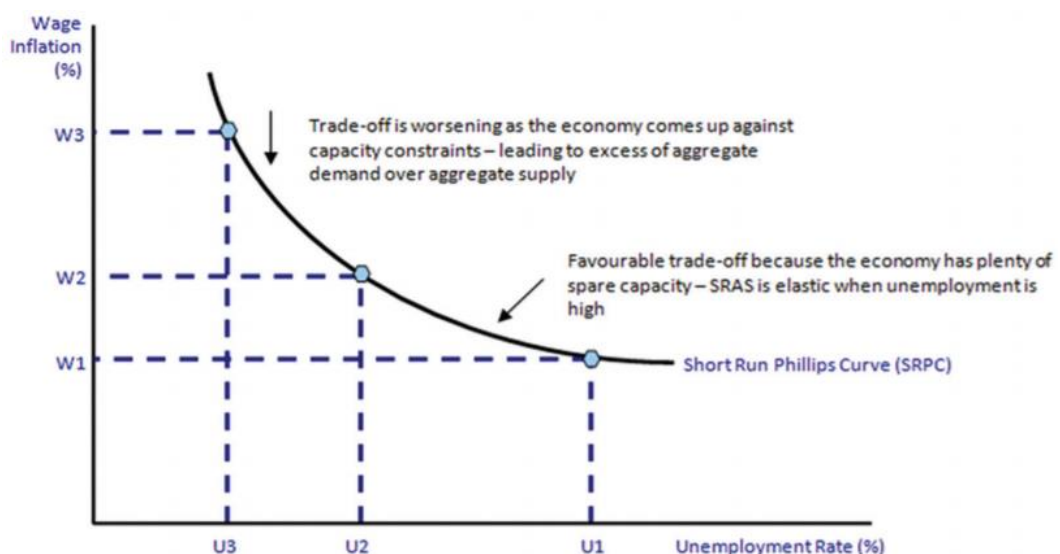
economy using a VAR model for more than forty years. Islam, et al. (2017) attributed this behavior to the actual demand on money in the market and confirmed that the relationship is proven to be positive through studies over long time periods. The authors investigated the relationship between inflation and each of unemployment and US dollar exchange rates in Malaysia. The regression model showed that exchange rates had the highest impact on inflation, followed by unemployment rate and money supply.

The negative relationship between exchange and unemployment rates with inflation are explained through economic theories. The Phillips curve, shown in Figure 2.1, illustrate the relationship between the increase in wage inflation with the reduction of the unemployment rate. Full employment in the market causes shortages in money supply that needed for wage increases, which leads to the increase in prices in the market to cover this shortage (Islam, et al., 2017). The quantity of money theory by Friedman (1969) establishes the relationship between money supply and other macroeconomic factors, as shown in equation 1:

$$M V = P Y \quad (1)$$

where,

M = quantity of money (money supply), V = the velocity of money circulation, P = price level, Y = national income



**Figure 2.1:** The Relationship between Unemployment Rate and Inflation

Source: (Islam, et al., 2017)

Exchange rates have also their significant influence on the economy and vice versa. It was established earlier that financial development has positive effects on economic growth; however, this volatility in exchange rates can lessen these positive effects. Therefore, stability in exchange rates are considered key in empowering the effects of financial development (Ehigiamusoe & lean, 2019). An analysis of eighteen economies confirmed the significance of exchange rate fluctuations on reducing the growth in the economy as a result of financial development (Basirat, et al., 2014). Instability of exchange rates alone has negative impacts on economic growth, especially if the country adopts financial openness and a flexible exchange rate strategy (Barguellig, et al., 2018). Ramasamy and Abar (2015) performed an empirical research in the macroeconomic factors that influence exchange rates and found that stable interest rates, lessened inflation rates and lessened unemployment has positive and influential impacts on enhancing exchange rates.

#### **2.1.4 Labor force and unemployment**

The participation level of the labor force and unemployment are two of the most intercorrelated macroeconomic factors in the literature (Ozerkek, 2013). Moreover, it is important to understand the definitions of both concepts in order to know their inclusions and exclusions of the work force population. Unemployment is a rate that includes people within the work force that are without jobs, available for work and actively seeking employment (Byrne & Strobl, 2009). Labor force participation rate is the percentage of the labor force that is currently employed through dividing the population into unemployed, employed and out of the labor force (Bullard, 2014). Data from the literature and theoretical studies show that unemployment affects labor force participation, while unemployment is influenced by several factors, including wage levels, prices and money supply (Kanapathy & Baharom, 2013). The working population according to US statistics consists of all population between the ages of 24 and 54. Therefore, labor force participation, employment rate and unemployment rates are calculated using equations 2, 3 and 4, respectively (Bown & Freund, 2019):

$$\text{Labor force participation} = \frac{\text{labor force}}{\text{working age population}} \times 100 \quad (2)$$

$$\text{Employment rate} = \frac{\text{employed population}}{\text{working age population}} \times 100 \quad (3)$$

$$\text{Unemployment rate} = \frac{\text{enemployed population}}{\text{labor force}} \times 100 \quad (4)$$

Kargi (2014) correlated labor force participation with the economic growth in Turkey a positive correlation between labor force and employment rates and a negative correlation between the labor participation rate and the unemployment rate. Through a sixth-degree polynomial consisting of six employment variables, the author concluded that the growth in the economy can be not reflected into employment and labor force variables. In countries that include significant numbers of immigrants, data analyses showed that the challenge is higher for an immigrant to find employment in the new community, which extends to the second generation of immigrants (Gorodzeisky & Semyonov, 2017). Andrei, et al. (2016) found that age, education levels, gender and ethnicity are all determinants of work force participation and affect, subsequently, unemployment rates.

### **2.1.5 Oil production and energy imports**

Despite all the attempt to find energy substitutions, oil and gas remain the main source of energy worldwide and they are considered part of the national security of all countries. The complex processes that accompany oil production and consumption make the issue complicated and tied to many factors, including availability, costs, energy losses and technological developments. Costs that are associated with exploration are the main obstacle in front of a lot of countries due to the high costs of the required technology. (Seljom & Rosenberg, 2011). Moreover, the oil and gas sectors provide employment for 40% of the labor force in the Alberta region in Canada (Mansell, et al., 2012) and 44% of the employment in the MENA region in 2010 (Radda, et al., 2015).

Samawi, et al. (2017) performed a study on energy importing countries and found that oil and gas imports are highly correlated to debt levels, inflation, cost of production, spending, sales tax and economic growth. Mardiana, et al. (2013) investigated the factors that affect oil imports in Indonesia and found that

transportation consumption is more influential than the economic growth of the country. The measures recommended for the study to decrease the dependence on oil importation were mainly addressed to utilization of natural gas and increase of oil production. Countries that lack oil and gas resources have several options in order to reduce the risks that are associated with energy imports, including the development of renewable energy, increase oil and gas exploration activities, utilization of engineering to increase energy efficiency and diversification of their energy portfolio (Esen, 2016).

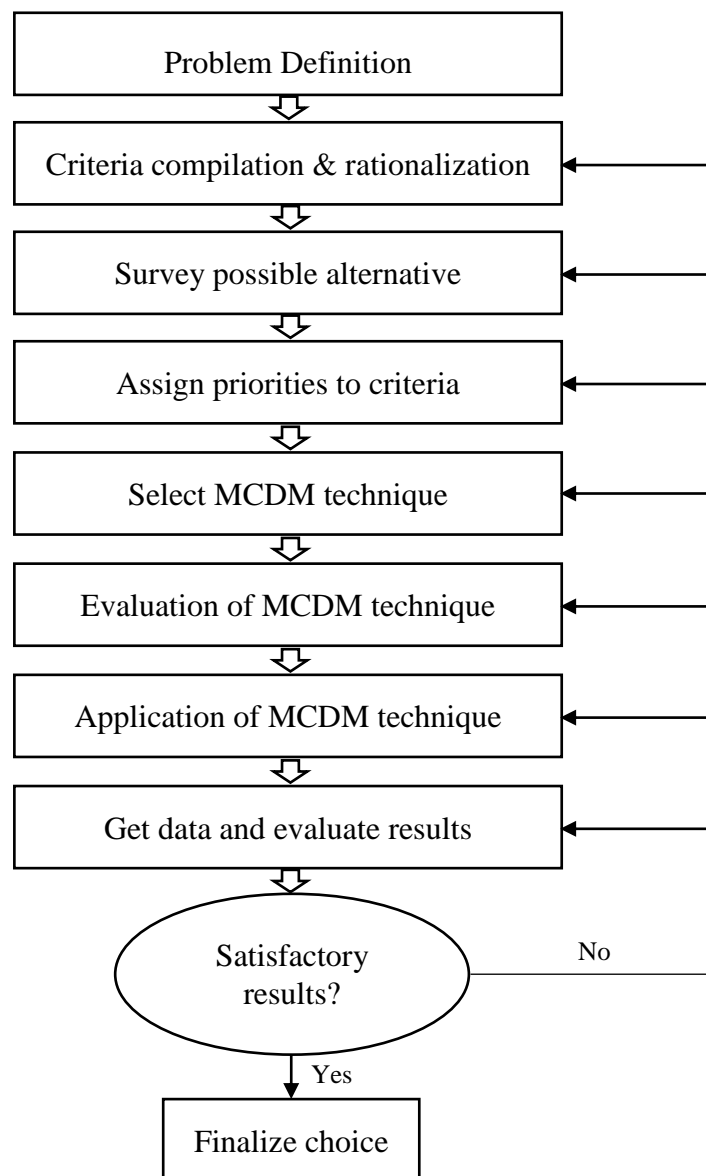
### **2.1.6 GDP**

The calculation of GDP is dependent on population consumption volume, investment, the volume of expenditure by the government and the difference between the total exports and imports (Uddin & Khanam, 2017). Furthermore, GDP has its influence on political instabilities, power shortages and fluctuating and high oil prices in developing countries (Kira, 2013). GDP is also considered the main economic indicator for the wellbeing of the economy as it reflects the actual consumptions and expenditures of the country (Dynam & Sheiner, 2018). Tampakoudis, et al. (2014) investigated the European economies following the financial crisis and found that there are opportunities for sustainable economic development indicated by the GDP growth that were shown in the Eurozone in the past years. Therefore, the country's GDP is an indication of the economic wellbeing, as well as a prediction factor for economic and political issues.

