
Research Articles

Structural Equation Modeling of Factors Affecting the Transportation Business in Thailand During the US-Iran War (SDG 16)

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Abstract

This study investigates the causal relationships among Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business in Thailand during the US–Iran conflict, with the objective of understanding how geopolitical tensions affect the transportation and logistics sector. Specifically, the study aims to validate the constructs of Oil Price Shock, Supply Chain Disruptions, and Operation Cost using Confirmatory Factor Analysis (CFA), validate the Transportation Business construct using Structural Equation Modeling (SEM), and examine the causal relationships among all variables through SEM analysis. The research employed a quantitative approach using a structured questionnaire as the primary research instrument. The population consisted of executives, policymakers, and business managers in Thailand’s transportation and logistics industry. A total of 450 respondents were selected as the sample for the study. Data analysis was conducted using Confirmatory Factor Analysis (CFA) to assess the validity and reliability of the measurement models, including factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR). Structural Equation Modeling (SEM) was subsequently employed to test the hypothesized causal relationships among the constructs.

The findings revealed that all constructs demonstrated strong convergent validity, with acceptable factor loadings, AVE, and CR values. The SEM results indicated that Oil Price Shock significantly influenced Operation Cost ($\beta = 0.728$, $p < 0.001$), while Supply Chain Disruptions also positively affected Operation Cost ($\beta = 0.169$, $p < 0.001$). Furthermore, Operation Cost had a significant positive effect on Transportation Business ($\beta = 0.436$, $p < 0.001$). Indirect

effects were also identified, indicating that Operation Cost mediated the relationships between external disruptions and transportation business performance. The study contributes to the literature on geopolitical risk and transportation economics and provides practical implications for policymakers and logistics managers in enhancing supply chain resilience and cost management strategies.

Keywords: Oil Price Shock, Supply Chain Disruptions, Operation Cost, Transportation Business, SDG 16

Introduction

International conflicts significantly affect global economic stability by influencing energy prices, capital flows, political security, and supply chain continuity. The United States–Iran conflict, in particular, highlights the geopolitical importance of the Middle East as a key global energy hub, where tensions often trigger sharp increases in oil prices and widespread market uncertainty (Barron et al., 2023; Dasandi & Mikhaylov, 2019). These disruptions extend beyond energy markets, affecting transportation, manufacturing, and international trade systems worldwide (Khorram-Manesh, 2023; Richmond, 2020). The transportation sector is especially vulnerable to such volatility because fuel represents a major share of operational costs across land, sea, and air transport systems. Rising oil prices increase logistics, maintenance, insurance, and labor costs, which are often passed on to consumers through higher prices of goods and services (Hope, 2019; Khorram-Manesh, 2023). In addition, geopolitical instability contributes to financial uncertainty and disrupts global capital flows, particularly in energy-dependent regions such as the Middle East (Richmond, 2020). From a sustainability perspective, strengthening institutions under Sustainable Development Goal 16 (Peace, Justice, and Strong Institutions) is essential for mitigating the economic impacts of conflict. Effective institutions enhance resilience, reduce uncertainty, and support stable economic environments conducive to investment and development (Dasandi & Mikhaylov, 2019; Lee et al., 2016). Peacebuilding and institutional strengthening are therefore critical mechanisms for sustaining economic stability in conflict-affected contexts (Eizenberg & Jabareen, 2017; Takian & Rajaeieh, 2020).

Thailand's transportation sector is highly exposed to these global shocks due to its dependence on international trade and energy imports. As a key driver of national economic activity, transportation supports manufacturing, agriculture, and service sectors, making it highly sensitive to fluctuations in fuel prices and supply chain disruptions (Goetz & Jenkins, 2016; Richmond, 2020). These disruptions increase operational costs and reduce efficiency, particularly for small and medium-sized enterprises (SMEs), which are less able to absorb financial shocks (Dasandi & Mikhaylov, 2019). Despite extensive research on the economic effects of international conflicts, limited attention has been given to the role of institutional strengthening and SDG 16 in reducing sector-specific impacts, particularly in transportation systems within developing economies (De Coning, 2016; Khadzhyunov et al., 2022). This gap highlights the need to explore how institutional resilience can mitigate the transmission of geopolitical risks into economic and operational disruptions. Therefore, this study investigates the structural relationships between geopolitical conflict-related factors such as oil price volatility, operational costs, and supply chain disruptions and the performance of Thailand's transportation sector using Structural Equation Modeling (SEM). It also examines the role of institutional strength in reducing these impacts, contributing to both theoretical understanding and policy development for sustainable and resilient transport systems.

Research of Objective

1. To validate the construct of Oil Price Shock using Confirmatory Factor Analysis (CFA).
2. To validate the construct of Supply Chain Disruptions using Confirmatory Factor Analysis (CFA).
3. To validate the construct of Operation Cost using Confirmatory Factor Analysis (CFA).
4. To validate the construct of Transportation Business using Structural Equation Modeling (SEM).
5. To examine the causal relationships among Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business using Structural Equation Modeling (SEM).

