

SUPPLY CHAIN ROBUSTNESS AND SUPPLY CHAIN PERFORMANCE

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Abstract

This paper examined the effect of supply chain robustness on supply chain performance. The paper draws upon pertinent literature to explain the concept of supply chain robustness and its influence on supply chain performance, which is measured in terms of supply chain responsiveness, supply chain reliability, supply chain flexibility and asset management efficiency. Drawing upon extant literature, the study aimed to trace the theoretical links between supply chain robustness and the aforementioned operational measures of supply chain performance. The study found that there are indeed theoretical links between the study variables which can be further assessed empirically.

Keywords: Supply chain flexibility, supply chain performance, supply chain responsiveness, supply chain reliability, supply chain robustness

Introduction

Today's operating environment of firms has become overly complex and dynamic. Firms deal with both business-related and non-business-related factors in the environment that have the capacity to influence business operations. Every business (manufacturing, service, intermediaries) belong to a supply chain. Supply chains are complex networks made up of different organizations that are involved in the flow of goods, services, information and funds to ensure that goods and services get to the ultimate consumer.

Singh et al. (2019) argue that the basic goal of a supply chain is to ensure the flow of products and information to end users. However, there are times when the supply chain is exposed to operational or disruptive risks (Munir et al., 2023) that can inhibit its capacity to achieve its objectives. Disruptive risks are events that have what can be called environment-altering consequences for the supply chain (Munir et al, 2023). The increased volatility in the global environment has produced repercussions for supply chains across the globe (Wieland and Wallenburg, 2012).

The COVID-19 pandemic of 2019 to 2020 virtually shut down the global economy with far-reaching consequences for manufacturers and other businesses. The Russia-Ukraine war came fast on the heels of the pandemic causing more disruptions in certain markets. The Israel-Hamas war which began in October, 2023 has also severely affected global supply chains thereby leading to increased delays in delivering goods and also increased transportation costs.

These events have made it quite clear that supply chains need to be more robust to deal with disruptions. Supply chain robustness is the anticipation and management of risks and aims to put procedures in place to prevent these risks and failing that, to minimize the damage caused by these risks to the operations of the supply chain.

Recent research in supply chain management is increasingly focused on performance based on the belief that to evaluate is to manage. Numerous researchers and practitioners in the field of supply chain management have tried to develop different measures of performance that range from the financial measures to the non-financial measures. This study is an attempt to identify links in literature between supply chain robustness and supply chain performance using non-financial indicators (supply chain responsiveness, supply chain reliability, supply chain flexibility and asset management efficiency) of performance.

Theoretical Foundation: Dynamic Capabilities Theory

One of the most important areas of research in the field of strategic management has been understanding how firms achieve and sustain competitive advantage (Teece et al., 1997). Dynamic capabilities (DC) theory is one of the theories proposed to explain firm competitiveness (Gremme and Wohlgemuth, 2017). DC theory was propounded by Teece et al. (1997). The theory argue that a firm's competitive advantage lies in its dynamic capabilities. These capabilities are learned processes and routines that are products of organizational learning and can be reconfigured to adapt to changing environmental circumstances.

Dynamic capabilities are an interplay of two forces which combine to shape a third force. The first two forces are; (i) the firm's routines and (ii) the firm's combination of assets. These two forces working together, decide the third one which is; (iii) the strategic alternatives available to the firm based on its capabilities.

Supply chains are not just a means of moving products from point of production to point of consumption; they are also points of strategic leverage. In today's business world, competition is no longer between business entities but between supply chains (Sweeney, 2006; Kotler & Kotler, 2016; Manurung et al., 2023). Teece et al. (1997) argue that a firm's capabilities are products of its routines and its current asset situation which includes its relationships with its suppliers and other collaborators.

Robust supply chains are networks that are configured to predict and prepare for systemic changes that can cause disruptions and map out means to ensure the performance of the supply chain is not adversely affected. This pro-activity requires some level of continuous learning to prepare for future events that may create performance problems for the firm. It is therefore believed that the development of robust capabilities in the supply chain would help to ensure that performance levels do not reduce.