## **2.2 Multi-Criteria Decision-Making Methods and their Applications**

Multi-Criteria Decision-Making (MCDM) methods are an essential part of research and application of several domains, including business, science and engineering. The popularity of MCDMs emerge from their ability to rationalize complex decision-making problems and make their components more explicit, as well as provide efficient solutions. Problems that are treated through MCDM techniques are usually complex and require taking decisions based on several criteria and have several alternatives as solution. Moreover, advances in technology and computational techniques allowed the utilization of these methods in timely manners (Jayant & Sharma, 2018).

The general steps of choosing and applying an MCDM technique are shown in Figure 2.2. There are many MCDM methods that were developed based on different mathematical models and processes. The methods differ in their objective and focus. While some methods focus on criteria ranking, other can emphasize alternative selection or reiterating inputs for more accurate results (Velasquez & Hester, 2013). Table 2.1 shows a comparison between some of the MCDM techniques, along with their advantages, disadvantages and application domains.



**Figure 2.2:** General MCDM Technique Selection and Application Process

**Source:** (Singh & Malik, 2014).

**Table 2.1:** A comparison between several MCDM methods (Velasquez & Hester, 2013)

<b>MCDM Technique</b>	<b>Pros</b>	<b>Cons</b>	<b>Application Domains</b>
Analytic hierarchy Process (AHP)	<ul style="list-style-type: none"> <li>- ease of use</li> <li>- comparable results</li> <li>- simplifies problem through the hierarchy structure</li> <li>- does not need excessive data input</li> </ul>	<ul style="list-style-type: none"> <li>- dependency of criteria and alternative on each other</li> <li>- inconsistencies can occur because of judgements</li> <li>- rank reversal</li> </ul>	<ul style="list-style-type: none"> <li>- political strategy</li> <li>- corporate policy</li> <li>- resource management</li> <li>- planning</li> <li>- public policy</li> <li>- performance</li> </ul>
ELECTRE	<ul style="list-style-type: none"> <li>- considers the vagueness and uncertainty of the problem</li> </ul>	<ul style="list-style-type: none"> <li>- hard to explain process and outcomes in layman's terms</li> <li>- the outranking process does not highlight the weaknesses and strengths of the alternatives</li> </ul>	<ul style="list-style-type: none"> <li>- transportation</li> <li>- environmental management</li> <li>- economics</li> <li>- energy</li> </ul>
Technique for Order Preferences by Similarity to Ideal Solutions (TOPSIS)	<ul style="list-style-type: none"> <li>- simplicity of process</li> <li>- ease of use</li> <li>- process steps do not depend on number of attributes or alternatives</li> </ul>	<ul style="list-style-type: none"> <li>- no consideration for the interrelations between the attributes due to using Euclidean Distance</li> <li>- weight calculation is difficult and no measurement of consistency</li> </ul>	<ul style="list-style-type: none"> <li>- human resources</li> <li>- engineering</li> <li>- supply chain management</li> <li>- water resources</li> <li>- marketing</li> <li>- business processes</li> <li>- logistics</li> <li>- manufacturing</li> </ul>
PROMETHEE	<ul style="list-style-type: none"> <li>- no assumption requirement for the proportionality of the criteria</li> <li>- ease of use</li> </ul>	<ul style="list-style-type: none"> <li>- weight assignment does not have a clear method</li> </ul>	<ul style="list-style-type: none"> <li>- energy</li> <li>- logistics</li> <li>- water resources</li> <li>- finance</li> <li>- chemistry</li> <li>- hydrology</li> </ul>

**Table 2.1:** (More) A comparison between several MCDM methods (Velasquez & Hester, 2013)

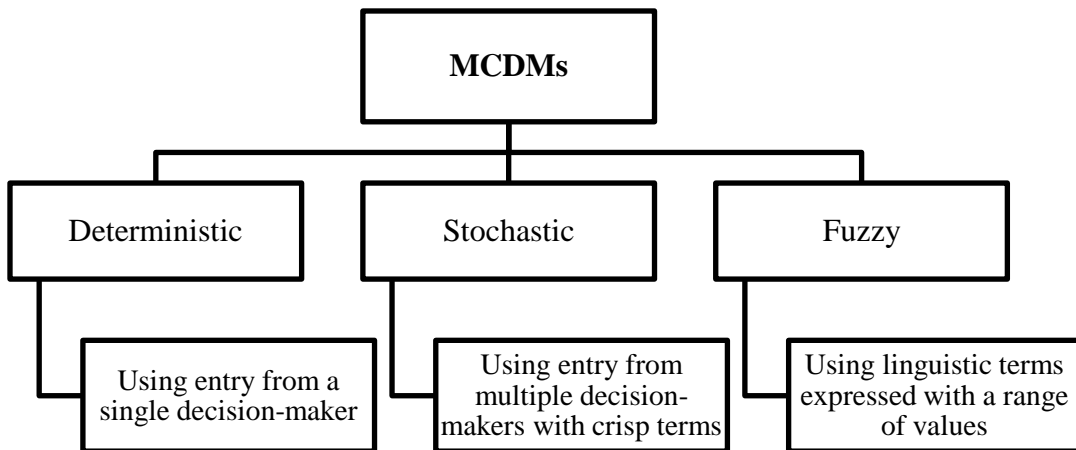
Multi-Attribute Utility Theory (MAUT)	<ul style="list-style-type: none"> <li>- considers uncertainty</li> <li>- preferences can be incorporated</li> </ul>	<ul style="list-style-type: none"> <li>- precision requirement for preferences</li> <li>- input volume is big</li> </ul>	<ul style="list-style-type: none"> <li>- agriculture</li> <li>- finance</li> <li>- economics</li> <li>- actuarial</li> <li>- energy</li> </ul>
Simple multi-Attribute Rating Technique (SMART)	<ul style="list-style-type: none"> <li>- simplicity of process</li> <li>- flexibility in weight assignment</li> <li>- lessened effort by the decision makers</li> </ul>	<ul style="list-style-type: none"> <li>- inconvenience of steps to achieve the procedure</li> </ul>	<ul style="list-style-type: none"> <li>- construction</li> <li>- logistics</li> <li>- manufacturing</li> <li>- transportation</li> <li>- military</li> <li>- assembly problems</li> </ul>
Simple Additive Weighting (SAW)	<ul style="list-style-type: none"> <li>- criteria can be interchangeable</li> <li>- intuitive judgements</li> <li>- simple calculations</li> </ul>	<ul style="list-style-type: none"> <li>- outcomes can be illogical and do not reflect the real situation</li> </ul>	<ul style="list-style-type: none"> <li>- business</li> <li>- finance</li> <li>- water resources</li> </ul>
DEMATEL	<ul style="list-style-type: none"> <li>- considers interrelations between criteria</li> <li>- outputs are easy to interpret</li> <li>- cause and effect analysis</li> </ul>	<ul style="list-style-type: none"> <li>- lengthy process</li> <li>- complicated calculations</li> </ul>	<ul style="list-style-type: none"> <li>- supply chain management</li> <li>- logistics</li> <li>- chemistry</li> <li>- business</li> <li>- finance and marketing</li> <li>- energy and resources</li> <li>- manufacturing</li> </ul>

It is evident that a single MCDM technique can be used in several domains; however, the main criteria in selecting one MCDM technique for a specific application depends on the desired outputs that the researcher seeks. Some MCDM techniques, such as ANP, can have lengthy computational process with little contribution to the accuracy of the results. Nonetheless, researchers can prefer lengthy process MCDMs in order to achieve a specific objective from the



machine-learning approach. In comparing the results of the same problems by using different MCDM methods, a study have shown that correlational coefficients between outcomes were all positive and ranged between moderate to strong relationship, which increase the reliability of the results that can be provided by most of the MCDM methods (Zamani-Sabzi, et al., 2016).

MCDMs are classified according to the type of data they use, as shown in Figure 2.3. Deterministic MCDMs use a single decision-maker to input the data, while stochastic MCDMs use multiple decision-makers. Deterministic and stochastic are called so because a single person would provide a firm one-time judgement and input from multiple persons would require approximating their answers. Furthermore, fuzzy MCDMs are the one that use linguistic terms to express judgements. Therefore, each decision-maker expresses the judgement within a range, rather than a single solid judgement. Accuracy of MCDMs is one of the most important subjects, which determines the confidence in taking its results seriously. For this purpose, sensitivity analysis is recommended after the study to understand the way changing a few judgements would impact the end results (Triantaphyllou, et al., 1998).



**Figure 2.3:** Classification of MCDM Techniques Based On Their Data Usage

**Source:** (Triantaphyllou, et al., 1998)

Since their inception in the 1960s, MCDMs have been built and developed to enhance their outputs and increase their efficiency. Thus, discrete and continuous MCDMs have been used depending on the application and the certainty of the input data. In surveying 393 MCDM studies over fourteen years (2000 to 2014), Mardani, et al. (2015) showed that 109 studies (27.74%) that

used MCDM techniques were in the field of operation research and soft computing, followed by energy, environment and sustainability (13.49%) and manufacturing systems (8.14%). The use of MCDMs in research has increased almost 400% over the same period of time, while AHP was the most used single MCDM, followed by TOPSIS and ELECTRE, respectively. MCDMs can also be used in hybrid models, where more than one MCDM technique is used for a single application, which formed 11.70% of the research (Mardani, et al., 2015).

