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The Determinants of Supply Chain Performance in Manufacturing Industries: A Case Study of Proton Malaysia

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Abstract: This study examines the key elements that significantly impact supply chain performance in Proton Malaysia, a prominent participant in the automotive sector in Southeast Asia. The objective is to understand the impact of crucial factors on Proton's supply chain's performance, including information quality, information technology, information sharing, big data analytics capacity, supply chain integration, traceability, and agility. The study used a qualitative research methodology to examine Proton's supply chain dynamics, focussing on its strategic collaboration with Geely and the incorporation of new technology. Both primary and secondary data are utilized for analysis. The results demonstrate that Proton's focus on up-to-date information, sophisticated analysis, and robust supplier connections has greatly improved its ability to respond quickly and effectively to operational challenges and maintain its ability to recover from disruptions. Furthermore, the research emphasizes the significance of supply chain agility and integration in effectively responding to market fluctuations and reducing risks. The findings indicate that Proton must consistently engage in technology and supply chain innovation to retain its competitive advantage and successfully traverse the intricate nature of the global automobile market. These lessons apply to Proton and other manufacturing enterprises aiming to optimize their supply networks in a progressively dynamic and linked environment.

Keywords: *Supply chain performance, information technology, information sharing, supply chain traceability, supply chain agility.*

1. Introduction

In the dynamic and ever-changing world of international business, the effectiveness and ability to recover a manufacturing industry's supply chain have become crucial factors in gaining a competitive edge and ensuring long-term sustainability. This is particularly apparent in the automobile sector, distinguished by complex supply chains, intense rivalry, and continuous advancement. An organization's capacity to efficiently oversee its supply chain can substantially influence its operational efficiency, market flexibility, and overall achievement. Automotive manufacturers working in dynamic and turbulent marketplaces face the constant challenges of globalization, technical innovation, and regulatory changes (Christopher, 2016).

Proton Malaysia, founded in 1983 as the first car maker in the country, provides a fascinating example for analyzing the intricacies and difficulties of supply chain management (SCM) in the manufacturing industry. At first, Proton received substantial assistance from the government, such as imposing tariffs and implementing policies that aimed to safeguard the young firm from global competition. Nevertheless, the landscape was significantly transformed during the late 1990s due to the relaxation of trade rules and Malaysia's inclusion in the ASEAN Free Trade Area. Proton faced significant competitive challenges from global automotive companies due to these changes, which required a strategic restructuring of its supply chain activities (Wad & Govindaraju, 2011).

To overcome these issues, Proton began a process of adaptation and transformation. The corporation recognized the need to adopt advanced technologies to compete, integrate novel methodologies, and reorganize supplier relationships. Industry 4.0 technologies such as automation, data in real-time analysis, and lean production systems highlighted improved flexibility and responsiveness of Proton's supply chain and its efficiency technologies (Büyüközkan & Göçer, 2018). These technologies helped better demand forecasting, inventory control, and cost management, which in turn affected the supply chain in general (Christopher, 2016). The most significant event that emerged in the company's journey toward growth was in 2017 when it formed a strategic alliance with Geely Automobiles, a prominent Chinese company. This partnership provided necessary fundraising and brought important experience in managing the supply chain as well as new opportunities to enter new global markets for Proton (Wad & Govindaraju, 2011). The collaboration also presents how this change in ownership affected Proton's supply chain management (SCM) since it began to integrate more international-oriented strategies and procedures. They ensured that this highlighted the fact that strategic partnerships are very crucial in enhancing the ability of supply chains particularly given the aggressive and global nature of the automotive industry. The changing legislation that surrounds the industry in which Proton operates has affected this organization's supply chain, in addition to technologies and strategic factors. Trade policies, tariffs, and FDI have shaped firms in the automotive industry, including Proton's operations and strategies (Srivastava, 2007). However, other than cooperation, the complementary conflicts in the political and economic system of Southeast Asia, such as trade agreements and market volatility, have posed huge competition and challenges for Proton to be extremely flexible and strategic in the management of its supply chain. The importance of analyzing and identifying the factors that affect supply chain performance (SCP) is underlined by an even greater number of factors within the external environment that have called the reliability and flexibility of global supply chains into question and their capability to learn and respond to the disturbances.

