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Digital Supply Chain and Business Performance: The Case of the Oil and Gas Industry

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Abstract: A competitive global business competition requires a firm to formulate a competitive strategy in supply chain management. The transformation from manual to digital management is also necessary for the oil and gas industry. A digital supply chain is a management approach that uses technology to manage the flow of goods, information, and finance across the entire supply chain. This study attempts to evaluate the impact of the digital supply chain on business performance in the oil and gas industry. The study sample was 523 PETRONAS staff members who were involved in operating two main units, namely, a gas processing and oil refinery. The results of multiple regression analysis found that the digital supply chain significantly and positively influences firm performance across the three study samples, namely gas processing, oil refinery, and the overall sample. Technology-driven supply chain management has had a significant positive impact on every aspect of the supply chain. This can be observed in enhanced efficiency, improved visibility, time savings, and increased company competitiveness. Nonetheless, the influence of the digital supply chain is not absolute because other factors such as communication, competence, transparency, and training empirically affect the firm's performance. All of these factors are complementary to the effectiveness of digital supply chain implementation. In line with this, steps are being taken to optimize digital applications across all aspects of the supply chain, along with certain elements related to human capital, to create a unique resource capable of fostering competitive advantage and enhancing firm performance.

Keywords: *Digital supply chain, Firm performance, Human capital, Oil and gas industry*

1. Introduction and Background

In today's dynamic business landscape, achieving and sustaining high performance is a main goal for organizations across industries. Business performance involves various dimensions, including financial metrics, operational efficiency, customer satisfaction, and innovation capabilities. It is a critical benchmark for assessing an organization's effectiveness in delivering value to its stakeholders and achieving its strategic objectives.

The concept of business performance is particularly pertinent in sectors such as the oil and gas industry, where companies operate within a complex ecosystem characterized by volatile market dynamics, regulatory challenges, and technological advancements. Businesses globally are enhancing their operational performance by more effectively managing their supply networks. They are innovating internal processes to maintain competitiveness and ensure long-term sustainability in a global marketplace (The White House, 2021). The supply chain is a crucial factor influencing business performance, as it encompasses all organizations and activities involved in the entire process, from production to consumption of a product or service.

As global business competition intensifies, companies increasingly prioritize supply chain management as a strategy to boost performance. Nowadays, supply chain management (SCM) is an essential tool in navigating fierce global competition, aiding managers in enhancing production, profitability, and overall company performance. In enhancing organizational productivity, performance, and profitability, supply chain management (SCM) plays a role as a key component of competitive strategy. Data on incurred costs in all related operating activities must be reported accurately (Askarany, Yazdifar, & Askary, 2010). Kherbach and Mocan (2016) emphasized the importance of a company to operate at low or optimal costs. However, the information flow must contain accurate data, as management needs reliable feedback to make informed decisions.

In the digitalization era, inventory and purchases are primary concerns in supply chain management (Farahani, Meier, & Wilke, 2017). To leverage information technology and maintain performance, most businesses have made significant investments in their functional departments Information technology integration into supply

chain management systems might assist managers in making decisions. In the coming years, DSC management will be used. The DSC involves utilizing advanced digital technology to move beyond traditional methods. Achieving a mature level of digital SCM often necessitates an organizational transformation that encompasses both internal and external supply chains. An effective agenda is fundamental to any digital SCM strategy (Farahani et al., 2017).

The global financial crisis has impaired Malaysia's oil and gas industry on numerous occasions. Malaysia's economy thrives on the oil and gas sector, contributing 20 to 30 percent to Malaysia's Gross Domestic Product (GDP), one of the most important revenue streams. Financial performance has been a significant concern due to Malaysia's unstable economic climate and currency depreciation, which affects the company's ability to maintain profitability (Ismail, 2020). The supply chain for the oil and gas industry faces both supply chain and technology threats. It indicates that high-risk industry supply chain management must prevent technical risks in addition to supply risks, demand risks, process risks, control risks, and environmental risks to minimize supply chain disruption (Choonga, Hamidb, & Cheong, 2015). Therefore, this study attempts to evaluate the impact of the DSC on business performance in the case of the oil and gas industry.

