DIJEFA:
Dinasti International Journal of Economics, Finance & Accounting
E-ISSN: 2721-303X
P-ISSN: 2721-3021
https://dinastipub.org/DIJEFA dinasti.info@gmail.com +62 811 7404 455
DINASTI PUBLISHER

DOI: https://doi.org/10.38035/dijefa.v7i3

Bridging Asset Specificity and Supply Chain Performance: Why Is Contractual Governance Superior to Relational Ties in Indonesia's Upstream Oil and Gas Sector?

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Abstract: The main focus of this research is to identify the relationship between asset specificity, contractual and relational governance, and supply chain performance. Transaction Cost Economics and Social Exchange Theory are the theoretical foundations of this research, which aims to investigate the mediating effect of contractual and relational governance on human and physical asset specificity. This study involved 162 supporting vendors in the oil and gas industry. Furthermore, PLS-SEM was used to analyze the data, which showed that physical asset specificity positively affected supply chain performance, but human asset specificity did not. Contractual governance also positively mediated the relationship between asset specificity and supply chain performance, but relational governance had no effect. The companies are expected to have policies focused on business contracts that serve as guidelines for conducting business. Managers, production sharing contractors, and supporting vendors should develop a framework based on contractual governance. This allows them to maintain occupational safety, improve company quality, and address business challenges, particularly costs, energy, and time in operational systems within the oil and gas industry.

Keywords: Asset Specificity, Contractual Governance, Relational Governance, Supply Chain Performance, Upstream Oil and Gas.

INTRODUCTION

Indonesia has developed an oil and gas industry that plays an important role in various aspects of life, especially in the economic sector (Dafana et al., 2024). One strategy is to protect, preserve, and renew resources so the industry can grow properly. One example is the Asta Cita program (Rafif, 2024). This program focuses on operational systems that are regulated and reviewed in accordance with applicable laws. Indonesia is capable of generating IDR 420 trillion annually, particularly from local products, which are influenced by the industry's supply chain (Putri & Sijabat, 2024). Furthermore, the companies should make great effort to develop it by designing a framework that provides long-term benefits (Ningombam & Telu, 2023). Technological developments are one influence on this framework, which aims to provide more sophisticated and modern operational systems. Technology-based operational

systems can achieve success, thanks to the crucial role of Production Sharing Contract (PSC) contractors and supporting vendors in the Indonesian oil and gas industry (Menhat et al., 2023). However, challenges encountered in this industry include the time required for drilling, distribution, and transactions (Alshibani et al., 2022). These constraints increase costs for these operational systems.

One of the provinces in Indonesia with an operational system is East Kalimantan, specifically Balikpapan (Putri & Sijabat, 2024). However, problems arise due to a decline in the supply chain caused by a poorly managed operational system (Katsaliaki et al., 2022). Furthermore, unproductive time is also one reason the operational system does not function optimally (Barakat et al., 2021). For example, the specificity of physical assets, which focuses on work equipment at drilling sites, requires an overly complex administrative system (Alhammadi et al., 2023; Ogbu et al., 2024; Zhu et al., 2020). This administrative system sometimes hinders work effectiveness because work preparation takes a lot of time. Furthermore, this complex administrative system prevents market demand from meeting business targets (Alehashemi & Hajiyakhchali, 2018; Santos & Soares, 2022). Furthermore, supply chain performance has declined drastically due to complex contracts and the time-consuming resolution of urgent issues (Vyas & Yadav, 2025). These complex contracts result in poor operational performance, as the supply chain cannot distribute quickly due to the need to go through various overly rigid administrative procedures (Falagara Sigala et al., 2022). Therefore, a strategy to improve supply chain performance is asset specificity, which focuses on the business's operational system.

Asset specificity is a benchmark in integrated collaboration between Indonesian Production Sharing Contractors (PSCs) and physical assets (Ariadi, 2022; L. Wang et al., 2019; Zheng et al., 2022). Physical Asset Specificity (PAS) plays a crucial role because it consists of investments in equipment or machinery with specialized technical designs tailored to specific drilling types, thereby increasing PSC oil drilling productivity and reducing supply chain operational costs (Sewandono et al., 2023; L. Wang et al., 2019). However, as PSC drilling expands across various asset types, supply chain performance declines because redesigning equipment or finding replacement vendors is relatively expensive (Montagna & Cafaro, 2019; Nakayima et al., 2025). In addition, Human Asset Specificity (HAS) refers to the knowledge, skills, and experience developed by expert vendor technicians to support PSC drilling operations (Takata & Parry, 2022; L. Wang et al., 2019), including exchanging information on oil and gas supply chain procedures and long-term drilling strategic planning (Sewandono et al., 2023). Conversely, HAS can lead to a decline in supply chain performance due to sudden vendor personnel changes, requiring new technicians to understand the characteristics of the same drilling wells (Farida et al., 2024; Nakayima et al., 2025). Thus, there is a research gap between PAS and HAS related to supply chain performance in the oil and gas industry.

