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# Determinants of Transportation Sector Growth: A Comparative Analysis among Selected ASEAN Member States

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## ABSTRACT

**Purpose:** This study examines the relationship between GDP per capita, FDI net inflows, fuel prices, and the Gross Value Added of the Transportation, Storage, and Communication sector ($GVA_{TSC}$) of five selected ASEAN member countries which are Philippines, Indonesia, Thailand, Singapore, and Malaysia over the period of 1981 to 2019.

**Methodology:** The secondary data on GDP per capita, FDI net inflows, fuel prices, and GVA of the Transport, Storage, and Communication sector were assessed using Levin-Lin-Chu (LLC, 2002) and Im-Pesaran-Shin (IPS, 2003) unit root tests and Johansen cointegration test to examine the properties of the variables. Panel Least Squares and Ordinary Least Squares were used to analyze the effects of GDP per capita, FDI net inflows, and fuel prices on $GVA_{TSC}$. Finally, Granger Causality test was applied to determine the direction of causality between the variables.

**Findings:** The results of Panel Least Squares and Ordinary Least Squares showed that GDP per capita has a significant and positive impact on $GVA_{TSC}$. FDI net inflows and fuel prices exhibit negative and positive relationships with $GVA_{TSC}$, respectively, but both are statistically insignificant. OLS test results revealed that FDI has a negative but insignificant impact, which is consistent across most countries, except for Singapore and Malaysia, where a significant negative relationship was found. Fuel prices show varying direction of impact across all countries, though the effect is insignificant.

**Contribution to Theory, Practice and Policy:** This study recommends that governments of ASEAN member states refine their investment strategies to better allocate resources toward initiatives that improve public infrastructures and tourism, thereby fostering economic growth and sustainable transportation sector growth.

**Keywords:** *GDP per capita, FDI net inflows, fuel prices, Gross Value Added, TSC sector*

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## 1.0. INTRODUCTION

The transportation sector, defined as the legal structure facilitating the movement of goods, people, and services across different locations (Mishra & Priya, 2018), has seen an increasing significance over the years. Its interconnectedness with economic growth has become a crucial concern, both domestically and internationally. The transportation sector has also been regarded as the lifeblood of an economy, as it actively promotes economic development (Mance et al., 2021). In the System of National Accounts 2008, transportation falls into the economic sector of Transportation and Communication (United Nations, 2010).

During these times of rapid globalization and technological advancements, transportation industries play pivotal roles in facilitating economic growth and development (Gao et al., 2016). According to Lee and Yoo (2016), the transportation sector is a vital component of enabling the smooth flow of goods and services across the supply chain. It is an important economic sector that connects producers and consumers by ensuring the delivery of goods and services in the market, significantly contributing to national economic growth. In the EU economy, the transportation sector directly impacts the daily lives of its citizens as it ensures their mobility, allowing them to move freely within the internal market (AndSoft, 2018 as cited by Kostiuk et al., 2021). In the ASEAN region, the member countries widely acknowledge that transportation plays a significant role in driving economic development and the region's economic integration, as evidenced by the ASEAN transport cooperation and the subsequent agreements (ASEAN, in The Twenty-Eighth ASEAN Transport Ministers Meeting). Essentially, the sector serves as a network that bridges people, goods, and services, supporting various industries' functioning.

Any substantial changes in the overall economy are expected to impact the service sector as a whole. According to Eichengreen and Gupta (2011), increasing income promotes the growth of the services sector. Moreover, in the study of Malhotra and Mishra (2019), it was proven that as the GDP of the service sector in India rises, the income of the transportation industry also experiences growth. The findings also suggest that shifts in economic activity, such as fluctuations in economic growth can significantly influence the performance and growth of the transportation sector.

Over the past few decades, there has been extensive research into the effects of transportation infrastructure on economic output. Several studies show that transportation infrastructure positively impacts economic growth and emphasizes the crucial role of transportation in economic activities (Bosede et al., 2013; Pradhan & Bagchi, 2013; Meersman & Nazemzadeh, 2017). There are also studies that show a positive and bi-directional relationship between transportation infrastructure and economic growth (Kollias & Paleologou, 2013; Pradhan et al., 2013; Hooi Lean et al., 2014; Beyzatlar et al., 2014; Saidi et al., 2020). Some authors have explored the effect of FDI on transportation infrastructure (Pradhan et al., 2013; Saidi et al., 2020).

As reported in the 2018 Census of Philippine Business and Industry (2021) by the Philippine Statistics Authority (PSA), the transportation and storage sector generated a 97.9% growth in its total revenue from PHP 373.1 billion in 2012 to PHP 738.6 billion in 2018. A total of PHP 242.6 billion of value added was derived from the transportation and storage sector in 2018. Additionally, in 2019, a Gross Value Added (GVA) of $28.5 billion was generated by the Transportation, Storage, and Communication (TSC) industry in the Philippines, $100.4 billion in Indonesia, $40.3 billion in Thailand, $39.8 billion in Singapore, and $35.3 billion in Malaysia (United Nations Statistics Division, 2024). In line with these figures, this study seeks to understand if economic growth, FDI, and fuel prices influence the growth of the transportation sector in the Philippines and selected ASEAN member states.

Preceding articles concluded that a positive relationship between economic growth, FDI, fuel prices, and the transportation sector exists such as the studies of Bolganbayev et al. (2020), Saidi and Hammami (2017), and Rith et al. (2022), respectively. Other studies claimed that economic growth, FDI, and fuel prices have a significant negative effect on the transportation sector (Wang et al., 2021; Dirir & Aden, 2023; Soile et al., 2014). There are also studies that found no significant relationship between economic growth, fuel prices, and transportation sector such as the studies of Albalate et al. (2015) and Zou and Chau (2019), respectively.

This study aims to contribute to the existing body of literature by examining the factors that drive growth in the transportation sector. This study conducts a comparative analysis of its growth factors namely economic growth, foreign direct investments, and fuel prices in selected ASEAN member states. In addition, GVA is used as the primary measure of transportation sector growth. In this study, the transportation sector growth is defined as the increase in revenue contribution of the transportation sector to the overall economy. By using GVA as a measurement, this study seeks to offer a new perspective on the factors influencing transportation sector growth.

The purpose of this research is to determine if GDP per capita, FDI net inflows, and fuel prices have a significant effect on the GVA of the Transportation, Storage, and Communication (TSC) sector. Through the results of this study, the proponents aim to help policymakers, government agencies such as the National Economic and Development Authority (NEDA), and research institutions such as the Philippine Institute for Development Studies (PIDS) seeking to enhance regional competitiveness and foster sustainable economic development. This study covers the Philippines, Indonesia, Thailand, Singapore, and Malaysia.

## 2.0. LITERATURE REVIEW

While this study aims to shed light on sectoral growth dynamics, it is essential to acknowledge limitations arising from scarcity in the existing literature that used GVA as a measurement for examining growth within economic sectors. Despite extensive literature review efforts, a notable dearth of comparable studies was found which may limit the study's contribution to the existing body of knowledge. However, this study intends to fill this gap in the field of research by utilizing

GVA as the primary metric in understanding the factors that affect growth in the TSC sector since according to Andreescu (2021), GVA is a key indicator of sectoral contribution to Gross Domestic Product (GDP).

