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FACTORS INFLUENCING THE FUEL OIL CONSUMPTION IN MALAYSIA : AN ARDL APPROACH

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LIST OF ABBREVIATIONS

ARDL : Autoregressive Distributed Lag

ECM : Error Correction Model

FOC : Fuel Oil Consumption

FOP : Fuel Oil Price

GDP : Gross Domestic Product

POP : Population

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ABSTRACT

This study investigates the factors influencing Fuel Oil Consumption (FOC) in Malaysia, focusing on Gross Domestic Product (GDP), Population (POP), and Fuel Oil Prices (FOP) over the period from 1980 to 2023. Utilizing the Autoregressive Distributed Lag (ARDL) model, the research explores both short-term and long-term relationships between these variables. The findings reveal that FOP plays a critical role in determining FOC, exhibiting a significant negative relationship in the long term, while GDP and POP demonstrate limited influence. This suggests that Malaysia's FOC is more sensitive to pricing mechanisms than to economic growth or demographic changes. Additionally, the analysis highlights a moderate speed of adjustment to equilibrium after disruptions, reflecting the resilience of Malaysia's energy market but also underscoring its vulnerabilities to global oil price volatility. These results emphasize the importance of dynamic pricing strategies, energy diversification, and efficiency improvements in shaping a sustainable energy future for Malaysia. The study provides key insights for policymakers and researchers in formulating evidence-based strategies to balance energy demand with sustainable economic growth.

Keywords: Fuel Oil Consumption, Gross Domestic Product, Population, Fuel Oil Prices, ARDL Model, Malaysia.

CHAPTER 1

INTRODUCTION

1.1 Introduction

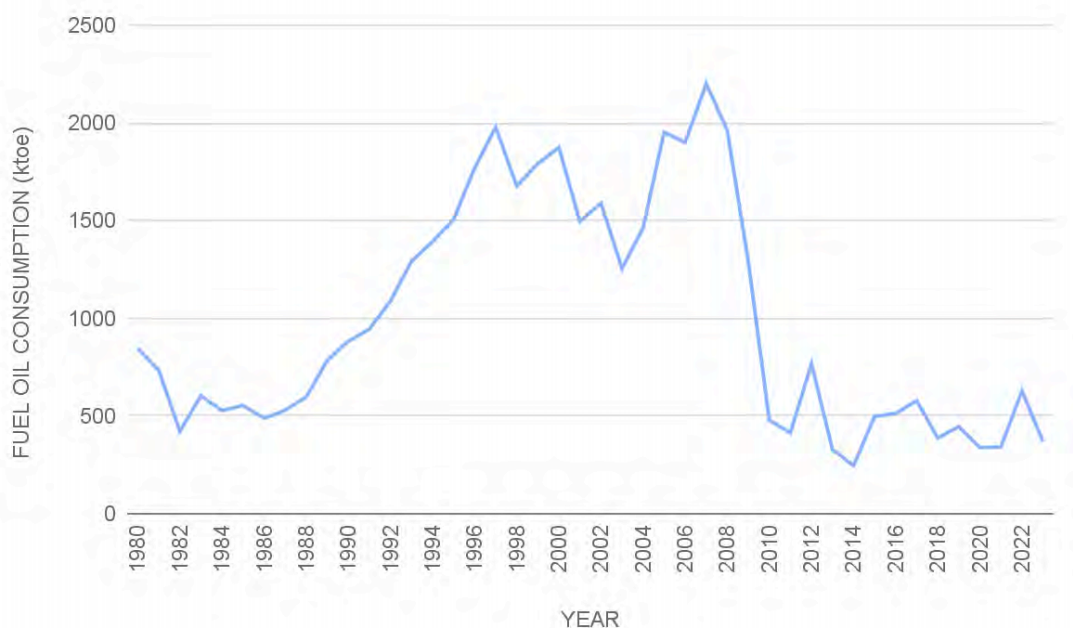
An economy is a broad, interconnected method of trade, production, and consumption which contributes to determining how scarce resources are distributed. Malaysia is blessed with a good mix of energy resources like oil, natural gas, coal and renewable energies such as biomass, solar and hydro. Despite having a scarcity of resources, Malaysia industrial and transportation sectors rely on fossil fuels such as oil, natural gas and coal. Fuel oil and other liquid petroleum products are produced from fossil fuels and are consumed by consumers for a wide range of purposes such as fueling transportations, supplying electricity, and being used as a raw material. The consumption of energy resources in Malaysia, especially the fuel oil consumption for the last 10 years indicates a fluctuating trend despite the increases in population and economic growth. Fuel oil consumption is significantly influenced by factors such as population growth, economic growth, and the prices of fuel oil. Despite many previous studies on the fuel oil, most of them examined the fuel oil effects on the demand and supply, or generally only focused on the crude oil and the petroleum products. Therefore, this study contributes to the literature by analyzing the factors of Gross Domestic Product, Population, and Fuel Oil Prices influencing the Fuel Oil Consumption in Malaysia. This study context is even more impressive since Malaysia is not an OPEC member country and only a small oil producing country.