To address the above research gap, the mediating role of Contractual Governance (CG) as a formal contract that protects the risk of Physical Asset Specificity (PAS) in the form of project equipment is examined to improve vendor supply chain performance and reduce the risk of increasing investment costs with a transaction cost economics theory approach (Sarhan et al., 2017). In addition, the role of CG mediates relationships through clauses related to vendor experts, facilitating the exchange of knowledge and information to improve supply chain stability and helping anticipate expert transfers to competing companies (Zhang et al., 2020). Relational Governance (RG) through flexibility mediation allows vendors with PAS to take immediate corrective actions based on agreements and trust in PSCs to complete their administration after carrying out project work, using a relational view theory approach (Sheng et al., 2018). It improves supply chain performance from a time-speed perspective because contract-based bureaucratic obstacles are successfully mediated by relational governance (Liu et al., 2017). Furthermore, RG builds long-term trust and commitment, allows vendor experts

to feel part of the project team, and encourages open information exchange with PSCs (Chan et al., 2025). This impacts the PSC's confidence in encouraging vendor experts to proactively provide innovative solutions to unstated technical project risks, thus improving supply chain performance (Baah et al., 2022).

This study analyzes the direct relationship between human and physical asset specificity to improve supply chain performance in the oil and gas industry. This analysis utilizes different governance approaches, in accordance with the objectives of each aspect of the analysis. Previous research has focused solely on distinguishing positions from transaction cost economics (contract cost efficiency) and social exchange theory (psychology). This study aims to identify contractual and relational governance, which are not exchange-based but operational systems that can mediate the relationship between human and physical asset specificity. This will improve supply chain performance and influence oil and gas supporting vendors to continue collaborating in an integrated manner.

Literature Review

Transaction Cost Economics Theory

Transaction Cost Economics (TCE) is a concept in corporate business that focuses on cost management used in operational system transactions (Ketokivi & Mahoney, 2020). TCE is used as a guide in the oil and gas industry to manage specific human and physical assets. HAS refers to workers' knowledge, experience, and skills in the oil and gas industry (Takata & Parry, 2022). PAS refers to the facilities used by workers to support the operational system (Chiu et al., 2023). TCE is closely linked to contractual governance, so the oil and gas industry has policies that focus on work rules based on safety and applicable laws. It also helps companies manage transaction costs effectively and efficiently. Therefore, contractual governance is integrated to support TCE because companies feel responsible for following the agreed-upon rules in the business partnership.

Social Exchange Theory

Social Exchange Theory (SET) is a crucial element of corporate business, focusing on collaboration through the exchange of resources such as experience, knowledge, and skills (Cook & Hahn, 2021). SET plays a crucial role in realizing relational governance, facilitating communication and interaction between companies. It helps companies connect to support collaborative relationships that can serve as a benchmark for developing the oil and gas industry (Frank et al., 2017). Furthermore, SET and RG can also enhance the specificity of human assets and physical assets (PAS) by fostering relationships between workers and the tools used in operational processes in the oil and gas industry. Therefore, SET strives to support corporate business through synergistic collaboration.

The Effect of Physical Asset Specificity on Supply Chain Performance

The Physical Asset Specificity (PAS) focuses on work equipment that TCE controls for transaction costs within the operational system (Ketokivi & Mahoney, 2020). Furthermore, Indonesian Production Sharing Contract (PSC) Contractors participate in the operational system by providing policies that focus on work regulations, safety, and applicable laws. Current technological developments influence PAS, which are designed to be more modern, sophisticated, and easier to operate in the drilling process at oil and gas industry sites (Sircar et al., 2021). PAS can help workers be more efficient in terms of time, energy, and costs. In addition, PAS is an important part of Health, Safety, and Environmental (HSE) standards, ensuring workers remain safe while following officially standardized protocols (Colombo et al., 2019). Therefore, PAS plays a crucial role in improving supply chain performance in the oil and gas industry.

H1: Physical asset specificity has a positive effect on supply chain performance.

The Effect of Human Asset Specificity on Supply Chain Performance

Human Asset Specificity (HAS) refers to the human resources who work for the company to achieve business goals in the oil and gas industry (Kryukov & Medzhidova, 2019). HAS receive training as part of the company's efforts to develop their quality. Technological developments require HAS to

increase work effectiveness by developing knowledge and skills through experience gained in training or company workshops (Farida et al., 2024). The company collaborates with other companies by developing HAS so they can coordinate on valuable and beneficial business strategies going forward. Their work determines the quality of HAS; they follow applicable rules and policies at work. This aims to maintain safety, comply with applicable laws, and decrease non-productive time.