Major events like the Asian financial crisis of 1997, the global economic recession of 2008, and the COVID-19 pandemic have also highlighted the need for a supply chain that has not only efficiency but also agility (Flynn et al., 2010). Proton has leveraged these disturbances to design its strategies toward building a stronger and more flexible supply chain to survive external and internal pressures. This research aims to conduct an extensive analysis of factors that affect the performance of the supply chain in the manufacturing firm, especially in Proton Malaysia. The objective of this study is to examine the elements that influence the supply chain performance The research offers a systematic understanding of the development of Proton. It aims to deepen the understanding of the strategies that can enhance supply chain performance in a world that is increasingly connected and volatile.

Problem Statement

Proton, the national car manufacturer in Malaysia, has faced severe challenges in maintaining an efficient and well-competitive supply chain that affects the company's performance with significant and long-term effects on its enterprise firm's performance (Tong et al., 2012). Government support and advantages have proved to be a problem for Proton as it has limited the ability to develop a competitive and independent supply chain. Proton's major problem is that it has not successfully integrated into the global automotive supply chain even though it has been operating for more than two decades and has followed many industrial policies. This is mainly because it lacks access to the necessary technology and experience from its Japanese counterpart (Natsuda et al., 2013). Although Hudin et al. (2017) did not focus on the Proton company, the findings highlight the numerous weaknesses of the supply chain system to the automotive sector in Malaysia that could have an impact on Proton.

Suhaidi (2022) emphasizes that DRB-Hicom and its subsidiary Proton Holdings Bhd faced notable difficulties with its supply chain during the initial quarter of 2022. The main problem was the lack of microchips, a vital element in contemporary automobiles. The shortages, probably caused by disruptions in the global supply chain, immediately affected Proton's ability to produce, resulting in a decrease in income despite the continuous exemption of sales tax for new vehicles. The article also cites the extensive floods in the Klang Valley in late 2021 as a significant cause of the supply chain difficulties. Although not expressly mentioned, the floods probably caused disruptions in logistics and potentially inflicted damage on infrastructure, further affecting Proton's supply chain. Anazawa (2021) discusses the overall situation of vehicle manufacturing in Malaysia, for example, but does not explicitly identify specific issues related to Proton's supply management. However, it does point to many factors that can threaten the automotive businesses in Malaysia. It may be declared that the situation in Proton Malaysia is rather critical, as it imports most of the components from other countries. This can be a problem if there are conflicts in global transportation or international trade. Furthermore, there is a lack of efficiency in the development of new technologies. This could limit the company's capacity to learn and adapt to modern manufacturing and supply chain processes. The other issue of concern emitted from the government regulations is that as much as they may have good intentions to help in the progress of the business, they may delay this progress. Their ability to acquire the latest innovations or practices from foreign counterparts may be limited by the existing policies that include import prohibitions or restrictions on local content. In addition, the current supply chain plans used by Proton must be changed to enhance the company's capacity for handling the issues related to technological advancement and the reliance on foreign parts. This will help Proton to be able to adjust to market needs and prevent itself from lagging in the competitive car manufacturing industry.