1.2 Research Background

Fuel oil has long been a cornerstone of Malaysia's energy landscape, powering the nation's economic engine and fueling growth in critical sectors such as transportation and industry. With Malaysia's unique position as a small oil producing country outside the Organization of the Petroleum Exporting Countries (OPEC), its energy dynamics offer a fascinating blend of challenges and opportunities. The interplay between fuel oil consumption and pivotal factors like GDP, population growth, and oil prices reveals deeper stories about the nation's industrialization, economic resilience, and policy strategies. As noted earlier in the previous section, most of the previous studies examined the fuel oil effects on the demand and supply. However, this study analyzes the relationship between the Fuel Oil Consumption with the factors Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia. To illustrate, the following illustrations are evaluating the time series data of this study variables including the Fuel Oil Consumption itself and its independent variables :

1.2.1 Fuel Oil Consumption

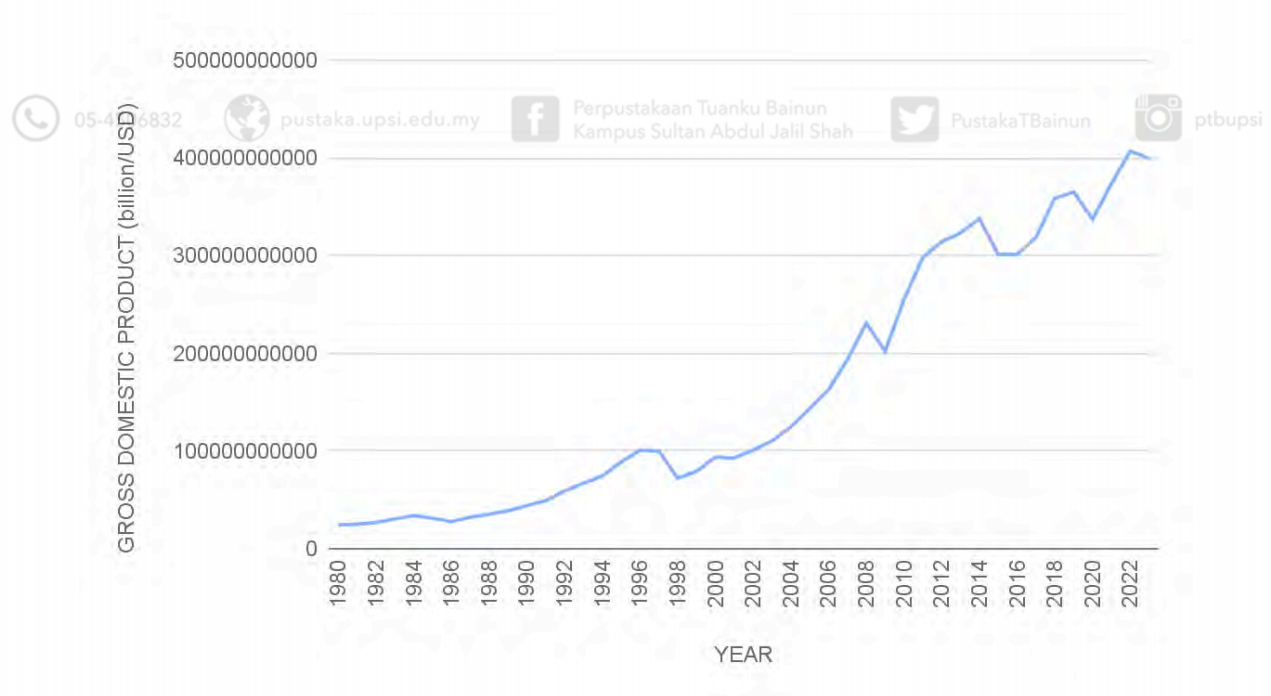
Figure 1 : Fuel Oil Consumption



