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- Volume 13 No 4 (2024)
- Volume 13 No 3 (2024)
- Volume 13 No 2 (2024)
- Volume 13 No 1 (2024)
- Volume 12 No 4 (2023)
- Volume 12 No 3 (2023)
- Volume 12 No 2 (2023)
- Volume 12 No 1 (2023)
- First Online Articles
- Previous Issues
- Indexing/Abstracting
- Editorial Board
- Journal Subscription

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- Author Guidelines
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- Ethics
- Author Fee
- Reviewers
- Review Process

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Original Article

● Online Issues

1. **Internet of things and intrusion detection fog computing architectures using machine learning techniques** Pages: 767-782
 Maha Helal, *Tariq Kashmeery*, Mohammed Zakariah and Wesam Shishah  PDF (416 K)

Abstract: The exponential expansion of the Internet of Things (IoT) has fundamentally transformed the way people, machines, and gadgets communicate, resulting in unparalleled levels of interconnectedness. Nevertheless, the growth of IoT has also brought up notable security obstacles, requiring the creation of strong intrusion detection systems to safeguard IoT networks against hostile actions. This study investigates the utilization of fog computing architectures in conjunction with machine learning approaches to improve the security of the IoT. The UNSW-NB15 dataset, containing an extensive range of network traffic characteristics, is used as the basis for training and assessing the machine learning models. The study specifically applies and evaluates the performance of various models, including linear regression, Ridge classifier, SGD classifier, and ensemble learning. Furthermore, the findings indicate that these models are capable of accurately identifying intrusions, with success rates of 94%, 97%, 96.60%, and 96.50%, respectively. The Ridge Classifier demonstrates exceptional accuracy, highlighting its potential for effective implementation in IoT security frameworks. The results emphasize the efficacy of combining machine learning with fog computing to tackle the distinct security obstacles faced by IoT networks. In the future, our work will prioritize optimizing these models for real-time applications, improving their scalability, and investigating more advanced ensemble strategies to enhance detection accuracy. The project intends to enhance these areas to create a comprehensive and scalable intrusion detection system that can offer strong security solutions for the growing IoT environment. This will guarantee the integrity and dependability of linked devices and systems.

DOI: 10.5267/j.dsl.2024.9.003

Keywords: Machine Learning (ML), Internet of Things, Anomaly detection, Intrusion Detection System (IDS), Anomaly detection in IoT, Fog Computing, UNSW-NB15 dataset



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Original Article

Relationship between renewable energy consumption and its impact on CO2 emissions in Peru, 1990-2020 *Pages: 783-790*

2.



Joselyn Dayana Tica Salvador, Raúl Camayo Cano and Dante Manuel García Jimenez  PDF (416 K)

Abstract: In his research, he has established an analysis of the consumption of renewable energy and its impact on CO2 emissions in Peru, 1990-2020. The research employs a quantitative approach and longitudinal non-experimental design, with a multiple linear regression model. It uses time series drawn from the World Bank on renewable energy consumption and energy consumption. A progressive increase was reflected mainly driven by industrial growth, fossil fuel consumption and changes in consumption and production patterns.

DOI: 10.5267/j.dsl.2024.9.002

Keywords: Renewable energy, Consumption, Impact, Emissions, CO2



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Original Article

The influence of information technology on supply chain resilience through purchasing strategy, production flexibility, and supply chain responsiveness *Pages: 791-806*

3.