### 2.1. Transportation Sector Growth

Since the mid-1980s, the Philippines has been recognized as a country where the export of services serves as the primary engine for economic growth which is evident in the consistently higher share of the service sector in the GDP compared to the industry sector (Mitra, 2013). Within the service sector, the Transportation, Storage, and Communication (TSC) segment rank as the fourth-largest contributor to the broader service sector (Ledda & Fernandez, 2015). This segment's significance is highlighted by its role in facilitating the movement of goods, people, and services across different locations, serving as a critical component of the economy. Mishra and Priya (2018) define the transportation sector as the legal framework enabling such movements, emphasizing its vital role in supporting economic activities. This sector encompasses a range of service providers offering transportation services via air, road, rail, and sea, alongside related services like warehousing, handling, and packaging.

In recent years, there has been a notable increase in mobility, with substantial volumes of physical goods, individuals, and services traveling across various locations (Beyzatlar et al., 2014). This increased mobility emphasizes the importance of transportation infrastructure in facilitating connectivity and trade. Numerous studies have established the transportation sector as a key driver of economic growth (Saidi et al., 2018; Meersman & Nazemzadeh, 2017; Malhotra & Mishra, 2019). The sector has also been found to have an effect on another macroeconomic variable that is the FDI inflows (Shahbaz et al., 2020; Munir & Iftikhar, 2021; Daniels & Ruhr, 2013; Mjacu, 2018). Furthermore, there are also studies that investigated the effect of shifts in various economic activities on the transportation sector such as the effect of the fluctuations in GDP on the transportation sector (Bolganbayev et al., 2020; Kalayci & Yanginlar, 2016; Comporek et al., 2022), effect of the fluctuations in FDI on the transportation sector (Saidi & Hammami, 2017; Dirir & Aden, 2023; Munir & Iftikhar, 2021), and effect of the fluctuations in fuel prices on the transportation sector (Valdes, 2015; Zou & Chau, 2019; Nwosa & Ajibola, 2013).

As economies continue to evolve and as globalization reshapes trade patterns, the transportation sector is experiencing rapid growth in its different subsectors. Notably, Choi et al. (2015) investigated the productivity growth in five major transportation industries in the United States. They found that the transportation industry demonstrates strong and positive productivity growth, except for the years during the global financial crisis. Different studies have used varying indicators in showing the transportation sector growth. In contrast to other studies that defined growth in the transportation sector as improvement in infrastructure development and volume of goods and passengers, this study defines transportation sector growth as the increase in revenue contribution of the transportation sector to the overall economy. As Soile et al. (2014) mentioned in their study, growth in the transportation sector is characterized by an increase in its value added. This growth reflects the sector's role in boosting economic activity by generating revenue through the efficient movement of goods and people, enabling trade and commerce and driving economic development. Thus, to measure this growth, this study utilized Gross Value Added (GVA) of the Transportation, Storage, and Communication (TSC) sector. GVA is a key indicator used for evaluating the contribution of specific sectors or industries to GDP within an economy (Andreescu, 2021). The System of National Accounts 2008 defined GVA as output less intermediate consumption and the TSC sector as an economic category involving activities related to land, pipeline, air, and sea transport, and services like storage, logistics, and telecommunications in the public, private, or mixed sectors (United Nations, 2010).

### 2.2. Economic Growth on Transportation Sector Growth

Transportation has become increasingly crucial within the national economy, emerging as a vital sector within the service industry (Gao et al., 2016). With the gradual expansion of transportation and logistics, its role, demands, fundamental principles, and significance have undergone significant evolution (Vilke et al., 2021). In the context of globalization and heightened international competition, the absence of robust logistical infrastructure poses a new economic challenge for nations involved in imports and exports. Furthermore, logistics plays a critical role in determining the competitiveness of nations with geographical advantages (Saidi et al., 2020). Given that transportation is a significant aspect of the services sector, it is intuitive to expect that economic development could have substantial positive effects on transportation (Beyzatlar et al., 2014).

Various studies have investigated the impact of transportation infrastructure on economic growth, consistently finding a positive relationship. For instance, Saidi et al. (2018) found a significant positive effect of transport infrastructure on economic growth in MENA regions, while Meersman and Nazemzadeh (2017) observed a positive impact of total transport network length on economic growth in Belgium. Similarly, Bosede et al. (2013) discovered that transport output and investment in transport infrastructure positively contribute to economic growth in Nigeria. Nihayah and Kurniawan (2021) studied the influence of road transport infrastructure and FDI on economic growth in ASEAN countries and found that both road infrastructure and FDI collectively influence economic growth. The transportation sector has become an essential component of trade as it plays an active role in a country's economic growth and development and is one of the largest and rapidly growing sectors in most economies (Malhotra & Mishra, 2019; Makridou et al., 2016).

Preceding studies investigating the effect of economic growth on the transportation sector have also been conducted. Some used specific subsectors of the transportation sector as a dependent variable, such as air transport, freight transport, and passenger transport, while some used the overall transportation sector as a dependent variable. Several of these studies suggest that economic growth impacts transportation positively. Andreescu (2021) found that the GVA of the

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transportation sector is highly affected by GDP in EU-27, both in the short and long run. Bolganbayev et al. (2020) identified a significant positive relationship between GDP and freight transportation in Kazakhstan. Kalayci and Yanginlar (2016) found that a significant positive relationship between GDP and air transportation in the long run wherein the effect of GDP increases air transportation. Vilke et al. (2021) studied the effect of economic growth on the value added of the specific sectors within transportation and storage industry in the 13 newest EU member states from 2008 to 2017 and found that changes in the overall economy have an empirically significant and positive impact on the freight industry. Similarly, Gao et al. (2016) studied the impact of economic growth on transportation freight using linear regression in China from 1978 to 2014 and demonstrated a positive correlation between GDP and the advancement of freight transport in China. In India, Maparu and Mazumder (2017) identified the presence of a long-term association between transport infrastructure and economic development, with causality flowing from economic development to transport infrastructure across the majority of cases. Kiboi et al. (2017) discovered that increases in GDP per capita increase the demand for air transportation in ten countries. Küçükönal and Sedefoğlu (2017) also found that a positive and significant effect of GDP on air transportation exists in 28 OECD countries. Malhotra and Mishra (2019) found that when the GDP of the economy's service sector increases, the net income of the transportation sector increases as well.

Moreover, there are also studies that have examined the relationship between GDP and freight transportation, finding a bi-directional association. Saidi & Hammami (2017) observed using the Arellano and Bond GMM estimator on global data that when GDP per capita increases by 1%, freight transport increases by 0.247%. At the same time, Saidi et al. (2020) found a significant bi-directional relationship between GDP and transport infrastructure in 46 developing countries. Beyzatlar et al. (2014) noted bidirectional causality between transportation and GDP in 15 EU member states, though the causality is not consistent across all cases. Tong and Yu (2018) concluded a bi-directional relationship between economic growth and freight transportation in the less developed central and western regions, whereas in the more prosperous eastern region, economic growth positively impacts freight transportation and not vice versa. Similarly, Pradhan et al. (2013) and Pradhan and Bagchi (2013) found bidirectional causality between transport infrastructure and economic growth in India, while Nasreen et al. (2018) also found bidirectional causality between freight transport and economic growth in 63 countries. Kollias and Paleologou (2013) observed bidirectional causality between highway expenditures and GDP growth in the United States, while Hooi Lean et al. (2014) confirmed a positive bi-directional relationship between logistics infrastructure and economic growth. Additionally, Mohmand et al. (2016) noted a bidirectional causality between economic growth and transportation infrastructure in the rich and highly developed provinces of Pakistan. However, in the underdeveloped provinces, a unidirectional causality exists between economic growth and transportation infrastructure.