Based on Figure 1 above, the movement represented Fuel Oil Consumption in Malaysia from 1980 to 2023. The data of Fuel Oil Consumption is obtained from *Malaysia Energy Information Hub (MEIH)*. The movements of Fuel Oil Consumption are relatively showing fluctuating trends throughout 1980 to 2023. The movements of Fuel Oil Consumption started with 846 ktoe in 1980 and ended with 369 ktoe in 2023. The movement of Fuel Oil Consumption for the first years of examination is showing downward sloping throughout 1980 to 1982 and then continuously showing fluctuating trend throughout 1982 to 2023. In conclusion, the lowest Fuel Oil Consumption in Malaysia is 246 ktoe in 2014 while the highest Fuel Oil Consumption in Malaysia is 2202 ktoe in 2007 throughout the whole period of years from 1980 to 2023.

1.2.2 Gross Domestic Product

Figure 2 : Gross Domestic Product

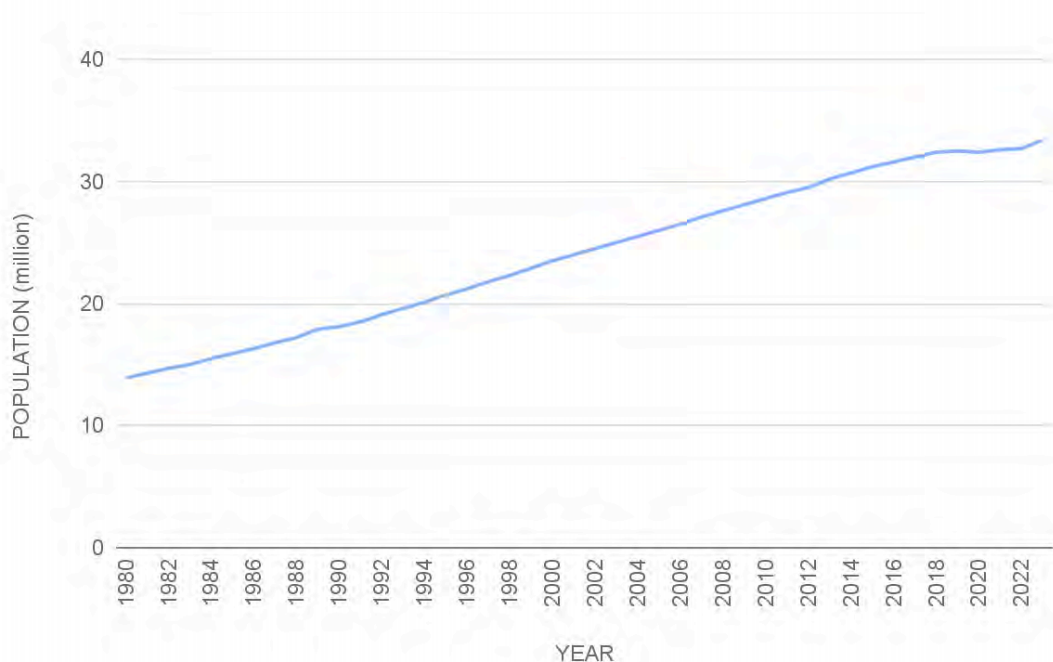


Based on Figure 2 above, the movement represented Gross Domestic Product in Malaysia from 1980 to 2023. The data of Gross Domestic Product is obtained from *The World Bank Open Data*. The movements of Gross Domestic Product are relatively showing upward trends throughout