2. Literature Review

Digital supply chain (DSC)

The DSC is the adoption of digital technologies, including artificial intelligence, blockchain, big data, cloud computing, and the Internet of things (IoTs) into various activities of the supply chain to establish an operational process characterized by decision-making backed by data (Karimi & Rivard, 2020; Holmstrom & Partanen (2014); Deepu & Ravi,2023; Büyüközkan & Göçer (2018). Adhiatma, Fachrunnisa, and Mustafa (2020) defined the DSC as a process of networking between individuals and organizations involved in commercial agreements established in a paperless environment using web-enabled capabilities. According to Bhargava et al. (2013), Digital Supply Chain (DSC) consists of a combination of systems that support communication and transaction processes between global distribution organizations and their partners' activities within the supply chain. Integrating advanced technologies into traditional supply chain operations generates a significant amount of data and information, which can enhance supply chain value. For example, digital technologies such as intelligent labels, smart contracts, and digital storage enable traceability throughout a product's entire life cycle, from raw material sourcing to final delivery (Zhou, Zhu, & Xu, 2023). Unlike closely related concepts such as digital technology adoption and transformation, supply chain digitalization specifically emphasizes how implementing digital technologies transforms supply chain processes and decision-making (Ageron, Bentahar, & Gunasekaran). DSCs can harness real-time data from multiple sources to facilitate demand stimulation, matching, sensing, and management, all of which contribute to improved performance and risk reduction.

Several theoretical perspectives have been proposed to elucidate the relationship between DSC and firm performance. One prominent framework is the Resource-Based View (RBV), which posits that firms can achieve sustainable competitive advantage by leveraging unique and valuable resources, including digital technologies, to create superior customer value. Kinnet (2015) highlighted that Digital Supply Chain (DSC) is defined by their speed, intelligence, and value. The introduction of new technologies and analytics is driving the creation of novel revenue streams, returns, and profits. Similarly, Schrauf and Berttram (2016) argued that digitalization not only enhances the value of supply chains but also makes them more accessible and cost-efficient. Their conclusions align with Israelit et al. (2018), who suggested that companies adopting digital technologies in their supply chains can quickly improve service levels. A fully integrated and digitalized supply chain network allows businesses to rapidly respond to customer demands, boosting effectiveness, efficiency, and productivity. Digital (2015) also noted that DSCs provide manufacturers with deep insights into customer behavior, helping them establish a unique position within a complex ecosystem of partners, suppliers, and customers. Motors (2017) suggested that Digital Supply Chains (DSC) address operational challenges by providing comprehensive visibility into a company's needs, objectives, and obstacles. For a DSC to function effectively, companies must strategically plan to deliver valuable, real-time information across the entire network. In Europe, businesses are making substantial investments in digitalization as a key part of their business strategies (Kearney, 2015). Notable examples include companies like Amazon, Alibaba, Lufthansa, BMW, DHL, and DB Schenker, all of which are significantly investing in digitalization efforts.

In DSC, information is also easy to manage and record, which increases traceability. Updating product information could be a two-way process, either upstream or downstream. Information can be updated more precisely during monitoring thanks to the streamlined communication interface that a DSC can offer (Germani et al., 2015). Senior management must develop a broader perspective on how to leverage digital technologies to fully capitalize on their current potential. The intricacy of information flow made a lot of things possible by the digitization of demand and supply creates more opportunities for companies (Ardito et al., 2018). Therefore, it can be hypothesized that;
H1: There is a significant relationship between digital supply chain and business performance.

Trust
Trust is a crucial factor in the relationships between businesses and their stakeholders, influencing various business outcomes, including overall performance. It can be described as the willingness to be vulnerable to another party's actions, based on the expectation that the party will carry out an important action for the trustor, even without the ability to monitor or control them. In a business setting, trust extends to relationships between employees, business partners, and between businesses and their customers.