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Wang et al. (2021) identified a relationship between GDP per capita and freight transportation in China characterized by an inverted U-shaped trend. Their findings revealed that initially, as economic development progresses, the demand for freight transportation increases steadily. However, when the GDP per capita achieves a certain threshold (41,500 yuan), the demand for freight transportation begins to decline. At a higher level of economic development (52,000 yuan), the demand for freight transportation grows at a negative rate. This indicates that a significant negative relationship exists between GDP per capita and freight transportation when economic development reaches an advanced stage in China.

Conversely, some findings suggest that GDP does not appear a significant determinant of transportation. In the USA, Plakandaras et al. (2019) applied Support Vector Regression (SVR) to study the correlation between GDP and transportation. The results showed an insignificant effect of real GDP on rail transportation demand. In Europe, Albalate et al. (2015) found that GDP negatively affects transportation but the associated coefficient was not statistically significant. Similarly, Hakim and Merkert (2016) found an insignificant relationship between GDP growth and passenger and freight air transportation in the short run. However, the study found that over the long term, with a lag of 3 to 4 years, the GDP growth impacts passenger and freight air transportation significantly.

This study assumes that the effects seen in specific transportation metrics, such as air transportation, scale up to influence the overall transportation sector. For instance, Saidi and Hammami (2017) found a positive relationship between freight transport and GDP per capita using global data. This study assumes that GDP per capita may have a broader impact on the transportation sector as a whole, as freight transport is a vital component of its overall performance.

### 2.3. Foreign Direct Investment (FDI) on Transportation Sector Growth

Globalization and structural changes have greatly hastened economic development leading to the opening of new markets. This expansion has emphasized the significance of efficient transport infrastructure, as it serves as a critical facilitator of trade and connectivity between nations. Consequently, developing nations have entered into intense competition, vying to attract FDI to bolster their transportation networks and enhance their competitiveness in the global market. The effect of the transportation sector on FDI has been explored in various studies. Shahbaz et al. (2020) studied the effect of transport infrastructure on FDI in France from 1965 to 2017 which found that transport infrastructure positively affects FDI. In line with their findings, they suggested that policymakers should give attention to transport infrastructure as a key factor influencing FDI. Munir and Iftikhar (2021) also studied the same relationship in Pakistan from 1973 to 2018, and from their time series test, the results indicated that all infrastructure indicators, including roads, railways, and air transport, have a positive and statistically significant influence on FDI in the long run. Moreover, there are also studies examining the effect of the transportation sector on FDI using panel data. Daniels and Ruhr (2013) which investigated the impact of transportation costs on FDI from 1985 to 2010 in 53 countries using the Hausman-Taylor model to derive empirical results showed that there is a positive significant relationship between transportation costs and total FDI. There are also studies that examined the relationship between air transport sector and FDI. Mjacu (2018) examined the effect of transport infrastructure to FDI in South African countries from 1994 to 2014. With panel data, they found that transport infrastructure has a significant positive effect on FDI. Saidi and Hammami (2018) examined the relationship between transport infrastructure and FDI as well in North African countries from 1990 to 2016. The finding showed that a transportation system can enhance the appeal of a host country for FDI in a manner similar to traditional determinants of FDI. Moreover, the researchers suggested that the empirical evidence from the countries confirms the importance of implementing development strategies that consider transportation infrastructure and logistics functions.

Furthermore, there are also studies that show the effect of FDI on the transportation sector. Saidi and Hammami (2017) investigated the effect of FDI on freight transport in 75 countries having different income levels during 2000 to 2014. Using Generalized Method of Moments, it was found that FDI has a positive and statistically significant effect on freight transport. Additionally, they found that freight transport depends significantly on FDI inflows, emphasizing the importance of FDI in shaping transportation sector activity. Kalayci and Yanginlar (2016) studied the effect of FDI on air transportation in Turkey between 1974 to 2014 using MLR and Johansen co-integration tests. They found evidence of a long-term positive significant relationship between FDI and air transportation. Valdes (2015) found a significant but marginal effect of FDI on air transportation demand in 32 middle-income countries (MICs). In Ho Chi Minh City, Vietnam, it was discovered that FDI has an impact on freight transportation productivity calculated on labor and capital of the logistics transportation industry (Hanh, 2021). The study of Sakura and Kondo (2014) showed that outward FDI has a positive effect on employment in the transportation industry in Japan. Also, the effect of FDI on transportation infrastructure was found to be positive and significant in 63 developing countries, wherein an increase in FDI inflows by 1% leads to improvement in transportation infrastructure by 0.184% (Samir & Mefteh, 2020). The transportation infrastructure increases by 0.013% when outward FDI inflow in China increases by 1% (Zhang et al., 2022). In France, it was found that FDI causes transportation infrastructure in the short run with a contribution of 14.04% (Shahbaz et al., 2020). Straková et al. (2016) highlighted the role of FDI in the development and stability of national and regional economies, specifically noting the influence of FDI on transport serviceability and infrastructure development in the V4 countries and Slovakia.

In contrast, Aarif and Tarique (2022) studied the effect of FDI on the employment of the service sector which involves Transportation, Storage, and Communication. Findings confirmed the presence of a negative relationship between FDI and employment in the service sector, however, it is not statistically significant. Dirir and Aden (2023) examined the effect of FDI inflows to transportation services in selected Eastern Asian countries from 1997 to 2021. The results indicated that FDI inflows have a significant negative impact on transportation services in East Asian countries. Specifically, a 1% increase in FDI inflows leads to a decrease in transportation services by 3.7%. Alike, Song et al. (2020) investigated the impact of actual utilization of FDI on air transport sector in 30 provinces in China during the year of 2017 which found that there is a significant negative relationship between FDI and air transport. Kiraci and Battal (2018) investigated the impact of FDI on international cargo demand and found that after a shock in the FDI, there is no significant change in the volume of international cargo volume. On the other hand, a shock in the international cargo volume initially boosts foreign direct investments positively but later impacts them negatively.

There are also studies that investigated the causal relationship between FDI and the transportation sector. Saidi et al. (2020) studied the bidirectional relationship of FDI and transport infrastructure from 2000 to 2016 in 46 developing countries which was divided into three sub-panels. By using GMM estimators, the results showed that there is a positive significant bi-directional relationship between FDI and transport infrastructure and also suggested that FDI can enhance the attractiveness of the transportation sector and contribute to sustainable economic development. Similarly, Pradhan et al. (2013) examined the long run relationship between transport infrastructure and FDI in India from 1970 to 2012. The causality test confirmed that there is bi-directional relationship between transport infrastructure and FDI. The researchers suggested that increasing FDI in the country can also stimulate the development of transport infrastructure and contribute to greater economic growth. Moreover, Rehman et al. (2020) studied the causal relationship between infrastructure and FDI in Pakistan from 1990 to 2018.

In addition to the existing literature on the relationship between FDI and the transportation sector, Epaphra (2016) studied the relationship between FDI and sectoral performance in Tanzania from 1970 to 2015. The study showed the positive and statistically significant coefficients for the FDI-to-GDP ratio on the Transport, Storage, and Communication sector. Their findings suggested that an increase in the FDI-to-GDP ratio may lead to a corresponding rise in the value added-to-GDP ratio of the Transport, Storage, and Communication sector. Desbordes and Franssen (2019) investigated how FDI affects productivity within and between different industries in 15 emerging market economies during 2000 to 2008. The study discussed the role of service sectors in facilitating downstream firms and their foreign employment shares. However, they did not find significant impacts of forward linkages from FDI in service sectors on total factor productivity.