1980 to 2023. The movements of Gross Domestic Product started with 24.49 billion USD in 1980 and ended with 399.65 billion USD in 2023. The movement of Gross Domestic Product for the first years of examinations is showing upward sloping throughout 1980 to 1984 and then continuously showing fluctuating trends throughout 1984 to 2023. In general, it is a stable increasing trend of Gross Domestic Product despite showing downward sloping throughout those years. In conclusion, Malaysia's lowest Gross Domestic Product is 24.49 billion USD in 1980 while Malaysia's highest Gross Domestic Product is 407.03 billion USD in 2022 throughout the whole period of years from 1980 to 2023. According to both Fuel oil Consumption and Gross Domestic Product time series data analysis, it shows that Fuel Oil Consumption had fluctuating trends from 1980 to 2023, while Gross Domestic Product consistently increased during the same period. Conclusively, the steady economic growth did not always lead to more fuel oil consumption.

1.2.3 Population

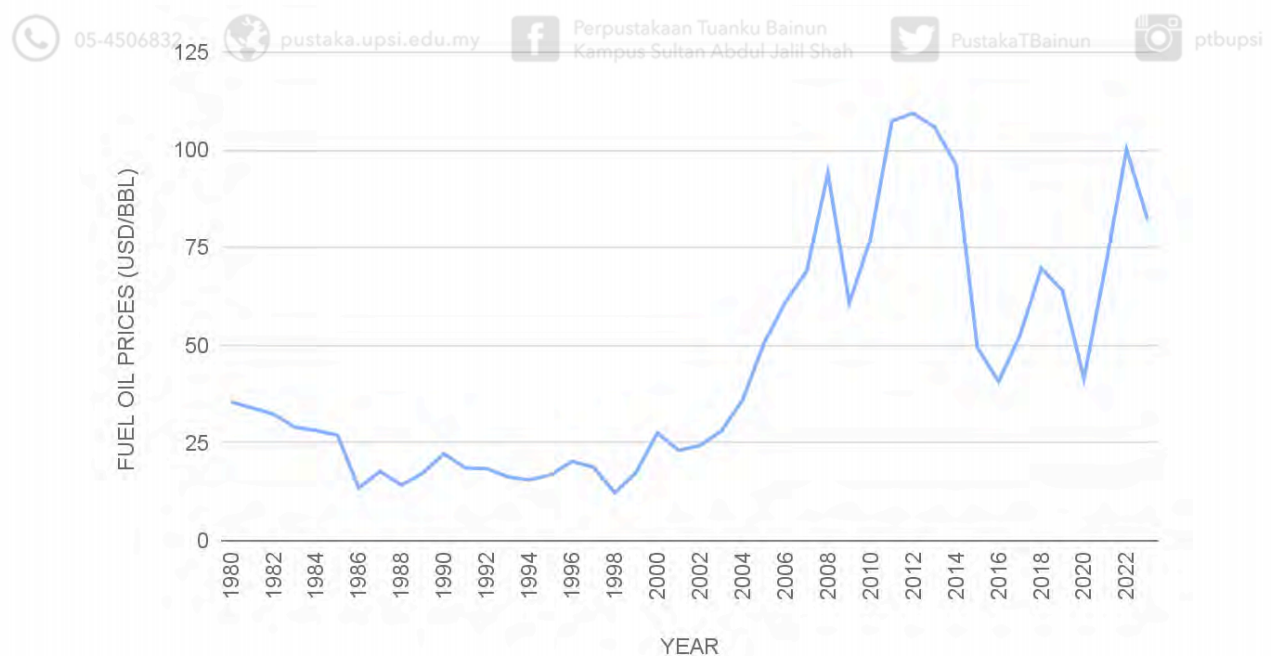
Figure 3 : Population



Based on Figure 3 above, the movement represented Population in Malaysia from 1980 to 2023. The data of Population is obtained from The *Department Of Statistic Malaysia (DOSM)*. The movements of Population are relatively showing upward trends throughout 1980 to 2023. The movements of Population started with 13.9 million people in 1980 and ended with 33.4 million people in 2023. In general, it is a stable and increasing trend of Population during that period of time. In conclusion, Malaysia's lowest Population recorded in 1980 which is 13.9 million people while Malaysia's highest Population recorded in 2023 which is 33.4 million people throughout the whole period of years from 1980 to 2023. According to both Fuel Oil Consumption and Population time series data analysis, it shows that Fuel Oil Consumption had fluctuating trends from 1980 to 2023, while Population steadily increased during the same period. Conclusively, the rising population did not always result in higher fuel oil usage.