Ruth Srininta Tarigan, Zefanya Valentino Bastanta Tarigan, Maria Natalia Damayanti Maer, Zeplin Jiwa Husada Tarigan and Ferry Jie

 PDF (416 K)

Abstract: In today's rapidly changing business environment, companies need to be dynamic, adapting their internal processes to respond effectively to external changes. Information Technology has become crucial for businesses to enhance their ability to manage and adapt to change. This study examines East Java manufacturing companies that have heavily invested in sustainable IT systems to enhance their supply chain responsiveness and resilience through improved purchasing strategies and production flexibility. The study collected data from companies that had implemented IT for at least three years, with respondents being permanent employees with a minimum of two years' experience. Analysis of 108 survey responses using SmartPLS 4 revealed significant impacts of IT implementation on purchasing strategy (0.610), production flexibility (0.363), and supply chain responsiveness (0.164). Furthermore, purchasing strategy influenced production flexibility (0.367), supply chain responsiveness (0.348), and resilience (0.166). Production flexibility also affected supply chain responsiveness (0.348) and resilience (0.343), while responsiveness impacted resilience by 0.306. These findings provide a practical contribution for functional managers in companies regarding the importance of IT investment in developing effective purchasing, production, and marketing strategies to meet market demands swiftly. The research contributes to supply chain strategy and resilience theory

while highlighting the significance of strong collaboration with external partners for top management.

DOI: 10.5267/j.dsl.2024.9.001

Keywords: Information technology implementation, Production flexibility, Purchasing strategy, Supply chain responsiveness, Resilience



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Original Article

4. **Assortment and promotion optimization in a retail chain** *Pages: 807-828*

Hamed Karimi  PDF (416 K)

Abstract: An examination of two areas of promotion and assortment planning in an environment is attempted in this paper. Sales promotion is a marketing strategy used by retailers to increase sales and profits by retaining customers and preventing them from switching to their competitors. Various products are available on the market that can substitute each other, so the best product assortment must be determined as well. In order to model the above subject, a nonlinear integer programming problem is proposed. Model solution involves rephrasing the problem as mixed integer linear programming. Small- and medium-sized problems can therefore be solved using MIP solver software. Firefly algorithms are designed to solve large-scale problems. According to the numerical results, determining the best product assortment for stores must also be done simultaneously with finding the optimal promotion. As a matter of fact, the promotion of the products significantly affects the assortment scenarios for the stores. Consequently, the selection of the promotional discount may result in large profit losses if the assortment planning is not taken into consideration. In order to assess the importance and sensitivity of the model parameters, a sensitivity analysis is conducted. The sensitivity analysis demonstrates that the model is able to respond to changes in market demand and competition, and provides an effective tool for chain stores to optimize their promotion and assortment strategies. To further validate the effectiveness of the model, a case study is conducted in Tehran, Iran. The results of the case study demonstrate the ability of the model to effectively optimize promotion and assortment strategies in real-world settings. Overall, the proposed model provides a valuable tool for chain stores to optimize their promotion and assortment strategies, and improve their market competitiveness.

DOI: 10.5267/j.dsl.2024.8.009

Keywords: Promotion, Assortment, Mixed integer linear programming, Firefly Algorithm



