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Research Article

Supply Chain Resilience During the Covid-19 Pandemic: Understanding the Role of Collaboration, Visibility, Velocity, and Flexibility in Supply Chain Resilience Using Structural Equation Modeling Approach

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ABSTRACT

The Covid-19 has wrought havoc on the supply chain across the world. During the global pandemic, supply chain managers were forced to rely on short-term solutions with little to no impact on their operations. This paper aims to assess the effect of collaboration, visibility, velocity, and flexibility on supply chain resilience. A total of 66 respondents constitutes the sample of the study, consisting of middle management employees across all depots nationwide. Eight research questions and eight hypotheses were generated and tested at 0.05 significance level using descriptive statistics and path analysis to quantify the relationships among multiple variables. Data were then analyzed through partial least squares - structural equation modeling. Results showed that collaboration, visibility, and flexibility have a significant impact on supply chain resilience. However, velocity did not have a significant impact on supply chain resilience. The research concludes that the supply chain capabilities play a crucial role in the supply chain resilience of the company and its supply chain partners. The key recommendations of the paper help enhance these capabilities to improve the resilience of its supply chain.

Keywords: *Collaboration, Flexibility, Supply chain resilience, Velocity, Visibility*

Introduction

The onslaught of Covid-19 has brought many industries into rethinking their strategies, business models, systems, including supply chain resilience. Significant supply chain disruptions triggered by COVID-19 taught firms a painful lesson anew (Linton and Vakil, 2020): that is, the main factors for surviving and thriving in the current business environment are no longer limited to low costs, high quality, or short delivery times, but also include a firm's ability to effectively respond to supply

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chain disruptions (Carvalho *et al.*, 2012). In 2020, significant shortages in the supply chain of many goods were the one of the many discussions in the media, policy discussions and everyday conversation.

Southwick et al. (2014) defined resilience as the process of adapting well in the face of adversity, trauma, tragedy, threats, or even significant sources of stress. It focuses on the organization's capacity to survive and grow, mobilize its characteristics to have a tolerable attitude, and overcome events and experiences (Mowbray, 2011). Sheffi and Rice (2005) initially defined in the supply chain domain as a capability that enables the supply chain to "bounce back" after a disturbance.

Juttner & Maklan (2011) postulated that supply chain resilience allows the supply chain to properly manage these disruptive events and risks to properly adapt and recover to its normal operations. It is based on the underlying assumption that business environments are volatile and constantly changing. Additionally, supply chain resilience can also mean "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Kamalahmadi & Parast, 2015). To be a resilient supply chain, it must be able to properly ready itself, have prompt response to the disruptive event, and go back to normal operations after the disruption. Lemke et al. asserted that it has become vital to identify innovative and practical strategies that can prevent and control risks and disruptions while maintaining the resilience of critical supply chains. A study by Hecht et al. (2019) identified ten factors that contribute to organization-level resilience for firms in the trucking industry that grow, distribute, and supply food: formal emergency planning; staff training; staff attendance; redundancy of food supply, food suppliers, infrastructure, location, and service providers; insurance; and post-event learning.

Supply chain resilience may be affected by numerous factors such as collaboration, visibility, flexibility, and velocity. In the event of a disruption, resilience cannot be achieved unless all participating firms collaborate and respond synergistically (Juttner and Maklan, 2011). Collaboration is viewed as long-term partnerships between supply chain members to share information, resources, and risk to reach common goals (Ellram and Hendrick, 1995). In a supply chain, it is necessary to align the activities, routines, and processes of individual firms in a synchronized manner to reap the benefits of collaboration (Mandal et al., 2016). Visibility refers to the requisite information accessible to firms (Mandal et al., 2016). Busse et al. (2017) highlights that information sharing relates to intangible resources concerning the information shared and is seen as a resource. This suggests that that information should be timely, complete, correct, and pertinent. Scheibe and Blackhurst (2018) posited the significance of visibility in preventing and diminishing the effects of disruptions. Juttner and Maklan (2011) also stressed that having visible risks and knowledge improves supply chain resilience. It is inevitable and relatively common for unexpected disruptive events to occur within a firm's operations.

Since disruptions are frequent in volatile environments, a firm must have the capability to be flexible. This includes being resourceful in coming up with alternative plans of action during a disruptive situation to make more sound decisions. Flexibility aims for developing alternative states or configurations in the event of an unexpected disruption (Mandal et al., 2016). Moreover, Sheffi and Rice (2005) argued that flexibility imparts an organic capability that helps detect seven disruption and emergency planning. It facilitates the coordination processes and enables firms to deal with high levels of uncertainty. This draws the inference that flexibility is a crucial component of a firm's resiliency during unexpected events.