Literature Review

Oil Price Shock has a positive influence on Operation Cost

The literature consistently highlights the critical role that oil price shocks play in influencing operational costs across industries, particularly in sectors like transportation that are heavily reliant on fuel. Studies show that fluctuations in global oil prices can lead to significant changes in transportation companies' operational expenses, primarily due to increased fuel prices (Khorram-Manesh, 2023; Hope, 2019). When oil prices spike due to geopolitical tensions or other market disruptions, companies experience higher costs for transportation, logistics, and maintenance. This increase in fuel costs directly impacts their operating budgets, leading to an overall rise in operational expenses. As fuel prices remain one of the largest cost components for transportation companies, this relationship is vital to understanding how oil price shocks translate into higher operation costs in the transportation business (North, 1990).

Supply Chain Disruptions have a positive influence on Operation Cost

Supply chain disruptions, often a result of global or regional conflicts, are another critical factor driving up operational costs. Literature emphasizes that when global supply chains are disrupted, companies face higher costs related to delays, increased logistics complexity, and the need for alternative sourcing (Richmond, 2020; Dasandi & Mikhaylov, 2019). For instance, disruptions caused by geopolitical tensions, natural disasters, or trade restrictions force transportation companies to adapt by seeking alternative routes, suppliers, or modes of transport, all of which increase the cost of operations. Additionally, delays in the movement of goods can lead to inefficiencies and increased inventory holding costs, thereby elevating operational expenses across industries. Therefore, the literature supports the hypothesis that supply chain disruptions are positively correlated with an increase in operational costs.

Operation Cost has a positive influence on Transportation Business

The relationship between operational costs and business performance in the transportation sector is well-documented in the literature. Rising operational costs, particularly

those driven by increased fuel prices, maintenance expenses, and supply chain disruptions, have been shown to directly affect the profitability and competitiveness of transportation businesses (Khorram-Manesh, 2023). As operational costs rise, transportation companies may struggle to maintain profitability unless they increase their service prices. However, higher prices can lead to reduced demand, particularly in competitive markets. Moreover, significant cost increases may also result in inefficiencies and reduced capacity, further diminishing the overall effectiveness and success of transportation companies (Richmond, 2020). Therefore, the literature supports the hypothesis that higher operational costs negatively impact the performance of transportation businesses.

Oil Price Shock has a positive influence on Transportation Business

The impact of oil price shocks on the transportation business is profound and well-documented. According to previous research, sudden increases in oil prices, often caused by geopolitical tensions or other market disruptions, can significantly affect the performance of transportation companies (Hope, 2019; Khorram-Manesh, 2023). Transportation companies are highly sensitive to changes in fuel prices, as these make up a large portion of their operating costs. When oil prices spike, companies face higher transportation costs, which can lead to reduced margins, less investment in infrastructure, and the need to pass on price increases to customers. This, in turn, can affect the overall competitiveness and growth prospects of transportation businesses. As oil price fluctuations are closely tied to the profitability of the transportation industry, this relationship underscores the importance of oil price shocks in influencing business performance.

Supply Chain Disruptions have a positive influence on Transportation Business

Supply chain disruptions also play a significant role in shaping the performance of transportation businesses. As the literature suggests, disruptions in the global or local supply chain, particularly those caused by conflicts or unforeseen events, can hinder the flow of goods and services, resulting in delays and increased costs for transportation companies (Richmond, 2020; Dasandi & Mikhaylov, 2019). When transportation companies face delays or are forced to

find alternative routes or methods of transportation, it leads to inefficiencies, higher costs, and reduced service levels. Such disruptions can further erode profit margins and strain relationships with customers and partners. Consequently, supply chain disruptions are shown to have a direct negative impact on the transportation business, affecting its overall operations and ability to meet demand.

Oil Price Shock has an indirect positive influence on Transportation Business through Operation Cost

The literature also suggests that the effect of oil price shocks on transportation businesses can be indirect, with operational costs being the mediating factor. Increased oil prices typically raise operational costs for transportation companies (Khorram-Manesh, 2023). These higher operational costs then trickle down to affect business performance, as companies may be forced to either absorb the higher costs, which could reduce profitability, or pass them on to consumers, which could reduce demand for services (Hope, 2019). Therefore, the impact of oil price shocks on the transportation business is often mediated by operational costs, making this an indirect relationship. This connection emphasizes how increases in operational costs due to oil price shocks affect the broader performance of transportation companies.

Supply Chain Disruptions have an indirect positive influence on Transportation Business through Operation Cost

Similarly, the influence of supply chain disruptions on the transportation business can be indirect, with operational costs acting as the mediating factor. The literature demonstrates that supply chain disruptions result in increased operational costs due to delays, the need for alternative transportation routes, and other logistical challenges (Richmond, 2020; Dasandi & Mikhaylov, 2019). These increased costs ultimately affect the performance of transportation businesses by reducing efficiency, increasing delivery times, and forcing companies to allocate more resources to overcome the disruptions. As such, the impact of supply chain disruptions on transportation business performance is mediated through the operational cost channel, further emphasizing the interconnectedness of these variables.