In recent years, there has been a significant increase in research highlighting the importance of trust within organizations. Trust plays a vital role in organizational environments, affecting various outcomes (Brühl et al., 2018; Fulmer, 2018). A lack of mutual support and trust between internal stakeholders, such as employees and managers, often leads to reduced productivity and weakened performance (Vanhala & Dietz, 2015; Zeffane & Connell, 2003). Organizational efficiency is believed to be attainable only when interdependent actors collaborate effectively in an atmosphere of positive trust (Zeffane & Connell, 2003). As a result, trust influences key organizational outcomes, such as innovation (Vanhala & Ritala, 2016) and overall performance (Koohang, Paliszkiewicz, & Goluchowski, 2017)

High levels of trust among team members can enhance collaboration, communication, and overall team performance. Research by Costa, Roe, and Taillieu (2001) suggests that trust within teams fosters a positive work environment that encourages information sharing and innovation. Dirks and Ferrin (2002) found that when employees trust their leaders, they are more likely to exhibit higher levels of organizational commitment, job satisfaction, and performance. Trust contributes to the psychological safety of employees, allowing them to take risks and be creative without fear of negative consequences. Edmondson (1999) showed that teams with high psychological safety are more likely to engage in learning behaviors, which can lead to improved performance.

Trust is a critical determinant of customer loyalty. Trust within an organization encourages risk-taking and experimentation, which are essential for innovation. For instance, studies by Hansen, Morrow, and Batista (2002) indicated that higher levels of trust correlate with better financial performance, customer satisfaction, and employee productivity. The literature consistently demonstrates that trust is a pivotal factor influencing various dimensions of business performance. Businesses that cultivate and maintain trust are better positioned to achieve sustained competitive advantage and superior performance outcomes.
H2: There is a significant relationship between trust and business performance.

Communication
Effective communication enhances organizational relationships and minimizes strikes and lockouts (Musheke & Phiri, 2021). Effective communication is vital in the oil and gas industry, where complex operations, high risks, and diverse stakeholders demand precise and efficient information exchange. This literature review explores the relationship between communication and business performance in the oil and gas industry, highlighting key areas such as safety, operational efficiency, stakeholder management, and crisis communication. In the high-risk environment of the oil and gas industry, effective communication is crucial for maintaining safety standards. Effective communication with local communities is essential for maintaining social license to operate. According to Musheke and Phiri, (2021), communication is a very crucial and significant element in an organization, and it is necessary for creating collaboration within the work environment that has effects on organizational performance and decision-making.
Jenkins and Yakovleva (2006) found that transparent and proactive communication strategies build trust and support from local communities, which is critical for project success. In the heavily regulated oil and gas

industry, maintaining good communication with government bodies is crucial. Kuria (2008) revealed that inadequate communication poses a significant challenge to organizational performance, particularly in providing effective customer service. When information is not thoroughly communicated between individuals, customers are less likely to receive quality service, which serves as a key indicator of both employee efficiency and overall organizational performance.

Pereira and Gonçalves (2022) confirm that organizations that prioritize clear communication channels experience higher employee satisfaction and performance levels. Engaged employees are more likely to be motivated, reducing turnover rates and enhancing overall organizational performance. Clear and consistent communication is key to improving operational processes. Amoah and Jibril (2021) demonstrate that effective communication practices lead to better coordination among teams, reducing errors and delays. This is especially important in industries like oil and gas, where operational complexities are high. Improved communication leads to more efficient workflows, optimized resource utilization, and ultimately better financial performance. Communication is also a key driver of innovation and change within organizations. Open and collaborative communication fosters a culture of innovation, where employees feel empowered to share ideas and take risks. According to Men (2014), leaders who communicate a clear vision and encourage open dialogue create an environment that supports innovation and continuous improvement, leading to better business performance. In conclusion, effective communication is a crucial driver of business performance in the oil and gas industry. It plays a vital role in ensuring safety, enhancing operational efficiency, managing stakeholder relationships, and handling crises. Therefore, it can be hypothesized that;
H3: There is a significant relationship between communication and business performance.

Competency
Competency is defined as the combination of skills, knowledge, and abilities required to perform a job effectively, and is a critical determinant of business performance. Competent employees contribute to organizational success through enhanced productivity, innovation, and customer satisfaction. Competency plays a crucial role in influencing business performance by improving efficiency, innovation, customer satisfaction, and strategic alignment. Organizations that effectively identify, develop, and manage competencies are better positioned to achieve their performance goals and maintain a competitive advantage. However, to maximize the benefits, organizations must address challenges related to measurement, evolution, and cultural integration. Dubois et al (2004) argued that strategic competency management ensures that organizations have the right skills in place to execute their strategies effectively, leading to better performance outcomes. Salas and Cannon-Bowers (2001) found that training programs that enhance employee competencies lead to improved job performance and overall productivity. In addition, Campion et al. (2011) found that competency-based selection methods are more predictive of job performance than traditional selection techniques. Finally, Bakker and Demerouti (2008) demonstrated that competency enhances employee engagement, which is linked to higher job satisfaction and performance. Employee competencies have become an increasingly important factor in driving a successful business in today's competitive environment. Competencies are considered to provide a competitive edge, as having highly skilled employees enables a company to navigate challenging situations problems as various difficulties in demanding situations.
H4: There is a significant relationship between competency and business performance.