1.2.4 Fuel Oil Price

Figure 4 : Fuel Oil Price



Based on Figure 4 above, the movement represented Fuel Oil Price in Malaysia from 1980 to 2023. The data of Fuel Oil Price is obtained from *Statista Research Department*. The movements

of Fuel Oil Price are relatively showing fluctuating trends throughout 1980 to 2023. The movement of Fuel Oil Price started with 35.53 USD per barrel in 1980 and ended with 81.98 USD per barrel in 2023. The movement of Fuel Oil Price for the first years of examinations is showing downward sloping throughout 1980 to 1986 and then continuously showing fluctuating trends throughout 1986 to 2023. In conclusion, the lowest Fuel Oil Price was 12.28 USD per barrel in 1998 while the highest Fuel Oil Price was 109.45 USD per barrel in 2012 throughout the whole period of years from 1980 to 2023. According to both Fuel Oil Consumption and Fuel Oil Price time series data analysis, it shows that both Fuel Oil Consumption and Fuel Oil Price had fluctuating trends from 1980 to 2023. Conclusively, changes in consumption do not always align with changes in price.

In conclusion, according to the figures above, Malaysia has witnessed dramatic fluctuations in fuel oil consumption. These trends, captured through time series data, tell a compelling narrative of the country's evolving energy demands amidst rapid economic development, population growth, and changing fuel oil prices. While Malaysia has achieved steady GDP growth and a rising population, fuel oil consumption patterns have not always mirrored these upward trends, reflecting the complexity of energy economics. Similarly, fluctuations in fuel oil prices have played a critical role in shaping consumption patterns, with both global market dynamics and domestic pricing policies influencing demand. Unlike many oil exporting nations, Malaysia's position as a relatively small producer heightens the significance of examining how global and domestic forces shape its fuel oil demand, providing unique insights for energy policy and economic planning.

1.3 Problem Statement

Fuel oil plays a vital role in a country's economy, serving as a critical energy source for key sectors such as transportation and industry. It contributes significantly to sustainable transportation, industrial productivity, and economic growth. Unlike most previous studies that have primarily examined fuel oil's effects on demand and supply, this study takes a distinct approach by analyzing the relationships between fuel oil consumption and the gross domestic product, population and fuel oil prices. these variables in Malaysia. Utilizing the Autoregressive Distributed Lag (ARDL) method, this approach allows for a detailed examination of both short-term and long-term dynamics, providing valuable insights into how these factors collectively shape fuel oil consumption.

Fuel oil consumption in Malaysia is primarily driven by the transportation and industrial sectors. Road transportation dominates energy usage in the transportation sector, significantly influenced by population growth and an increase in motor vehicles. Between 2013 and 2023, Malaysia's population grew by 10%, from 30.2 million to 33.4 million, which heightened the demand for fuel oil as a critical energy source for mobility and essential services (Akhmad Pide & Amir, 2018). Similarly, the industrial sector depends heavily on fuel oil for large-scale manufacturing processes, such as steel production and heavy machinery operations. Advancements in automation and modernization have further escalated fuel oil consumption, with the energy's reliability and cost-effectiveness making it indispensable for industrial applications (Saidur et al., 2007).

The interplay between fuel oil consumption, economic growth, and fuel prices underscores its critical role in Malaysia's economy. Studies indicate a strong link between energy consumption and GDP growth, as energy serves as both a driver and a consequence of economic performance (Rachid Hafsi et al., 2021; Lach, 2014). For instance, Kolthoom Alkofahi & Jihen Bousrih (2024) found that higher oil consumption leads to greater GDP growth. Additionally, global oil market dynamics, influenced by geopolitical factors, significantly impact Malaysia's domestic fuel oil prices, shaping demand patterns (Aimon et al., 2020). Price trends and prior consumption levels further emphasize the interconnectedness of these variables, revealing the importance of understanding Malaysia's fuel oil consumption trends holistically (Akhmad Pide & Amir, 2018).