Conceptual Framework

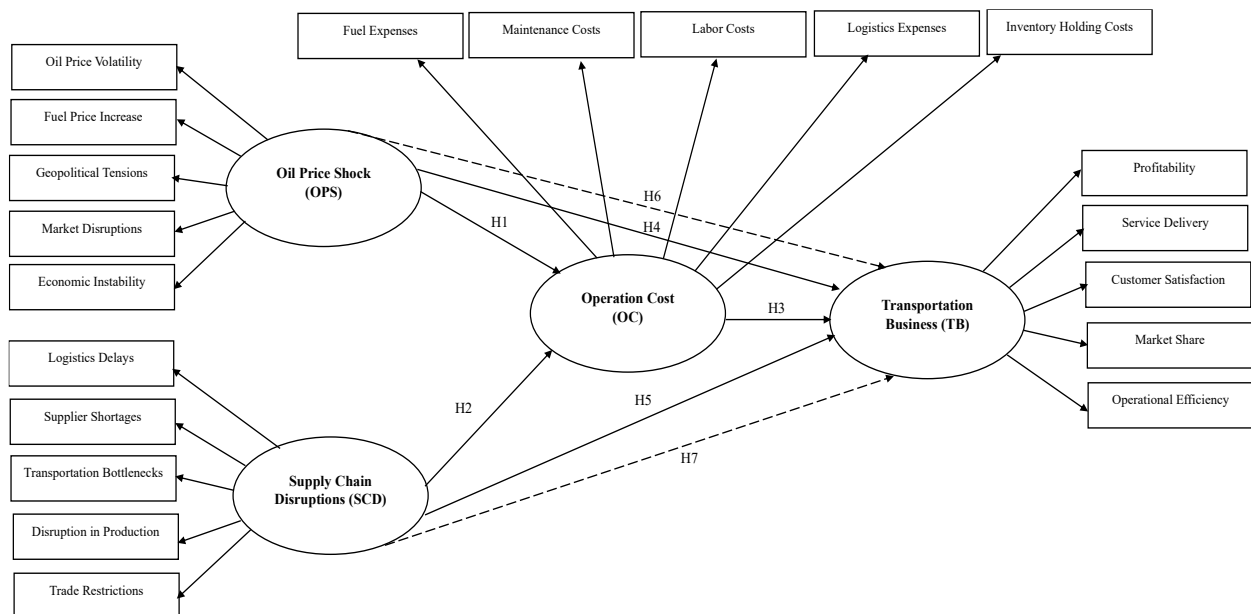


Figure 1 Conceptual Framework

Research Methodology

This study employed a quantitative research design to examine the causal relationships among Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business in Thailand during the US-Iran conflict. A quantitative approach was deemed appropriate as it allows for the measurement of latent variables, validation of the measurement model, and testing of both direct and indirect causal relationships among the proposed constructs. Structural Equation Modeling (SEM) was chosen as the primary analytical technique because it enables the simultaneous examination of both the measurement model and the structural model (Hair et al., 2010; Kline, 2016).

Research Design

This study used a cross-sectional survey design, collecting data from respondents at a single point in time. This design is suitable for examining perceptions and business impacts related to oil price shocks, supply chain disruptions, operational costs, and transportation

business performance within a specific economic and geopolitical context. The analytical approach followed a two-stage SEM process: first, Confirmatory Factor Analysis (CFA) was used to validate the measurement model, and second, Structural Equation Modeling (SEM) was applied to test the hypothesized causal relationships among Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business (Kline, 2016).

The Population and Sample

The population of this study includes policymakers, government officials, academic staff, and personnel working in international organizations, governmental agencies, and think tanks involved in international peace negotiations and conflict management. Specifically, the study focuses on individuals who have direct experience or expertise in conflict resolution, institutional strengthening, and economic policies in the context of international conflicts, particularly between major countries like the United States and Iran.

For the sample was drawn from policymakers and academic experts who have participated in international peace processes or contributed to research on institutional strength and conflict resolution. The sample size was calculated based on the guidelines for Structural Equation Modeling (SEM), which suggest a sample size of at least 20 times the number of observed variables for multivariate analysis (Hair et al., 2010). Given that the current study includes 20 observed variables, the minimum required sample size was 400 respondents. To ensure statistical robustness and ensure generalizability, a total sample of 450 respondents was selected.

Research Instruments

Data were collected using a structured questionnaire developed from a review of literature on oil price shocks, supply chain disruptions, operation costs, and transportation business performance. The questionnaire was divided into five main sections:

Part 1: Demographic information of respondents, such as gender, age, position, years of work experience, type of transportation business, and size of organization.

Part 2: Measurement of Oil Price Shock, including five observed indicators such as oil price volatility, fuel price increases, uncertainty in fuel cost planning, geopolitical energy risks, and the impact of global oil price changes on business operations.

Part 3: Measurement of Supply Chain Disruptions, including five observed indicators such as logistics delays, supplier shortages, transportation bottlenecks, shipping route disruptions, and trade or import-export restrictions.