H2: Human asset specificity has a positive effect on supply chain performance.

Relational Governance Mediates the Relationship between Human Asset Specificity and Supply Chain Performance

Relational Governance (RG) acts as a bridge between individuals in conducting business between companies. SET supports RG by emphasizing social concepts that serve as a reference for connecting companies (Chowdhury et al., 2019; Zhang et al., 2020). HAS are workers who must be able to socialize with others. This aims to establish more intense cooperative relationships. Thus, supply chain performance can develop over time. In addition, RG can also help HAS learn how to communicate and interact with individuals and teams because they are social creatures who always need each other's help (Islam et al., 2023). HAS and RG have synergy that can help minimize obstacles and provide solutions, especially in coordinating between workers (Bonatto et al., 2020). If their relationship is mutually sustainable, supply chain performance can succeed. This is the business goal of the oil and gas industry.

H3: Relational governance positively mediates the relationship between human asset specificity and supply chain performance.

Relational Governance Mediates the Relationship between Physical Asset Specificity and Supply Chain Performance

Relational Governance plays a crucial role in developing PAS to achieve supply chain performance in the oil and gas industry. SET can mediate these relationships by focusing on resource exchange, including strategies, decisions, and collaboration between companies to achieve superior supply chain performance (Prajogo et al., 2021). RG aims to develop social relationships between companies by providing transparency in the form of honest, fair, and committed rights and obligations (Huang & Huang, 2019). PAS also supports these social relationships, namely collaboration, by providing facilities in the form of RG. Furthermore, RG also plays an important role in evaluating operational systems in the oil and gas industry, which is the responsibility of the PSC (Silvestre & Gimenes, 2017). This is why RG is important in mediating PAS and supply chain performance.

H4: Relational governance positively mediates the relationship between physical asset specificity and supply chain performance.

Contractual Governance Mediates the Relationship between Human Asset Specificity and Supply Chain Performance

Contractual Governance (CG) focuses on work contracts in the form of agreements based on the rules, policies, and laws applicable in the oil and gas industry (Wacker et al., 2016). The production sharing contract is responsible for managing CG, which is integrated into companies' operational systems and requires guidelines (Sewandono et al., 2023). The CG focuses on HSE and is then designed based on TCE, which aims to develop HAS. HAS plays a crucial role in the operational system that can manage all aspects applicable in the oil and gas industry, namely costs, energy, and time required to achieve superior supply chain performance (Chiu et al., 2023; Kryukov & Medzhidova, 2019). Furthermore, the CG also consists of job training that helps HAS develop useful and valuable work effectiveness (You et al., 2019). Through this training, regulated in the CG, companies can improve their quality, as evidenced by the knowledge and capabilities of HAS. Therefore, CG helps mediate the relationship between HAS and supply chain performance.

H5: Contractual governance positively mediates the relationship between human asset specificity and supply chain performance.

Contractual Governance Mediates the Relationship between Physical Asset Specificity and Supply Chain Performance

Contractual Governance also serves as a work guide for PAS because it contains rules and policies that workers must follow (Dirani & Ponomarenko, 2021). This is used to minimize the risks and problems during working time. CG focuses on SOPs and HSE, which aim to improve supply chain performance (Martins et al., 2020). The production sharing contract evaluates the CG, which is then integrated into the company as the main reference in the operational system. In addition, PAS is a work tool that oil company determines CG and adjusts TCE due to the importance of transaction cost management in the operational system. The company also develops CG based on current technological developments because in modern times, work equipment is more sophisticated (H. Wang et al., 2022). Therefore, CG has a significant effect in mediating the relationship between physical asset specificity and supply chain performance.

H6: Contractual governance positively mediates the relationship between physical asset specificity and supply chain performance.