Concept of Supply Chain Robustness

A discussion of supply chain robustness necessarily must begin with a definition of a supply chain. Singh et al (2019) depicts the supply chain as a system that connects different specialists from suppliers to end users, with the aim of maintaining flow of goods and information. Lofti et al. (2013) describe a supply chain as a series of organizations involved in different processes and activities to produce products for upstream and downstream customers.

Supply chain robustness has been identified as a proactive approach to forestalling supply chain issues from occurring which in turn helps to avoid deteriorating business performance (Juan et al., 2021). Juan et al. (2021) define supply chain robustness as a supply chain's ability to resist changes without any adjustments to its initial configuration.

Wieland and Wallenburg (2012) define supply chain robustness as the proactive ability of a supply chain to resist change without adapting its original stable configuration. Thus, a robust supply chain has the capability to maintain its operations and functions in spite of disruptions from within and without (Brandon-Jones et al., 2014). Robustness does not make the supply chain immune to change i.e. static rather it makes the chain more able to absorb systemic shocks by making some changes within the system.

Supply Chain Performance

Supply chain performance measurement is a critical aspect of supply chain management (Agami et al., 2012; Mellat-Parast & Spillan, 2013). Effective management generally requires planning, implementation, evaluation and control. Evaluation and control cannot be done

properly without a system for measuring performance. Supply chain performance measurement is important because; (i) it drives supply chain actions by identifying areas for improvement and areas for correction, (ii) it provides a framework for decision-making and (iii) it provides a feedback mechanism (Agami et al., 2012).

Supply chain performance measurement quantifies the efficiency and effectiveness of supply chain activities (Agami et al., 2012). Gunasekaran et al. (2001) argue that supply chain performance measurement focus on an assessment of four links of the supply chain which are (a) plan (b) sourcing (c) make/assemble and (d) delivery/customer.

In other words, an assessment of the performance of any supply chain must assess how well planning, materials and products sourcing, making/assembling a product and delivering the product to the end user is done. Supply chain performance following the views of Gunasekaran et al. (2001) does not just assess the management of flow of productive resources and finished goods, but the management of the manufacturing process.

Supply chain performance measures, regardless of the different views proposed in literature, can be generally categorized into two key groups i.e. financial performance measures and non-financial performance measures (Agami et al, 2012; Ambe, 2014). This study would focus primarily on non-financial measures of supply chain performance specifically supply chain responsiveness, supply chain reliability, supply chain flexibility and asset management efficiency.

Supply chain responsiveness

Supply chain responsiveness is a strategic imperatives to competitiveness (Somuyiwa & Adebayo, 2013; Al-Hawajneh & Attiany, 2014). Minnich and Maier (2006) define supply chain responsiveness as the ability of a supply chain to react deliberately and within an appropriate time frame to customer demands or change in market conditions.

Mandal et al. (2001) refer to supply chain responsiveness as the extent to which supply chain partners respond cooperatively to market changes. They argue that responsiveness is a relational capability that enable firms react positively to market fluctuations. Responsive supply chains prioritize ability to react to changing customer requirements (Al-Hawajneh & Attiany, 2014), hence, they seek to avoid stockouts (Minnich & Maier, 2006). In other words, supply chain responsiveness is the speed of reaction of the supply chain to changing market demands while keeping costs to the barest minimum (Somuyiwa & Adebayo, 2013).

Supply chain reliability

Reliability refers to the ability of a system or component to perform its required operations under clearly stated conditions for a specified period of time (Prasad, 2012). Lennon (2019) describes supply chain reliability as the degree to which a supply chain yields consistent performance.

Ambe (2014) defines reliability from the perspective of delivery reliability, as the performance of the supply chain in delivering the right product, to the right destination at the right time, in the right condition and packaging in the right quantity with proper documentation to the right customer. Indicators of reliability include accuracy in billing, order accuracy, on-time completion of order, delivery of expected quality, delivery of the expected quantity etc (Ambe, 2014; Wasiak et al, 2019) and delivering as promised.

Supply chain flexibility

Supply chain flexibility is crucial to the success of a supply chain because the supply chain exists in an uncertain environment (Agus, 2011). Agus (2011) defines supply chain flexibility as the capacity of the supply chain to react with little loss in effort, time, cost or performance. Macclever et al (2017) defined it as the suppliers' ability to respond quickly to changes in downstream demand with a smaller increase in time and cost.