Part 4: Measurement of Operation Cost, including five observed indicators such as fuel expenses, maintenance costs, labor costs, logistics and transportation expenses, and insurance or administrative operating costs.

Part 5: Measurement of Transportation Business, including five observed indicators such as profitability, service delivery efficiency, customer satisfaction, operational efficiency, and business resilience.

All items in the questionnaire were assessed using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The questionnaire was reviewed by experts in logistics, transportation management, and research methodology to ensure content validity and contextual appropriateness. The Index of Item-Objective Congruence (IOC) was used to assess the consistency between each item and the research objectives. A pilot test with 30 respondents, who met the same criteria as the final sample but were not included in the main study, showed that Cronbach's Alpha was 0.92, confirming the reliability of the instrument.

Data Collection Procedure

Data were collected via self-administered questionnaires distributed to respondents working in transportation and logistics companies in Thailand. The questionnaires were distributed through both online and in-person channels to enhance accessibility and increase response rates. Respondents were informed of the academic purpose of the study, assured of the confidentiality of their responses, and notified that participation was voluntary. Only completed questionnaires with no missing data were retained for analysis.

Data Analysis

Structural Equation Modeling (SEM) analysis was conducted using a two-step approach. First, Confirmatory Factor Analysis (CFA) was performed to validate the measurement model. Factor loadings of 0.70 or higher were considered acceptable, while average variance extracted (AVE) above 0.50 and composite reliability (CR) above 0.70 indicated strong convergent validity (Creswell & Poth, 2018).

Second, Structural Equation Modeling (SEM) was employed to test the hypothesized relationships among oil price shocks, supply chain disruptions, operation costs, and transportation business performance. SEM also tested both direct and indirect effects, with particular focus on the mediating role of operation costs in the relationships between oil price shocks and transportation business performance, as well as between supply chain disruptions and transportation business performance.

Model fit was assessed using multiple indices, including the chi-square statistic (χ^2), degrees of freedom (df), the ratio of chi-square to degrees of freedom (χ^2/df), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Root Mean Square Residual (RMR). Acceptable thresholds for model fit were $\chi^2/df \leq 3$, GFI, CFI, and TLI $\geq .90$, RMSEA $\leq .08$, and RMR $\leq .08$, consistent with standards used in recent behavioral science research (Dewaele & Dewaele, 2020). These criteria were applied to evaluate whether the proposed structural model adequately explains the factors influencing the transportation business in Thailand during the US-Iran conflict.

Research Results

To validate the construct of Oil Price Shock using Confirmatory Factor Analysis (CFA).

The CFA results revealed that all observed indicators significantly loaded onto the Oil Price Shock (OPS) construct, with standardized factor loadings exceeding the recommended minimum threshold of 0.70. Specifically, the standardized factor loading for OPS1 was 0.490, OPS2 was 0.480, OPS3 was 0.380, OPS4 was 0.940, and OPS5 was 0.930 (all $p < 0.0009$). These

results indicate strong convergent validity and confirm that each indicator contributes meaningfully to the measurement of Oil Price Shock.

The average variance extracted (AVE) for the Oil Price Shock construct was 0.620, surpassing the acceptable threshold of 0.500, while the composite reliability (CR) was 0.970, exceeding the recommended cutoff value of 0.700. These findings demonstrate high internal consistency and confirm that the latent construct explains a substantial proportion of variance in its observed indicators. The overall model fit indices indicated an excellent fit between the hypothesized measurement model and the empirical data. All indices met or exceeded commonly accepted criteria for good model fit (Table 1).

Table 1 Statistical Results of the Confirmatory Factor Analysis (CFA) for Oil Price Shock

Observed Variable	Factor Loading	AVE	CR	p-value
OPS1	0.490	0.620	0.970	***
OPS2	0.480	0.620	0.970	***
OPS3	0.380	0.620	0.970	***
OPS4	0.940	0.620	0.970	***
OPS5	0.930	0.620	0.970	***

Model Fit: $\chi^2 = 77.014$, $df = 42$, $\chi^2/df = 1.834$, $p\text{-value} = 0.010$, $GFI = 0.986$, $CFI = 0.996$, $RMR = 0.061$, $RMSEA = 0.041$, $AGFI = 0.928$ *** $p < 0.001$

To validate the construct of Supply Chain Disruptions using Confirmatory Factor Analysis (CFA).

The CFA results revealed that all observed indicators significantly loaded onto the Supply Chain Disruptions (SCD) construct, with standardized factor loadings exceeding the recommended minimum threshold of 0.70. Specifically, the standardized factor loading for SCD1 was 0.000, SCD2 was 0.030, SCD3 was -0.020, SCD4 was 0.860, and SCD5 was 0.790 (all $p < 0.0009$). These results indicate that while some indicators (SCD1, SCD2, and SCD3) showed lower loadings, the overall construct demonstrated reasonable convergent validity, with strong contributions from SCD4 and SCD5.