However, Zulkepli et al. (2015) oppose this by stating that to accomplish this, Proton should attempt to establish stronger partnerships with domestic and international suppliers as well as invest in technologies that can lead to optimization in manufacturing and supply chain management activities. Due to strengthened global competition as well as advancement in fast-paced technologies in the modern world, all manufacturing sectors must upscale their supply chain functions to maintain market competitiveness and optimize performance. In these sectors, supply chain performance, or SCP, is a measure of profit, customer satisfaction, or efficiency. Although the concept of supply chain optimization is highly regarded in the 21st-century business environment, many manufacturing organizations like Proton Malaysia in the automobile industry face many problems in the optimization of their supply chain. A few antecedents are known to affect supply chain performance (SCP) in manufacturing industries. But how these determinants affect or moderate each other, in particular information quality (IQ), information technology (IT), information system (IS), big data analytics capabilities (BDAC), supply chain integration (SCI), supply chain traceability (SCT), and supply chain agility (SCA) remain ambiguous. Relatively, Proton Malaysia, which is among the leading automobile companies in Malaysia, provides a good example. The company has developed several supply chain management initiatives; nevertheless, it suggests that the performance of such measures has not been consistent and standardized. This difference draws attention to a crucial knowledge gap regarding the precise roles that each of these elements plays either alone or in combination with supply chain performance, specifically in the highly competitive environment and rapidly evolving changing automotive industry.

According to research, enhancing coordination and flexibility within supply chain networks depends critically on the quality and exchange of information (Lee & Whang, 2000). Similarly, it is well known that supply chain process integration improves operational effectiveness (Flynn et al., 2010). Improvements in technology, such as the use of big data analytics and sophisticated information technology systems, are becoming more widely acknowledged for their ability to completely transform supply chain management by facilitating improved decision-making and predictive capacities (Hudin, 2017). But there is also more to learn about applying and effectively using these technologies to improve supply chain traceability and competence, especially in industrial contexts such as Proton Malaysia. To determine how these factors, which are information quality, supply chain integration, information technology, information sharing, supply chain traceability, supply chain ability, and big data analytics capability, affect the performance of Proton Malaysia's supply chain, this study aims to close these important gaps. It is anticipated that the results will provide focused insights that could direct the development of strategic decisions and policies meant to improve the responsiveness and efficiency of the supply chain. By examining these relationships in the context of Proton Malaysia, the research will add to the growing body of knowledge on supply chain management in the manufacturing sector and provide other businesses with comparable difficulties with a more sophisticated understanding.

3. Research Methodology

This study involves a literature review investigating the factors influencing supply chain performance (SCP) in the manufacturing sector. To achieve this purpose, a thorough review of pertinent literature and past research is carried out, gathering information from credible scholarly journals, books, conference proceedings, reports, websites, and numerous commentaries.

4. Literature Review

This section explores several variables proposed by researchers, including supply chain performance, information quality, information technology, information sharing, big data analytics capability, supply chain integration, supply chain traceability, and supply chain agility.

Supply Chain Performance (SCP): SCP is a complicated concept that has been carefully studied in numerous contexts in academic works. Fawcett and Magnan (2002) discovered the theory and practice of supply chain integration and pointed out the significance of strategic alignment in improving SCP results. Miocevic and Crnjak-Karanovic (2012) stated that SCP depends on management's capability to integrate strategic goals among supply chain parties. Peng et al. (2020) stated that the degree to which the organization uses its resources can be utilized to measure the SCP level, thereby increasing the efficiency of its processes. Li et al. (2006) study the influence of supply chain management practices, precisely the implementation of technology, on competitive edge and organizational performance. Carter and Rogers (2008) offer an all-encompassing sustainable supply chain management model, highlighting the need to integrate environmental, social, and economic aspects in SCP assessment. (Flynn et al., 2010) evaluate the conditional outcomes of supply chain integration on operational performance, highlighting its complex effect. Prior studies have characterized SCP as the capacity of the supply chain to 1) provide quality products and services in exact quantities and at specific times and 2) reduce the overall costs of products and services for the end consumers of the supply chain (Green & Inman, 2005). Furthermore, Chen, Sohal, and Prajogo (2013) investigate the contribution of innovation in reducing operational risks in the supply chain, advocating for cooperative strategies to stimulate innovation and enhance SCP results. SCP is an essential element of manufacturing industries' competitiveness since efficient and effective management directly impacts successful supply chain operations (Lee & Whang, 2001).