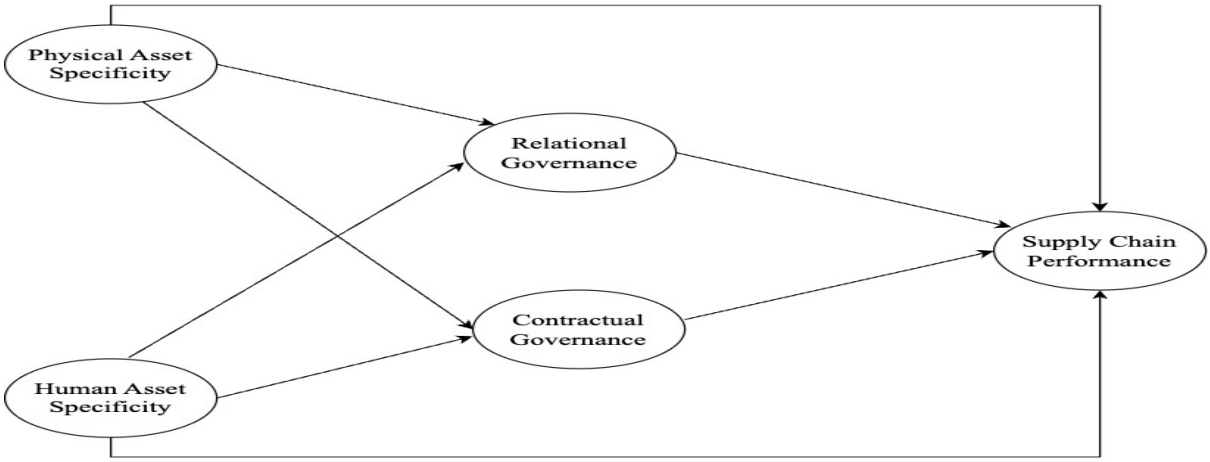

Figure 1. Conceptual Model

METHOD

This study analyzed two types of variables, namely HAS and PAS, using Partial Least Squares Structural Equation Modeling (PLS-SEM). RG and CG were also integrated to mediate the relationship between the variables in this study. Furthermore, the population in this study was 162 vendor companies based on system data from the Integrated Centralized Vendor Database issued by the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) (SKK Migas, 2025). These oil and gas support service vendors have procured goods/services from SKK Migas, especially those operating in East Kalimantan. Respondents were operational managers of oil and gas support service companies who understand oil and gas drilling supply chain management activities, starting from project procurement, drilling and pipe installation, rig mobilization, and well recording, and have collaborated with the Special Task Force for Upstream Oil and Gas Activities (SKK Migas). The sampling technique used the Slovin formula (error = 5%) for 116 oil and gas support service vendor companies located in Balikpapan City. Table 1 presents the data obtained using a random sampling technique.

This research questionnaire uses a Likert scale, with 1 meaning strongly disagree and 5 meaning strongly agree. Each questionnaire indicator was developed by experts who produced five items each. PAS was developed by (Farida et al., 2024; Sewandono et al., 2023); HAS was developed by (Nakayima et al., 2025; Takata & Parry, 2022); RG was developed by (Sheng et al., 2018); CG was developed by (Um & Oh, 2020); supply chain performance was developed

by (Menhat et al., 2023). In addition, Table 2 shows the standardized factor loadings of measurement items (0.896 to 0.952). Cronbach's Alpha values for the constructs (0.957 to 0.968) and AVE values (0.854 to 0.888). Internal consistency and reliability are in the high category. Each construct is significantly discriminant, with HTMT ratios of less than 0.9, which empirically demonstrate differences between constructs (Hair Jr et al., 2017). The HTMT values (0.635 to 0.817) are below the conservative threshold of 0.9, indicating that the constructs are conceptually separate and that the measurement model does not exhibit multicollinearity.

Table 1. Demographics

Characteristic	Category	Frequency	Percent (%)
Business Classification	Big business	45	27.8
	Medium Business	117	72.2
Types of Supporting Services	Drilling Services	32	19.8
	Construction & Installation Services	41	25.3
	Inspection & Technical Services	35	21.6
	Logistics & Transportation Services	28	17.3
	Maintenance Services	26	16.0
Duration Operation in the Oil and Gas Sector	< 5 Year	18	11.1
	5 – 10 Years	52	32.1
	11 – 20 Years	64	39.5
	> 20 Years	28	17.3
Ownership Status	Local Company (PMDN)	115	71.0
	Foreign/Joint Venture Companies	47	29.0
Number of Contracts with PSCs	1 – 3 Active Contracts	68	42.0
	4 – 6 Active Contracts	59	36.4
	> 6 Active Contracts	35	21.6

Source: Author's Own Work

Table 2. Item Measurement Model

Item Name	Item Loading	Cronbach's Alphas	AVE
Human Asset Specificity (HAS)			
HAS1: Our personnel have in-depth technical knowledge specifically tailored to the operational procedures (SOP) of PSCs partners.	0.914		
HAS2: Our team has a specific understanding of the geological or technical characteristics of the field in the PSCs work area that is not available elsewhere.	0.910	0.957	0.854
HAS3: Our personnel have internalized Health, Safety, and Environmental (HSE) Standards which are strict requirements of PSCs partners.	0.934		
HAS4: We are replacing core personnel who are used to working with this PSCs partner. HAS5: It takes a lot of time and training costs for new personnel to reach the same level of proficiency in serving these PSCs partners.	0.921 0.941		
Physical Asset Specificity (PAS)	0.952		
PAS1: We make special modifications to heavy equipment/rigs to suit the technical specificity of oil wells or partner PSCs projects.		0.968	0.888