### 2.3 TOPSIS Technique and its Applications

The TOPSIS technique is performed through calculating hypothetical ideal and worst solutions based on the maximum and the minimum weights yielded from judgements with the criteria. The Euclidean distance is calculated from both solutions and the most ideal alternative is the one that achieves the shortest distance from the positive solution and the furthest distance from the negative solution. The main advantage of the TOPSIS technique is its ability to contain any number of criteria for judgement and its ability to provide an intuitive solution based on distances from ideal solutions. Nonetheless, the disadvantages of the method is the possibility of giving unreliable results and dependency on deterministic judgements in its standard form, which does not take into consideration uncertainty (Gavade, 2014).

Hwang and Yoon (1981) established the first form of TOPSIS technique, which was mainly used as a hypothetical alternative ranking method. The basic steps of TOPSIS are presented by the authors, as follows:

Step 1: Construction of normalized decision matrix.

$$r_{ij} = \frac{x_{ij}}{\sqrt{(\sum x_{ij}^2)}} \quad \text{for } i = 1, \dots, m; j = 1, \dots, n \quad (5)$$

Where  $x_{ij}$  is the original score and  $r_{ij}$  is the normalized score from the decision matrix.

Step 2: Construction of the weighted decision matrix from the normalized matrix.

$$v_{ij} = w_j r_{ij} \quad (6)$$

Where  $w_j$  is the weight for the  $j^{\text{th}}$  criterion.

Step 3: Determination of positive ideal solution.

$$A^* = \{v_1^*, \dots, v_n^*\} \quad (7)$$

Where  $v_i^* = \{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\}$

Step 4: Determination of negative ideal solution.

$$A' = \{v_1', \dots, v_n'\} \quad (8)$$

Where  $v_i' = \{\min(v_{ij}) \text{ if } j \in J; \max(v_{ij}) \text{ if } j \in J'\}$

Step 5: Calculation of separation measurement from positive ideal solution for every alternative.

$$S_i^* = \sqrt{\sum (v_j^* - v_{ij})^2} \quad i = 1, \dots, m \quad (9)$$

Step 6: Calculation of separation measurement from negative ideal solution for every alternative.

$$S_i' = \sqrt{\sum (v_j' - v_{ij})^2} \quad i = 1, \dots, m \quad (10)$$

Step 7: Calculation of relative closeness to ideal solution.

$$C_i^* = \frac{S_i'}{(S_i^* + S_i')} \quad (11)$$

Where  $0 < C_i^* < 1$

Step 8: Selection of alternative that has its closest relative closeness to 1.

In business administration and management research, the TOPSIS technique have been used widely in the literature. The application of the method extended for many case studies, such as performance evaluations, corporation performance, financial assessments, comparison of business units, risk assessment, forecasting success and failure factors, investment options, determining business alliances, and evaluating business platforms. Table 2.2 shows a literature survey of the TOPSIS method utilization for business administration studies, along with variations, comparisons and combinations that were carried out in each study.

**Table 2.2:** A compiled literature survey of business administration and management studies that used the TOPSIS techniques

<b>Authors</b>	<b>Year</b>	<b>TOPSIS Application</b>	<b>TOPSIS variation used</b>
Deng, et al.	2000	Relative performance ranking of competing firms in textile manufacturing	A modified TOPSIS approach
Feng & Wang	2000	Assessment of performance of airline companies based on their financial data	Grey relation analysis
Tsaur, et al.	2002	Service quality assessment for airline companies	AHP and TOPSIS with fuzzy terms
Jahanshahloo, et al.	2006	Comparison of business units of the same corporation (bank branches) based on financial indicators	Interval data input in extended TOPSIS
Shyur	2006	Selection of electronic products for a specific company	A modified TOPSIS approach and ANP
Benitez, et al.	2007	Assessment of hotel service quality through key performance indicators for quality	Fuzzy TOPSIS
Isiklar & Buyukozkan	2007	User evaluation of mobile phone device options	Comparison with AHP
Wang & Lee	2007	Operation performance evaluation for an airport	TOPSIS with fuzzy terms
Dia & Zaghal	2008	Enterprise assessment through their annual report-announced risk factors	Fuzzy TOPSIS
Amiri, et al.	2009	Performance assessment and ranking of competing companies	Fuzzy TOPSIS
Ertugrul & Karakasoglu	2009	Financial assessment for fifteen Turkish companies in the cement manufacturing industry	Fuzzy TOPSIS compared with Fuzzy AHP
Secme, et al.	2009	Using non-financial and financial indicators to rank 5 commercial banks	Fuzzy TOPSIS and fuzzy AHP combined
Sun & Lin	2009	Assessment of online shopping platforms based on their competitive advantage	Fuzzy TOPSIS

**Table 2.2:** (More) A compiled literature survey of business administration and management studies that used the TOPSIS techniques

Wu, et al.	2009	Solving the finance alliance challenge through preferences of bancassurance alliance	Compared with AHP
Chang, et al.	2010	Assessment of mutual funds in Taiwan over a three-year period	Extended TOPSIS with different distancing approach
Garcia, et al.	2010	Performance assessment for several firms	Fuzzy compared with goal programming
Khademi-Zare, et al.	2010	Evaluation of cellular companies in Iran based on strategic action	Fuzzy TOPSIS compared with AHP
Li	2010	Using criteria of growth, risk and environmental impact, TOPSIS used to select investment companies	Fuzzy TOPSIS with interval evaluation
Lin, et al.	2010	Customer application for the selection of the most suitable vehicle	TOPSIS combined with ANP and DEMATEL
Sun	2010	Assessment of computer manufacturing companies based on their performance	Combined fuzzy TOPSIS and fuzzy AHP
Vahdani, et al.	2010	Evaluation of insurance firms based on property responsibility performance	Combined fuzzy TOPSIS, fuzzy ANP and fuzzy VIKOR
Ye	2010	Selection of partners for establishing a virtual company	Extended fuzzy TOPSIS
Aydogan	2011	Performance evaluation of Turkish airline companies based on key indicators	Combined rough TOPSIS and AHP
KarimiAzari, et al.	2011	A model for construction companies to perform risk assessment	Fuzzy TOPSIS
Li, et al.	2011	Business failure forecast using performance data	Standard TOPSIS
Peng, et al.	2011	Choosing between different algorithm systems that compute financial risk	Combined with VIKOR and PROMETHEE

**Table 2.2:** (More) A compiled literature survey of business administration and management studies that used the TOPSIS techniques

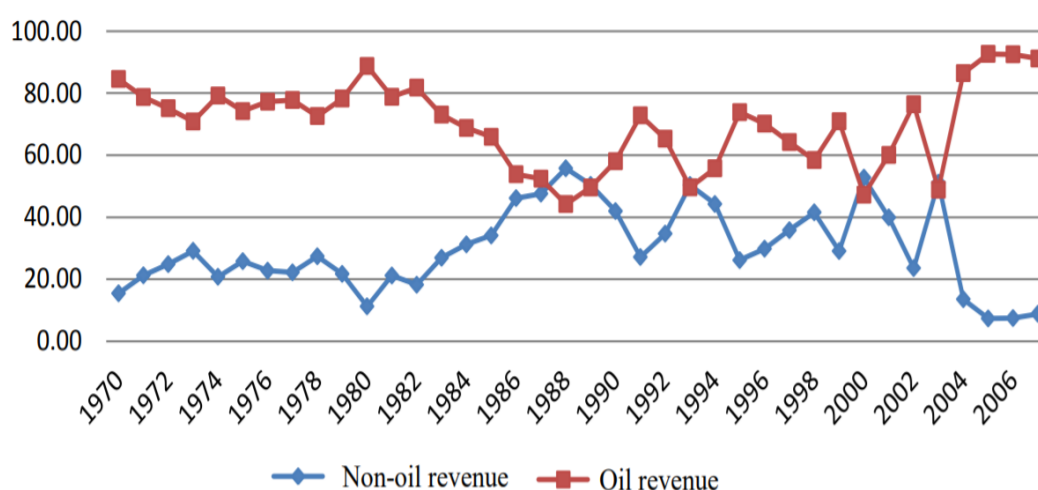
Tan	2011	Evaluation of investment options for middle-class employees	Choquet fuzzy TOPSIS
Yu, et al.	2011	Performance assessment of e-commerce online platforms	Combined AHP and fuzzy TOPSIS
Zhang, et al.	2011	Competitiveness assessment for touristic destinations in Asia at a domestic location in China	Standard TOPSIS with Entropy
Buyukozkan & Cifci	2012	Assessment of the quality of electronic services provided in healthcare entities	Combination of fuzzy TOPSIS and fuzzy AHP
Huang & Peng	2012	Competitiveness assessment for nine touristic destinations in Asia	Fuzzy Rasch model TOPSIS
Paksoy, et al.	2012	Developing organizational strategy using attributes of distribution channels	Combination of fuzzy TOPSIS and fuzzy AHP
Tansel İç	2012	A model to assist banks to allocate credit limits	Combination of linear programming and fuzzy TOPSIS
Baykasoglu, et al.	2013	Selecting truck models based on consumer profile and needs	Combined fuzzy TOPSIS and fuzzy DEMATEL
Erdogan, et al.	2013	Public transportation customer satisfaction evaluation	ServQual model and fuzzy TOPSIS
Esfahani, et al.	2013	Setting priorities of a specific company in order to achieve competitive advantage through its key competencies	Standard TOPSIS
Chen, et al.	2014	Determination of the most optimum location of logistic center for airline companies	Combined MCGP and TOPSIS
Ghazanfari, et al.	2014	Assessment of the most vital competencies of business intelligence within community systems in order to assist seaport managers for selection	Fuzzy TOPSIS
Patil & Kant	2014	Solving challenges in supply chain through choosing knowledge management solutions	Combination of fuzzy TOPSIS and fuzzy AHP