Meantime, a volatile and changing environment with inevitable disruption also accounts for velocity. Velocity is mainly concerned with the pace of adaptation or transformation (Stevenson and Spring, 2009). This means that velocity pertains to how fast a firm could react to the situation and decide on a course of action to address the disruptive event. Mandal (2016) averred that a higher velocity level will make a supply chain more resilient by increasing the speed to recover from a disruption. Juttner and

Maklan (2011) highlighted the importance of velocity at all phases of a risk event: before, during, and after the disruption. This suggests that the more a firm can quickly respond to these disruptions, the more supply chain resilience.

In the Philippines, it was reported that 266,915 trucks are operating in the country and that a part of the over two million Filipinos employed as truck drivers, truck helpers, and truckers (Gumasing and Pacheco, 2018). These actors work in the industry of transportation and logistics, a young industry continuously expanding. As the Philippine economy grows, so does the logistics and transport industry. With increased demand and production of goods comes the increased need to move and distribute these items. This is where the trucking industry enters the picture. Logistics, particularly the trucking industry plays a critical role in the supply chain, specifically transporting goods in a country where thousands of islands are connected through links in a massive archipelago.

Like all industries in the Philippines, the trucking industry undoubtedly has its fair share of problems and challenges. According to Excelsior Worldwide Freight Logistics Corporation (2018), a critical issue that the industry faces is an excise tax on fuel. Along with implementing the TRAIN law back in 2018, the Philippine government decided to add an excise tax on fuel. This poses a problem for truckers as it adds further encumbrance to them. Traffic congestion is another problem that the trucking industry faces in the Philippines. While heavy traffic means that the economy is doing good, it negatively affects truckers' productivity. CNN Philippines Staff (2020) mentions that the traffic index by the same network (which ranks congestion in cities worldwide) showed that Manila's level of congestion is at 71 percent, meaning drivers spend an average of 71 percent extra travel time stuck in traffic. Truckers are unable to maximize their time as most of it is spent waiting in traffic. Due to the heavy traffic in the Philippines, particularly in Metro Manila, several areas now have truck bans.

The study focused on a logistics firm as the main subject of the study since the company is regarded as the largest trucking company in the Philippines. Furthermore, with globalization taking over the supply chain evolution and the increase of e-commerce, the transportation and logistics sector has been beneficial in the economy's overall growth rate (Arora et al., 2020). With COVID-19 and other disruptions taking their toll, global impacts were reported worldwide, which have affected the supply chain logistics, workforce, and suppliers.

The logistics firm can incorporate the practice of supply chain resilience in preparation for future disruptions and adversities. This is due to their logistics management, which includes related services involving supply chain activities, such as information, integration, transport, and distribution. The services being provided have room for innovation and strengthening businesses using ingenuity, creativity, and other modern supply chain technologies to lessen risks and face disruptions. Moreover, logistics and supply chain management have grown over the years, and the firm is a strong candidate for being equipped to know their operating costs. The company could systematically be analyzed to improve its services through opportunities offered by collaboration, flexibility, velocity, and visibility. These would then lead to improved performance and implementation of risk management strategies through building supply chain resilience.

Literature Review

Supply Chain Resilience

In recent years, several high-profile events and persistent problems have severely disrupted firm operations, including earthquakes, political turmoil, fuel crises, diseases, and terrorism (Pereira et al., 2014). Supply chain resilience is a concept that reduces the impact of disruption by increasingly recognizing strategies that encourage the supply chain to react while recovering to its original or better functional state (Scholten & Schilder, 2015). It encourages the firm to take a bigger-picture approach to its supply chain by assessing its weaknesses and strengths to adapt and grow when faced with unexpected challenges. Supply chain resilience enables firms to be ready for events to lessen the possibility of these challenges heavily impacting their supply chain, and to recover from these challenges as quickly

as possible. Improving supply chain resilience has become a strategic priority for firms and they look to academia for a solution (Nikookar & Yanador, 2021). A firm that has achieved supply chain resilience is said to have gained a competitive advantage. Recently, the World Economic Forum conducted a study in 2013 which reported that more than 80% of firms are increasingly gaining concern about their supply chain's resilience. Past research on supply chain resilience has identified various organizational and inter-organizational resources and capabilities that contribute to the development of supply chain resilience (Kamalahmadi and Parast, 2016).