PAS2: Our company uses technology or software that is specifically integrated with the control/data systems of PSCs partners.	0.936		
PAS3: We provide supporting facilities (such as warehouses or workshops) in locations close to the remote work areas of PSCs partners.	0.947		
PAS4: Most of the physical assets we used in this project are difficult to transfer to another company's project without significant modification costs.	0.930		
PAS5: The economic value of our physical assets will decrease drastically if the contractual relationship with this PSCs partner ends suddenly.	0.946		
Relational Governance (RG)	0.926		
RG1: There is a high level of trust that PSCS partners will act fairly and not take unilateral advantage when field problems occur.		0.964	0.876
RG2: We voluntarily share sensitive technical information with PSCs partners for the smooth running of the project, although it is not strictly required by the contract.	0.936		
RG3: Both parties demonstrated high flexibility in adjusting schedules or work methods when operational situations on site changed.	0.942		
RG4: If a technical issue occurs, we prefer collaborative discussions to find a solution rather than directly referring to legal claims.	0.930		
RG5: We have a strong commitment to maintaining long-term business relationships with these PSCs partners beyond the duration of the current contract.	0.945		
Contractual Governance (CG)	0.945		
CG1: Our work contracts include a very detailed description of the scope of work and legal responsibilities.	0.948	0.967	0.882
CG2: The contract has a clear and express penalty clause in the event of delay or failure to achieve technical targets.	0.953		
CG3: There is a formal protocol in the contract that regulates the steps to be taken in the event of force majeure or sudden changes in the field.	0.925		
CG4: The contract provides clear rights for PSCS to conduct technical audits and regular performance monitoring of our operations.	0.925		
CG5: Dispute resolution procedures (legal or arbitration) have been regulated in detail and written in the contract documents.			
Supply Chain Performance (SCP)			
SCP1: This collaboration has succeeded in minimizing the number of operational downtimes (Non-Productive Time/NPT) due to technical or logistical constraints.	0.938		
SCP2: Our supply chain operations consistently achieve occupational safety (Zero Accident) and (HSE) targets.	0.946	0.963	0.871

SCP3: The procurement and distribution process for supporting services is carried out efficiently to reduce operational costs below the budget.	0.949
SCP4: Personnel mobilization and equipment availability at the project site are always on time according to dynamic needs in the field.	0.896
SCP5: The quality of the vendor's work consistently meets or exceeds established international technical standards (such as ISO).	0.935

Source: Author's Own Work

Table 3. Discriminant Validity (HTMT Ratio)

Variable	CG	HAS	PAS	RG	SCP
CG					
HAS	0.716				
PAS	0.744	0.692			
RG	0.635	0.722	0.689		
SCP	0.776	0.791	0.678	0.817	