**Table 2.2:** (More) A compiled literature survey of business administration and management studies that used the TOPSIS techniques

Wang & Wang	2014	Assessment of high-tech firms in China based on competitiveness	TOPSIS with improved process
Tavana, et al.	2015	Investment portfolio selection	Integer programming and fuzzy TOPSIS
Trstenjak, et al.	2015	Assessment of economic development strategies for Croatia through prioritizing key performance indicators	Fuzzy TOPSIS combined with a SWOT analysis and K-means methods
Shafii, et al.	2016	Human resource performance analysis in healthcare entities in Iran performed for hospital managers	Combination of fuzzy TOPSIS and fuzzy AHP
Zyoud, et al.	2016	Assessing resource loss prevention strategies for developing countries	Combination of fuzzy TOPSIS and fuzzy AHP
Anyaeche, et al.	2017	Banking services selection based on project portfolio	Combination of fuzzy TOPSIS and COPRAS
Dooki, et al.	2017	Selection of banking inspectors based on qualifications and costs	Combined fuzzy TOPSIS and fuzzy AHP
Radenovic & Veselinovic	2017	Evaluation of the efficiency of health management systems	Combined AHP and TOPSIS
Han & Trimi	2018	Assessment of the performance of reverse logistics management strategies of social media platforms	Fuzzy TOPSIS
Rahim, et al.	2018	Selection of best employee as part of human resource control and management	Standard TOPSIS
Rashidi & Cullinane	2019	Sourcing management alternatives for the sustainability of supplier selection	Comparison between fuzzy TOPSIS and fuzzy DEA
Tang, et al.	2019	Knowledge management evaluation with specific emphasis on blockchain access for the public	TOPSIS and entropy
Yilmaz	2019	Assessment of real estate investment firms based on their financial performance	Standard TOPSIS

## 2.4 Libyan Economy and Economic Performance Studies

The reliance of Libyan economy on oil production and income is evident since early studies and as shown in the comparison between oil and non-oil revenues contribution to public budget in Figure 2.4, which is based on data from the central bank of Libya (Ali, 2011). Despite being amongst the richest countries with oil reserves, the government failed in establishing an encouraging investment and development environment for decades. Investment in agriculture is limited to specific regions, while manufacturing had its limitation due to the lack of knowledge, technology and development interests (heitmann, 1969). Nonetheless, the wave of globalization and the rapid advancements in technologies have simulated an apparent development in the country. The effects of these factors can be observed on the quality of manufactured goods and provided services. The impact of globalization and technology remained limited due to the lack of national development plans, systems and processes (Triki, 2017).



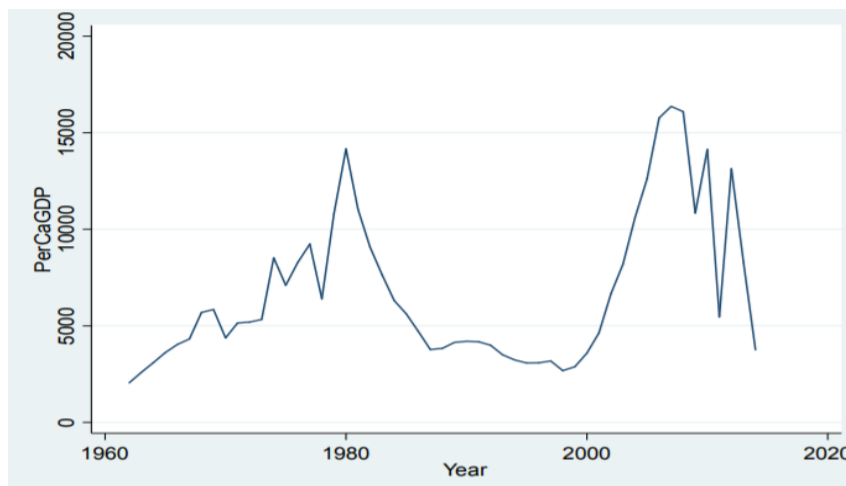
**Figure 2.4:** Contribution of Oil and Non-Oil Production in Libyan Public Budget

**Source:** (Ali, 2011)

Bhattarai and Taloba (2017) investigated the oil-dependent economy of Libya through an application of the Mankiw, Romer and Weil (MRW) model. The research commenced by reviewing the key macroeconomic performance indicators. The per Capita GDP graph for data from 1965 to 2015, as shown in Figure 2.5 (GDP in Libyan Dinars), shows steep declination between the years of 1981 and 1988, followed by a mild decrease pattern until the late 1990s.



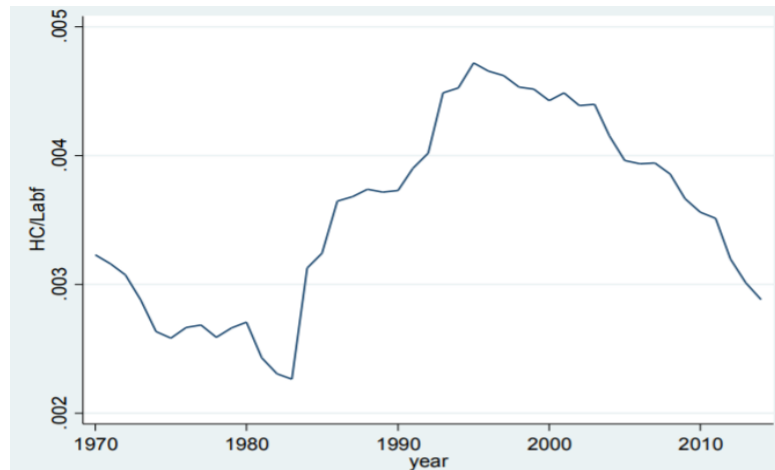
Libya had a challenging period due to the American and International sanctions that were imposed on it. The GDP started to improve in the early 2000s with continuous fluctuations due to the high dependency on oil as the main product of the country and political instability.



**Figure 2.5:** Per Capita GDP in Libyan Dinars

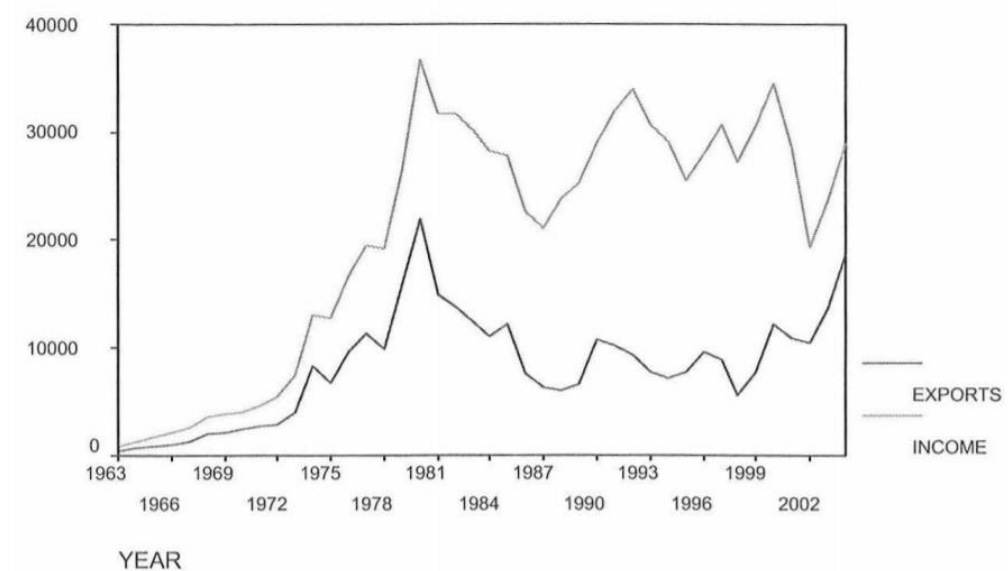
**Source:** (Bhattarai & Taloba, 2017)

The human capital increased at the same declination period and the ratio between human capital and labor force (H/L) increased due to the decrease in labor force. With the start of development in the early 2000s, the H/L ratio declined gradually, indicating more utilization of the human capital into the different development schemes that were set by the government, as shown in Figure 2.6. The fluctuation in human capital versus labor force is attributed to the problems that were faced in allocation within the economy. The findings of the study show that capital in the oil sector in Libya is the main driver for economic growth, while labor has less importance in influencing development (Bhattarai & Taloba, 2017). Moreover, the dependency relationship between the Libyan GDP and oil exportations is evident through data (Etelawi, et al., 2017), which hindered economic growth and development in the country's modern history (Yahia & Metwally, 2007), as presented in Figure 2.7.