Since transportation is arguably the backbone of a supply chain (Sharma and Sajeev, 2018), trucking companies play a growingly important role in the supply chain. In the same way, the trucking industry's supply chain plays a critical role in functioning optimally. In a study by Sharma and Sajeev in 2018, they highlighted the vitality of supply chain resilience in the truckload transportation industry or the trucking industry. It was pointed out that unforeseen disruptive events are both human-caused and natural events. These include non-functioning equipment, supplier price increases, delays in supplier delivery of container vans, supplier defaults, politically unstable environments, changing customer demands, and natural events such as earthquakes and tsunamis.

Considering the pandemic, the truck drivers' complex spatial and social networks pose COVID-19 acquisition and transmission risks. Lemke et al. (2020) propose that four actions must be undertaken to mitigate disease acquisition and to protect vital supply chains: collecting detailed data on both regular and pandemic-impacted driver routes over an extended period; establishing COVID-19 incidence, prevalence, morbidity, and mortality rates among drivers and their key social contacts; identifying efficacious and practical preventive measures that curb COVID-19 acquisition and transmission.

Overall, the current volatile business and ever-changing environment, especially in the trucking industry, remains the main objective. Transportation is the foundation of the supply chain, and business continuity and supply chain performance depend primarily on the quality and efficiency of the transportation systems (Sharma et al., 2018).

Collaboration

Over the years organizations aimed to improve the efficiency of their activities (Fawcett and Magnan, 2002). Collaboration between firms and integrated partnerships has become very popular in recent years (Madhok and Tallman, 1998). The topic of collaboration among members of the supply chain has gathered growing interest. Collaboration's frequent definition is a partnership of firms to collaborate or work together and share resources to reach similar goals. Fawcett and Magnan (2002) highlight the vitality of having a trusting relationship among supply chain members, where each party has confidence in the other members' capabilities and actions. It is a partnership process where two or more independent firms work closely to plan and execute common goals and mutual benefits (Cao and Zhang, 2011). Sahay (2003) posited that organizations must interact cooperatively with their channel partners to benefit the channel and each player's gain.

Collaboration may deliver benefits and advantages substantially. It helps firms share risks, obtain information, access complementary resources, improve technical capabilities, reduce logistical costs, reduce transaction costs, and enhance productivity (Cao and Zhang, 2011). Many authors cite mutual benefit, rewards, risk-sharing, and information exchange as the foundation of collaboration (Barratt, 2004). Therefore, there is a need for firms in a supply chain to collaborate to ensure uninterrupted access to resources (Mentzer and Zacharia, 2004). Conducting collaborative activities with suppliers should be driven by a clear business need and a convergence of interest (Cao and Zhang, 2011). However, instead of being restricted to coordination only, the relationship between the partners should transform into a more collaborative one (Sahay, 2003). This is because failing to collaborate would result in the distortion of information as it moves through the supply chain, leading to

costly inefficiencies and slow responses (Lee and Rha, 2016).

Visibility

According to Vernon (2008), visibility is commonly used in supply chain management and the logistics communities. Prior research has conceptualized supply chain visibility as a capability that may reduce a supply chain disruption. It is defined as the extent to which all the actors along the supply chains have a shared understanding of and access to the information they requested, without loss, delay, or distortion (Brandon-Jones et al., 2014). More specifically, it pertains to the visibility of demand and supply chain information across the supply chain (Somapa et al., 2018).

Other scholars such as Barrat (2004) have underlined the importance of visibility as vital for improved performance in supply chains. It represents the extent to which a firm can acquire real-time external information and quickly recognize changes in the environment (Wei and Wang, 2010). In the same way, Wei and Wang (2010) averred that "the most crucial external information in supply chains is market intelligence about customer needs, which is the basis for information visibility." Market trends and customer demand information are critical for responding to market change and creating new opportunities (Wei and Wang, 2010).

Velocity

According to Juttner and Maklan (2011), "velocity signifies speed of motion, action, or operation, rapidity, and swiftness with which an organization can react to market changes or events." Velocity in a risk event determines the loss per unit of time (Juttner and Maklan, 2011). Moreover, velocity is concerned with increasing the speed of response of the supply chain to market changes (Mandal et al., 2016). It is also concerned with the pace of adaptation or transformation (Stevenson and Spring, 2009) and emphasizes efficiency rather than the effectiveness of the supply chain's response and recovery throughout and after a disruption (Juttner and Maklan, 2011). Hence, to increase velocity, time must be reduced (Christopher and Peck, 2004). Juttner and Maklan (2011) also pointed out that "velocity in the context of resilience is the speed with which a supply chain can recover and respond to disruption and underscored the importance of velocity at all phases of a risk event."