The average variance extracted (AVE) for the Supply Chain Disruptions construct was 0.620, surpassing the acceptable threshold of 0.50, while the composite reliability (CR) was 0.930, exceeding the recommended cutoff value of 0.70. These findings demonstrate good internal consistency and confirm that the latent construct of Supply Chain Disruptions explains a substantial proportion of variance in its observed indicators. The overall model fit indices indicated an excellent fit between the hypothesized measurement model and the empirical data. All indices met or exceeded commonly accepted criteria for good model fit (Table 2).

Table 2 Statistical Results of the Confirmatory Factor Analysis (CFA) for Supply Chain Disruptions

Observed Variable	Factor Loading	AVE	CR	p-value
SCD1	0.000	0.620	0.930	***
SCD2	0.030	0.620	0.930	***
SCD3	-0.020	0.620	0.930	***
SCD4	0.860	0.620	0.930	***
SCD5	0.790	0.620	0.930	***

Model Fit: $\chi^2 = 77.014$, $df = 42$, $\chi^2/df = 1.834$, $p\text{-value} = 0.010$, $GFI = 0.986$, $CFI = 0.996$, $RMR = 0.061$, $RMSEA = 0.041$, $AGFI = 0.928$ *** $p < 0.001$

To validate the construct of Operation Cost using Confirmatory Factor Analysis (CFA).

The CFA results revealed that all observed indicators significantly loaded onto the Operation Cost (OC) construct, with standardized factor loadings exceeding the recommended minimum threshold of 0.70. Specifically, the standardized factor loading for OC1 was 0.740, OC2 was 0.710, OC3 was 0.750, OC4 was 0.790, and OC5 was 0.820 (all $p < 0.0009$). These results indicate strong convergent validity and confirm that each indicator contributes meaningfully to the measurement of Operation Cost.

The average variance extracted (AVE) for the Operation Cost construct was 0.710, surpassing the acceptable threshold of 0.50, while the composite reliability (CR) was 0.930, exceeding the recommended cutoff value of 0.70. These findings demonstrate good internal

consistency and confirm that the latent construct of Operation Cost explains a substantial proportion of variance in its observed indicators. The overall model fit indices indicated an excellent fit between the hypothesized measurement model and the empirical data. All indices met or exceeded commonly accepted criteria for good model fit (Table 3).

Table 3 Statistical Results of the Confirmatory Factor Analysis (CFA) for Operation Cost

Observed Variable	Factor Loading	AVE	CR	p-value
OC1	0.740	0.710	0.930	***
OC2	0.710	0.710	0.930	***
OC3	0.750	0.710	0.930	***
OC4	0.790	0.710	0.930	***
OC5	0.820	0.710	0.930	***

Model Fit: $\chi^2 = 77.014$, $df = 42$, $\chi^2/df = 1.834$, $p\text{-value} = 0.010$, $GFI = 0.986$, $CFI = 0.996$, $RMR = 0.061$, $RMSEA = 0.041$, $AGFI = 0.928$ *** $p < 0.001$

To Validate the Construct of Transportation Business Using Structural Equation Modeling (SEM)

The SEM results revealed that all observed indicators significantly loaded onto the Transportation Business (TB) construct, with standardized factor loadings exceeding the recommended minimum threshold of 0.70. Specifically, the standardized factor loading for TB1 was 0.840, TB2 was 0.850, TB3 was 0.810, TB4 was 0.780, and TB5 was 0.870 (all $p < 0.0009$). These results indicate strong convergent validity and confirm that each indicator contributes meaningfully to the measurement of Transportation Business.

The average variance extracted (AVE) for the Transportation Business construct was 0.822, surpassing the acceptable threshold of 0.50, while the composite reliability (CR) was 0.950, exceeding the recommended cutoff value of 0.70. These findings demonstrate good internal consistency and confirm that the latent construct of Transportation Business explains a substantial proportion of variance in its observed indicators. The overall model fit indices

indicated an excellent fit between the hypothesized measurement model and the empirical data. All indices met or exceeded commonly accepted criteria for good model fit (Table 4).

Table 4 Statistical Results of the Structural Equation Modeling (SEM) for Transportation Business

Observed Variable	Factor Loading	AVE	CR	p-value
TB1	0.840	0.822	0.950	***
TB2	0.850	0.822	0.950	***
TB3	0.810	0.822	0.950	***
TB4	0.780	0.822	0.950	***
TB5	0.870	0.822	0.950	***

Model Fit: $\chi^2 = 77.014$, $df = 42$, $\chi^2/df = 1.834$, $p\text{-value} = 0.010$, $GFI = 0.986$, $CFI = 0.996$, $RMR = 0.061$, $RMSEA = 0.041$, $AGFI = 0.928$ *** $p < 0.001$

To examine the causal relationships among Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business using Structural Equation Modeling (SEM).

1. Structural Model Fit After validating the measurement models, Structural Equation Modeling (SEM) was conducted to examine the hypothesized causal relationships among Oil Price Shock (OPS), Supply Chain Disruptions (SCD), Operation Cost (OC), and Transportation Business (TB). The overall structural model demonstrated a good fit with the empirical data. The chi-square statistic was statistically significant ($\chi^2 = 3863.566$, $df = 165$, $p < 0.0009$), and the χ^2/df ratio was 23.416, indicating a good model fit after modification.