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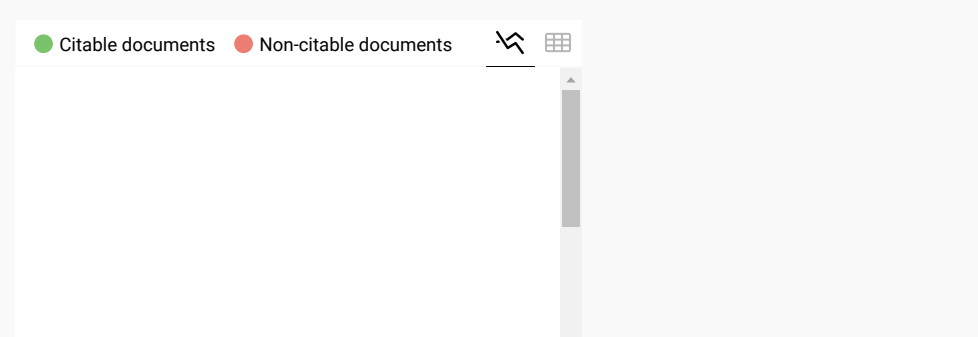
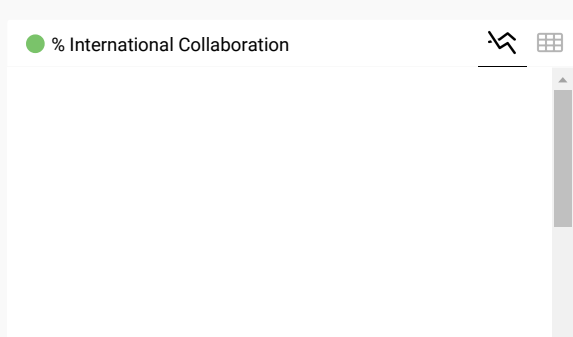
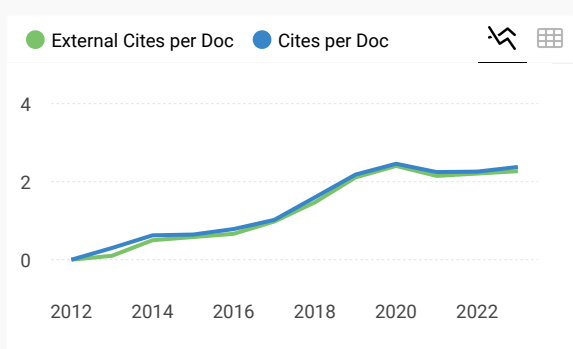
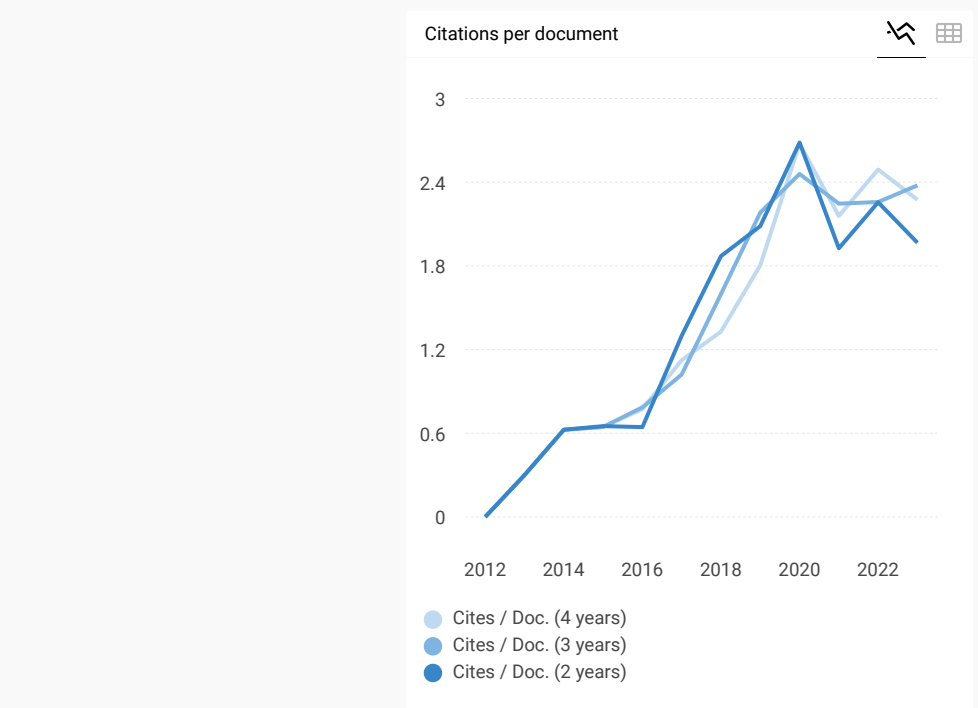
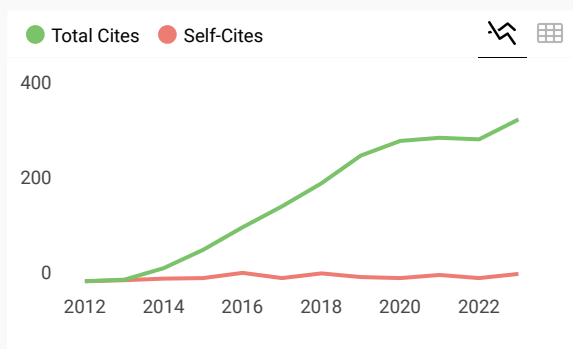
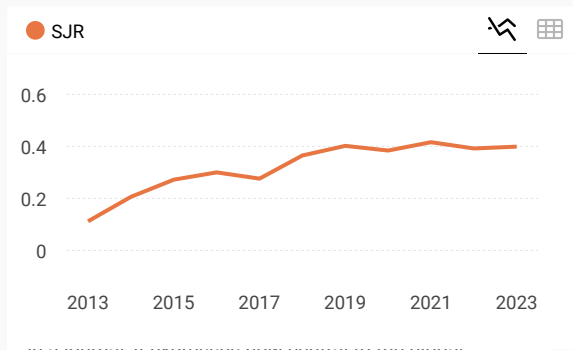