Flexibility

In the past few decades, flexibility has been widely investigated. Flexibility is an object of great interest in the current literature on operations management (Blome et al., 2014). Particularly in the supply chain, flexibility has been linked to supply chain management in companies' survival and growth (Huo et al., 2018). According to Vickery et al. (1999), flexibility captures an organization's ability to effectively respond to changes from the perspective of the whole value chain. Flexibility is referred to as the ability of the supply chain function to react to changes in the environment (Duclos et al., 2003). In volatile, dynamic environments, flexibility is needed to maintain competitiveness (Blome et al., 2013). In Supply chain flexibility is concerned with how to reconfigure organizational resources in response to the disruptions. In creating resilience through flexibility, a supply chain manager effectively reconfigures organizational resources to recover from a supply chain disruption (Rice and Caniato, 2003). Most studies consider the best supply chain to be the most flexible (Stevenson and Spring, 2019). A flexible supply chain can be employed as a reactive capability, but it can also perform a strategic role (Rojo et al., 2016). For Rojo et al. (2016), flexibility is not only a response that enables an organization to adapt to uncertainty in the environment. It also functions to create uncertainty that competitors find difficult to contend with.

Research Model

The research model (Fig. 1) posits the relationship of four independent variables consisting of collaboration, visibility, velocity and flexibility with the dependent variable, supply chain resilience. Mandal et. al. (2016) asserted that collaboration represents "the partnership process where two or more independent firms work closely to plan and execute common goals and mutual benefits." Visibility pertains to the company's knowledge of risk event

conditions." Velocity refers to the speed with which an enterprise can execute coping strategies." Flexibility represents a company's ability to adjust following a disruption. Supply chain resilience pertains to the ability of a firm to alert and respond to environmental changes and to adapt rapidly to disruptions."

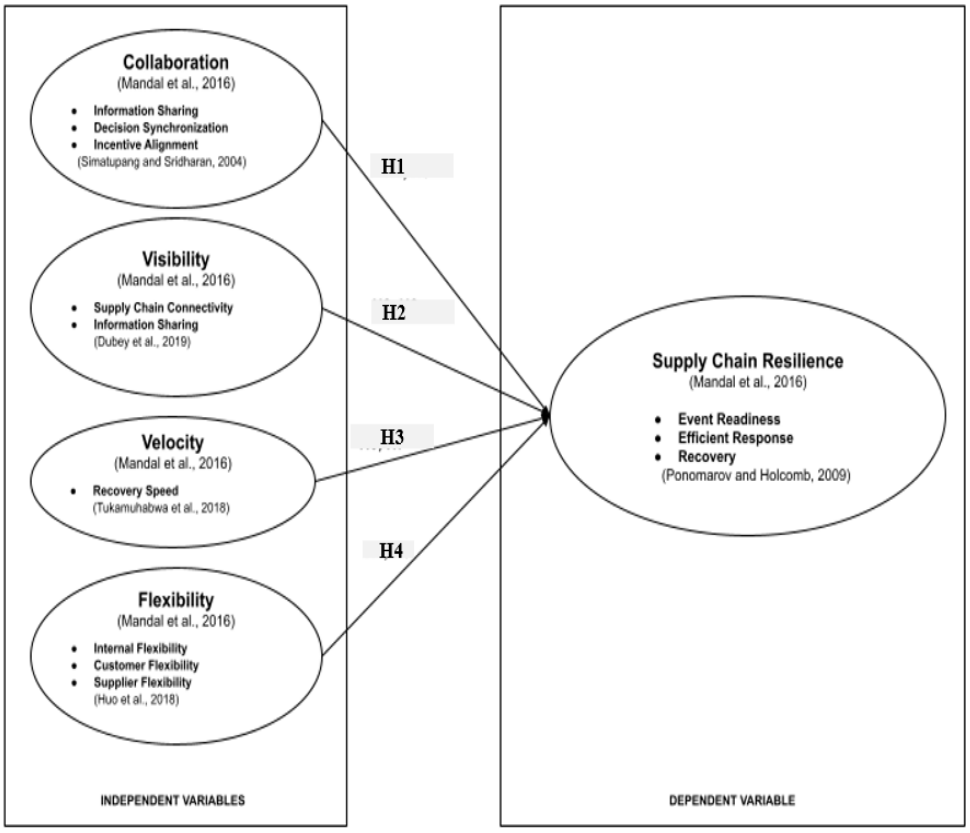

Figure 1. Research model

The Resource-Based View Theory supports the connection of supply chain velocity, supply chain flexibility, and supply chain visibility to supply chain resilience. It used the theoretical and strategic lens of RBVT for the company to use its resources and capabilities to generate optimal performance. In the same theoretical lens, "supply chain flexibility, supply chain velocity, and supply chain visibility are needed in developing supply chain resilience (Juttner and Maklan, 2011). Meantime, DCT or dynamics capabilities theory is used as a theoretical lens on how the company uses its capabilities, namely: collaboration, visibility, velocity, and flexibility in fulfilling supply chain resilience in a volatile environment.