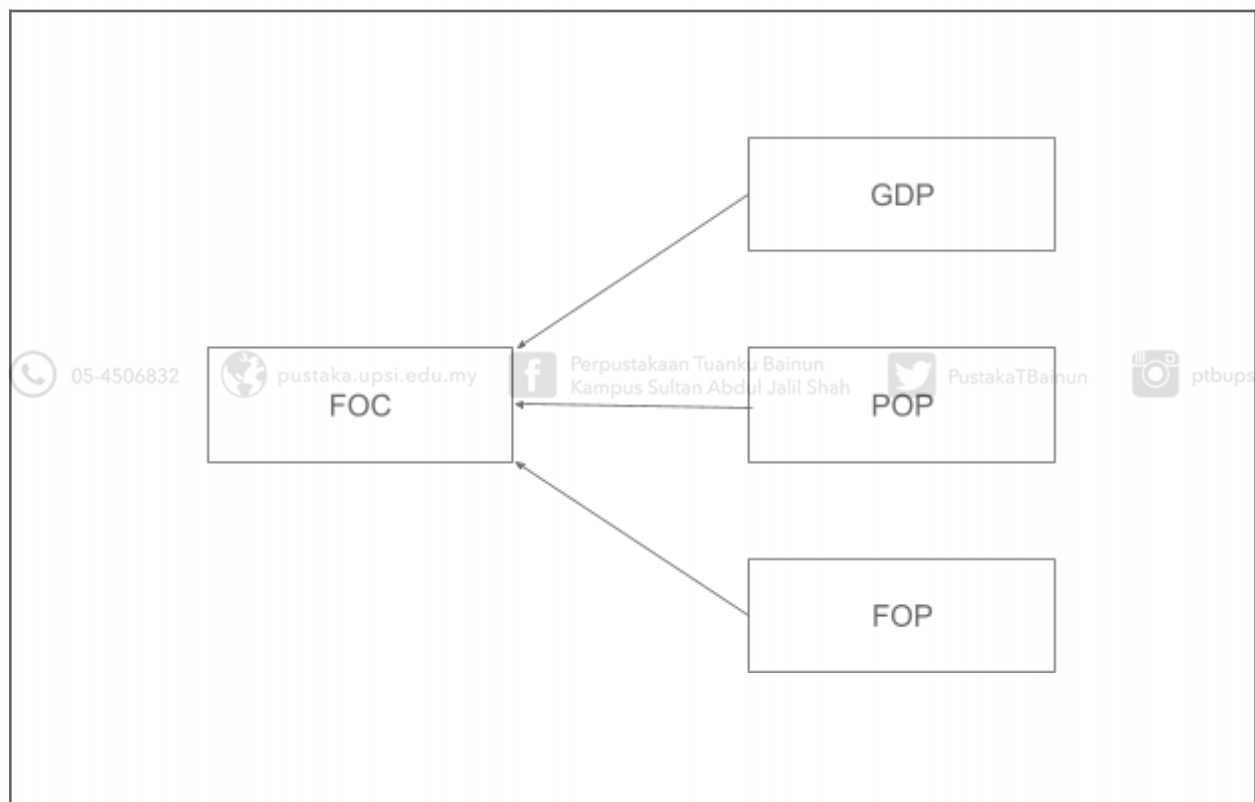
In conclusion, this study highlights the crucial role of fuel oil in Malaysia's economy, particularly in the transportation and industrial sectors. By examining the relationships between fuel oil consumption and key factors such as Gross Domestic Product, Population, and Fuel Oil Prices utilizing the Autoregressive Distributed Lag (ARDL) model, this research bridges a significant gap in the literature. It provides critical insights into how these variables interact, both in the short term and long term, offering a deeper understanding of Malaysia's energy dynamics. As Malaysia continues to grow and industrialize, understanding these relationships is essential for balancing energy demand with sustainable development. The findings also underscore the need for policy makers to explore alternative energy sources and implement measures that promote energy efficiency, ensuring long-term economic stability and environmental protection.



1.4 Conceptual Framework

The focal point of this research is the yearly data of the Fuel Oil Consumption, Gross Domestic Product, Population, and Fuel Oil Prices of Malaysia. The conceptual framework includes the causality linkage between variables namely Fuel Oil Consumption (FOC), Gross Domestic Product (GDP), Population (POP), and Fuel Oil Prices (FOP).