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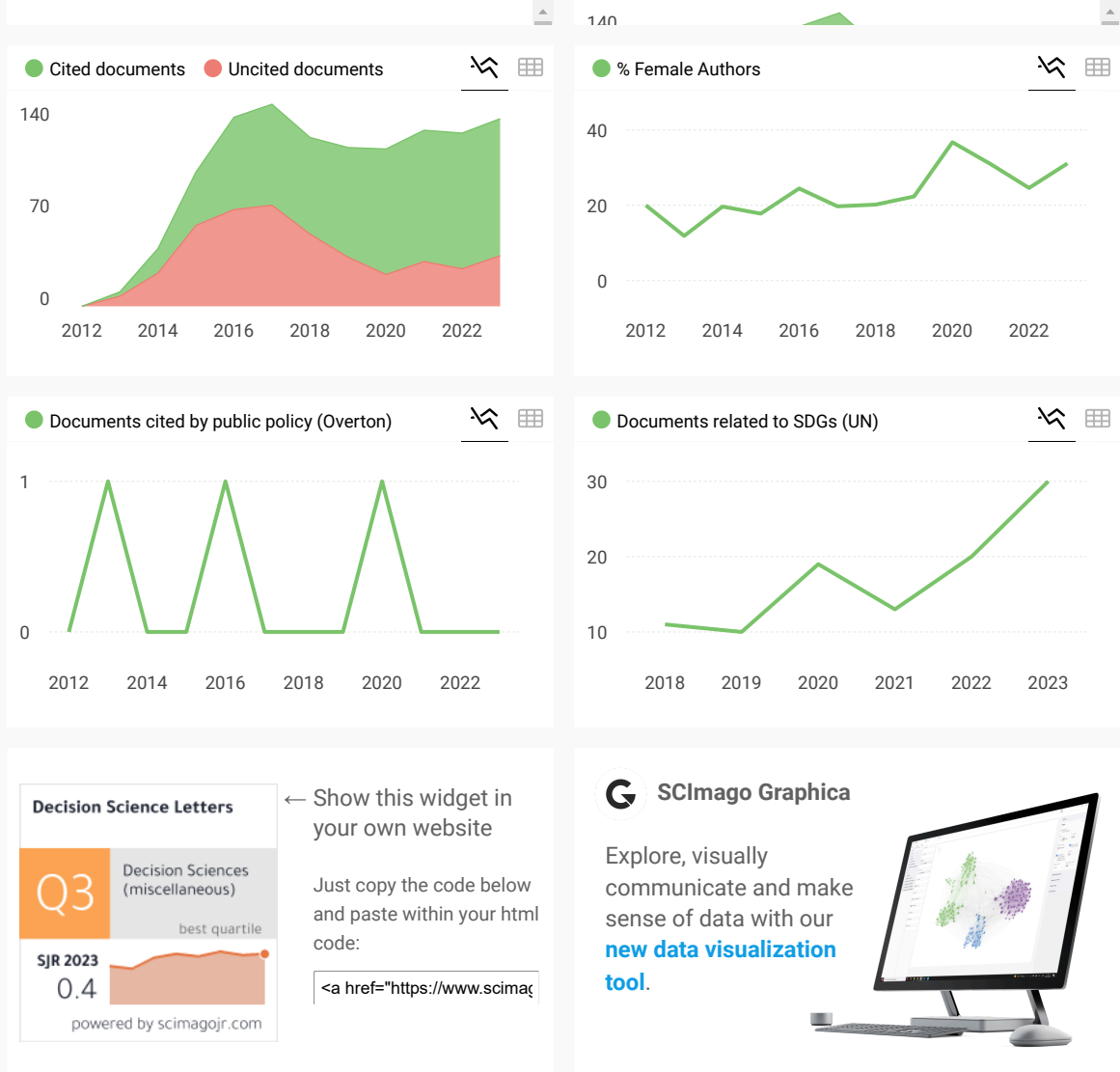
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The influence of information technology on supply chain resilience through purchasing strategy, production flexibility, and supply chain responsiveness