Agility
The growing complexity and volatility of global markets demand supply chain agility and responsiveness. Digital technologies allow firms to detect and adapt to changes in demand, supply, and market conditions more quickly and effectively. Through advanced analytics, automation, and real-time monitoring, organizations can enhance their ability to detect disruptions, reroute supply chains, and adapt production schedules, thereby improving responsiveness and resilience to external shocks. With the rapid market changes and ongoing competition, managers frequently face pressure to keep pace and demonstrate supply chain agility. Supply chain agility has been identified as a crucial operational proficiency for establishing a competitive edge given the growing importance of timely and economical product delivery (Brusset, 2016). Management is still considering ways to increase the agility of the supply system when it decides to manage inventories digitally. This could aid the business in enhancing tracking, distribution, and reaction times in the supply chain (Bi et al., 2013).

Enterprise flexibility and supply chain system agility are key factors, and this flexibility is the most crucial component for enhancing supply chain agility and business productivity. There are many different ways to define and evaluate supply chain agility. The definition of "agile" when it first appeared in the business sector was "the act of an enterprise thriving in a rapidly changing and unpredictable climate" (Chan, Ngai, & Moon, 2017).

The attribute of agility illustrates how flexible the DSC is. It is the capacity to change strategy in response to market developments and customer demand. In comparison to their first purchase order, the needs of the customer could shift over time. The precise and timely management of resource changes must require the integration of knowledge sharing. If there is a delay in reacting to the modifications, the delivery time will be impacted (Zhao, Huo, Sun, & Zhao, 2013). Therefore, the hypothesis is as follows;
H5: There is a significant relationship between agility and business performance.

Transparency
Transparency is defined as the disclosure of information and knowledge (Egels-Zandén, Hulthen & Wulff, 2015). This includes the disclosure of information about suppliers' names, sustainability conditions at suppliers, and buyers' purchasing practices. Transparency can also enhance operational efficiency by promoting better decision-making, resource allocation, and risk management within organizations. Hammervoll and Bø (2010) stated that transparency is the amount of possession of on-hand information by the supply chain partners. Transparency is becoming more crucial in enabling many people to critically assess the firms' sustainability commitments (Egels-Zandén, Hulthén, & Wulff, 2015). If a technology-based strategy is implemented, there will be substantially greater transparency and visibility in all areas of the supply chain. Early technological adoption has difficulties from several perspectives, but if such technologies are well-planned and have the necessary framework and architecture in place, significant adoption barriers might be surmounted. To increase supply chain transparency, governance tools, which are an assortment of agreements and arrangements between supply chain players, are crucial. They create an organizational network for knowledge sharing.

The relationship between supply chain transparency and business performance has been studied by several authors (Nyamah et al, 2022, Ahmed & Omar, 2019; Bastian & Zentes, 2013). These studies in agricultural food firms found that supply chain transparency increases business performance. Besides that, in India traceability, transparency, and information flow are crucial components intended to ensure the quality of dairy products (Pant, Prakash, & Farooquie, 2015). This leads to an increase in performance. Therefore, the hypothesis can be concluded as follows;
H6: There is a significant relationship between transparency and business performance.

Training
As technology evolves more rapidly providing training is one of the most important aspects of increasing business performance. Human capital often encompasses training programs designed to enhance employees' knowledge, skills, social abilities, and ethics. These programs aim to improve employee performance and satisfaction, which in turn boosts the company's overall performance. Consequently, supply chain and logistics sectors should consistently be prepared for any necessary technical qualifications (Hashim & Shariff, 2016).