### 2.4. Fuel Prices on Transportation Sector Growth

Wijeweera et al. (2014) suggested that the relationship between fuel price and rail passenger transportation varies across Australian cities. In Melbourne, the proponents discovered that fuel price significantly affects rail passenger transportation, indicating that 1% increase in fuel price leads to an increase in rail passenger transportation by 0.22% as people tend to use public transportation more. In contrast, a significant inverse relationship between fuel price and rail passenger transportation was found in Sydney, wherein an increase in the former would lead to a decrease in the latter. While in Adelaide, fuel price has an insignificant positive effect on rail passenger transportation. In Perth, an insignificant negative effect of fuel price on rail passenger transportation was identified (Wijeweera & Charles, 2013). Nwosa and Ajibola (2013) discovered that in the short run, fuel price does not have a significant impact on the transportation sector of Nigeria, but they found that in the long run, an increase in the fuel price by 1% would result in a decrease in outputs of the transportation sector by 20%. Zhang et al. (2024) found that the transportation sector in China responds differently to upward and downward jumps in oil prices.

In Colombia, a study confirmed the significant effect of oil prices on the Transportation, Storage, and Communication sector, wherein an increase in oil prices by 1% would lead to an estimated increase in the sector's production by 3.1% four years after the occurrence of oil price shock (Otero, 2020). The estimations were made by employing Vector Autoregression (VAR) model. In the Philippines, it was estimated that an increase in fuel prices leads to an increase in the prices of output produced by the land transportation sector, such as bus, jeepney, and railway subsectors (Rith et al., 2022). For example, a 5% increase in fuel price would result in a 1.29% increase in the price of land transportation services, while a 10% increase in fuel price would lead to a 2.59% price increase, and a 15% increase in fuel price would lead to 3.88% price increase. The projections were done using Discrete Choice and Input-Output modeling. Anyars and Adabor (2023) observed that a 1% increase in fuel price leads to an increase in transport price by about 0.304% in Ghana. Moreover, a study in Indonesia revealed that the increase in production costs in the road transportation sector of 12.78% was brought about by the increase in fuel price of 10% (Setyawan, 2014). Harun et al. (2018) found that the rise in fuel price due to fuel subsidy removal in Malaysia led to an increase in production costs in the transportation sector which can be translated into the increase in the price of outputs of the transportation sector.

Some studies identified a significant and negative effect of fuel prices on the transportation sector. Soile et al. (2014) found that the increase in fuel price brought about by the fuel subsidy removal policy in Nigeria would lead to a decline in transportation sector growth in the short run. Timilsina (2015) found that the transportation sector experienced a decline in outputs due to an increase in fuel prices in 25 countries. Solaymani and Kari (2013) and Sulaiman et al. (2022) also identified a significant negative relationship between fuel price and transportation sector output in Malaysia. The same findings were obtained in the Philippines by Roquel et al. (2018) using Input-Output modeling in the Philippines, wherein a 10%, 20%, and 30% increase in fuel prices will lead to a reduction in total outputs of about 1.66%, 3.32%, and 4.97%, respectively, of the GDP. The study highlights that the transportation sector bears a considerable portion of this impact with an estimated 13% decrease in its output. Similarly, increases in oil prices to US$115, US$150, and US$200 per barrel would result to output reductions by 8.3% to 22.1% for air transport and 5.7% to 16.2% for water transport sectors in Spain (Logar & van den Bergh, 2013). Chai et al. (2016) found that when fuel prices increase by 1%, traffic demand decreases by 0.14% in the short run and 0.48% in the long run in China as people tend to change their driving behavior and transportation choices. In 32 middle income countries, a significant negative effect of fuel price on air transportation was found (Valdes, 2015). Moreover, Plakandaras et al. (2019) found that fuel prices have a significant impact on road transportation wherein a decrease in fuel price leads to reduction in road transportation cost, making it economically attractive. Similarly, in the EU-28, a 50% decrease in oil prices scenario would lead to an estimated increase in production of air transportation by 2.31% and land transportation by 1.4% (Vrontisi et al., 2015).

In contrast, there are studies that discovered an insignificant relationship between fuel prices and the transportation sector. The change in fuel prices was found to not have a significant effect on air transportation demand in the U.S.A. (Wadud, 2015). While Zou and Chau (2019) also found no significant relationship between fuel prices and freight transportation both in the short run and long run in Shanghai, China. The results were obtained by applying Phillips–Ouliaris and Johansen tests.

## 3.0 MATERIAL AND METHODS

### 3.1. Data

This study uses secondary data on ASEAN member states which include Indonesia, Thailand, Singapore, Malaysia, and the Philippines, with annual data from 1981 to 2019. As previously mentioned, transportation falls into the sector of Transportation and Storage. However, the lack of data on GVA of Transportation and Storage led to the use of GVA of Transportation, Storage, and Communication. Moreover, the countries were chosen based on their GVA of the TSC sector in 2019 with Indonesia generating the highest GVA, followed by Thailand, Singapore, Malaysia, and then the Philippines (United Nations Statistics Division, 2024). Due to lack of data on FDI net inflows of Vietnam, the country was excluded in this study.

The indicators used to observe their trends and their effects on the countries' transportation sector growth are GDP per capita, FDI net inflows, and fuel prices. The data on GDP per capita and FDI net inflows are retrieved from the World Bank (n.d.), while the data on fuel prices are obtained from the Federal Reserve Bank of St. Louis (n.d.). GDP per capita is at constant 2015 U.S. dollars, FDI net inflows is at current 2015 U.S. dollars, and fuel prices are U.S. city average per gallon in U.S. dollars. The data on GVA in the Transport, Storage, and Communication sector are retrieved from the United Nations Statistics Division (n.d.) and are expressed at constant 2015 U.S. dollars.

### 3.2. Method

This study focused on the effect of economic growth, FDI, and fuel prices on the transportation sector growth. Thus, this study employed the following econometric model:

$$GVA_{TSC} = \beta_0 + \beta_1 GDP_{PC} + \beta_2 FDI - \beta_3 FP + \varepsilon$$

where $GVA_{TSC}$ refers to Gross Value Added of Transportation, Storage, and Communication sector, $GDP_{PC}$ refers to Gross Domestic Product per capita, $FDI$ refers to Foreign Direct Investment net inflows, $FP$ refers to fuel prices, and $\varepsilon$ refers to the error term.

This study assessed how GDP per capita, FDI net inflows, and fuel prices influence the GVA of the Transport, Storage, and Communication sector over time by employing a historical quantitative analysis method, utilizing systematic empirical regression techniques. This study used panel data regression to demonstrate the impact of $GDP_{PC}$, FDI, and FP on the transportation sector growth of ASEAN member countries. Saidi et al. (2020) and Saidi and Hammami (2018) also used panel data regression when they examined the relationship between economic growth, FDI, and transportation.