Information Quality (IQ): Information quality (IQ) is a fundamental cause of supply chain performance (SCP), influencing decision-making processes and operational efficiency within the supply chain. High-quality information decreases uncertainties and enhances cooperation among supply chain participants, improving overall SCP (Zhou et al. (2007). Gunasekaran et al. (2004) discovered that timely and accurate information greatly improves overall performance by assisting organizations in anticipating market demands and modifying supply chain activities accordingly. Trkman et al. (2010) highlighted the strategic importance of information quality in building a strong supply chain capable of quickly adjusting to disturbances and preserving uninterrupted operations. (Chen et al., 2015) in their research on how the strategic use of information impacts supply chain capabilities, found that IQ positively affects both the strategic and operational aspects of SCP.

Information Technology (IT): IT is a significant factor in improving SCP so that the supply chain network can better cooperate and operationalize itself to function effectively and effectively. The massive literature review focusing only on the integration of IT in supply chain management pointed out various advantages such as Improved operational performance, cost reduction, and improved consumer satisfaction. The use of IT in the supply chain has been well studied and explored. It has been shown to offer different values, including operational values, cost efficiencies, and positive customer value. Carr and Smeltzer (2002) explain further that IT also acts as a business platform for making relations with suppliers, creating computer-to-computer connections and relations with information systems, and integrating suppliers through the exchange of electronic data. It refers to the physical and conceptual components of computer organizations that facilitate sustainable business internal operations, management, and strategy (Thong & Yap, 1995). According to Prajogo & Olhager (2012), another key area discussed was the enhancement of the strategic alignment between IT and business goals as essential to increase the value of IT to enhance SCP.

Information Sharing (IS): Kwon et al. (2017) described IS as essential for developing connections that stimulate communication and increase trust and mutually shared goals. Mathu (2019) examined the impact of information technology (IT) on information sharing in the supply chain management practices of small and medium-sized enterprises (SMEs) in South Africa. The study revealed that IT deployment in these SMEs significantly boosted information sharing by facilitating better communication between suppliers and customers. Dominguez et al. (2018) developed a strategy for adopting partial IS among supply chain retailers to enhance performance. Chen & Huan (2021) highlighted the importance of IS in the re-manufacturing sector for tracking end-of-life products. Moreover, Wijewickrama et al. (2021) discovered that IS is crucial in reverse logistics, presenting more complexity and uncertainty than forward logistics. Additionally, Chen et al. (2024) analyze the interplay between IS and risk management in supply chains disrupted by pandemics, suggesting that practical IS is necessary for managing risks associated with supply chain interruptions.

Big Data Analytics Capability (BDAC): Recent scholarly research has focused on integrating BDAC with SCP, demonstrating a growing awareness of its strategic significance. After studying how BDAC influences operational effectiveness, Saggi and Jain (2020) concluded that enhanced analytics capabilities can greatly improve supply chain decision-making. In the same way, Zhang et al. (2021) discovered that BDAC improves supply chains' agility and reactivity, enabling quick changes to shift consumer needs and market conditions. Li et al. (2022) claim that using predictive analytics in supply chain management enables the optimization of inventory management and anticipating demand changes, which lowers costs and increases customer satisfaction. The significance of BDAC for enhancing supply chain traceability and transparency has been studied by Kumar and Singh (2023). This is important for sectors like food and pharmaceuticals, where safety and compliance are critical. They emphasized that following a product's life span from production to distribution requires real-time data analytics. Ramesh & Raj (2024) stated that BDAC provides for improved risk management by giving tools for anticipating and mitigating supply chain interruptions. Johnson & Marquis (2024) discussed how load balancing and logistics route optimization might be achieved by integrating machine learning algorithms with big data technologies, enhancing supply chain operations' general effectiveness and sustainability.