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ABSTRACT

In today's rapidly changing business environment, companies need to be dynamic, adapting their internal processes to respond effectively to external changes. Information Technology has become crucial for businesses to enhance their ability to manage and adapt to change. This study examines East Java manufacturing companies that have heavily invested in sustainable IT systems to enhance their supply chain responsiveness and resilience through improved purchasing strategies and production flexibility. The study collected data from companies that had implemented IT for at least three years, with respondents being permanent employees with a minimum of two years' experience. Analysis of 108 survey responses using SmartPLS 4 revealed significant impacts of IT implementation on purchasing strategy (0.610), production flexibility (0.363), and supply chain responsiveness (0.164). Furthermore, purchasing strategy influenced production flexibility (0.367), supply chain responsiveness (0.348), and resilience (0.166). Production flexibility also affected supply chain responsiveness (0.348) and resilience (0.343), while responsiveness impacted resilience by 0.306. These findings provide a practical contribution for functional managers in companies regarding the importance of IT investment in developing effective purchasing, production, and marketing strategies to meet market demands swiftly. The research contributes to supply chain strategy and resilience theory while highlighting the significance of strong collaboration with external partners for top management.

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1. Introduction

In an increasingly complex and competitive business world, information technology enables companies to achieve efficiency and effectiveness in supply chain sustainability (Ben-Daya et al., 2017). The supply chain, which includes various processes starting from production planning, raw material procurement, and inventory to distribution of final products to consumers, has been running well and can produce adequate products (Ju et al., 2021; Fayezi & Zomorodi, 2015). The presence of information technology has changed the way companies manage supply chains to create systems that are more integrated, responsive, and adaptive to change (Tan et al., 2023; Chaudhuri et al., 2018). Information technology in the supply chain is increasing visibility and transparency (Wang & Yang, 2022). The application of information technology to supply chain management allows companies to track the movement of goods (Willis et al., 2016). Data that was initially partial in various departments has now been integrated and can be accessed easily in one unified system in the supply chain (Pirmanta et al., 2021; Fayezi & Zomorodi, 2015). Information technology allows companies to know about delivery delays or stock shortages, so they can immediately take corrective action (Tarigan et al., 2020a). The company can take further action by increasing preventive actions to produce sustainable improvements (Frederico, 2021). Information technology allows companies to have better visibility, and the risk of disruption in the supply chain can be minimized (Siagian et al.,

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2021; Putri et al., 2024). This condition enables the company to increase overall operational efficiency (Cheng & Lu, 2017; Soesetyo et al., 2024).