### 3.2.1. Panel unit root tests

To verify the stationarity properties of the variables, panel unit root tests were applied. The study used Levin-Lin-Chu (LLC, 2002) and Im-Pesaran-Shin (IPS, 2003) unit root tests which were also used by Saidi et al. (2020) and Saidi and Hammami (2017). Saidi et al. (2020) were able to confirm the stationarity of their variables and accept the alternative hypothesis at first difference, while Saidi and Hammami (2017) did so at level. The equation for LLC (2002) test is specified as follows:

$$GVA_{TSC_{it}} = \alpha_i + \beta_1 GDP_{PC_{it}} + \beta_2 FDI_{it} - \beta_3 FP_{it} + \rho Y_{i,t-1} + \varepsilon_{it}$$

where $\alpha_i$ refers to the individual fixed effects for each country, $\rho$ refers to the autoregressive coefficient, and $\varepsilon$ refers to the error term.

### 3.2.2. Panel cointegration test

After confirming the stationarity of the variables, this study utilized the cointegration test of Pedroni (2004) to examine the long-run relationship between the variables. This test was also employed by Saidi et al. (2020) in their study. The alternative hypothesis of cointegration was accepted for three of their sub-panels, allowing them to conclude that the dependent and independent variables have a long-term relationship to all panels. The equation is represented as:

$$GVA_{TSC_{it}} = \alpha_i + \delta_t + \beta_1 GDP_{PC_{it}} + \beta_2 FDI_{it} - \beta_3 FP_{it} + \varepsilon_{it}$$

where $\delta_t$ refers to time fixed effects.

### 3.2.3. Panel data model

This study employed Panel Least Squares to identify if there is a relationship between GDP per capita, FDI net inflows, and fuel prices, and GVA of TSC sector in the selected ASEAN member states. The equation for Panel OLS is specified as follows:

$$GVA_{TSC_{it}} = \alpha_i + \beta_1 GDP_{PC_{it}} + \beta_2 FDI_{it} - \beta_3 FP_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $\mu_i$ refers to the individual-specific effects for each cross-sectional unit $i$ and $\lambda_t$ represents the time-specific effects for each time period $t$.

### 3.2.4. Time series model

This study employed multiple linear regression using Ordinary Least Squares (OLS) estimation to analyze the individual impact of GDP per capita, FDI net inflows, and fuel prices on the GVA of TSC sector in the Philippines, Indonesia, Thailand, Singapore, and Malaysia. Linear regression analysis is employed to determine whether the independent variables significantly influence the response variable, either positively or negatively, within each country (Tuckey, 1977). The equation is represented as:

$$GVA_{TSC} = \beta_0 + \beta_1 GDP_{PC} + \beta_2 FDI - \beta_3 FP + \varepsilon$$

### 3.2.5. Causality test

This study conducted a causality test to determine the direction of causality between GDP per capita, FDI net inflows, fuel prices, and transportation sector growth. As Beyzatlar et al. (2014) have conducted in their study wherein the autoregressive coefficients and the slopes of the regression coefficients are treated as constants. Granger (1969) causality is defined as follows: the variable $x_{i,t}$ causes $y_{i,t}$ if incorporating all available information improves the prediction of $y_{i,t}$ compared to using information without $x_{i,t}$, for each individual $i \in [1, N]$.

## 4.0. FINDINGS

To assess the influence of the GDP per capita ($GDP_{PC}$), FDI net inflows, and Fuel Prices (FP) on the GVA of the Transportation, Storage, and Communication ($GVA_{TSC}$) sector in the five selected ASEAN countries, we used a historical quantitative analysis method using different systematic empirical regression techniques. We first employed the panel unit root test following the studies of Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003), where results can be seen in Table 1.

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**Table 1. Panel Unit Root Tests Results**

| Variable | **Levin-Lin-Chu (LLC)** | | | | **Im-Pesaran-Shin (IPS)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Level | | First difference | | Level | | First difference | |
| | T-Stat | Prob. | T-Stat | Prob. | T-Stat | Prob. | T-Stat | Prob. |
| $GVA_{TSC}$ | 4.8942 | 1.0000 | -3.0598 | 0.0011 | 8.1351 | 1.0000 | -3.1616 | 0.0008 |
| FDI | 2.3173 | 0.9898 | -4.2075 | 0.0000 | 2.1479 | 0.9841 | -12.2456 | 0.0000 |
| $GDP_{PC}$ | 4.0444 | 1.0000 | -5.8306 | 0.0000 | 6.6457 | 1.0000 | -5.67249 | 0.0000 |
| FP | 0.6054 | 0.7275 | -7.6012 | 0.0000 | 1.4476 | 0.9261 | -8.79877 | 0.0000 |

By comparing the p-values to 5% level of significance, the null hypothesis of non-stationarity of the variables is accepted at level. However, the alternative hypothesis of stationarity of the variables is accepted at the first difference since the p-values are less than the 5% significance level, thereby confirming the presence of stationarity in the variables at the first difference. This verifies that the variables are integrated of order I(1). The results generated from our panel root tests are similar to the study of Saidi and Hammami (2017) who also used both the LLC (2002) and IPS (2003) panel unit root tests for their study where they determined the influence of $GDP_{PC}$, FDI inflows, energy consumption, carbon dioxide emissions, capital stock, and urbanization rate on freight transport.

After confirming the order of integration and the stationarity of the panel data, we employed panel cointegration test following the study of Pedroni (2004) to examine the long run relationship of the variables. The results of the panel cointegration test can be seen in Table 2.

**Table 2. Panel Cointegration Test Results**

**Dependent variable: D($LGVA_{TSC}$)**

**Method: Pedroni Residual Cointegration Test**

**Sample: 1981-2019**

Tests within-dimension

| | v-Statistic | rho-Statistic | PP-Statistic | ADF-Statistic |
|---|---|---|---|---|
| Statistic | 2.8728 | -3.9842 | -6.7013 | -4.0222 |
| Prob. | 0.0020 | 0.0000 | 0.0000 | 0.0000 |

Tests between-dimension

| | rho-Statistic | PP-Statistic | ADF-Statistic |
|---|---|---|---|
| Statistic | -3.2054 | -7.6219 | -4.5208 |
| Prob. | 0.0007 | 0.0000 | 0.0000 |

The Pedroni cointegration tests are categorized into two groups, considering the variability in the cointegration relationship across different data sets. The within-dimension tests focused on the relationships between the $GVA_{TSC}$ and $GDP_{PC}$, FDI net inflows, and FP within each country, assuming some level of similarity in their behavior. Meanwhile, the between-dimension tests account for variations in these relationships across the five selected ASEAN countries, capturing potential differences in how these variables interact over time. As shown in Table 2, the results of Pedroni's test reject the null hypothesis of no cointegration. Based on the p-values, we conclude that the $GVA_{TSC}$ and its determinants are cointegrated in the long run.

After confirming the long run relationship between the $GVA_{TSC}$ and its determinants, we continued with the regression tests for each of the selected ASEAN countries. We first employed the Panel Least Squares regression to determine the influence of the $GDP_{PC}$, FDI net inflows, and FP on the $GVA_{TSC}$ where its results can be seen on Table 3.