Hypotheses of the Study

The study formulated a total of four hypotheses to examine the potential impact of the collaboration, visibility, velocity, and flexibility on supply chain resilience.

*H*1: Collaboration has a significant effect on the supply chain resilience.

*H*2: Visibility has a significant effect on the supply chain resilience.

*H*3: Velocity has a significant effect on the supply chain resilience.

*H*4: Flexibility has a significant effect on the supply chain resilience.

Research Methodology

Research Locale

The study chose a logistics service company founded in 2012 with its headquarters located Central Luzon. Philippines. The company started with 50 employees, a fleet of 60 trucks with one container yard and later expanded to 13 locations nationwide.

Currently, it has a fleet of over 500 prime loaders and heavy equipment. The firm specializes in container transportation and other services. It offers trucking services, interisland delivery, warehousing and cross-docking, and container depot services. It also offers different kinds of containers for storage and provides services such as laden container storage, empty container storage, and cross-docking facilities. The company's fleet includes temperature-controlled trucks for products that require refrigeration, pressurized vessel trucks for specialized products from liquid chemicals to industrial gasses, bulk trailer trucks for powdered and liquid products, and low bed trucks for heavy equipment.

Sampling Design

The study employed an expert sampling which involves the selection of respondents through their accumulated knowledge and experience (Frey, 2018). A census was performed through surveying all the top and middle management employees because of their experience and knowledge of the operations of the company, specifically on its supply chain. These individuals have the authority to make decisions within their departments, which gives them a higher degree of knowledge in terms of the company's supply chain management.

Data Source

This study utilized primary data through a survey consisting of 66 middle management employees with accumulated years of experience and knowledge in supply chain.

The measures employed to operationalize the variables in the research model are adapted from prior research (Table 1). Supply chain resilience was measured using three dimensions, event readiness, efficient response, and recovery. Meanwhile, collaboration consists of three measures – information sharing, decision synchronization and incentive alignment, velocity with two measures - supply chain connectivity and information sharing: velocity with a single dimension, recovery speed and flexibility with three measures – internal flexibility, customer flexibility and supplier flexibility.

Table 1. Source of Measure

Construct	No. of items	References
Supply chain resilience	9	Ponomarov and Holcomb, 2009; Mandal et al., 2016
Collaboration	7	Mandal et al., 2016
Visibility	8	Dubey et al., 2019; Mandal et al., 2016
Velocity	3	Mandal et al., 2016
Flexibility	7	Huo et al., 2018; Mandal et al., 2016

Data Analysis

The study utilized the Partial Least Squares Structural Equation Modeling to investigate the effect among the variables under consideration, specifically in testing the hypotheses. In contrast to the covariance-based SEM, PLS-SEM requires less stringent assumptions related to measurement levels of the manifest variables, multivariate normality, and sample size (Dimaunahan and Amora, 2016; Hulland, 1999). Structural equation modeling employing partial least square is typically analyzed and interpreted sequentially, in two stages, which involve the analysis of the measurement model followed by the analysis of the structural model (Amora, 2021; Amora et al., 2016).

Results

Out of the total respondents, Operations Ground Managers ranked the highest with 30 or 45.45%, followed by operations maintenance accounting for 14 or 21.21%. Human Resource, and Accounting-Purchasing, with 10.61% and 9.09%, respectively. The remaining positions comprise employees from Motorpool, Shipping Line Relations, Accounting – Budgeting, Accounting – Receivables, Container Yard, Operations – Control and Terminal with combined frequency percentage of 13.66%.

Table 2.

Position	Frequency	Percentage
Ground Operations	30	45.45%
Maintenance	14	21.21%
Human Resource	7	10.61%
Purchasing	6	9.09%
Motorpool	2	3.03%
Shipping Line Relations	2	3.03%
Budgeting	1	1.52%
Receivables	1	1.52%
Container Yard	1	1.52%
Operations – Control	1	1.52%
Terminal	1	1.52%
Total	**66**	**100%**

Measurement Model

All indicator loadings are higher than the acceptable 0.5, bigger in value than the cross-loading values in each column and have p-values of lower than 0.05. This means that there is good convergent validity observed in the measurement instrument and that the respondents were able to properly understand the question-statements as intended.