**Figure 2.6:** Log Graph Presenting Human Capital per Labor Force (H/L) In Libya

**Source:** (Bhattarai & Taloba, 2017)



**Figure 2.7:** The Interrelation between Oil Exportation and GDP in Libya

**Source:** (Yahia & Metwally, 2007)

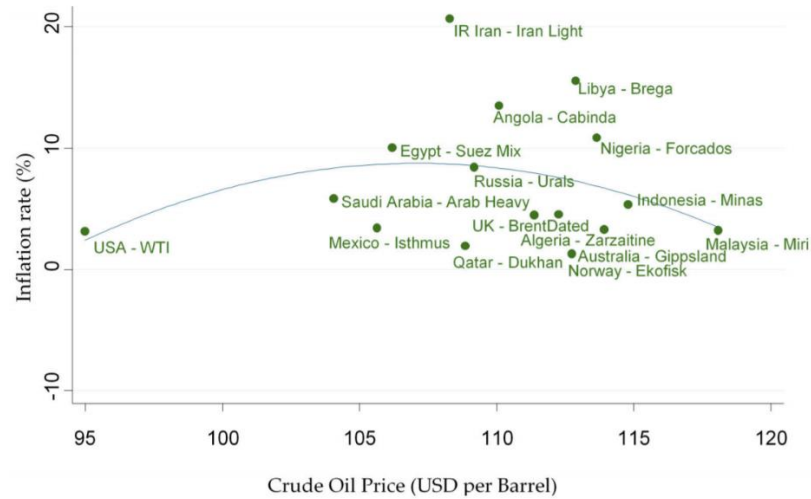
The influence of oil exports based on their fluctuating prices does not only affect the income of Libya, but also the different economic sectors that are operating in the country. While the increase in oil prices did not have any positive effects on the manufacturing and agriculture sectors, the decrease in oil income slowed down their development, which requires a strong development policy that reduce the oil-dependency of the Libyan economy (Aimer, 2016). In spite of the economic reforms that were proposed and implemented prior the rising in 2012 and the noticeable changes on macroeconomic performance indicators, the presence of a real development plan remains vague under the

current instability in Libya. The reforms that led to that growth are (Alafi & de Bruijn, 2010):

- Distribution of wealth on the people, which simulated the establishment of new businesses.
- Establishment of a national joint-stock corporation, following the lift of the economic sanctions, that held the foreign currency wealth of the country and allowed the importation of modern equipment and technology.
- The establishment of a privatization program, which attracted foreign investments and development of publicly owned companies.

A study on the Libyan economy from 1980 to 2011 showed different impact of several factors in pressuring inflation in the country. The factor that had the most influence on inflation is foreign currency exchange rate followed by the domestic price level. Money supply and real income had their effects by their results were less significant (Alkoum & Agil, 2013). However, a research on African economies, including Libya, showed that oil prices has significant impact on inflation. The increase in oil prices increased inflation to a certain point, while inflation rates began to reduce at higher prices showing an asymmetric profile (Bala & Chin, 2018), as shown in Figure 2.8. Furthermore, Bazina (2017) carried out a research in order to identify the influential determinants that affect exchange rates in Libya. The author identified three drivers that change the exchange rates of the Libyan Dinar:

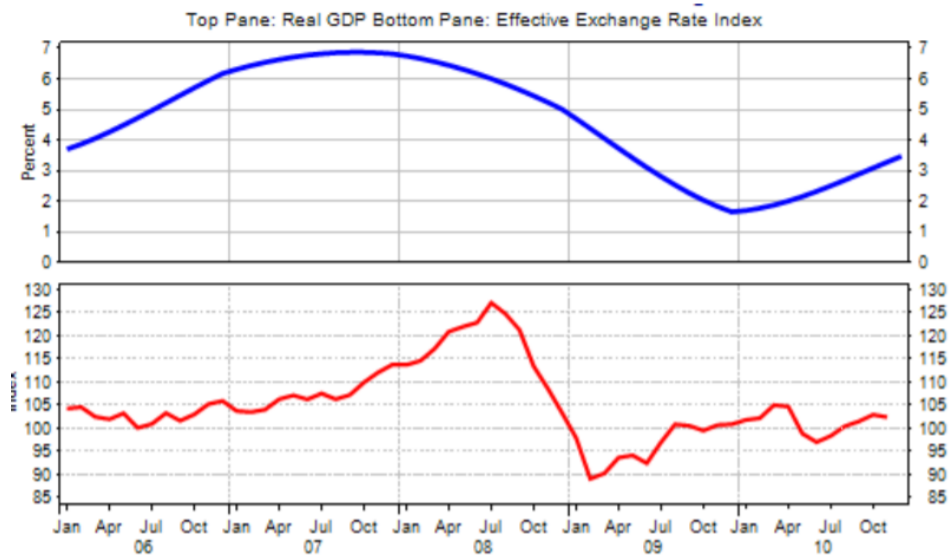
- Political events and challenges
- The reduced oil prices internationally
- The deterioration in balance of payments



**Figure 2.8:** Best-Fit Graph for Inflation Rate Changes With The Increase Of Oil Prices

**Source:** (Bala & Chin, 2018)

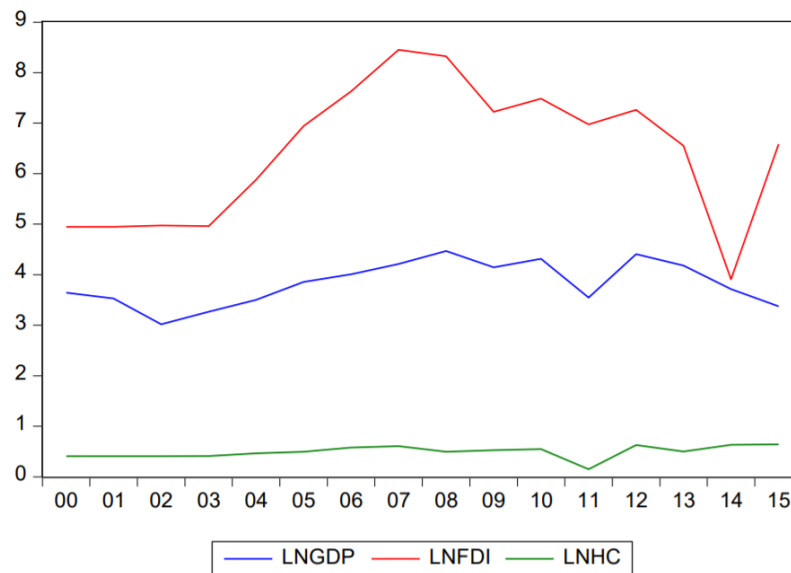
The study showed also the change in profiles that is interrelated between real GDP and effective exchange rate of the Libyan Dinar, as shown in Figure 2.9. The results of the research showed that there are three main factors that affected exchange rates in Libya; terms of trade, oil prices and consumer price index (Bazina, 2017).



**Figure 2.9:** The similarity in change profile between the Libyan real GDP and effective exchange rate index

**Source:** (Bazina, 2017)

While research emphasized the importance of adopting information, communication and technological advances in order to drive economic development and growth in the MENA region and specifically Libya (Lusta & Aimer, 2017; Sassi & Goaid, 2013), other macroeconomic factors had substantial effect on the Libyan economy, such as Foreign Direct Investment (FDI). Hamoudi and Aimer (2017) showed that FDI had significant impact on Libyan GDP, especially during its growth between the years of 2006 to 2008. The regression analysis showed an adjusted R square value of 0.549, indicating the positive relationship and its extent. Nevertheless, human capital did not show any significant effect on GDP and was not affected by the increase of foreign investments. The behavior of the three variables is illustrated in Figure 2.10. Moreover, a questionnaire taken by foreign investors and coreporations in Libya showed the high level of satisfaction from the oil, mining and non-mining resources of the country; however, a high level of dissatisfaction was expressed towards human resources, legal environment, administrative procedures and basic infrastructure, which could indicate the main issues that are suffered by Libya in attracting FDI's (Abushhewa & Zarook, 2016).



**Figure 2.10:** Behavior of GDP, FDI and human capital (HC) in Libya between 2000 and 2015

**Source:** (Hamoudi & Aimer, 2017)

### **3. METHODOLOGY AND APPLICATION**

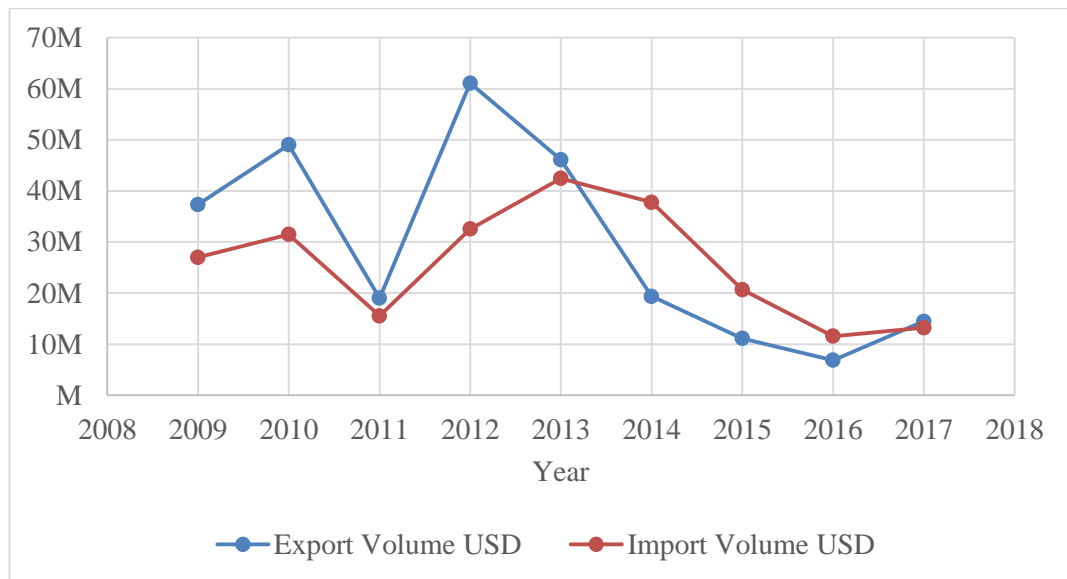
#### **3.1 Methodology Design and Data for Libyan Economy**

As shown in the literature review performed in the last chapter and presented through several studies in Table 2.2, the TOPSIS method has been used widely in order to determine the closest alternative to the ideal solution. Like other MCDM methods, TOPSIS requires a set of criteria for judgement another set of alternatives as possible final solutions. In economic performance research, understanding the behavior of the key indicators that influence the performance of an economy could provide an understanding of the possible measures and priorities in developing economic strategies for the country. Therefore, it is possible to acquire data of these indicators over several years and treat them as criteria, while the years that are corresponding to data can be used as the alternatives. Specifying the closest year to the ideal solution provides the most desired combination of the indicators that could achieve the best economic performance. Moreover, studying the behavior of the indicators separately and collectively allows researchers and specialists to diagnose the economic issues that requires immediate intervention and provides a cause and effect analysis for the economic indicators.