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**Table 3. Panel Least Squares Results**

**Dependent variable: $LGVA_{TSC}$**

**Method: Panel Least Squares**

**Sample: 2004 – 2019**

**Included observations: 78**

| Variable | Coefficient | Std. Error | t-Stat | Prob. | | |
|---|---|---|---|---|---|---|
| C | 14.3089 | 2.5026 | 5.7177 | 0.0000 | **R-squared** | 0.9983 |
| $LGDP_{PC}$ | 0.6775 | 0.2135 | 3.1735 | 0.0022 | **Adjusted R-squared** | 0.9982 |
| LFDI | -0.0010 | 0.0039 | -0.2599 | 0.7957 | **F-statistic** | 8342.361 |
| LFP | 0.0124 | 0.0114 | 1.0846 | 0.2817 | **Prob (F-statistic)** | 0.0000 |
| AR(1) | 1.3921 | 0.1573 | 8.8474 | 0.0000 | **Durbin-Watson Stat** | 1.6667 |
| AR(2) | -0.3848 | 0.1575 | -2.4426 | 0.0170 | **Jarque-Bera Prob.** | 0.1659 |

Based on the results, the alternative hypothesis that there is a significant relationship between $GDP_{PC}$ and $GVA_{TSC}$ is accepted since the p-value of 0.0022 is less than the significance level of 0.05. $GDP_{PC}$ has a positive and significant effect on $GVA_{TSC}$, wherein the $GVA_{TSC}$ increases by 0.6775% when $GDP_{PC}$ increases by 1% for all the five selected ASEAN countries. This is similar with the findings of Saidi and Hammami (2017) which notes that the growth in GDP per capita affects freight transport strongly and positively using global panel data. This result also resembles the observations of Andreescu (2021) which identified a significant and positive relationship between GDP and GVA of the transportation sector in EU-27. On the other hand, this result is in contrast with the findings of Wang et al. (2021) and Plakandaras et al. (2019) wherein a negative and insignificant relationship between economic growth and transportation sector growth was found in China and USA, respectively. It was also found in the results of this study that there is a decrease in $GVA_{TSC}$ by 0.0010% when FDI increases by 1%, which is similar with the findings of Dirir and Aden (2023) where they found that FDI has a negative impact on transportation services. However, the p-value of our result indicates that the relationship between $GVA_{TSC}$ and FDI net

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inflows is insignificant since 0.7957 is greater than the 0.05 level of significance. An insignificant relationship between FDI and the transportation sector has also been found by the study of Kiraci and Battal (2018). Lastly, the increase in FP by 1% leads to a corresponding increase in $GVA_{TSC}$ by 0.0124% but the impact is found to be insignificant. This is similar with the finding of Wijeweera et al. (2014) where they found that fuel prices have a positive effect on transportation sector in Adelaide, Australia, however the relationship is not statistically significant.

We then employed the time series analysis for each of the five selected ASEAN countries using Ordinary Least Squares regression, and the results can be seen in Table 4.

**Table 4: OLS Regression Test Results**

**Dependent variable: $LGVA_{TSC}$**

**Method: ARMA Maximum Likelihood (OPG-BHHH)**

**Sample: 1981 – 2019**

| | **Variable** | **Coefficient** | **Std. Error** | **t-Stat** | **Prob.** | | |
|---|---|---|---|---|---|---|---|
| Included observations: 34 | | | | | | | |
| Indonesia | C | 4.7184 | 1.6938 | 2.7857 | 0.0098 | **R-squared** | 0.9993 |
| | $LGDP_{PC}$ | 2.4967 | 0.2413 | 10.3465 | 0.0000 | **Adjusted R-squared** | 0.9991 |
| | LFDI | -0.0009 | 0.0103 | -0.0935 | 0.9262 | **F-statistic** | 5261.690 |
| | FP | -0.0157 | 0.0115 | -1.3643 | 0.1842 | **Prob (F-statistic)** | 0.0000 |
| | AR(1) | 1.3614 | 0.2675 | 5.0889 | 0.0000 | **Durbin-Watson Stat** | 1.7587 |
| | AR(2) | -0.4222 | 0.5651 | -0.0736 | 0.1759 | | |
| | AR(3) | 0.0007 | 0.3035 | -1.3912 | 0.0012 | | |
| Included observations: 39 | | | | | | | |
| Malaysia | C | 4.2039 | 0.5120 | 8.2112 | 0.0000 | **R-squared** | 0.9967 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | LGDPPC | 2.2117 | 0.0618 | 35.8066 | 0.0000 | **Adjusted R-squared** | 0.9962 |
| | LFDI | -0.0255 | 0.0109 | -2.3481 | 0.0252 | **F-statistic** | 2009.674 |
| | FP | 0.0236 | 0.0334 | 0.7073 | 0.4845 | **Prob (F-statistic)** | 0.0000 |
| | AR(1) | 0.8782 | 0.1373 | 6.3953 | 0.0000 | **Durbin-Watson Stat** | 1.5268 |
| | AR(2) | -0.3503 | 0.1487 | -2.3564 | 0.0247 | | |
| Included observations: 39 | | | | | | | |
| Philippines | C | 18.4940 | 1.5280 | 12.1032 | 0.0000 | **R-squared** | 0.9988 |
| | LGDPPC | 0.5928 | 0.1734 | 3.4179 | 0.0018 | **Adjusted R-squared** | 0.9986 |
| | LFDI | -0.0026 | 0.0042 | -0.6111 | 0.5456 | **F-statistic** | 3826.382 |
| | FP | 0.0057 | 0.0079 | 0.7256 | 0.4735 | **Prob (F-statistic)** | 0.0000 |
| | AR(1) | 1.4280 | 0.1885 | 7.5776 | 0.0000 | **Durbin-Watson Stat** | 2.0597 |
| | AR(2) | 0.0539 | 0.3621 | 0.1488 | 0.8827 | | |
| | AR(3) | -0.4874 | 0.1809 | -2.6945 | 0.0113 | | |
| Included observations: 39 | | | | | | | |
| Singapore | C | 6.6247 | 0.8016 | 8.2641 | 0.0000 | **R-squared** | 0.9966 |
| | LGDPPC | 1.7097 | 0.0991 | 17.2432 | 0.0000 | **Adjusted R-squared** | 0.9961 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | LFDI | -0.0419 | 0.0168 | -2.4955 | 0.0178 | **F-statistic** | 1951.228 |
| | FP | -0.0096 | 0.0201 | -0.4767 | 0.6367 | **Prob (F-statistic)** | 0.0000 |
| | AR(1) | 0.7752 | 0.1544 | 5.0192 | 0.0000 | **Durbin-Watson Stat** | 1.9137 |
| Included observations: 39 | | | | | | | |
| Thailand | C | 9.0634 | 0.96245 | 9.4170 | 0.0000 | **R-squared** | 0.9977 |
| | $LGDP_{PC}$ | 1.7678 | 0.1198 | 14.7621 | 0.0000 | **Adjusted R-squared** | 0.9972 |
| | LFDI | -0.0118 | 0.0108 | -1.0950 | 0.2819 | **F-statistic** | 1953.588 |
| | FP | 0.0008 | 0.0216 | 0.0383 | 0.9697 | **Prob (F-statistic)** | 0.0000 |
| | AR(1) | 1.2534 | 0.1757 | 7.1337 | 0.0000 | **Durbin-Watson Stat** | 2.0428 |
| | AR(2) | -0.2231 | 0.3208 | -0.6955 | 0.4919 | | |
| | AR(3) | -0.1836 | 0.2105 | -0.8719 | 0.3900 | | |

The OLS results show that in the Philippines, Indonesia, Thailand, Singapore, and Malaysia, a significant and positive relationship between $GVA_{TSC}$ and $GDP_{PC}$ exists. This result is similar to the Panel Least Squares findings of our study. When $GDP_{PC}$ increases by 1%, $GVA_{TSC}$ increases by 2.4967%, 2.2117%, 0.5928%, 1.7097%, and 1.7678% in Indonesia, Malaysia, Philippines, Singapore, and Thailand, respectively. An increase by 1% in FDI leads to a decrease in $GVA_{TSC}$ by 0.0010%, 0.0026%, and 0.0118% in Indonesia, Philippines, and Thailand, respectively. However, the impact of FDI on $GVA_{TSC}$ is insignificant for these countries. Interestingly, a significant and negative relationship exists between $GVA_{TSC}$ and FDI in Singapore and Malaysia wherein a decrease in $GVA_{TSC}$ by 0.0419% and 0.0255% are brought about by an increase in FDI by 1%. For the FP, the impact is an increase by 0.0236%, 0.0057%, and 0.0008%, in $GVA_{TSC}$ when FP increases by $1 in Malaysia, Philippines, and Thailand, respectively. While an increase by $1 in FP leads to a decrease by 0.0157% and 0.0096% in Indonesia and Singapore, respectively.