Table 3: Indicator Loadings and Cross-Loadings

	SCRES	COLLAB	VIS	VEL	FLEX	P-VALUE
SCRES1	-0.917	-0.029	0.006	-0.031	-0.148	<0.001
SCRES2	-0.912	0.136	0.005	0.011	-0.083	<0.001
SCRES3	-0.921	0.127	0.055	0.032	0.021	<0.001
SCRES4	-0.909	-0.048	0.033	-0.115	0.165	<0.001
SCRES5	-0.923	-0.138	0.147	0.040	0.001	<0.001
SCRES6	-0.841	0.011	-0.138	0.185	0.007	<0.001
SCRES7	-0.846	-0.065	-0.155	-0.149	-0.013	<0.001
SCRES8	-0.846	-0.069	-0.042	0.000	-0.001	<0.001
SCRES9	-0.921	0.068	0.066	0.034	0.051	<0.001
COLLAB1	0.385	-0.774	-0.307	0.077	-0.323	<0.001
COLLAB2	-0.226	-0.794	0.034	0.254	-0.069	<0.001
COLLAB3	0.279	-0.655	0.061	-0.210	-0.058	<0.001
COLLAB4	-0.168	-0.627	0.135	-0.120	0.157	<0.001
COLLAB5	0.083	-0.868	-0.006	0.176	-0.040	<0.001
COLLAB6	-0.098	-0.767	0.074	-0.140	0.410	<0.001
COLLAB7	-0.080	-0.614	0.056	-0.154	-0.057	<0.001
VIS1	0.390	-0.153	-0.737	-0.053	0.055	<0.001
VIS2	-0.089	-0.103	-0.761	0.473	-0.088	<0.001
VIS3	0.051	-0.115	-0.672	-0.043	0.081	<0.001
VIS4	-0.073	0.045	-0.728	-0.037	-0.074	<0.001
VIS5	-0.170	0.018	-0.756	0.034	-0.033	<0.001
VIS6	-0.125	0.138	-0.585	-0.119	0.115	<0.001
VIS7	0.218	0.128	-0.610	-0.335	-0.100	<0.001
VIS8	-0.214	0.102	-0.617	-0.115	0.072	<0.001
VEL1	0.118	-0.125	0.054	-0.862	-0.115	<0.001
VEL2	-0.142	0.022	-0.025	-0.877	0.074	<0.001
VEL3	0.026	0.101	-0.029	-0.877	0.039	<0.001
FLEX1	0.226	0.095	-0.113	0.141	-0.598	<0.001
FLEX2	0.063	0.396	-0.263	-0.016	-0.799	<0.001
FLEX3	-0.140	-0.186	0.153	0.039	-0.805	<0.001
FLEX4	0.155	-0.182	0.119	-0.003	-0.685	<0.001
FLEX5	-0.221	0.283	0.127	-0.041	-0.759	<0.001
FLEX6	-0.019	-0.214	-0.157	-0.211	-0.586	<0.001
FLEX7	0.000	-0.292	0.083	0.083	-0.644	<0.001

Based on the AVEs and the HTMT ratios, it can be concluded that the measurement model has good discriminant validity.

Table 4. Correlations Among Latent Variables with Square Roots of AVEs

	SCRE	COL	VIS	VEL	FLEX
SCRE	0.869	0.623	0.617	0.552	0.657
COL	0.623	0.734	0.518	0.454	0.527
VIS	0.617	0.518	0.686	0.338	0.436
VEL	0.552	0.454	0.338	0.872	0.462
FLEX	0.657	0.527	0.436	0.462	0.702

Table 5. HTMT Ratios

	SCRE	COL	VIS	VEL	FLEX
SCRE					
COL	0.682				
VIS	0.678	0.618	0		
VEL	0.612	0.518	0.38		
FLEX	0.734	0.620	0.521	0.563	

Based on the common method bias results, it showed that the AFVIF amounts to .933, an ideal result as it is lower than the acceptable 3.3 (Kock, 2020; Amora, 2020). The result showed that there was no common method bias, which means the instructions of the questionnaire did not influence the answers provided by the different respondents in the same general direction, causing different indicators to share a certain amount of common variation. This validates that the questionnaire instructions and question-statements were unbiased, so respondents were able to answer honestly and indifferently.