Figure 5 : Nexus Relationship between Dependent Variable and Independent Variables



1.5 Research Questions

In order to achieve the objectives of this study, there are several research questions that must be addressed. The research questions are listed as follows :

1. What is the bound cointegration relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia, using the ARDL approach?
2. What is the long term relationship between Fuel Oil Consumption with Gross Domestic Product (GDP), Population, and Fuel Oil Prices in Malaysia, using the ARDL approach?
3. What is the short term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia, using the ARDL approach?

1.6 Research Objectives

The general objective of this study is to find how Fuel Oil Consumption is influenced by the independent variables while the specific objectives are :

1. To examine the bound cointegration between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia, utilizing the ARDL approach.
2. To analyze the long term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia, utilizing the ARDL approach.
3. To analyze the short term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia, utilizing the ARDL approach.

1.7 Research Hypothesis

The research hypothesis is a speculation that expresses the study's initial expectations in which the hypothesis refers to the predicting of relationships between the independent and dependent variables. In order to answer the study, the hypothesis are developed as below:

1. Bound Cointegration Hypothesis :

H0 : There is no bound cointegration between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

H1 : There exists bound cointegration between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

2. Long term Relationship Hypothesis :

H0 : There is no long term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

H1 : There exists a long term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

3. Short term Relationship Hypothesis :

H0 : There is no short term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

H1 : There exists a short term relationship between Fuel Oil Consumption, and Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia.

1.8 Scope of Study

As mentioned before in the previous sections, this study will focus on Malaysia as the geographical location of investigation. The general purpose of this study is to analyze the factors Gross Domestic Product, Population, and Fuel Oil Prices influencing the Fuel Oil Consumption in Malaysia. This study will include the key economic variables such as Gross Domestic Product (GDP), Population (POP), and Fuel Oil Prices (FOP) to analyze their relationship with Fuel Oil Consumption (FOC). In addition, this study is focusing on the transportation and industrial sectors considering their significant contributions to the Fuel Oil Consumption and overall economic activity. Moreover, the annual data used in this study were obtained from the databases of the *Malaysia Energy Information Hub (MEIH)*, the *World Bank Open Data*, the *Department Of Statistic Malaysia (DOSM)*, and the *Statistica Research Department*. This study also covered a specified time period starting from the year of 1980 until the year of 2023, in order to examine the trends and patterns of the Fuel Oil Consumption and its independent variables. Furthermore, this study will apply the Autoregressive Distributed Lag (ARDL) approach to examine the bound cointegration between Fuel Oil Consumption and its independent variables, as well as its long term and short term relationship.



1.9 Definition Operational

For this section of definition operational, this study provide a clear framework for the data collection of the dependent variable Fuel Oil Consumption and its independent variables Gross Domestic Product, Population, and Fuel Oil Prices as table below :

Table 1 : Definition Operational of Dependent Variable and Independent Variables

Variable	Mnemonic	Description and Measurement	Source
Dependent Variable	Fuel Oil Consumption (FOC)	Consumption is an activity in which institutional units use up goods or services; consumption can be either intermediate or final. FOC in this study is the amount of fuel oil that is consumed per barrel in Malaysia. (Final Consumption of Petroleum Products (ktoe))	<i>Malaysia Energy Information Hub</i>
Independent Variables	Gross Domestic Product (GDP)	Consumption is an activity in which institutional units use up goods or services; consumption can be either intermediate or final. GDP is this study is the monetary value of final goods and services produced In Malaysia. (GDP Current USD)	<i>World Bank Open Data</i>





	Population (POP)	Total population counts all residents regardless of legal status or citizenship. POP in this study is the total number of individuals living in Malaysia. (Million)	<i>Department Of Statistic Malaysia</i>
	Crude Oil Price (COP) as a proxy to Fuel Oil Price (FOP)	The price of a good or service is defined as the value of one unit of that good or service. The crude oil price is defined by the price of the so-called OPEC basket. This basket is an average of prices of the various petroleum blends that are produced by the OPEC members. FOP in this study is the cost at which fuel oil is used for various purposes in the market. (USD per Barrel)	<i>Statistica Research Department</i>