Bauer and Gohl (2017) referred to supply chain flexibility as the ability of a supply chain to respond to unexpected events effectively without sacrificing time, cost and efficiency leading to performance improvements. As Perez-Perez et al (2019) point out, reacting to unexpected surges or drops in demand requires re-configuring key aspects of the supply chain's operations and this ability to quickly re-calibrate operations is a critical capability of the firm and its partners i.e. it is a shared capability.

The capacity to respond to changes is not the main factor in flexibility rather it is the ability to reconfigure necessary supply chain systems and approaches to effectively deal with changes in demand. For the purpose of this study, supply chain flexibility would be defined as the ability of the supply chain to quickly reconfigure and realign systems and processes to respond to changes in demand to achieve better results.

Asset management efficiency

Asset management efficiency refers to the efficiency with which an organization manages its assets to support demand satisfaction (Ambe, 2014; Leonczuk, 2016; Nag & Ferdausy, 2021). Indicators that measure asset management include cash-to-cash cycle, asset turns and inventory days of supply. Cash-to-cash cycle refers to the time lapse between when a firm pays cash to its suppliers and when it receives cash from its customers. Asset turns are calculated by dividing revenue by total assets i.e. capital and fixed assets. Inventory days of supply measure the number of days cash is tied up in inventory.

Supply Chain Robustness and Supply Chain Responsiveness

Responsiveness is the supply chain's ability to respond adequately to changes in customer demands promptly (Somuyiwa and Adebayo, 2013). Intermediate customers and end users have expectations from the focal firm and its supply chain that need to be met. Disruptions caused by events outside the supply chain can impact on the ability of the network to deliver on its core objectives of ensuring that the customer has the product when it is required (Christopher & Peck, 2004).

Brandon-Jones et al (2014) have argued that robust supply chains are systems that are able to absorb shocks caused by disruptions and still deliver on its objectives no matter the change in demand levels. In other words, robustness in the supply chain enables the supply chain to absorb external shocks to still respond quickly to internal or operational risks i.e. demand variations (Munir, Hanif and Afzal, 2023). Therefore, it is proposed therefore that supply chain robustness has a positive effect on supply chain responsiveness.

Supply Chain Robustness and Supply Chain Reliability

Kotler and Keller (2016) aver that a supply network's objectives must be stated not in terms of what the firm considers to be value but what the customer considers to be value. They argue further that customer expectations hinge around some key indices included shorter lead time, higher spatial convenience, broader product assortment and better services.

Ambe (2014) has also argued that reliability as far as the customer is considered is the firm's ability to deliver the expected product assortment, at the expected time, in the right condition and packaging and at the expected quantity. Munir et al (2023) argue that robustness requires the supply chain partners to be proactive by developing routines that enable it to adjust to the unexpected.

This means that robust supply chains are those proactively prepare for the possibility of unexpected or unanticipated events (Singh et al, 2019) that may hinder the chain from delivering on its promise to its customers. In summary, robust supply chains are those that are still able to deliver what the customer expects in spite of external shocks due to proactive steps and processes already put in place. Therefore, it is proposed therefore that supply chain robustness has a positive effect on supply chain reliability.

Supply Chain Robustness and Supply Chain Flexibility

Durach et al. (2015) argue that robust supply chains are chains that implement measures to cope with turbulence before it happens and not after it occurs. They further argue that incorporating redundancy i.e. reserves or back-up options is a crucial means of enhancing the robustness of the supply chain. The Oxford Learner's dictionary (2024) has defined flexibility as "the ability to change to suit new conditions or situations."

Juan et al (2021) point out that flexibility is the supply chain's ability to adapt to new, different or changing requirements. Following the arguments of Durach et al (2015) that robust supply chains have redundancy built into them, it can be argued that the "allowances" built into the system makes it more able to adjust to additional strains that may come on the system. In other words, the built-in slack makes the system more flexible. Therefore, it is proposed therefore that supply chain robustness has a positive effect on supply chain flexibility.