Table 6. Average Full Collinearity Variance Inflation Factor

Ave Full Collinearity VIF	1.933	<=5, ideally <=3.3

Model Fit and Quality Indices

To further support the results of the study, the model fit, and quality indices were assessed. The criteria presented in the table below shows that all models fit and quality indices, namely the Average Path Coefficient (APC), Average R-Squared (ARS), Average Adjusted R-Squared (AARS), Average Block Variance Inflation Factor (AVIF), Average Full Collinearity Variance Inflation Factor (AFVIF), and Standardized Mean Absolute Residual (SMAR) were within the acceptable range for each criterion. However, the Standardized Root Mean Squared Residual (SRMR) showed slightly higher results than the acceptable range. This may be explained by the relatively small sample size the study had, wherein increasing sample size results in smaller SRMR values (Taasoobshirazi and Wang, n.d.). With most model fit, and quality indices satisfied, this ensures that the model of the study is valid and ensures reliable and valid research findings and conclusions.

Meantime, the results of the Goodness of Fit (GoF) showed that there is a large GoF, where the larger the GoF, the better the fit of the data to the model (Kock, 2020). In this case, this may be explained by the quality of the questionnaire, which has been thoroughly tested to ensure that it is of good, valid, and reliable quality.

Table 7. Model Fit and Quality Indices (Kock, 2020)

	P-value	Acceptable
APC*1*	0.006	< 0.05
ARS*2*	0.001	< 0.05
AARS*3*	0.001	< 0.05
AVIF*4*	1.999	<=5, ideally <=3.3
AFVIF*5*	1.993	<=5, ideally <=3.3
SRMR*6*	0.122	<=0.1
SMAR*7*	0.095	<=0.1
GOF*8*	0.670	Small >=0.1 Medium >=0.25 Large >=0.36

1Ave Path Coefficient
2Average R-Squared
3Average Adjusted R-Squared
4Av4erage Block Variance Inflation Factor
5Ave5rage Full Collinearity Variance Inflation Factor
6Standardized Root Mean Squared Residual
7Standardized Mean Absolute Residual
8Goodness of Fit

Analysis of Structural Model

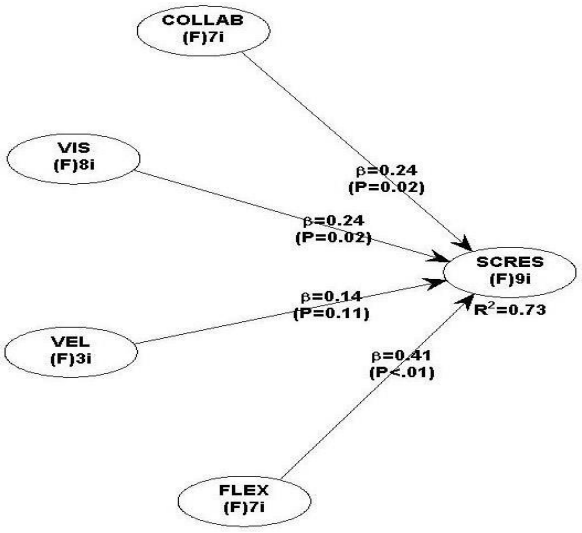

Figure 2: Structural Model

The result shows (Fig. 2) an R-Square of 0.73, which means that 73% of the data fit the model. The high R-Square result indicates that the model of the study is an overall well-fitted model for the independent variables and the dependent variable. The path analysis also shows positive path coefficients, as shown by the beta values. Positive coefficients means that a unit increase in the activity measure of one structure, leads to a direct increase in the activity measure of structures it projects to (Massachusetts Institute of Technology, n.d.). Furthermore, it can be observed that flexibility has the highest path coefficient value, meaning it gives most effect on supply chain resilience. On the other hand, velocity shows the least value for path coefficient, which means that velocity has the least effect, or none, on supply chain resilience.

Table 8: PLS-SEM Result Summary

Hypothesis	Beta	P-Value	Decision
Collaboration on Supply Chain Resilience	0.24	0.02	Supported
Visibility on Supply Chain Resilience	0.24	0.02	Supported
Velocity on Supply Chain Resilience	0.14	0.14	Not Supported
Flexibility on Supply Chain Resilience	0.42	0.01	Supported

Overall, the findings show that collaboration, visibility, and flexibility have a positive significant effect on the supply chain resilience with p-value less than .05.

The significance of collaboration corroborates with the findings of Mandal et al. (2016), Scholten and Schilder (2015) in which collaboration is needed for firms to have supply chain resilience mainly because businesses usually do not possess all the required resources and recreation or development of these resources which may be crucial in responding to unexpected disruptive events. Moreover, firms along the supply chain need collaboration to work together to enhance performance and response to disruptions.