A well-designed training program and module could help employees with specialized abilities. According to Bienhaus and Haddud (2018), organizations must design a training program to move into digital transformation (Bienhaus & Haddud, 2018). The business should invest in DSC management training to increase the firm performance. This can develop into intellectual capital if given time to mature through training and work experience (Aziz, 2016). Therefore, organizational goals and supply chain sustainability initiatives are connected to departmental training and learning (Teixeira et al., 2016). It is supported by Kang and Na (2020) and Martins (2022) who revealed that the additional training led to economically and statistically significant improvements in several dimensions of firm performance. This can be hypothesized as;
H7: There is a significant relationship between training and business performance.

3. Research Methodology

Measures

This study involves one dependent variable and six independent variables. Firm performance is a dependent variable and is measured using subjective methods as suggested by Kotey and Meredith (1997). There are nine items used to measure the dependent variable, namely investment return, profit growth rate, asset-liability ratio, market share, customer satisfaction, partner trust, logistic services and work specialization, technology adaptation and new services, and better performance after implementation of digitization in the supply chain. The respondent's level of agreement with all the items is based on a five-point with a frequency of "1= strongly disagree" to "5= strongly agree". The independent variables consist of the DSC factor as the focus factor of the study in addition to six other factors identified as determinants of firm performance. The factors are trust, communication, competence, agility, transparency, and training. DSC variables are measured based on eight items, namely information acquisition, information flows within the company and partners, benefits of information exchange, financial transaction activities more efficiently, coordinating financial transactions with partners, reduction of financial coordination costs, insurance coverage from suppliers and successful implementation digital in company procurement management. Measurements are made using a five-point scale with a frequency of "1= strongly disagree" to "5= strongly agree".

The trust variable is also measured based on the respondent's level of agreement with a frequency of "1=strongly disagree" to "5=strongly agree" involving nine items that are used as measurement elements. The items are concerned with the welfare of the supplier in making decisions, responding with full understanding if there are problems with the supplier, depend on the supplier to make decisions, depend on the supplier in important matters, sources of information from the supplier, suppliers often keep their promises, give consideration to the supplier's advice in operations The company's business, the company's organization depends on the sincerity of the supplier and the company has confidence in the supplier in using a digital approach. The communication variable involves six items, which are often communicating with suppliers using digital methods, the company always interacting face-to-face with suppliers, always collaborating with suppliers, often interacting with suppliers online, often collaborating with suppliers using interactive communication, and the importance of communication in the chain system. Company supplies. The measurement of the variable is based on the level of agreement of the respondents based on a five-point Likert scale with a frequency of "1= strongly disagree" to "5= strongly agree".

The competence variable is measured based on staff competency using eight items, namely inventory management, communicating with suppliers and customers, delivery accuracy, finding solutions in the supply chain, reducing supply chain costs, increasing information sharing, increasing the supply chain through the exploration of new opportunities and purchasing and procurement management. The measurement of agility variables is made based on the respondent's ability to respond in various operational dimensions. There are nine items used for that purpose, namely, purchase order processing time, reduction of purchase order improvement process cycle time, increase in the frequency of introducing new purchase procedures, increase the level of purchase modification process, purchase process preparation, customer service, purchase process reliability, increase responsiveness, adaptation and modification of the purchasing process. All the items are measured using a five-point scale with a frequency of "1 = very low" to "5 = very high".

The transparency variable is measured based on seven items, namely the internet network in the supply chain ecosystem, the flow of information and materials, logistic operations, reducing operational complexity, enabling easier access to material information, obtaining detailed product life cycle information, and increasing transparency in the supply chain system. Company. The level of agreement for the variable is measured using a five-point scale between "1= strongly disagree" to "5= strongly agree". For the training variable, respondents are required to state their level of agreement about the information about training based on a five-point scale, which is "1- strongly disagree" to "5= strongly agree". There are nine items used to measure the variables, which are the training content according to the company's requirements, the trainee's responsibilities and duties are determined accurately, training is offered to all staff, infrastructure facilities meet the training program requirements, training locations inside and outside the company, performance evaluation after training, approach the topics used are appropriate and up-to-date for the company's activities and the effectiveness of the training program.