Supply Chain Robustness and Asset Management Efficiency

Profit maximization is a function of increasing revenue while keeping costs to the barest minimum. Revenue is directly influenced by service levels but increasing service levels result in increasing costs (Kotler and Keller, 2016). Robust supply chains are chains that factor in excess capacity like additional production capacity, alternative transportation options etc. but these ultimately increase overall supply chain costs (Ivanov et al., 2014).

However, Ivanov et al (2014) argue that this so-called excess capacity can also lead to increase in sales. Asset management efficiency is the firm's effectiveness in managing the firm's assets including its networks in achieving customer satisfaction. Supply chain robustness enables the firm to still deliver on its promises to customers even in the face of disruptions thereby leading to their satisfaction. Therefore, it is proposed that supply chain robustness has a positive effect on asset management efficiency. Fig. 1 was developed based on the foregoing treatise.

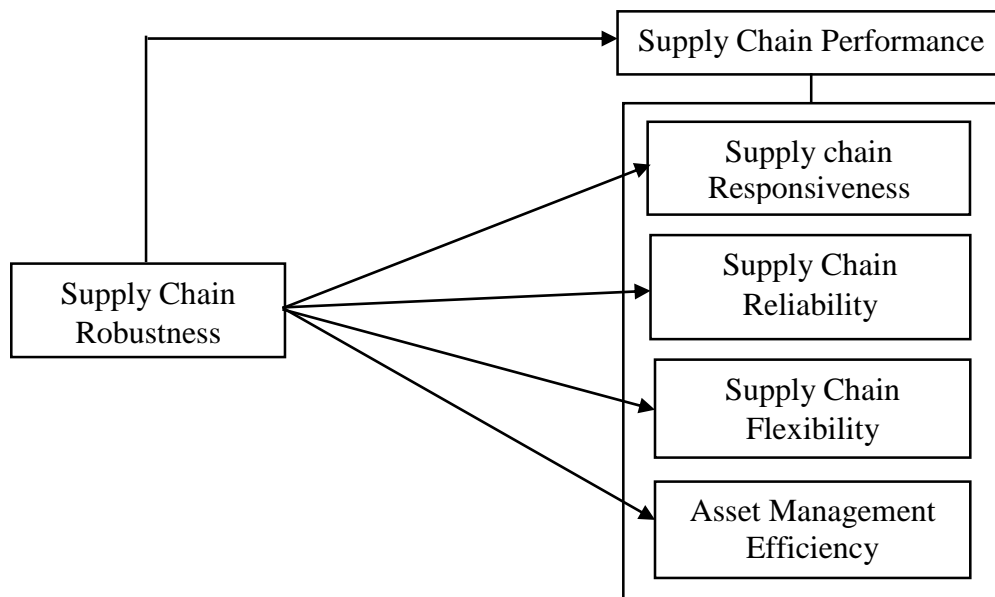


Fig. 1: Conceptual framework of supply chain robustness and supply chain performance.

Conclusion and Direction for Future Studies

Managing supply chains involves also managing the risks that can hinder the operational effectiveness of the supply chain. Literature has established that supply chain performance can be impaired by changes from within the chain and disruptions from outside the chain. However, this theoretical study has tried to establish the fact that supply chain robustness is a valid supply chain risk management approach and firm capability that enables the firm to achieve good performance in its supply chain operations.

Specifically, the study has shown that supply chain robustness has a conceptual linkage with supply chain responsiveness, reliability, flexibility and asset management efficiency. It is also noteworthy that while quite a number of studies have been done on the effect of supply chain capabilities like robustness on supply chain performance, the effect of robustness on supply chain performance as measured from an operational standpoint has barely received any research attention.

In specific terms, the relationships identified in this study have not been properly tested empirically and would benefit from a good empirical assessment to ascertain these linkages. It is therefore necessary to empirically test the effect of supply chain robustness on the criterion variables identified.

References

- Agami, N., Saleh, M., & Rasmy, M. (2012). Supply chain performance measurement approaches: Review and classification. *Journal of Organizational Management Studies*. DOI: 10.5171/2012.872753
- Agus, A. (2011). Supply chain management, supply chain flexibility and business performance. *Journal of Global Strategic Management*, 5(1), 134-145.