Turan, et al. (2016) presented an application of the TOPSIS methodology on data for the Russian economy twenty-three years from 1992 to 2014. The authors started by presenting the available data in numeric and graphical forms in order to show the independent changes over the specified period. Thereafter, the TOPSIS method was applied in order to determine the best and worst economic years in order in comparison with the calculated ideal solution. Nine key performance indicators were used as criteria for each year, including inflation rate, interest rate, GDP in different forms, exportation volume, employment rate and unemployment rate. The TOPSIS method allowed the authors to arrange the years from best to worst based on equal and unequal weights, which were used for comparison. The results showed the year 1995 as

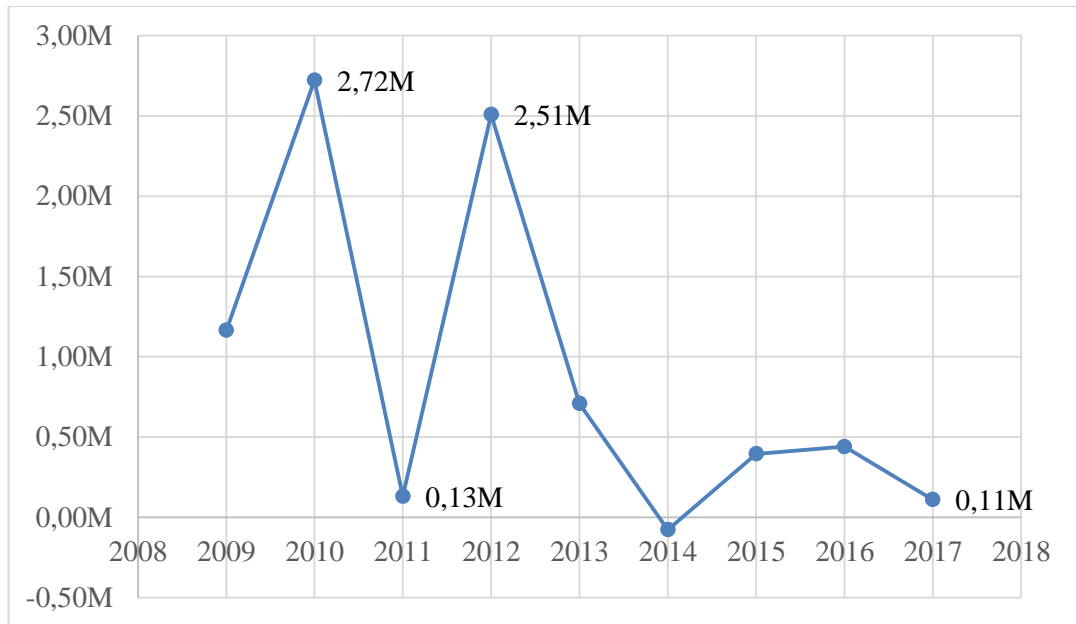
the best and the year 1992 as the worst based on equal weights, while unequal weights showed 1995 and 2009 as the best and worst years, respectively. Furthermore, ideal solutions in the equal and unequal weight assignment were plotted for a clearer comparison between the different years.

Nine criteria are considered for the case study of the Libyan economy, which are export volume, import volume, foreign direct investment (FDI), labor force, inflation (GDP deflator), net secondary income, unemployment, US dollars exchange rate, and oil production. The criteria are studied over a nine-year period from 2009 to 2017. Figure 3.1 shows the exportation and importation volumes of Libya in million US dollars. The highest export volume was in 2012, while the lowest was in 2016. In import volumes, the highest and the lowest values were in 2013 and 2017, respectively. The export volumes were higher than import volumes from 2009 to 2013; however, this trend changed with imports exceeding exports from 2014 to 2017. A sudden in export and import volumes is observed in 2011 due to severe political and security instabilities.



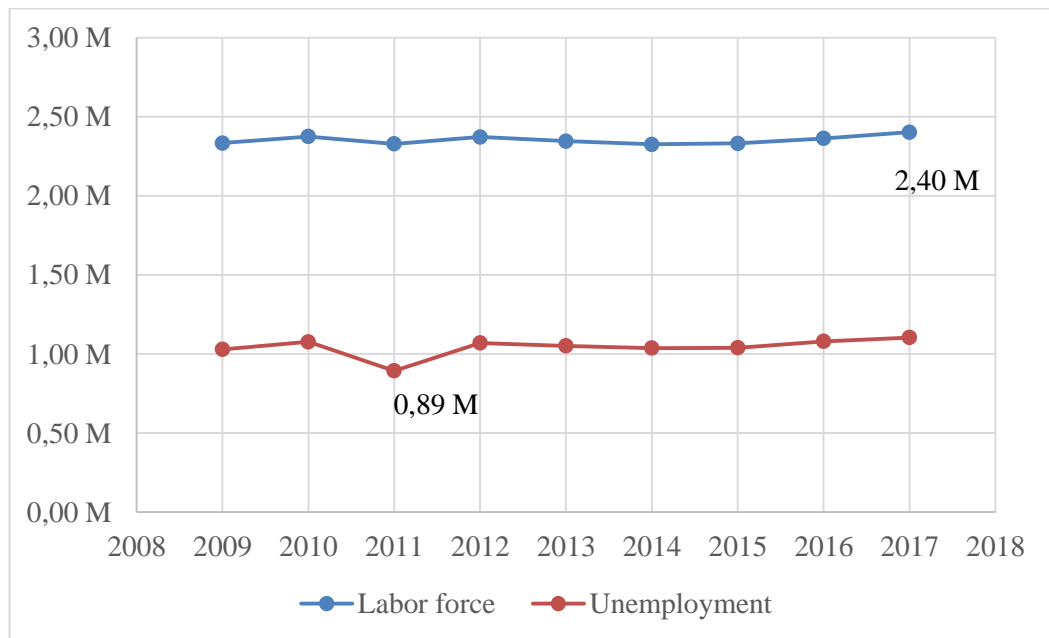
**Figure 3.1:** Comparison between Export and Import Volumes of Libya from 2009 to 2017

A similar trend is observed with foreign direct investment, with a sudden drop in 2011 and a negative value in 2014, as shown in Figure 3.2. The highest values for FDI were in 2010, followed by 2012. Nonetheless, FDIs relatively dropped from 2013 onwards to less than 1 million US dollars.



**Figure 3.2:** Foreign Direct Invest in Libya from 2009 to 2017

As shown in Figure 3.3, the total labor force in Libya was stable over the specified period from 2009 to 2017 at around 2.35 million, while the unemployment rate is very high at 45%. Unemployment dropped to 38.4% in 2011, which can be mainly driven by the slight drop in labor force population.



**Figure 3.3:** Labor force and unemployment in Libya from 2009 to 2017



### 3.2 TOPSIS Application and Discussion

As mentioned earlier the period considered in the research to study the Libyan economy is the years between 2009 and 2017, with nine criteria presented in Table 3.1. Weights are assigned to each criterion to give oil production and exchange rate the highest weights with 0.25, while the remaining weight is distributed on other criteria equally.

**Table 3.1:** Economic Indicators Used For the Evaluation

Notation	Criterion/ Economic indicator	Weight ( $w_{ij}$ )
$C_1$	Exports of goods and services (volume in USD)	0.071429
$C_2$	Imports of goods and services (volume in USD)	0.071429
$C_3$	Foreign direct investment (FDI), net outflows (BoP, USD)	0.071429
$C_4$	Labor force, total	0.071429
$C_5$	Inflation, GDP deflator (annual %)	0.071429
$C_6$	Net secondary income (BoP, USD)	0.071429
$C_7$	Unemployment, youth total (% of total labor force ages 15-24) (modeled ILO estimate)	0.071429
$C_8$	Exchange rate of US dollars	0.25
$C_9$	Oil production (thousand barrels per day)	0.25

Table 3.2 presents the data that are used in the assessment of the Libyan economy using the TOPSIS method according to the selected economic indicators from 2009 to 2017.

**Table 3.2:** Libyan Economy Data Used For TOPSIS Application (Decision Matrix)

	$C_1$	$C_2$	$C_3$	$C_4$	$C_5$	$C_6$	$C_7$	$C_8$	$C_9$
<b>2009</b>	37.335.46 0.710	26.990.027.9 22	1.165.000.0 00	2.334.7 99	- 25,3 1	- 1.572.000.0 00	44,1 1	1,25 3	1.556, 46
<b>2010</b>	49.055.09 9.463	31.477.739.1 85	2.722.000.0 00	2.375.3 76	14,1 6	- 1.828.000.0 00	45,3 3	1,26 7	1.564, 91

**Table 3.2:** (More) Libyan Economy Data Used For TOPSIS Application (Decision Matrix)

<b>2011</b>	19.025.48 6.032	15.542.395.0 33	131.000.00 0	2.328.7 81	18,2 5	- 377.000.000	38,4 0	1,22 0	368,36
<b>2012</b>	61.096.14 0.128	32.541.808.6 71	2.508.800.0 00	2.372.5 30	8,98	- 2.824.200.0 00	45,1 2	1,25 1	1.424, 09
<b>2013</b>	46.136.11 7.009	42.464.181.8 04	707.700.00 0	2.346.0 67	-6,67	- 3.252.200.0 00	44,8 5	1,25 8	930,75
<b>2014</b>	19.342.97 3.908	37.803.285.1 30	-77.600.000	2.325.9 88	- 17,3 1	- 1.120.900.0 00	44,6 1	1,64 0	464,00
<b>2015</b>	11.127.57 0.229	20.680.929.6 26	394.900.00 0	2.332.6 98	- 19,4 0	- 839.800.000	44,5 7	2,75 0	403,75
<b>2016</b>	6.853.934. 202	11.557.411.2 73	439.500.00 0	2.363.3 36	-2,56	- 755.800.000	45,7 1	5,00 5	438,58
<b>2017</b>	14.457.19 6.478	13.212.068.7 17	110.000.00 0	2.403.1 25	14,4 2	- 1.571.237.5 00	45,9 4	8,87 8	896,08