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However, the relationship between $GVA_{TSC}$ and FP for all selected ASEAN member states is insignificant.

Lastly, we employed Pairwise Granger Causality to determine the direction of causality between the following relationships: (1) $GDP_{PC}$ and $GVA_{TSC}$, (2) FDI net inflows and $GVA_{TSC}$, (3) FP and $GVA_{TSC}$, (4) FDI and $GDP_{PC}$, (5) FP and $GDP_{PC}$, and (6) FP and FDI. We tested the causality between the relationships in the panel and time series approach for each of the selected five ASEAN countries. The results for the panel Granger causality can be seen in Table 5, and the results for the time series Granger causality can be seen in Table 6. The acceptance/rejection of the null hypothesis is based on the 5% level of significance.

**Table 5. Panel Granger Causality Test Results**

| **Sample: 1981-2019** | | | |
|---|---|---|---|
| **Null Hypothesis:** | **Obs** | **F-Statistic** | **Prob.** |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 190 | 2.3720 | 0.1252 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 0.1808 | 0.6712 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 183 | 0.8846 | 0.3482 |
| $LGVA_{TSC}$ does not Granger Cause FDI | | 17.2222 | 5.1229 |
| LFP does not Granger Cause $LGVA_{TSC}$ | 190 | 2.1583 | 0.1435 |
| $LGVA_{TSC}$ does not Granger Cause LFP | | 16.5843 | 6.8656 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 183 | 3.4804 | 0.0637 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 6.8995 | 0.0094 |
| LFP does not Granger Cause $LGDP_{PC}$ | 190 | 0.6501 | 0.4211 |
| $LGDP_{PC}$ does not Granger Cause LFP | | 0.7490 | 0.3879 |
| LFP does not Granger Cause LFDI | 183 | 1.2439 | 0.2662 |
| LFDI does not Granger Cause LFP | | 9.2844 | 0.0027 |

As shown in Table 5, $GDP_{PC}$ and $GVA_{TSC}$, FDI net inflows and $GVA_{TSC}$, FP and $GVA_{TSC}$ do not Granger cause each other using panel data. The absence of causality between FDI net inflows and

$GVA_{TSC}$ is similar with the finding of Odi and Hammajumba (2023) where they found no causality between FDI and the transportation sector. However, the absence of causality between the $GDP_{PC}$ and $GVA_{TSC}$ is in contrast with the findings of Beyzatlar et al. (2014) and Tong and Yu (2018) which found bidirectional causality between the two variables in 15 EU member states and some regions of China, respectively, where both studies used panel data. Moreover, the absence of causality between $GDP_{PC}$ and $GVA_{TSC}$ is also in contrast with the findings of Hakim and Merkert (2016) where a unidirectional causality running from GDP to air transportation is found in 8 South Asian countries. The results also showed the causality between the explanatory variables where a unidirectional causality from $GDP_{PC}$ to FDI and FDI to FP is found, and no causality between FP and $GDP_{PC}$.

**Table 6. Time Series Granger Causality Test Results**

| **Sample: 1981-2019** | | | |
|---|---|---|---|
| **Null Hypothesis:** | **Obs** | **F-Statistic** | **Prob.** |
| *Indonesia* | | | |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 38 | 5.0754 | 0.0306 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 4.9059 | 0.0334 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 31 | 0.8487 | 0.3648 |
| $LGVA_{TSC}$ does not Granger Cause LFDI | | 5.2612 | 0.0295 |
| FP does not Granger Cause $LGVA_{TSC}$ | 38 | 3.2509 | 0.0800 |
| $LGVA_{TSC}$ does not Granger Cause FP | | 4.1649 | 0.0489 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 31 | 4.4954 | 0.0430 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 9.4348 | 0.0047 |
| FP does not Granger Cause $LGDP_{PC}$ | 38 | 0.9897 | 0.3267 |
| $LGDP_{PC}$ does not Granger Cause FP | | 2.7843 | 0.1041 |
| FP does not Granger Cause LFDI | 31 | 0.0207 | 0.8867 |
| LFDI does not Granger Cause FP | | 1.3934 | 0.2478 |

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| | | | |
|---|---|---|---|
| *Malaysia* | | | |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 38 | 0.5896 | 0.4477 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 2.3245 | 0.1363 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 38 | 1.1223 | 0.2967 |
| $LGVA_{TSC}$ does not Granger Cause LFDI | | 10.4507 | 0.0027 |
| FP does not Granger Cause $LGVA_{TSC}$ | 38 | 0.6526 | 0.4246 |
| $LGVA_{TSC}$ does not Granger Cause FP | | 4.1156 | 0.0502 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 38 | 0.0189 | 0.8914 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 10.6127 | 0.0025 |
| FP does not Granger Cause $LGDP_{PC}$ | 38 | 0.2790 | 0.6007 |
| $LGDP_{PC}$ does not Granger Cause FP | | 3.4471 | 0.0718 |
| FP does not Granger Cause LFDI | 38 | 1.1815 | 0.2845 |
| LFDI does not Granger Cause FP | | 0.3706 | 0.5466 |
| *Philippines* | | | |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 38 | 5.9385 | 0.0200 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 12.4766 | 0.0012 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 38 | 4.0244 | 0.0526 |
| $LGVA_{TSC}$ does not Granger Cause LFDI | | 4.6898 | 0.0372 |
| FP does not Granger Cause $LGVA_{TSC}$ | 38 | 4.9384 | 0.0328 |
| $LGVA_{TSC}$ does not Granger Cause FP | | 6.0510 | 0.0190 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 38 | 12.4136 | 0.0012 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 0.7609 | 0.3890 |