- Al-Hawajneh, K.M., & Attiany, M.S. (2014). The effect of supply chain responsiveness on competitive advantage: A field of manufacturing companies in Jordan. *European Journal of Business and Management*, 6(13), 151-162
- Ambe, I. M. (2014). Key indicators for optimizing supply chain performance: The case of light vehicle manufacturers in South Africa. *The Journal of Applied Business Research*, 30(1), 277-290.
- Bauer, D., & Göbl, M. (2017). Flexibility measurement issues in supply chain management, *Journal of Applied Leadership and Management*, 5, 1-14,
- Brandon-Jones, E., Squire, B., Autry, C. W., & Petersen, K. J. (2014). A contingent resource-based perspective of supply chain resilience and robustness. *Journal of Supply Chain Management*, 50(3), 55-73.
- Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, 15(2), 1-13.
- Durach, C. F., Wieland, A., & Machuca, J. A. D. (2015). Antecedents and dimensions of supply chain robustness: A systematic literature review. *International Journal of Physical Distribution & Logistics Management*, 45(1/2), 118-137.
- Gremme, K. M., & Wohlgemuth, V. (2017). Dynamic capabilities: A systematic literature review of theory and practice. *European Journal of Management Issues. Special issues: Dynamic Capabilities of firms*, 25 (1), 30-35.
- Ivanov, D., Sokolov, B., & Dolgui, A. (2014). The ripple effect in supply chains: Trade-off efficiency-flexibility-resilience in supply chain disruption management. *International Journal of Production Research*, 52(7), pp.2154-2172.10.1080/00207543.2013.858836
- Juan, S., Li, E.Y., & Hung, W. (2021). An integrated model of supply chain resilience and its impact on supply chain performance under disruption. *The International Journal of Logistics Management*. DOI 10.1108/IJLM-03-2021-0174
- Kotler, P., and Keller, K.L. (2016). *Marketing Management (15th edition)*. Pearson Education.
- Lennon, C.D. (2019). The impact of trust on performance in a supply chain: Bridging the gap between reliability and power. *Journal of Business Administration Research*, 8(2), 15-20.
- Leonczuk, D. (2016). Categories of supply chain performance indicators: An overview of approaches. *Business, Management and Education*, 14(1), 103-115.
- Macclever, A. B., Annan, J., & Boahen, S. (2017). Supply chain flexibility, agility and firm performance. *European Journal of Logistics, Purchasing and Supply Chain Management*, 5(3), 13-40.
- Manurung, H., Yudoko, G., and Okdinawati, L. (2023). A conceptual framework of supply chain resilience towards sustainability through a service-dominant logic. *Heliyon* 9, e13901.
- Minnich, D & Maier, F.H. (2006). Supply chain responsiveness and efficiency: Complementing or contradicting each other? Retrieved from systemdynamics.org/2006/proceed/papers/MINNI308.pdf
- Munir, A., Hanif, A., & Afzal, N. (2023). Impact of supply chain robustness and resilience on firm performance: A perspective of Pakistan textile industry. *Business Review*, 18(1), 91-106.
- Nag, T. & Ferdausy, S. (2021). Supply chain management practices and supply chain performance in the manufacturing industries of Bangladesh: An empirical study. *Logistics & Supply Chain Review* 2(1), 1-26.
- Prasad, V.S.N.V. (2012). Multiple performance dimensions to measure supply chain performance. *International Journal of Business and General Management*, 1(1), 40-55.

- Somuyiwa, A., & Adebayo, T.I. (2013). Firm's competitiveness through supply chain responsiveness and supply chain management practices in Nigeria. *Journal of Poverty, Investment and Development*, 1, 142-148.
- Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533.
- Wasiak M., Jacyna-Golda I, Markowska, K., Jachimowski, R., Klodawski M., & Izdebski M. (2019). The use of a supply chain configuration model to assess the reliability of logistics processes. *Maintenance and Reliability*, 21(3), 367–374.
- Wieland, A., & Wallenburg, C. M. (2012). Dealing with supply chain risks: Linking risk management practices and strategies to performance. *International Journal of Physical Distribution & Logistics Management*, 42(10), 887-905.