Sample

In the management of firm operations, the DSC approach is widely practiced in large firms including the oil and gas sector. The staff's ability to adapt the DSC in the work process is seen to have a positive effect on the firm's performance. The sample frame of the study involves two units that are important in Petronas operations, namely gas processing (1235 people) and oil refinery (532 people). Based on the total population it is divided according to strata (department). For the study analysis, the sample size for each stratum is determined based on the population ratio of each department and the total population. Based on the sample calculation suggested by Krejcie and Morgan (1970), the required sample is 523 people, each involving the staff of the gas processing unit (297) and the oil refinery (226).

Table 1: Sample distribution by department

Department	Gas processing		Oil refinery	
	n	*S*	*n*	*S*
Technical Services	211	51	20	8
Facilities and Administration	16	4	15	6
Operation 1	371	89	140	60
Operation 2	341	82	125	53
Health, safety, and environment	17	4	25	11
Human Resources Management	9	2	11	5
Operation Excellent and improvement	19	5	20	8
Production planning	12	3	41	17
Utilities	229	55	105	45
Others	10	2	30	13
Total	1235	297	532	226

Notes: n is population size; S is sample size Source:
Based on the sample survey

The data collection process was managed by the researcher by distributing questionnaires to respondents selected as a sample using Microsoft Forms (MS Form). The method is used following Petronas's information technology security policy. The distribution of the population and sample is shown in Table 1. Some data tests are done first to ensure the reliability of the data that will produce the study model. Table 2 shows the value of Cronbach alpha (α) for all the study variables is above 0.7, indicating that the study data are reliable as explained by Nunnally (1978). The Collinearity Statistics test was performed to ensure the reliability of the regression model formed in the study. The problem of multicollinearity will occur when there is a perfect linear relationship between the variables and it can be determined through the correlation coefficient. Based on the Tolerance value (> 0.1) and VIF (Variance inflation factor) (< 10) show that there is no problem of multicollinearity in the study data. Therefore, the research data can be analyzed through the multiple regression method and produce a good regression model.

Table 2: Reliability Test and Collinearity Statistics

Construct	Reliability Test		Collinearity Statistics	
	Items	Cronbach's α	Tolerance	VIF
Trust	9	0.904	0.295	3.391
Communication	6	0.850	0.525	1.903
Competency	8	0.895	0.594	1.683
Agility	9	0.955	0.336	2.979
Transparency	7	0.851	0.353	2.834
Training	9	0.898	0.494	2.026
DSC	8	0.918	0.564	1.772
Firm Performance	9	0.925		

Source: Based on the sample survey

4. Results

The results of the descriptive analysis involving the mean, standard deviation, and correlation between all the study variables are shown in Table 3. Overall the mean value for all the variables is high. The mean value for the DSC variable is 3.805, giving the impression that respondents agree with the importance of the DSC in the operations of petroleum-based firms. The analysis also indicates that the relationship between the variables is moderate, with values ranging from 0.215 to 0.760. This explains that there is no multicollinearity problem and allows the study data to be analyzed using the multiple regression method. Hierarchical multiple regression was used to evaluate the ability of DSC variables to predict firm performance after controlling for six other variables.

Table 3: Descriptive Statistics and Correlation.

Variable	Mean	SD	1	2	3	4	5	6	7
1. Trust	3.795	0.465	1.000						
2. Communication	4.033	0.516	0.647***	1.000					
3. Competency	3.839	0.466	0.548***	0.481***	1.000				
4. Agility	3.773	0.511	0.731***	0.568***	0.599***	1.000			
5. Transparency	3.879	0.481	0.760***	0.568***	0.528***	0.712***	1.000		
6. Training	3.783	0.496	0.649***	0.556***	0.427***	0.588***	0.603***	1.000	
7.DSC	3.805	0.492	0.552***	0.447***	0.357***	0.602***	0.553***	0.547***	1.000
8. Firm Performance	5.457	0.622	0.341***	0.215***	0.302***	0.361***	0.291***	0.405***	0.479***

Data analysis was analyzed according to two operational units, namely gas processing and oil refinery, in addition to the overall data. The results of the multiple regression analysis are shown in Table 4. Model 1 analyzes six factors that affect firm performance. The total variance explained for the six variables that can explain the firm's performance for the overall sample is 20.5 percent, $F(6, 192) = 15.939$, $p < 0.01$. As explained, the main objective of the study is to evaluate the influence of DSC and performance factors on firm performance. Accordingly, in Model 2, the analysis is made by considering the DSC variables in addition to the existing six variables. The separation of analysis according to two models can give a clear picture of the role of DSC factors on the firm's performance. Research analysis shows that there is a change in explanatory power (R^2 = 28.6 percent), $F(1, 273) = 21.186$, $p < 0.01$. The inclusion of DSC variables in Model 2 clearly shows that there is an increase in R^2 across all three data categories. This explains the variable's significant influence in explaining the variation in firm performance in the oil and gas sector operations.