The positive effect of visibility on supply chain resilience is supported by the findings of Brandon-Jones et al.'s study in 2014, where visibility is considered an important antecedent to risk reduction mainly because its presence helps organizations proactively track products and identify potential disruptions, and at the same time because its absence can create new risks. This can be explained through how visibility ensures that the supply chain has easily detected and clear information that is transported and relayed across the supply chain, ensuring that all those involved in the supply chain are clearly informed of the valuable information. In return, this enhances supply chain resilience. It is important to note that the study empirically found that increasing visibility (i.e. making supply chain partners aware of the supply chain related events and happenings) in supply chains help supply chain members to collaborate better. This is because increased visibility mandates efficient information exchange that fosters enhanced transparency and strengthens supply chain relationships (Chopra & Sodhi, 2004).

The results show that the speed at which firms along its supply chain can recover from disruptions does not directly cause resilience in the supply chain. The result (Mandal et al. 2016), may be since the said study sample selection is comprised of one supply chain representative from each company across various industries in India, while this study's respondents are middle management employees of a single company in the trucking industry in the Philippines.

It was observed that flexibility considered the greatest predictor, out of all the variables, of supply chain resilience with the smallest p-value. This outcome is supported by the findings of Sheffi and Rice (2005), where it found that strategic flexibility enables firms to adapt to changing environments and in creating new market opportunities. Flexibility imparts an organic capability in supply chains that helps the detection of disruption and emergency planning. This is mainly because flexibility captures an organization's ability to effectively respond to changes from the perspective of the whole value chain. This gives the supply chain a holistic approach to how to deal with disruptions, through its reactive capability.

Conclusions

The logistics firm's management should take measures to strengthen partnership with other firms to collaborate or work together and share resources to reach similar goals, expand its ability to acquire real-time external information and quickly recognize changes in the environment, as well as enhance its ability to respond to changes in the whole value chain. These capabilities should be maintained to be embedded in its operations and be constantly assessed for improvements to enhance supply chain resilience.

Among the supply chain capabilities, flexibility showed the most significant effect on the supply chain resilience. Flexibility, as the best predictor of supply chain resilience, should be

the prioritized capability. Results also show that middle management employees mostly agree that the firm is flexible in terms of supply chain agent-based changes. With this, the firm's management must maintain its adaptability in supplier booking adjustments, delivery time and schedules adjustments, hauling volume capacity changes, different functional plans, and different customer- and supplier-related plans. Additionally, it should also equip its employees with resources to adapt during hauling accidents that could significantly delay schedules and damage assets, which could potentially affect suppliers and clients.

Recommendations

Prioritizing intrapreneurship through allowing the middle management employees and those under them to be open with their ideas and suggestions may improve the firm's flexibility capability. This is because these individuals have their own specific scope of responsibilities, which over time they have mastered to do.

Integrate information technology systems that still are not present in firm's current system. Global Position System (GPS) trackers are suggested for the fleet of the company. HERE Technologies provides flexible solutions to fleet management in over 200 countries, including the Philippines. Their GPS technology includes precision location data which is easily accessible for their clients. Additionally, their system would allow to visualize the data gathered from the chips embedded to each vehicle. This technology also decreases the cost of running company fleet through reviewing, analyzing, and understanding fleet performance for real-time decision making and forecasting (HERE Technologies, n.d.). Moreover, the system would enable them to plan routes ahead of time. This reduces re- routing time by over 90% in times of disruptions and delays (HERE Technologies, n.d.). This system generates routes based on truck sizes, cargo, and driver experience for greater safety and compliance. Headquarters is alerted once trucks are overspeeding or have come to an abrupt stop or crash. This would give a more accurate picture of potential risks in their operations, as well as a more-prepared rescue team in times of disruption. Furthermore, now that management would have access to the data of trucks that may have gotten into accidents or are delayed in traffic or unfavorable weather conditions. It can now notify its suppliers such as shipping companies, terminal operators, and its clients ahead on the possible delay of the trucks.

Partner with third-party logistics company where it has routes in. The company management can tap these partner logistics companies whenever truck locations are too far away from station depots to send its in-house rescue team. For every 100 km radius, it must have at least one partner to help mitigate truck accidents such as tire blowouts, truck rollovers, jackknives, rear-ending accidents, lost loads, head-on collisions, T-bone accidents, and wide-turn swings. If fully reliant on in-house rescue teams, this could lengthen the response time. The delay in response could affect other trips scheduled for the day, which could affect the firm's supply chain, in which most agents in its supply chain, especially shipping lines, port operators, other container yard operators, and its clients are tightly scheduled.

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