Supply Chain Integration (SCI): SCI is the degree of integration between the internal business operations and a supply chain's partners, suppliers, and customers (Flynn et al., 2010). Prior studies have extensively shown the crucial function of SCI in augmenting SCP. According to Thompson and Frazier (2020), the implementation of integrated supply chains leads to enhanced coordination and information exchange, hence resulting in a notable improvement in operational efficiency and adaptability to market fluctuations. Wu et al. (2021), by reducing reliance on outside suppliers, vertical integration of supply chains helps businesses reduce costs and enhance service standards. Similarly, Park and Patel (2022) concluded that better SCP is achieved through more synchronized activities made possible by integration across logistics, information systems, and human resources. Companies with higher levels of integration are more successful in implementing sustainable practices because they have more visibility and control over the supply chain (Lim & Carter, 2023). Harper & Green's (2024) study points out that supply chains need integration to be resilient and agile, especially in unstable markets. Khan et al. (2024) studied how technology integration, such as ERP systems, can improve SCP. They observed that these systems increase process efficiency, demand forecasting, and inventory management accuracy.

Supply Chain Traceability (SCT): The importance of SCT in improving existing supply chains' efficiency, compliance, and transparency is becoming more broadly recognized. Moe (2014) emphasizes the importance of boosting product safety and lowering the dangers of fake goods. SCT is as significant in appropriately supporting a firm in managing the total development of assistance. As stated by Cousins et al. (2019), this function entails the continuous observation and monitoring of a product from its sources to the time it gets to the final consumer. Companies that have enhanced their SCM practices often leverage technology for information interchange at multiple levels to ensure their supply chain managers can monitor their partners' offerings in the long term (Núñez-Merino et al., 2020). Donnelly et al. (2018) explain how one can learn about the technical enhancements to the traceability systems that can enhance the data security and the transparency of the supply Chain. Blockchain implies a trustworthy record-keeping method that accurately registers procedural activities in a centralized and irreversible way. This makes it possible for all the stakeholders involved in supplying a product to have an accurate and detailed understanding of the supply process to enhance traceability (Casino et al., 2021). According to Aung and Chang (2014), traceability systems support decision-making since they provide a detailed history and origin of items.

Supply Chain Agility (SCA): SCA acknowledges the outside information on the change and distraction of end-user preferences as well as competitive activities to modify decisions and actions (Tarafdar & Qrunfleh, 2017). Sangari et al. (2015) mentioned that supply chain agility (SCA) should be considered critical for achieving competitiveness, given that the current business environment is unpredictable. According to Aslam et al. (2018), SCA can be described as the capability of reacting to unusual shifts in the supply and demand forces. McGaughey (1999) defined agility as the capability that an organization possesses compared to its capability to transform as quickly as possible in reaction to extrinsic conditions. From the perspective of Swafford et al. (2006), it can be argued that an SCA enhances performance because it reacts promptly to fluctuations within the market and customers' needs. Lee (2004) cited that supply excellence operations must have the capability of being sensitive and responsive for the achievement of flexibility in addressing uncertainties in the supply environment. Christopher and Towill (2001) particularly point out the variability management issue that necessitates integrated implementation of both lean and agile paradigms.