In order to construct the normalized decision matrix according to equation (5), presented below, the square roots of the matrix values are calculated and the square root of the sum of the column  $x_{ij}$  values are calculated, as shown in Table 3.3. Finally, the first step of the TOPSIS analysis is completed by producing the normalized decision matrix in Table 3.4.

$$r_{ij} = \frac{x_{ij}}{\sqrt{(\sum x_{ij}^2)}} \quad \text{for } i = 1, \dots, m; j = 1, \dots, n \quad (5)$$

**Table 3.3:** Calculation of the Square Roots of the Column Square Values

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>
<b>2009</b>	1,39394E <sup>+21</sup>	7,28E <sup>+20</sup>	1,36E <sup>+18</sup>	5,45E <sup>+12</sup>	640,7376	2,47E <sup>+18</sup>	1945,427	1,569854	2422552
<b>2010</b>	2,4064E <sup>+21</sup>	9,91E <sup>+20</sup>	7,41E <sup>+18</sup>	5,64E <sup>+12</sup>	200,5358	3,34E <sup>+18</sup>	2054,99	1,605781	2448940
<b>2011</b>	3,61969E <sup>+20</sup>	2,42E <sup>+20</sup>	1,72E <sup>+16</sup>	5,42E <sup>+12</sup>	333,0887	1,42E <sup>+17</sup>	1474,867	1,488449	135691,7
<b>2012</b>	3,73274E <sup>+21</sup>	1,06E <sup>+21</sup>	6,29E <sup>+18</sup>	5,63E <sup>+12</sup>	80,65244	7,98E <sup>+18</sup>	2035,724	1,564751	2028035
<b>2013</b>	2,12854E <sup>+21</sup>	1,8E <sup>+21</sup>	5,01E <sup>+17</sup>	5,5E <sup>+12</sup>	44,46118	1,06E <sup>+19</sup>	2011,881	1,583362	866295,6
<b>2014</b>	3,74151E <sup>+20</sup>	1,43E <sup>+21</sup>	6,02E <sup>+15</sup>	5,41E <sup>+12</sup>	299,6025	1,26E <sup>+18</sup>	1990,052	2,6896	215296
<b>2015</b>	1,23823E <sup>+20</sup>	4,28E <sup>+20</sup>	1,56E <sup>+17</sup>	5,44E <sup>+12</sup>	376,3023	7,05E <sup>+17</sup>	1986,842	7,5625	163014,1
<b>2016</b>	4,69764E <sup>+19</sup>	1,34E <sup>+20</sup>	1,93E <sup>+17</sup>	5,59E <sup>+12</sup>	6,541131	5,71E <sup>+17</sup>	2089,13	25,05003	192355,3
<b>2017</b>	2,09011E <sup>+20</sup>	1,75E <sup>+20</sup>	1,21E <sup>+16</sup>	5,78E <sup>+12</sup>	207,9266	2,47E <sup>+18</sup>	2110,943	78,81001	802965,3
$\sqrt{(\sum x_{ij}^2)}$	<b>1,03815E<sup>+11</sup></b>	<b>8,36E<sup>+10</sup></b>	<b>3,99E<sup>+09</sup></b>	<b>7061297</b>	<b>46,79581</b>	<b>5,43E<sup>+09</sup></b>	<b>133,0408</b>	<b>11,04193</b>	<b>3045,512</b>

**Table 3.4:** Normalized Decision Matrix

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>
2009	0.3596	0.3229	0.2917	0.3306	-0.5409	-0.2894	0.3315	0.1135	0.5111
2010	0.4725	0.3766	0.6817	0.3364	0.3026	-0.3365	0.3407	0.1148	0.5138
2011	0.1833	0.1859	0.0328	0.3298	0.3900	-0.0694	0.2887	0.1105	0.1210
2012	0.5885	0.3893	0.6283	0.3360	0.1919	-0.5199	0.3391	0.1133	0.4676
2013	0.4444	0.5080	0.1772	0.3322	-0.1425	-0.5987	0.3371	0.1140	0.3056
2014	0.1863	0.4522	-0.0194	0.3294	-0.3699	-0.2063	0.3353	0.1485	0.1524
2015	0.1072	0.2474	0.0989	0.3303	-0.4145	-0.1546	0.3350	0.2491	0.1326
2016	0.0660	0.1383	0.1101	0.3347	-0.0547	-0.1391	0.3436	0.4533	0.1440
2017	0.1393	0.1581	0.0275	0.3403	0.3081	-0.2892	0.3453	0.8040	0.2942

The second step is calculating the weighted decision matrix (Table 3.5) through applying the weights assigned for each criterion in Table 3.1 and using equation (6) below.

$$v_{ij} = w_j r_{ij} \quad (6)$$

**Table 3.5:** Weighted Decision Matrix

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>
2009	0.03	0.02	0.02	0.02	-0.04	-0.02	0.02	0.03	0.13
2010	0.03	0.03	0.05	0.02	0.02	-0.02	0.02	0.03	0.13
2011	0.01	0.01	0.00	0.02	0.03	0.00	0.02	0.03	0.03
2012	0.04	0.03	0.04	0.02	0.01	-0.04	0.02	0.03	0.12
2013	0.03	0.04	0.01	0.02	-0.01	-0.04	0.02	0.03	0.08
2014	0.01	0.03	0.00	0.02	-0.03	-0.01	0.02	0.04	0.04
2015	0.01	0.02	0.01	0.02	-0.03	-0.01	0.02	0.06	0.03
2016	0.00	0.01	0.01	0.02	0.00	-0.01	0.02	0.11	0.04
2017	0.01	0.01	0.00	0.02	0.02	-0.02	0.02	0.20	0.07

The positive and negative ideal solutions are determined through calculating the maximum and minimum values of each criterion from the weighted decision matrix from equations (7) and (8), respectively, as shown in Table 3.6.

$$A^* = \{v_1^*, \dots, v_n^*\} \quad (7)$$

Where  $v_i^* = \{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\}$

$$A' = \{v_1', \dots, v_n'\} \quad (8)$$

Where  $v_i' = \{\min(v_{ij}) \text{ if } j \in J; \max(v_{ij}) \text{ if } j \in J'\}$

**Table 3.6:** Calculation of Positive and Negative Solutions

	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>
<b>Max A*</b>	0.04	0.04	0.05	0.02	0.03	0.00	0.02	0.20	0.13
<b>Min A'</b>	0.00	0.01	0.00	0.02	-0.04	-0.04	0.02	0.03	0.03

Separation measurement from the positive ideal solution is calculated for each value using equation (9), as shown in Table 3.7.

$$S_i^* = \sqrt{\sum(v_j^* - v_{ij})^2} \quad i = 1, \dots, m \quad (9)$$

**Table 3.7:** Separation Measurement from Positive Ideal Solution

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	S <sub>i</sub> *
<b>2009</b>	0.0003	0.0002	0.0008	0.0000	0.0044	0.0002	0.0000	0.0298	0.0000	0.1889
<b>2010</b>	0.0001	0.0001	0.0000	0.0000	0.0000	0.0004	0.0000	0.0297	0.0000	0.1739
<b>2011</b>	0.0008	0.0005	0.0021	0.0000	0.0000	0.0000	0.0000	0.0301	0.0096	0.2079
<b>2012</b>	0.0000	0.0001	0.0000	0.0000	0.0002	0.0010	0.0000	0.0298	0.0001	0.1768
<b>2013</b>	0.0001	0.0000	0.0013	0.0000	0.0014	0.0014	0.0000	0.0298	0.0027	0.1917
<b>2014</b>	0.0008	0.0000	0.0025	0.0000	0.0029	0.0001	0.0000	0.0269	0.0082	0.2035
<b>2015</b>	0.0012	0.0003	0.0017	0.0000	0.0033	0.0000	0.0000	0.0192	0.0091	0.1869
<b>2016</b>	0.0014	0.0007	0.0017	0.0000	0.0010	0.0000	0.0000	0.0077	0.0085	0.1450
<b>2017</b>	0.0010	0.0006	0.0022	0.0000	0.0000	0.0002	0.0000	0.0000	0.0030	0.0845

Separation measurement from the negative ideal solution is calculated for each value using equation (10), as shown in Table 3.8.

$$S_i' = \sqrt{\sum(v_j' - v_{ij})^2} \quad i = 1, \dots, m \quad (10)$$

**Table 3.8:** Separation measurement from negative ideal solution

Year	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	S <sub>i</sub> '
<b>2009</b>	0.0004	0.0002	0.0005	0.0000	0.0000	0.0005	0.0000	0.0000	0.0095	0.1054
<b>2010</b>	0.0008	0.0003	0.0025	0.0000	0.0036	0.0004	0.0000	0.0000	0.0096	0.1315
<b>2011</b>	0.0001	0.0000	0.0000	0.0000	0.0044	0.0014	0.0000	0.0000	0.0000	0.0771
<b>2012</b>	0.0014	0.0003	0.0021	0.0000	0.0027	0.0000	0.0000	0.0000	0.0075	0.1190
<b>2013</b>	0.0007	0.0007	0.0002	0.0000	0.0008	0.0000	0.0000	0.0000	0.0021	0.0677
<b>2014</b>	0.0001	0.0005	0.0000	0.0000	0.0001	0.0008	0.0000	0.0001	0.0001	0.0409
<b>2015</b>	0.0000	0.0001	0.0001	0.0000	0.0001	0.0010	0.0000	0.0012	0.0000	0.0495
<b>2016</b>	0.0000	0.0000	0.0001	0.0000	0.0012	0.0011	0.0000	0.0073	0.0000	0.0988
<b>2017</b>	0.0000	0.0000	0.0000	0.0000	0.0037	0.0005	0.0000	0.0301	0.0019	0.1852

Relative closeness coefficients to the ideal solution are calculated for the years from 2009 to 2017 using equation (11), as shown in Table 3.9.