Source: Author's Own Work

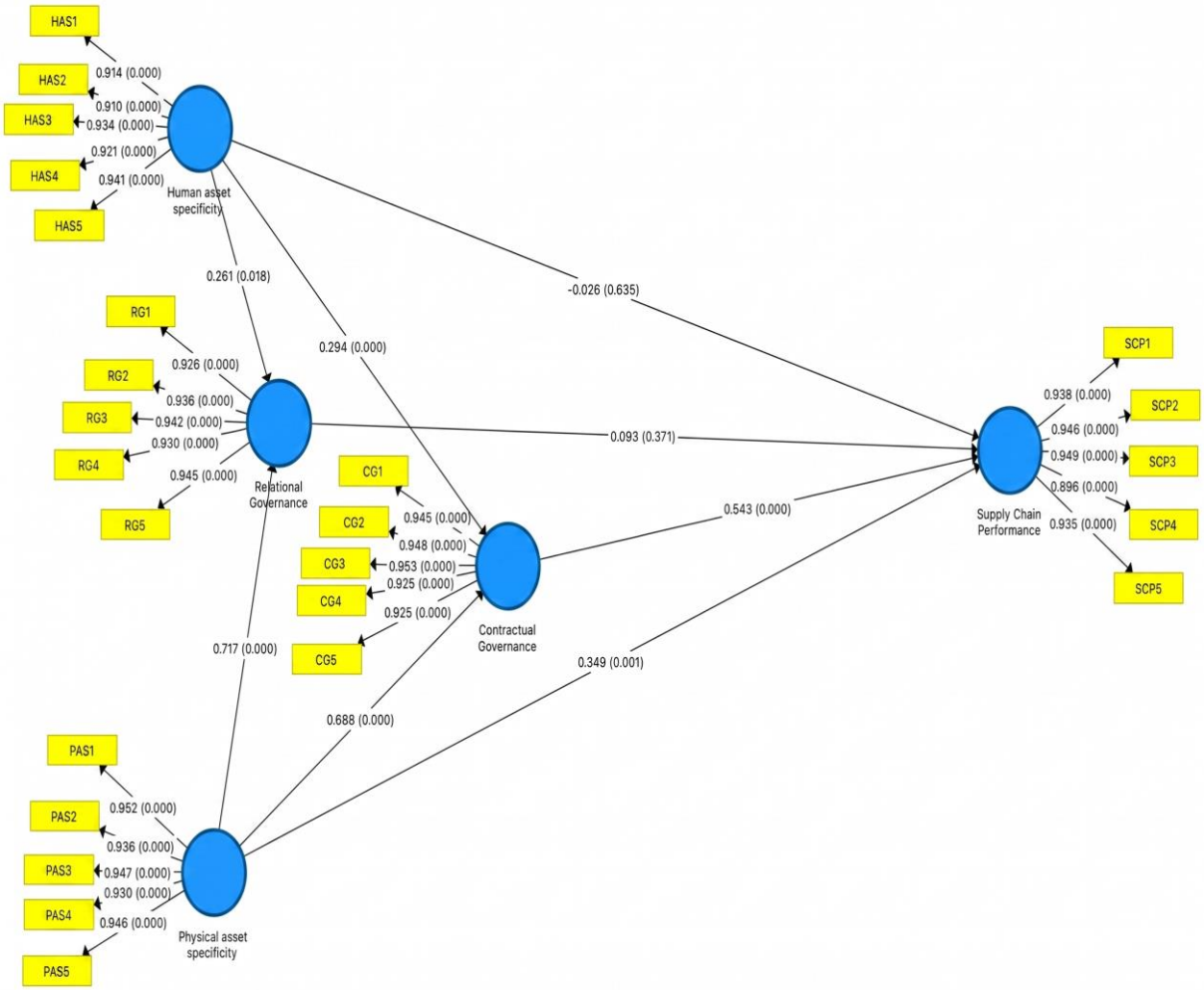

Figure 2. Model Results (Source: Author's Own Work)

Results

The hypotheses of this study were analyzed using PLS-SEM, focusing on the conceptual model and the variables tested using regression coefficients and t-statistics. This study used two indices, namely t and p, to test the significance of the hypothesis. Furthermore, For a two-tailed test at the 5% significance level, a hypothesis is supported when *t-test* > 1.96 and p < 0.05. The 95% and 99% significance levels indicate that each hypothesis is categorized as supported if the p-value is less than 0.05. The results of the coefficient (β) and t-test analysis are shown in Table 4. Furthermore, H1 is rejected (β = -0.026; p-value > 0.05), so the relationship between HAS and supply chain performance is categorized as negatively insignificant. Increasing the specific skills or knowledge possessed by vendor personnel does not directly affect supply chain performance. The path coefficient (β), which is close to zero and insignificant, indicates an isolated influence, meaning that the HAS variable does not directly drive supply chain performance. Furthermore, PAS has a significant positive effect on Supply Chain Performance (β=0.349, p<0.01), that supports for H2. In addition, the substantial path coefficient states that vendors are committed to a high level of physical customization by focusing on the specific field requirements of the PSCs. This sustainable relationship can minimize technical disruptions. As a result, supply chain reliability and cost efficiency can be declared successful. Empirical findings also show that relational governance cannot mediate thein the relationship between HAS and supply chain performance (β=0.024, p>0.05;), the results reject H3. These results are not in line with Social Exchange Theory because specific social capital should improve performance through relational governance. Hypothesis H4, which states that RG can be a mediator in the relationship between PAS and supply chain performance, is not supported (β=0.067, p>0.05).

The analysis results confirm that the indirect effect is small. H5 is supported, as CG can mediate the relationship between HAS and supply chain performance (β = 0.293, p < 0.01). It means that contractual governance significantly mediates the relationship between HAS and Supply Chain Performance. In addition, H6 is supported by the results of the structural model analysis: CG can mediate the relationship between PAS and supply chain performance (β = 0.264, p < 0.01). The operational system develops through specific physical investments implemented by vendors, focusing on formal contracts that play an important role in developing the indirect path. It means that contractual governance significantly mediates the relationship between PAS and Supply Chain Performance. Contractual governance in the form of inter-company contracts must be used as a guide in developing the oil and gas industry.