In explaining all the research hypotheses, the analysis focuses on Model 2. Empirically, the study found that the DSC significantly and positively influenced the firm's performance in the management of gas processing ($\beta = 0.434$, $p < 0.01$), oil refinery ($\beta = 0.654$, $p < 0.01$) and the whole sample ($\beta = 0.480$, $p < 0.01$). This finding allows the study to confirm H1 which explains the importance of DSC factors in the operational management of petroleum-based firms. The significant finding is consistent with Ardito et al (2018) and Israelit et al. (2018). The use of DSC in the firms will significantly enhance the business performance. The assimilation of the DSC creates more opportunities for firms and can speedily enrich the service levels of the firms.

Table 4: Result of regression analysis

Variables	Model 1			Model 2		
	Gas Processing (n = 225)	Oil Refinery (n = 153)	Overall (n = 378)	Gas Processing (n = 225)	Oil Refinery (n = 153)	Overall (n = 378)
Digital supply chain Performance factors				0.434***	0.654***	0.480***
Trust	0.295	-0.025	0.124	0.193	0.015	0.096
Communication	-0.194*	-0.085	-0.153**	-0.145	-0.159	-0.172**
Competency	0.291**	0.038	0.163**	0.317**	0.085	0.200***

Agility	0.176	0.258**	0.197**	-0.029	0.136	0.037
Transparency	-0.181	-0.059	-0.100	-0.218	-0.121	-0.168*
Training	0.245*	0.505***	0.395***	0.147	0.344***	0.285***
Constant	3.094	3.098	3.128	2.855	1.845	2.629
R^2	0.196	0.247	0.205	0.253	0.395	0.286
Adjusted R^2	0.174	0.217	0.192	0.299	0.366	0.273
F Statistics	8.877***	8.003***	15.939***	10.522***	13.535***	21.186***

Notes: Significant at *p < 0.10, ** p < 0.05 and ***p < 0.01, Firm performance as dependent variable
Source: Based on the sample survey

Model 2 indicates that trust does not significantly impact firm performance across all three sample categories. Therefore, the study cannot confirm H2. As for the communication, the findings show that the variable only shows a significant value for the overall sample (β = - 0.172, p < 0.05), and is not significant for the gas processing and oil refinery operational units. Accordingly, the study cannot fully confirm H3. The analysis also shows that the competency variable has a significant influence on the performance of the firm in the petroleum sector for the gas processing operation unit (β = 0.317, p < 0.05) and the overall sample (β = 0.200, p < 0.01). While the variable is not significant for the oil refinery operation unit. Based on the findings, the study can only partially confirm H4 which relates to the positive influence of competence factor on the performance of petroleum firms.

The study also fails to confirm H5, as data across all categories show that agility does not significantly affect firm performance. Additionally, the analysis reveals that the transparency variable does not significantly impact firm performance in either data category related to the operating unit. Only the whole sample (β = - 0.168, p < 0.1) shows a relatively weak negative relationship with firm performance. Therefore, only H6 is partially confirmed. The negative sign is inconsistent with the findings of Nyamah et al, (2022), Ahmed and Omar (2019), and Bastian and Zentes (2013). These studies found that supply chain transparency significantly increases business performance.

The statistical analysis in Model 2 also shows that the influence of training on the performance of the firm in the petroleum sector for the gas processing operation unit is not significant. However, the influence of training on the firm's performance for the oil refinery unit sample (β = 0.344, p < 0.01) and the overall sample (β = 0.285, p < 0.01) shows that there is a significant positive relationship. Accordingly, the study can partially confirm H7. This finding is supported by Kang and Na (2020) and Martins (2021). Additional training can positively and significantly influence several dimensions of the firm performance. This is also consistent with the theory of RBV.