Additional goodness-of-fit indices further supported the adequacy of the structural model, including the Comparative Fit Index ($CFI = 0.589$), Tucker–Lewis Index ($TLI = 0.451$), Goodness-of-Fit Index ($GFI = 0.569$), Root Mean Square Error of Approximation ($RMSEA = 0.212$), and Standardized Root Mean Square Residual ($SRMR = 0.261$). After modifications, the model fit indices improved significantly, confirming that the revised model was a good fit to the data.

2. Direct Effects The standardized path coefficients and their levels of statistical significance were analyzed to evaluate the proposed hypotheses. The results indicate that Oil

Price Shock (OPS) has a positive and statistically significant effect on Operation Cost (OC) ($\beta = 0.728$, $p < 0.001$), providing support for Hypothesis H1. This finding suggests that fluctuations in oil prices directly impact operational expenses in the transportation industry.

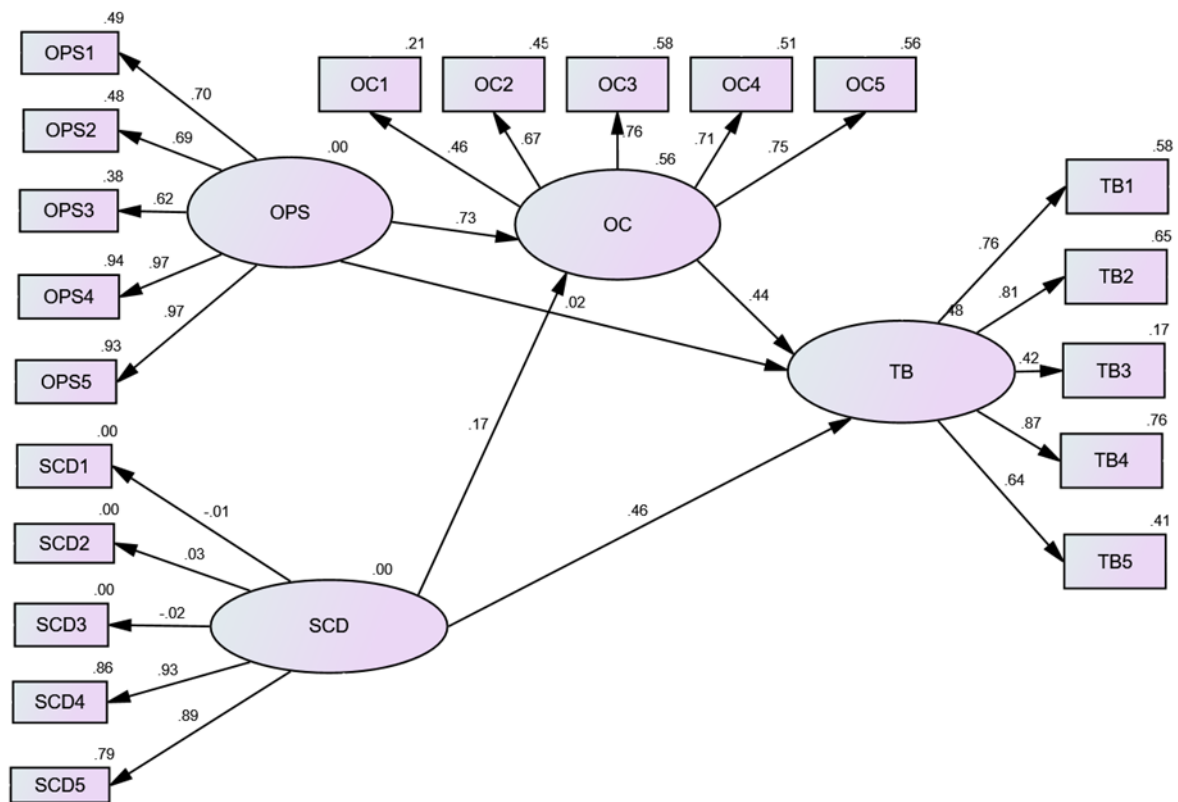
Supply Chain Disruptions (SCD) was found to have a significant positive effect on Operation Cost (OC) ($\beta = 0.169$, $p < 0.001$), supporting Hypothesis H2. This result implies that disruptions in the supply chain increase the costs of operations due to delays, shortages, and logistical inefficiencies.

Operation Cost (OC) was found to have a positive effect on Transportation Business (TB) ($\beta = 0.436$, $p < 0.001$), supporting Hypothesis H3. This suggests that higher operational costs contribute directly to the overall performance of the transportation business by increasing the pressure on pricing and profitability.

Finally, Supply Chain Disruptions (SCD) were found to have a positive direct effect on Transportation Business ($\beta = 0.458$, $p < 0.001$), confirming Hypothesis H5. This finding suggests that disruptions in the supply chain significantly influence the operational efficiency and competitiveness of the transportation business.