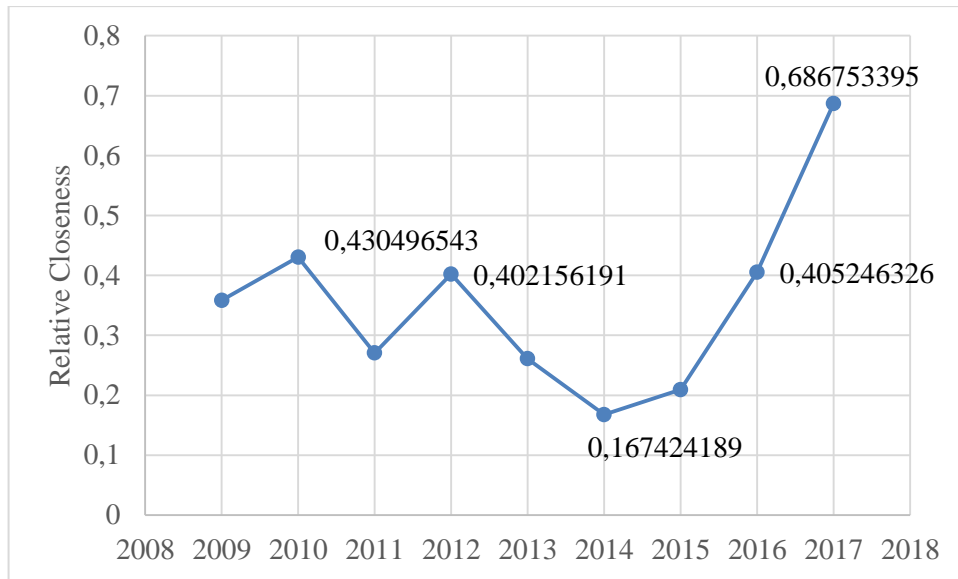
$$C_i^* = \frac{S_i'}{(S_i^* + S_i')} \quad (11)$$

Where  $0 < C_i^* < 1$

Moreover, the years are arranged according to their closeness to 1; from the best year to the worst. The coefficients are plotted in order to illustrate the timeline changes in the Libyan economy from one year to another. As shown in Figure 3.4, a drop in the economic performance of Libya is observed in 2011 due to the political instability in the country, while the period from 2012 to 2014 had security instability due to the civil war. From 2015 until 2017, the economic performance analysis shows a continuous enhancement in the economy, which is attributed to the period of stability in the country. The political and security stabilities influence many economic indicators in the Libyan economy, especially oil production and the export and import volumes.

**Table 3.9:** Relative closeness coefficient and order of year from best to worst based on data of the Libyan economy

Year	$S_i^*$	$S_i'$	$C_i^*$	Order
2009	0.1889	0.1054	0.358207814	5
2010	0.1739	0.1315	0.430496543	2
2011	0.2079	0.0771	0.270526098	6
2012	0.1768	0.1190	0.402156191	4
2013	0.1917	0.0677	0.260900308	7
2014	0.2035	0.0409	0.167424189	9
2015	0.1869	0.0495	0.20930626	8
2016	0.1450	0.0988	0.405246326	3
2017	0.0845	0.1852	0.686753395	1



**Figure 3.4:** Performance of the Libyan economy (2009 to 2017)

Performance of Libyan economy increased in 2010 by 20.18% from the previous year; however, a declination by 37.16% occurred in 2011 due to political instability in the region. While 2012 brought a 48.66% of improvement in the economic performance, the revolution in the same year affected oil production and exportation, as well as the exportation of other goods and service. This is noticeable in the decrease in economic performance by 70.9% by 2014, as the revolution was followed by a civil war that hindered economic activities in the country. With the establishment of a new government in 2015, the economic performance increased by 25.01% due to the resumption of oil production, manufacturing and trading activities. The following year showed the highest economic performance amongst the research period with 93.61% increase, followed by 2017 with another 69.47% enhancement in the Libyan economic performance.

As emphasized by Ali (2011), Bhattarai & Taloba (2017) and Etelawi, et al. (2017), the Libyan economy is highly dependent on oil production, which can be noticed through the declination of other economic activities with any issues facing production and exportation of oil. Furthermore, oil can be observed to affect unemployment, inflation and exchange rates, as suggested by Bala & Chin (2018). The selected time period in the current study provides an insight on the transition period the Libyan economy is experiencing between different political and economic regimes. The political regime that existed prior the

revolution depended mainly on oil production with a communist-like economic system that hindered economic development for decades. Nevertheless, the revolution and civil war from 2012 to 2014 added to the challenges of the Libyan economy with impeded oil production, which controls and affects most of the economic indicators of the country. Noticeable improvements were noticed between 2015 to 2017 due to the establishment of a new government adopting a capitalist economic strategy. The results of the current research confirm the insights provided by Turan, et al. (2016) about the challenges in economic performance faced by the Russian economy during political and economic transition periods, which are similar circumstances faced by the Libyan economy today.

#### **4. CONCLUSIONS**

The study of a country's economic performance is significant due to its contribution into planning for development and growth. Therefore, key performance indicators are used to assess the economy and calculate determinants that can imply influence or drawbacks. The current equations and models for economic performance assessment provide outcomes based on limited factors through a one-year period. Thus, the current study presented a model that can help with the evaluation process over an extended period. Several key economy performance indicators are used in the application, where some of them are general factors that are considered in several studies and some of them are included for the case-specific economy of Libya.

The model applied in the study is based on the TOPSIS method, which is an MCDM technique used to evaluate alternatives based through their closeness to ideal solutions through judgements on several attributes. MCDM methods have been effective in problem-solving as techniques that simplify complex issues through a logical structure and a mathematical algorithm. The precision and accuracy of MCDMs have been enhanced in several studies through implementing stochastic and fuzzy inputs, as well as using hybrid techniques for results comparison and enhancement. The TOPSIS method is widely used in economic and management applications, as it is helpful in determining the alternative that is the closest to the ideal solution. The current application of the TOPSIS technique uses actual economic data of Libya, which solves the challenge of the varying human judgement that are faced by MCDMs.

The main aim of the current research was to assess the performance of the Libyan economy between the years of 2009 and 2017 using the TOPSIS method in order to understand the factors that contributed into enhancing the economy in the best years. The literature review for studies that were focused on the Libyan economy showed that the Libyan economy is highly dependent on oil production, which hindered development besides lack of national development



plans, processes and systems. The fluctuating oil market affected the Libyan economy with instability and influenced other factors, such as exchange rates, GDP and employment, as well as growth and development. In the late years of instability on the political and security levels, the high dependency on oil exports had severe impacts on the country, especially during the civil war between 2012 and 2014. Foreign currency exchange rates were also one of the most unstable economic factors in the selected years of the current study. Thus, oil production and exchange rates are emphasized in the application of the TOPSIS method.

In method application, data for nine key economic performance indicators over nine years were obtained to construct the initial decision matrix, which is then normalized to produce the normalized decision matrix. Weights are incorporated into the normalized decision matrix to consider the difference in effect amongst the attributes and to produce the weighted decision matrix. The highest weights were given to oil production and exchange rates as the most affecting and affected factors based on the literature review of the Libyan economy. Ideal positive and negative solutions were calculated, as well as the separation measures between the weighted decision matrix elements and the ideal solutions. Finally, a relative closeness coefficient for each year was calculated indicating its closeness from the ideal solutions.

Worth mentioning, this study can be done by other MCDM techniques and it is possible that these techniques will have results that differ from the results from this study. It is highly recommended to compare these different results (if exist) to arrive to more accurate suggestions and recommendation.

The findings of the research showed that 2017 was the best year for economic performance for the Libyan economy in relevance to the studied period between 2009 and 2017. Prior the late political instability in the country, 2010 is indicated as the second-best year for economic performance with 20.18% enhanced performance from the year before. The worst years for economic performance in Libya were between 2012 and 2014 due to the civil war between the different political and militant powers in the country. However, from 2015 to 2017 a substantial enhancement in the economic performance is observed during a stability period. The current crisis in the country highlighted the impact

of oil-dependency on the Libyan economy. Thus, it is understood that adopting oil as the main income of the country increase the vulnerability of the economy and has impacts on the other economic factors, including foreign currency exchange rates. Based on the findings of the research, the following recommendations are made:

- It is necessary to empower a rapid political solution in Libya in order to be able to create and execute economic strategies and plans that can contribute into the development and growth of the country.
- The necessary infrastructure needs to be provided in the country on the logistical, financial and technological levels in order to encourage investments and trading.
- Economic plans are necessary in order to reduce the high dependency on oil as the main income of Libya. It is suggested that substantial government investments are made into manufacturing and agricultural sectors in order to diversify the economic portfolio and reduce the impact of oil market fluctuations on the Libyan economy.
- Other economic indicators, especially exchange rates, need to be monitored by the central bank in order to implement policies that limit their fluctuations. Executing an overall development plan is expected to reduce unemployment and increase the participation of the labor force.
- Future studies should consider repeating the application presented in the current research for continuous monitoring and modification to strategic economic plans.

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## **HOBBIES, INTERESTS OR ACTIVITIES:**

**Photography.**

**Television:** Movies, intelligent drama, news and documentaries.

**Journalism:** reading a broad range of publications (local and national) for the latest news and criticism.

**New Media:** researching and exploring on the Internet; computer Programs.

**Literature:** continue to pursue this interest by reading a diverse range of texts.

**Music:** listening to many different genres of music.