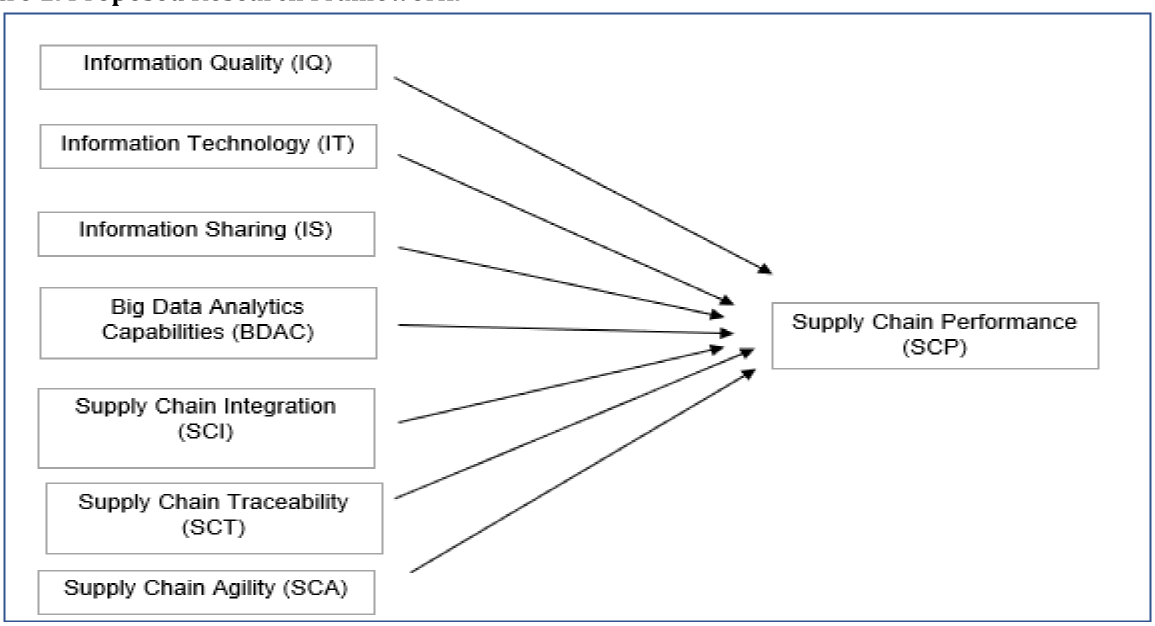
Underpinning Theory
Based on the study, a theory has been applied to the factors underpinning SCP. This theory has been employed in this investigation. Consequently, this study aims to evaluate the proposed theoretical framework by utilizing this theory.

Resource-Based View (RBV): The resource-based view (RBV) is a fundamental concept for understanding how a company's distinct resources, such as information technology and big data analytics skills, contribute to its competitive advantage and performance results. According to RBV, companies with valued, uncommon, hard-to-duplicate and non-substitutable resources will have a sustained competitive advantage (Barney, 1991). This theory can effectively be used to analyze how Proton Malaysia utilizes technologies to enhance its SCP.

Information Processing Theory (IPT): IPT is a framework for assessing how businesses handle data and information flow throughout their supply chains. According to IPT, the ability of an organization to meet information processing demands with its available resources determines how effective the organization will be (Galbraith, 1973). This idea can be especially helpful when examining how Proton Malaysia's supply chain's responsiveness and efficiency are impacted by information sharing, information quality, and general information flow, all made possible by IT systems.

Theory of Supply Chain Integration: To achieve greater efficiency and effectiveness, the Theory of Supply Chain Integration emphasizes the strategic alignment and interlinking of processes and activities across the supply chain (Flynn et al., 2010). It makes the case that integrated supply chains are more suited to manage resources and react to market needs effectively. The study of how supply chain traceability and integration affect the overall effectiveness of Proton Malaysia's supply chain can be guided by this idea.

Figure 1: Proposed Research Framework:



The research framework of this study proposes that Supply Chain Performance (SCP) can be enhanced synergistically by the interaction of the following independent variables: Information Quality (IQ), Information Technology (IT), Information Sharing (IS), Big Data Analytics Capabilities (BDAC), Supply Chain Integration (SCI), Supply Chain Traceability (SCT), and Supply Chain Agility (SCA). This interaction suggests that when these components are successfully coupled, the influence on SCP is a product rather than merely a simple sum. For instance, the accuracy and accessibility of data can be enhanced by combining high-quality data with complex IT systems. The distribution of this data across a single supply chain can significantly increase operational effectiveness and agility. Furthermore, using big data analytics to interpret this high-quality, seamlessly connected information can result in better predictive insights and strategic decision-making. Therefore, the model suggests that the interplay of these factors creates a robust setting in which every component reinforces the others, resulting in a total improvement in SCP, thereby representing a system in which the total exceeds the sum of its parts.