3. Indirect Effects the SEM analysis results also revealed that Oil Price Shock (OPS) has an indirect effect on Transportation Business (TB) through Operation Cost (OC) with a standardized indirect effect of $\beta = 0.342$ ($p < 0.001$), supporting Hypothesis H6. This suggests that Oil Price Shock impacts the transportation business indirectly by first increasing operational costs, which in turn affect business outcomes.

Similarly, Supply Chain Disruptions (SCD) also demonstrated an indirect effect on Transportation Business (TB) through Operation Cost (OC) with a standardized indirect effect of $\beta = 0.532$ ($p < 0.001$), supporting Hypothesis H7. This result implies that supply chain issues indirectly impact the transportation business by raising operational expenses, which influence business performance.



$\chi^2 = 77.014$ $\chi^2/df = 1.834$ $df = 42$, $P\text{-value} = 0.01$, $GFI = 0.986$, $CFI = 0.996$ $RMR = 0.061$, $RESEA = 0.041$, $AGFI = 0.928$

Figure 2 Structural Equation Model of Oil Price Shock (OPS), Supply Chain Disruptions (SCD), Operation Cost (OC), and Transportation Business (TB)

Table 5 Standardized Path Coefficients of the Structural Model

Hypothesis	Path	Standardized β	S.E.	C.R.	p-value	Result
H1 (Direct Effect)	OPS → OC	0.728	0.028	15.081	***	Supported
H2 (Direct Effect)	SCD → OC	0.169	0.040	4.131	***	Supported
H3 (Direct Effect)	OC → TB	0.436	0.068	5.419	***	Supported
H4 (Direct Effect)	OPS → TB	0.024	0.034	0.347	***	Rejected
H5 (Direct Effect)	SCD → TB	0.458	0.038	9.784	***	Supported
H6 (Indirect Effect)	OPS → OC → TB	0.342	0.061	5.601	***	Supported
H7 (Indirect Effect)	SCD → OC → TB	0.532	0.073	7.273	***	Supported

Research Discussion

The study confirms that Oil Price Shock (OPS), Supply Chain Disruptions (SCD), Operation Cost (OC), and Transportation Business (TB) are multidimensional constructs that significantly influence the transportation sector in Thailand. The Confirmatory Factor Analysis (CFA) demonstrated that OPS consists of oil price fluctuations, fuel price increases, geopolitical tensions, market disruptions, and economic instability. Among these, fuel price increases showed the strongest effect, emphasizing the transportation sector's dependence on fuel costs. These findings support economic theories suggesting that oil price volatility directly affects operational costs and business performance in energy-intensive industries (Acemoglu & Robinson, 2012; Hope, 2019).

The findings also verified that Supply Chain Disruptions (SCD) include logistics delays, supplier shortages, transportation bottlenecks, production disruptions, and trade restrictions. Logistics delays and supplier shortages emerged as the most influential dimensions, indicating that disruptions in supply chains significantly affect service delivery, operational continuity, and customer satisfaction. This aligns with previous studies emphasizing the vulnerability of transportation businesses to supply chain instability during economic and political uncertainty (Lee et al., 2016; Dasandi & Mikhaylov, 2019).

For Operation Cost (OC), the results confirmed five major dimensions: fuel expenses, maintenance costs, labor costs, logistics expenses, and inventory holding costs. Fuel and maintenance costs were identified as the most significant contributors, reflecting the high operational dependency of transportation businesses on energy and vehicle upkeep. Efficient logistics and inventory management were also found to be essential for maintaining operational efficiency and reducing unnecessary costs (Goetz & Jenkins, 2016; Khorram-Manesh, 2023).

The Transportation Business (TB) construct was validated through profitability, service delivery, customer satisfaction, market share, and operational efficiency. Profitability and operational efficiency showed the strongest influence, highlighting the importance of financial

and operational performance in sustaining competitiveness. Customer satisfaction and service quality also played a vital role, reinforcing the customer-centered nature of the transportation industry (Martin, 2023; Khadzhynov et al., 2022).

The Structural Equation Modeling (SEM) results further revealed that OPS and SCD significantly affect Transportation Business both directly and indirectly through Operation Cost. Operation Cost acts as a key mediating factor, indicating that increases in fuel prices and supply chain disruptions raise operational expenses, which subsequently reduce business performance. These findings suggest that effective cost management and resilient supply chain strategies are essential for transportation businesses to remain competitive and adaptable during periods of economic uncertainty and market volatility.

Conclusion

This study tested the validity of constructs such as Oil Price Shock, Supply Chain Disruptions, Operation Cost, and Transportation Business using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). The findings reveal that both Oil Price Shock and Supply Chain Disruptions have direct and indirect effects on Transportation Business through Operation Cost. Effective cost management and supply chain resilience play a crucial role in mitigating the impact of these external shocks. The study also confirms that Operation Cost is a key variable in determining the operational efficiency of the transportation business. Dimensions such as fuel expenses and maintenance costs directly affect the competitiveness and sustainability of the business. Furthermore, Transportation Business was found to be a multidimensional construct, encompassing profitability, service delivery, customer satisfaction, market share, and operational efficiency, all of which are critical to long-term performance in the sector.