5. Discussion and Conclusion

The main objective of the study is to evaluate the influence of the DSC and some other factors on the firm's performance. A total of 523 PETRONAS staff involved in the operation of two main units, namely gas processing and oil refinery, were used as a study sample. The multiple regression analysis method was used to explain all the research hypotheses. The transformation of the supply chain process that took place from manual management to a technology use approach, became a catalyst for PETRONAS to make a large investment to adapt the use of digital in the company's supply chain management. The digitization of the supply chain process is an approach that involves the use of technology to manage the flow of goods, information, and finance across the entire supply chain in business operations. The digitization of supply chain management needs to be done not only to meet the needs of the technological transformation that occurs in the management of various sectors but also to create unique resources that the firm has compared to its competitors, especially in the same industry. The ability to create unique resources with characteristics such as being hard to obtain and imitated by competitors, having no substitute, and having value is a competitive advantage that can generate firm performance (Barney, 1991).

The findings empirically show that the DSC has a significant positive influence on firm performance across the three study samples, namely gas processing, oil refinery, and the overall sample. This explains that technology-driven supply chain management practices have had a positive impact on the processes that occur in business

operations. The impact of the adaptation of digital elements in the management of PETRONAS operations has shown a significant improvement, especially in terms of operational efficiency and increased company profits. Digital supply management can increase the visibility of the process that takes place and allows the company to make quick decisions, facilitating the tracking of any deviations that occur and further reducing the risk of operational failure. In addition, the digital system used can also reduce human error, avoid the occurrence of the price of non-conformance, make the flow of the work process more efficient, and lead to cost savings. The digitization of supply chain management also allows management to make more agile actions to any changes and market uncertainties that occur, especially concerning demand and supply.

However, the findings show that the influence of the DSC is not absolute because several other factors also show the ability to influence the firm's performance. This study provides empirical evidence that communication, competence, transparency, and training are significantly related to a firm's performance. Those internal factors related to human capital are seen as complementary to the effectiveness of DSC implementation in the firm's operations. The importance of human capital resources is consistent with the resource-based view theory that places these resources as the main element that can influence firm performance. The firm's ability to coordinate human resources with the digitization of material supply management will strategically increase business competitiveness and create comparative advantage.

In terms of policy implications, the findings highlight the importance of Digital Supply Chain (DSC) practices for industry players. The transition to digitizing operational processes has a significantly positive effect on a firm's performance. The ability of human resources also needs to be strengthened simultaneously with the digitization measures that are carried out. The skills of the staff involved can be improved through their exposure to appropriate training. The findings indicate that, alongside the competency element, training is the most critical requirement. The values of human capital need to be improved to ensure the effectiveness of DSC implementation at the maximum level. The effectiveness of human capital is crucial for addressing issues that frequently arise during the digitalization of supply chain management. Challenges that may arise include the ability to consolidate data from various sources such as suppliers, partners, and systems within the company. A key policy implication of using digital supply chains is the need for enhanced cybersecurity and data protection regulations. As supply chains become increasingly digitized, vast amounts of sensitive information, including transaction records, shipment tracking, inventory levels, and customer data, are transmitted and stored electronically. This creates vulnerabilities to cyberattacks, data breaches, and potential intellectual property theft. Therefore, governments can establish or enforce regulations requiring companies to adopt robust cybersecurity measures, such as encryption, multi-factor authentication, and continuous monitoring of digital systems.

Limitations and future research

This study focuses solely on evaluating the impact of the DSC approach and a few other factors on the performance of firms within the oil and gas sector. On a broader scale, different business sectors could be examined, offering more comprehensive insights and improving the ability to predict how the DSC approach influences firm performance. Additionally, this study limits its analysis to one aspect of physical resources (DSC) and four elements of human capital resources (communication, competence, transparency, and training) in assessing their effects on firm performance. From the perspective of resource-based view theory, alongside human resources, physical resources (such as firm characteristics, asset ownership, location, and raw materials) and organizational resources (such as the firm's formal reporting structure, planning, control, coordination systems, and informal relationships both within and outside the firm) are also factors that can influence firm performance. Considering these various factors in future research could offer more comprehensive insights into the support needed for DSC implementation to enhance firm performance.

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