Discussion

Proton Malaysia had faced some issues and challenges through supply chain management that reduced their performance. The major concerns of the company were forming a strong base of suppliers and the issue of trade-off between quality and price. Additionally, with a clear social policy of targeting specific suppliers while at the same time disregarding the merit of suppliers, its supply chain also became complex. Consequently, the company was left wide open to issues to do with international competitiveness (Tong et al., 2012). Furthermore, there is a high tendency to have domestic suppliers who are even technologically less capable than some of their global counterparts. This hinders Proton's ability to optimize its supply chain procurement and flexibility in responding to the rapidly changing market demands in the automotive industry. This shows the need to have a better competitive supplier in the industry to foster innovation and to have more resilience. Supply chain performance in Proton is highly dependent on the degree of information technology, information exchange, and information quality. These components enable the fast and continuous flow of accurate and timely information between people or teams, enhance decision-making processes, and enhance organizational performance (Tong et al., 2012). The tremendous importance of the information quality for the supply chain of Proton cannot be overemphasized here because it involves the decision that directly impacts the chain supply network. Therefore, demand forecasting, inventory management, and overall supplier coordination should be done optimally to maintain a competitive advantage in the long run. These processes are aided by high-quality information. Moreover, sharing information across the SCM and with suppliers and partners requires them to endorse Proton's strategic direction. More transparency ensures very low chances of misunderstanding, hence cooperation, improving the supply chain (Christopher, 2016).

The implementation of big data analytics helps Proton to incorporate useful information from large data sets. It also allows the firm to forecast market trends and adjust its supply chain processes to meet this new competitive landscape, which is important due to the dynamic nature of the industry (Mohamad & Kari, 2008). Further, there should be a better-aligned supply chain system that can effectively reduce the gap between local and overseas suppliers. Several studies have established that foreign suppliers often possess better technologies and capabilities than local suppliers, thus making worse competitiveness issues that affect Proton. The incorporation of complex digital solutions has greatly improved the supply chain management and the overall operations of Proton. The company has managed to attain real-time visibility in the supply chain activities through the adoption of ERP systems and digital supply chain platforms. This has enabled them to counter any interruption that might have occurred without so much delay. Furthermore, through its increased big data analytics capability, Proton's corporation has been able to review large volumes of data to discover new patterns, improve its operations, and predict future supply chain challenges. There are recommendations that overall supply chain efficiency can be increased by using big data in decision-making by Proton (Büyüközkan & Göçer, 2018).

Both supply chain integration and supply chain traceability have similar importance in increasing the ability of Proton's supply chain to become more resilient. Proton needs to enhance its capability to compose disruptions and make new opportunities as the company may facilitate effective interaction between suppliers, manufacturers, and distributors of its products. This will also assist in guaranteeing that it conducts its affairs meaningfully and that its products reach the consumers satisfactorily. In addition, the flexibility of the supply chain of Proton needs to be enhanced to quickly react to the changes in consumers' requirements and the general conditions of the market. It must fill this gap, especially given the current situation where the free trade rules are a sore issue, and there is stiff competition from the automakers in the region. The case of Proton provides a good lesson on the importance of being not only a passive consumer who relies on local suppliers but also an active partner in the global value chains and networks. These alliances can help to introduce innovations and the world's experience and, therefore, decrease the differences between local and overseas suppliers' performance. Finally, it contributes to the development of an enhanced supply chain environment. Supply chain flexibility is another area where Proton needs to adapt to market trends and other issues affecting the organization, including the shift in customer preference or the effects of the COVID-19 pandemic. Such changes are opaque and complex and, therefore, result in Proton's adaptable supply chain that allows it to respond to these changes efficiently while still satisfying its clients and avoiding operational hiccups. This flexibility of Proton is a result of social capital in the form of investments in information technology and supply chain integration, thus allowing the company to apply dynamic capability and counter-adjust to match the changing of its supply chain strategy in real-time, as suggested by Christopher (2016).

5. Implication of Study

The study's implications relate to how the findings can be applied in practice, particularly for Proton Malaysia and other similar manufacturing companies.