Table 4. The Hypotheses Result

Hypothesis	Relationship	Path Koefisien	Test Result
H1	Human asset specificity → Supply chain performance	-0.026	Non-Significant
H2	Physical asset specificity → Supply chain performance	0.349	Significant at 99%
H3	Human asset specificity → Relational governance → Supply chain performance	0.024	Non-Significant
H4	Physical asset specificity → Relational governance → Supply chain performance	0.067	Non-Significant
H5	Human asset specificity → Contractual governance → Supply chain performance	0.293	Significant at 99%
H6	Physical asset specificity → Contractual governance → Supply chain performance	0.264	Significant at 99%

Discussion

Based on the analysis results, this study shows that Specific Human Assets (HAS) do not have a significant impact on supply chain performance, thus rejecting H1. The results of this study are not in accordance with Transaction Cost Economics (TCE). The Indonesian oil and gas industry has rules and policies regulated by the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas). These rules and policies focus on work procedures that have strict SOPs and must be followed by the company. The company requires workers to have high quality to achieve success in supply chain performance. The oil and gas industry had limited human resources, so government-mandated SOPs were not implemented effectively (Naghavi-Konjin et al., 2020). Furthermore, these workers' skills are still considered standard, as workers with superior knowledge, experience, and abilities are still limited. This has resulted in unsuccessful supply chain performance. Yet, workers, as human resources, play a crucial role in running the company's operational system. One solution to this obstacle is the PSC's role in supporting the company's operational system through the synergy of HAS. However, limited human resources cause some companies to employ workers who lack quality in their fields, especially in the oil and gas industry. Human resources have a crucial role in developing operational systems in the company. Companies are able to compete globally because of the presence of human resources who have experience, knowledge, and skills appropriate to their fields in the oil and gas industry. In addition, Production Sharing Contracts (PSCs) are also the basis for meeting customer needs supported by the vendor. Companies must have management that focuses on implementing HAS by connecting these PCSs so that supply chain performance can achieve success.

Physical Asset Specificity (PAS) shows a significant influence on supply chain performance, thus supporting H2. These results are consistent with TCE and align with the empirical findings from Nakayima et al. (2025), Takata & Parry (2022), and L. Wang et al., 2019). PAS is the primary focus in organizing work equipment to support operational systems in the oil and gas industry. Physical investments are designed to adapt to the situation and conditions at the drilling site, such as drilling rigs and subsea infrastructure. PSCs also play a crucial role in PAS because they can support vendors in demonstrating synergy in working within the company, which is the costs required in operational systems in the oil and gas industry. Therefore, PAS can be a solution to obstacles that occur at the drilling site. As a result, supply chain performance can run smoothly. Furthermore, the PAS analysis results have a significant effect on supply chain performance, which aligned TCE is supported. PAS is a crucial aspect of the operational system because it provides work facilities that support workers in achieving maximum results. The use of technology contributes to the development of PAS by managing time, energy, and costs effectively and efficiently.

The empirical results of this study confirm that relational governance is unable to mediate the relationship between Human Asset Specificity and supply chain performance, thus rejecting H3. This result is inconsistent with Social Exchange Theory (SET), which states that specific social capital is expected to improve performance by focusing on relational values. Strict regulations in the oil and gas industry in Indonesia also contribute to this mediation failure, which is a problem in the formal structure. The rigid framework implemented by the industry limits the positive influence of informal relational ties (Sewandono et al., 2023). Although vendor employees possess superior specialized skills, if regulations are too binding and strict, their performance will be suboptimal because they are obliged to follow the regulations and do not focus on the relationship between the PSC and the vendor in the relational exchange. Furthermore, human resources are a key factor in the success of supply chain performance in the oil and gas industry. Although specialized skills and knowledge are not the benchmark within a company, they are the foundation that can provide synergy, integrity, and opportunities for the company's development. Production sharing contracts in Indonesia can also support the

development of this supply chain by providing binding rules and policies. However, sometimes this becomes an obstacle for workers to show maximum work effectiveness because they are too regulated to do work wherethey are able to provide maximum results.

The Relational Governance does not significantly mediate the relationship between Physical Asset Specificity and Supply Chain Performance, thus rejecting H4. These results clarify that HAS provides integrity and synergy for supply chain performance, while HAS provides facilities in the form of drilling equipment tailored to the needs at drilling sites, especially in the oil and gas industry. The relationship between Indonesian PSCs and vendors does not guarantee the development of these physical investments due to strict rules and policies, so that informal relationships with other companies are not well established. The relational governance also does not guarantee superior performance, especially in environments with strict and complex rules and procedures (Um & Kim, 2019). This condition is inconsistent with Social Exchange Theory because social relationships and cooperation do not play a significant role due to the existence of formal rules, technical standards, and obligations that are too much the company's primary focus.