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| | | | |
|---|---|---|---|
| FP does not Granger Cause $LGDP_{PC}$ | 38 | 0.2778 | 0.6015 |
| $LGDP_{PC}$ does not Granger Cause FP | | 2.1989 | 0.1471 |
| FP does not Granger Cause LFDI | 38 | 1.5640 | 0.2194 |
| LFDI does not Granger Cause FP | | 1.7549 | 0.1938 |
| *Singapore* | | | |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 38 | 3.1455 | 0.0848 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 1.2042 | 0.2800 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 38 | 5.5887 | 0.0238 |
| $LGVA_{TSC}$ does not Granger Cause LFDI | | 23.5645 | 0.0000 |
| FP does not Granger Cause $LGVA_{TSC}$ | 38 | 3.9505 | 0.0547 |
| $LGVA_{TSC}$ does not Granger Cause FP | | 4.5784 | 0.0394 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 38 | 0.3416 | 0.5627 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 29.1508 | 0.0000 |
| FP does not Granger Cause $LGDP_{PC}$ | 38 | 1.1716 | 0.2865 |
| $LGDP_{PC}$ does not Granger Cause FP | | 4.8367 | 0.0346 |
| FP does not Granger Cause LFDI | 38 | 0.9351 | 0.3402 |
| LFDI does not Granger Cause FP | | 7.9612 | 0.0078 |
| *Thailand* | | | |
| $LGDP_{PC}$ does not Granger Cause $LGVA_{TSC}$ | 38 | 0.1760 | 0.6774 |
| $LGVA_{TSC}$ does not Granger Cause $LGDP_{PC}$ | | 0.8830 | 0.3538 |
| LFDI does not Granger Cause $LGVA_{TSC}$ | 38 | 0.0150 | 0.9031 |
| $LGVA_{TSC}$ does not Granger Cause LFDI | | 9.2261 | 0.0045 |

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| | | | |
|---|---|---|---|
| FP does not Granger Cause $LGVA_{TSC}$ | 38 | 0.1872 | 0.6679 |
| $LGVA_{TSC}$ does not Granger Cause FP | | 4.4922 | 0.0412 |
| LFDI does not Granger Cause $LGDP_{PC}$ | 38 | 0.3043 | 0.5847 |
| $LGDP_{PC}$ does not Granger Cause LFDI | | 11.2891 | 0.0019 |
| FP does not Granger Cause $LGDP_{PC}$ | 38 | 0.2500 | 0.6202 |
| $LGDP_{PC}$ does not Granger Cause FP | | 3.8108 | 0.0590 |
| FP does not Granger Cause LFDI | 38 | 0.2917 | 0.5926 |
| LFDI does not Granger Cause FP | | 4.5562 | 0.0399 |

For the Granger Causality test per country, $GVA_{TSC,}$ $GDP_{PC}$, and FDI were transformed to their logarithmic forms. In the Philippines and Indonesia, we found that a bidirectional relationship exists between $GVA_{TSC}$ and $GDP_{PC}$ with their p-values having coefficients of less than 0.05 level of significance, leading to the rejection of null hypothesis of non-Granger causality. Contrarily, the null hypothesis that $GVA_{TSC}$ and $GDP_{PC}$ do not Granger cause each other is accepted in countries Malaysia, Singapore, and Thailand. For FDI and $GVA_{TSC,}$ we found a unidirectional causality running from $GVA_{TSC}$ to FDI in countries Philippines, Indonesia, Malaysia, and Thailand, while a bidirectional causality was found in Singapore. Furthermore, a bidirectional causality between FP and $GVA_{TSC}$ is observed in the Philippines only, and a unidirectional causality from $GVA_{TSC}$ to FP is found in countries Singapore, Thailand, and Indonesia. Meanwhile, FP and $GVA_{TSC}$ do not Granger cause each other in Malaysia.

For the causality between the explanatory variables, there is a unidirectional causality from FDI net inflows to $GDP_{PC}$ in the Philippines, unidirectional causality from $GDP_{PC}$ to FDI in Thailand, Singapore, and Malaysia, and a bidirectional causality between FDI and $GDP_{PC}$ in Indonesia. For the causality between FP and $GDP_{PC}$, it is observed that there is no Granger causality between FP and $GDP_{PC}$ in the Philippines, Indonesia, Thailand, and Malaysia, while a unidirectional causality from $GDP_{PC}$ to FP is observed in Singapore. Lastly, for the causality between FP and FDI, there is no causality between the two variables in the Philippines, Indonesia, and Malaysia, while a unidirectional causality is observed from FDI to FP in Thailand and Singapore.

## 5.0. CONCLUSION AND RECOMMENDATIONS

This study examines the effect of GDP per capita ($GDP_{PC}$), FDI net inflows, and fuel prices (FP) on the Gross Value Added of Transportation, Storage, and Communication ($GVA_{TSC}$) sector in the selected ASEAN member states namely Indonesia, Malaysia, Philippines, Singapore, and

Thailand. The results of Panel Least Squares confirmed that $GVA_{TSC}$ increases when $GDP_{PC}$ increases in the selected ASEAN countries. FDI net inflows and FP have negative and positive effects, respectively, but the impacts on $GVA_{TSC}$ are both statistically insignificant, which suggests that FDI net inflows and FP may not directly contribute to transportation sector growth in the selected ASEAN countries. Moreover, the Multiple Linear Regression results showed that in all five ASEAN member countries, there is a significant positive relationship between $GDP_{PC}$ and $GVA_{TSC}$ which aligns with the results of the Panel Least Squares test. However, the effect of $GDP_{PC}$ on $GVA_{TSC}$ is stronger in individual countries compared to the panel results, especially in Indonesia and Malaysia, indicating that the impact of economic growth on the transportation sector varies per country. The results for FDI net inflows reveal a negative but statistically insignificant effect on $GVA_{TSC}$ in most countries, similar to the panel results where FDI also showed an insignificant negative relationship, except in Singapore and Malaysia where a significant negative relationship between FDI and $GVA_{TSC}$ is found. Therefore, the governments of Singapore and Malaysia should reassess how FDI is being allocated within their economies to encourage more balanced FDI distribution and focus on technological upgrades and skills development within the TSC sector to improve its productivity. An insignificant relationship between FP and $GVA_{TSC}$ was also found for all five countries. However, the direction of the relationship differs across countries. The varying impact of FP on $GVA_{TSC}$ suggests that while energy costs are a factor, they may not be the primary driver of transportation sector growth in the ASEAN region, and other structural factors might play a more dominant role.

The findings of this study emphasize the critical role of $GDP_{PC}$ in shaping the growth in the TSC sector across ASEAN member states. In the study of Vilke et al. (2021), the hypothesis that without economic growth, there will be no growth in the transport industry was also confirmed in which the proponents concluded that changes in the overall economy affect the transportation sector. Thus, governments of the selected ASEAN member states should fund initiatives that allow overall economic growth such as investment programs focusing on improving public infrastructures and tourism. While FDI and fuel prices appear less impactful, governments should also consider refining investment strategies and addressing structural inefficiencies to allow these factors to aid in promoting sustainable TSC sector growth. Moreover, the results of panel Granger Causality test revealing the absence of causality between the $GVA_{TSC}$ and $GDP_{PC}$, FDI, and FP suggest that other factors may influence the growth of the TSC sector in the selected ASEAN countries. Possible factors may include government policies or other economic variables that were not considered in this study. However, using a time series approach, the bidirectional causality between the $GDP_{PC}$ and $GVA_{TSC}$ in the Philippines and Indonesia shows the importance of growth in the transportation sector in driving economic growth and vice versa. Improvements in the transportation sector likely enhance economic output in these countries, allowing them to increase its sectoral productivity. Ultimately, the multifaceted nature of the relationships between the Gross Value Added of the TSC sector and GDP per capita, FDI net inflows, and fuel prices highlight the need for further research. Future studies are therefore encouraged to explore these relationships across a broader range of regions, time periods, and methodological approaches to allow for a deeper understanding of how these economic variables interact with transportation sector growth.

## 6.0. REFERENCES

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**Conflicts of Interest Declaration**

The authors declare no conflicts of interest related to this research.