Theoretical Implication: This study emphasizes the essential role of integrating technological advancements and strategic management in supply chains. This research broadens the scope of the firm's Resource-Based View (RBV), arguing that unique capabilities like information quality, technology, and big data analytics are key drivers of competitive advantage (Barney, 1991). Supported by the Information Processing Theory, which contends that efficiently managing information flow is essential to reduce uncertainty and increase responsiveness in volatile markets, it further emphasizes the significance of capabilities for information sharing and integration (Galbraith, 1973). The research also incorporates elements of the Dynamic Capabilities Framework, proposing that to improve performance, the supply chain's traceability and agility should dynamically interact with both internal and external uncertainty (Teece et al., 1997). Analyzing these interactions in a real-world setting adds to the theoretical discourse by showing how multi-dimensional integration affects manufacturing supply chains' operational efficiency while supporting pre-existing theoretical frameworks.

Managerial Implication: This research offers numerous actionable insights for managers in the manufacturing industry, especially those aiming to boost supply chain efficiency and adaptability. The results indicate that enhancing information quality and technological infrastructure through strategic investments can significantly elevate performance by facilitating precise forecasting and efficient resource distribution (Li & Lin, 2006). In addition, enterprises should anticipate changes in the market and take proactive measures by cultivating a robust culture of information sharing and developing big data analytics competencies (Wang et al., 2016). Furthermore, supply chain processes are strategically consolidated, and traceability is improved. These developments improve operational transparency and promote agility, enabling businesses to swiftly adapt to demand or supply chain disruptions (Christopher & Peck, 2004). It is recommended that managers consider these components essential to their operational and strategic planning to guarantee a sustained competitive advantage and improved supply chain efficiency.

Policy Implication: The present study underscores the necessity of enacting policies that facilitate manufacturing enterprises' use of advanced technology and optimal supply chain management strategies. Policies that provide incentives for developing and applying advanced information systems, enhanced capabilities in data analytics, and comprehensive supply chain integration can significantly increase the manufacturing sector's overall productivity and competitiveness. It is recommended that policymakers focus on creating frameworks that facilitate information sharing and technological integration throughout supply chains. These frameworks may be created by tax breaks, grants for new technology, or more robust intellectual property protections to drive innovation (Chen et al., 2007; Fawcett et al., 2008). Moreover, legislative support for supply chain traceability system standardization can help improve transparency, lower risks, and increase market responsiveness to changes, ultimately leading to more robust supply chains.

Conclusion

In conclusion, the supply chain performance in Proton is positively influenced by the organization's capability in information quality, information technology, information sharing, big data analytics capability, supply chain integration, supply chain traceability, and supply chain agility. The mutual integration of these areas emphasizes the constant development to achieve sustainable efficiency and competitive advantage, especially in a context of great change, as is automotive; observing the relationship in the supply chain affects organizational performance and customer satisfaction. In addition, more focus should be put on the acquisition of a local network of suppliers capable of using high standards of quality and technologies. Therefore, Proton is not only improving its efficiency and effectiveness of operations but also strengthening its capability to adapt to new conditions and sustain and compete more effectively in the future (Simpson et al., 1998) (Tong et al., 2012) (Mohamad & Kari, 2008). In addition, agility has also been seen to be adopted by Proton, especially through the organization's efforts to adopt just-in-time inventory management practices. One benefit of that approach is the reduction of various losses and the increase in the level of product turnover; as a result, the company can efficiently distribute resources according to customer needs (Simpson et al., 1998). Concerning such strategies, there is the need for Proton to conduct periodic assessments of its supply chain skills and ensure that they align with the current international standards to be sure that all forms of resistance are well handled through comprehensive engagement with the suppliers and customers. This will not only increase efficiency but also would make the improvement permanent and sustainable in the future. Critical factors that are vital for the success and performance of Proton Malaysia's supply chain are quality information, advanced information technology, sound information sharing and use of big data, supply chain linking, end-to-end traceability, and operation agility. Proton has enhanced its efficiency, durability, as well as competitiveness within the worldwide automotive market through a tactical focus on these elements. That way, through the implementation of technology and data analysis, Proton has benefited from operation efficiencies and predictions of disruptions. Also, the supply chain and integration that the company possesses make it nimble and able to respond to changes. It is, therefore, important for Proton to sustain its investment in these areas due to the complexity that is being observed in the global market.

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