The relationship between Physical & Human Asset Specificity and supply chain performance may be mediated by contractual governance, supporting H5 and H6. PAS focuses on drilling equipment designed and customized to the needs of the oil and gas industry, particularly at the drilling site. Furthermore, contracts provide a reference for cooperation between companies, including responsibilities, decisions, profits, and more. As explained in Transaction Cost Economics (TCE), contracts provide solutions to problems, constraints, and risks that occur in PAS by PSCs and vendors. Furthermore, contracts also serve as a company's operational system, consisting of regulated rules and studies that focus on various important aspects in developing the oil and gas industry. Thus, companies have guidelines that can address issues that arise in the supply chain performance process. This study confirms that contractual governance plays a crucial role in the development of physical asset investments and supply chain performance. Therefore, this contract aims to implement specific physical assets so that PSCs and vendors can achieve operational excellence.

Governance and assets have different concepts, but the results of this study prove that contractual governance has a significant influence as a mediator in transforming latent specific assets into superior supply chain performance. Social Exchange Theory also serves as a basis for managing asset specificity as demonstrated by the influence of contractual structures and relational ties. Rules and procedures in the oil and gas industry have guidelines in the form of formal contracts that have a role that is more important than mere administration. Contracts provide a clear structure for specific assets, namely equipment and workers suitable for specific jobs. Thus, the contract can mitigate opportunistic behavior by the party leasing the drilling equipment—such as delays in returning the equipment—thereby ensuring that both parties effectively adhere to the cooperation agreement. In addition, TCE states that contracts are used to impose penalties on companies that do not comply with the contract because the contract is an agreement between companies. In a highly regulated upstream oil and gas context, contractual governance appears to be a more effective mechanism for converting asset specificity into supply chain performance than relational governance.

The implications outlined in this discussion are expected to support a more focused and structured approach. In the oil and gas industry, supply chain performance is closely linked to the management of Production Sharing Contracts (PSCs) and vendor involvement. Effective company management in this sector requires a higher degree of structure and organization. Contracts play a central role in facilitating collaboration between companies, as they provide a clear framework that brings together both human and physical resources, and open up opportunities for achieving operational excellence. The responsibility of PSC managers is to implement these contracts in a way that supports coordination with vendors and other firms.

Contracts are not only administrative documents but also serve as strategic guidelines that can influence the overall success of the organization. Contracts should include Key Performance Indicators (KPIs) and Health, Safety, and Environment (HSE) standards so PSC managers can improve supply chain performance by managing Non-Productive Time (NPT) more effectively. In some cases, asset development may require designing specialized underwater sensors aligned with established KPIs and HSE requirements. Vendors also play a significant role by prioritizing formal contractual agreements. This structured approach is expected to support better supply chain performance and provide benefits for the agreements. This approach supports successful supply chain performance and delivers advantages to the oil and gas industry.

CONCLUSION

This study demonstrates that Physical Asset Specificity significantly improves Supply Chain Performance, whereas Human Asset Specificity does not show a significant direct effect. More importantly, Contractual Governance significantly mediates the relationships of both Human Asset Specificity and Physical Asset Specificity with Supply Chain Performance, while Relational Governance does not provide significant mediation. These findings suggest that in the highly regulated Indonesian upstream oil and gas sector, formal contractual mechanisms may be more effective than relational ties in transforming asset-specific investments into supply chain performance. The study contributes to Transaction Cost Economics and Social Exchange Theory by demonstrating that the effectiveness of governance mechanisms may depend strongly on the institutional and regulatory characteristics of the industry. Furthermore, RG has no impact due to the existence of binding policies, which prevents SET from being implemented effectively and efficiently. However, the results of this study indicate that CG plays a crucial role by guiding the company's operational system. HAS and PAS receive valuable benefits through CG. HAS receive on-the-job training that helps develop their knowledge and skills through their previous experience. PAS can also be used in conjunction with SOPs, HSE, and applicable laws to manage risks, obstacles, and problems effectively. Furthermore, TCE is integrated into CG because it can regulate the company's operational system, focusing on time, energy, and transaction costs. However, this study has limitations in that it focused on the oil and gas industry; other industries may have different results in the future. While these results cannot be used as a representative sample for other industries, they can serve as a source of scientific information. Future researchers can develop variables that focus on paired dyadic data to provide novel insights related to governance and assets in supply chain performance.

Acknowledgement

The authors would like to thank for the Directorate General of Research and Development, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia, which had provided funding for this research through research grant No: 285/C3/DT.05.00/PL-BARU/2026 and derivative contract No: 01/LL6/ AL.04.03/PL-BARU/2026.

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