1.10 Limitation of Study

This study of Fuel Oil Consumption and its relationship with Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia faces several limitations and one of them is related to the availability and the accuracy of the data. The validity of the findings and the reliability of the analysis made are significantly affected by the accuracy of the data. Hence, the time series data of the Fuel Oil Consumption and its independent variables may be inaccurate for certain years resulting in gaps that affect the reliability of the time series analysis. Moreover, it can be challenging to prove the relationship between the Fuel Oil Consumption and its independent variables due to the numerous connections between multiple factors. Fuel Oil Consumption and its independent variables also can be influenced by external factors such as technological advancements, geopolitical events, global oil price shocks, and policy changes that could potentially impact the findings. Furthermore, this study is focused in Malaysia, thus, it is possible that the findings are not applicable to other countries with different economic systems, energy consumption patterns, and legislative frameworks. To address these limitations, future research could use more accurate data, try different modeling methods, and include comparisons with other countries. Therefore, this may improve better understanding of the relationship between the Fuel Oil Consumption and economic factors.

1.11 Significance of Study

This study of the Fuel Oil Consumption and its relationship with the Gross Domestic Product, Population, and Fuel Oil Prices in Malaysia is significant for several reasons. Whereby, understanding the dynamics between the Fuel Oil Consumption and economic growth is crucial for policymakers and researchers. This study also provides valuable insights into the factors that are influencing the Fuel Oil Consumption in Malaysia by analyzing the influence of the Gross Domestic Product, Population, and Fuel Oil Prices which can help in identifying key determinants of fuel oil demand to ensure energy consumption. Besides that, by identifying how changes in the Fuel Oil Consumption impact the economic variables, policymakers and researchers can make informed decisions about energy policy, resource allocation, and economic planning which can help in developing strategies to ensure sustainable economic growth. By focusing on Malaysia, a country with a rapidly developing economy and increasing energy demand, this study could contribute to the broader understanding of energy economics in emerging markets and offer insights that are applicable to other similar economies.

Moreover, this study time series data of the Fuel Oil Consumption and its independent variables the Gross Domestic Product, Population, and Fuel Oil Prices that are obtained from the databases of the *Malaysia Energy Information Hub (MEIH)*, the *World Bank Open Data*, and the *Department Of Statistic Malaysia (DOSM)* are also being examined over several decades starting from the year of 1980 until the year of 2023. This time series data analysis provides a comprehensive overview of how these economic variables have evolved and interacted over time. Furthermore, the Autoregressive Distributed Lag (ARDL) approach that is used in this study is suitable to examine the bound cointegration between Fuel Oil Consumption and its independent variables, as well as its long term and short term relationship. This ARDL approach can serve as a reference for future research especially in a similar context as it provides empirical evidence on the effectiveness of current energy policies and suggest areas for improvement which is crucial for achieving long term sustainability and economic elasticity. Overall, the significance of this study is in its potential to help policymakers make better decisions regarding energy policy, resource allocation, and economic planning.

1.12 Conclusion

In conclusion, this study thoroughly examines the key factors that influence fuel oil consumption in Malaysia, specifically focusing on Gross Domestic Product (GDP), Population, and Fuel Oil Prices. The analysis spans over four decades, utilizing time series data from 1980 to 2023. This long-term perspective allows for a comprehensive understanding of how these variables interact with fuel oil consumption over time. The data for this study were gathered from reliable sources, including the *Malaysia Energy Information Hub (MEIH)*, the *World Bank Open Data*, the *Department of Statistics Malaysia (DOSM)*, and the *Statistica Research Department.*, ensuring the accuracy and relevance of the findings. This study highlights the significant influence of these factors on Fuel Oil Consumption patterns and provides valuable insights for policymakers and researchers. While this research has certain limitations, such as potential external factors, it underscores the critical importance of analyzing the interplay between fuel oil consumption and economic variables. These insights are crucial for optimizing resource allocation, developing informed energy policies, and making sound economic planning decisions that align with Malaysia's long-term energy goals. In the next chapter, this study will dive into a comprehensive literature review where it will involve an in depth analysis of existing research of Fuel Oil Consumption and its relationship with factors Gross Domestic Product, Population, and Fuel Oil Prices.