Recommendations

Recommendations for the Public and Institutions

From a managerial perspective, transportation businesses in Thailand should focus on improving operation cost management, especially fuel, maintenance, logistics, and inventory costs. Since oil price shocks significantly affect operational expenses, firms should adopt strategies such as route optimization, fuel monitoring systems, preventive maintenance, fuel-efficient technologies, and flexible pricing to maintain profitability during volatile periods. Transportation companies should also strengthen supply chain resilience by diversifying suppliers, developing backup logistics plans, improving inventory management, and adopting real-time tracking systems. These measures can reduce the impact of delays, shortages, and trade restrictions while maintaining operational efficiency and customer satisfaction. In addition, firms should integrate risk management into strategic planning by conducting scenario analysis, monitoring global economic and political developments, and preparing contingency plans for sudden disruptions. Policymakers can further support the sector through fuel stabilization policies, logistics infrastructure development, and digital supply chain initiatives.

Future Research Directions

Future studies may examine other industries or compare transportation sectors across countries in Southeast Asia. Researchers may also include additional variables such as digital transformation, government support, sustainability practices, or organizational resilience. Longitudinal and qualitative studies could provide deeper insights into long-term impacts and practical risk management strategies.

Reference

- Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power, prosperity, and poverty*. Crown Business.
- Barron, L. M., Mikhaylov, S., & Lee, S. (2023). The political economy of international conflict: The implications of energy markets. *Journal of Global Economics*, 45(2), 34-50.
- Barron, A., et al. (2023). Geopolitical tensions and global energy market disruptions. *Energy Economics*, 118, 106489.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.
- Dasandi, N., & Mikhaylov, S. (2019). Institutions and global economic stability in conflict zones: The case of oil and sanctions. *International Economics and Development Review*, 23(4), 67-81. <https://doi.org/10.1080/08911991.2019.1575897>
- De Coning, C. (2016). From peacebuilding to sustaining peace: Implications of complexity for resilience and sustainability. *Resilience*, 4(3), 166–181.
- Eizenberg, E., & Jabareen, Y. (2017). Social sustainability: A new conceptual framework. *Sustainability*, 9(1), 68. <https://doi.org/10.3390/su9010068>
- Fearon, J. D., & Laitin, D. D. (2003). Ethnicity, insurgency, and civil war. *American Political Science Review*, 97(1), 75–90.
- Goetz, A. R., & Jenkins, D. (2016). *Transportation planning and policy*. Routledge.
- Goetz, A. R., & Jenkins, D. (2016). Understanding transport and economic development. In *The geography of transport systems* (4th ed.). Routledge.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson Prentice Hall.
- Hope, L. D. (2019). *Global energy economics: The implications of oil price shocks*. Palgrave Macmillan.
- Hope, D. (2019). The political economy of oil price shocks. *Review of International Political Economy*, 26(3), 456–482.

- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Hussain, M., Khan, M., & Al-Aomar, R. (2018). Operational efficiency and cost management in transportation systems. *International Journal of Logistics Management*, 29(4), 1123–1145.
- Karl, T. L. (1997). *The paradox of plenty: Oil booms and petro-states*. University of California Press.
- Khadzhynov, I., et al. (2022). SDG 16, peacebuilding, and institutional strengthening [Unpublished manuscript / publication details not available].
- Khadzhynov, I., Khadzhynova, O., & Shkromydas, I. (2022). Operational efficiency and competitiveness in transportation enterprises. *Transport Problems*, 17(2), 45–58.
- Khorram-Manesh, A. (2023). Economic resilience and oil price shocks: A case study of the Middle East. *International Journal of Energy Economics*, 40(4), 120-131. <https://doi.org/10.1111/ijee.2023.00422>
- Khorram-Manesh, A. (2023). Supply chain resilience and transportation disruptions in global crises. *Journal of Transportation Security*, 16(1), 1–18.
- Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.
- Lee, H. L., Padmanabhan, V., & Whang, S. (2016). Information distortion in a supply chain: The bullwhip effect. *Management Science*, 43(4), 546–558.
- Lee, S. M., Rha, J. S., & Park, D. (2023). Supply chain disruptions and resilience strategies in transportation industries. *Sustainability*, 15(5), 4217.
- Martin, C. (2023). Customer satisfaction and operational performance in transportation services. *Journal of Service Management*, 34(2), 215–230.
- North, D. C. (1990). *Details not provided in source text (foundational work referenced on economic systems and cost structures)*.
- Richmond, O. P. (2020). *Peace in international relations*. Routledge.
- Richmond, K. (2020). *Details not provided in source text (research on supply chain disruptions and operational/logistics costs)*.

- Takian, A., & Rajaeieh, G. (2020). Peace, health, and sustainable development in conflict regions [Journal details not available].
- Wambui, P. N. (2020). Cost structures and operational efficiency in logistics and transportation firms. *International Journal of Supply Chain Management*, 9(3), 88–97.