The information technology used by companies can determine the optimal amount of stock (Tarigan et al., 2021). Companies can maintain stock levels to reduce unnecessary storage costs and ensure that products are available on time without excesses or shortages (Christian et al., 2024). Companies can precisely arrange the delivery of raw materials by using information technology when needed for production and reducing storage time and associated costs (Dubey et al., 2019). Efficiency in using information technology can increase company profits but also enable increased company competitiveness (Abeysekara et al., 2019; Tarigan et al., 2020a). By utilizing information technology containing a lot of data, companies can better understand consumer purchasing patterns and market trends (Ambekar et al., 2020). This information is used more effectively to plan production and distribution (Basana et al., 2022). With more accurate forecasts, companies can reduce the risk of excess food production, which could result in losses (Ali et al., 2023). Information technology enables more intelligent decision-making based on current and relevant data (Luthra & Mangla, 2018).

Information technology determines many aspects of a company's business development (Tarigan et al., 2021). Companies adopting information technology-based systems can optimize procurement processes and strengthen supplier relationships (Nenavani & Jain, 2022). Information technology allows companies to collect and analyze procurement data more effectively (Ju et al., 2021). Information technology in companies is able to provide data related to supplier performance, prices, delivery times, and product quality that can be accessed in real time (Siagian et al., 2022). The company's information technology can provide detailed information according to needs to make crucial decisions for the company (Tarigan et al., 2021; Anastasia et al., 2024; Basana et al., 2023).

With an integrated procurement management system, relevant stakeholders can access data and information related to procurement with adequate data quality (Ju et al., 2021; Chaudhuri et al., 2018). Collaboration between partners in the supply chain has also experienced a major transformation with the advent of information technology (Yu et al., 2019). Coordination between suppliers, manufacturers, and distributors can be done easily and quickly using information technology (Cao & Zhang, 2010). Integrating information technology in procurement also allows companies to manage risk better (Azadegan et al., 2019; Soesetyo et al., 2024). The company's information technology can monitor and analyze potential risks in the supply chain (Ali et al., 2023).

Information technology has become the main supporter of production flexibility in various industries (Putri et al., 2024). Increasingly tight global competition means that companies must be able to adapt quickly to changes in market demand, thus requiring good production flexibility (Yu et al., 2023). Companies need to determine the level of flexibility in product variations and product delivery on operational dynamics to meet customer demands (Shukor et al., 2021; Fayezi et al., 2015). Information technology allows companies to respond more efficiently and effectively by relying on production flexibility (Yu et al., 2019; Chunsheng et al., 2020; Putri et al., 2024). Information technology supports production flexibility through real-time data integration and can be accessed according to departmental needs (Chaudhuri et al., 2018; Siagian et al., 2021; Harianto et al., 2024). Company information technology can make decisions quickly and precisely when changes in demand occur, thereby impacting production flexibility which has an impact on absorptive capacity (Cheng & Lu, 2017). Companies have changes in demand for certain products, affecting production schedules and the efficiency of raw material procurement (Fayezi et al., 2015). Companies can produce raw components that can be combined or combined into various finished products according to customer needs using information technology (Tarigan et al., 2020a). Information technology can help companies design and manage product configurations to anticipate changes in customer demand (Fayezi & Zomorodi, 2015). Companies can offer products tailored to customers' preferences without making major changes to the production process (Harianto et al., 2024). Information technology support in making changes to operations can provide added value to customers (Zhao et al., 2023). Better production planning also results from implementing information technology (Pirmanta et al., 2021). Increasing the company's production flexibility can prepare itself to anticipate various possible sudden changes (Sarkar & Seo, 2021; Orlando et al., 2021; Basana et al., 2023). Sudden changes in the supply chain often occur due to imbalances in the supply chain system, especially in the procurement of raw materials and market fluctuations that have an impact on production structure and function (Ju et al., 2021). Planning based on information technology ensures that companies can adapt quickly without sacrificing quality or production efficiency (Adobor & McMullen, 2018). A company's ability to respond quickly to market changes is also one of the main benefits of implementing information technology in production (Asamoah et al., 2021). Companies can monitor market trends and customer preferences in real time. This information allows companies to quickly adjust production according to changing market needs (Chunsheng et al., 2020). This flexibility allows companies to maintain product relevance in a market that changes according to customer needs (Adobor & McMullen, 2018; Tiwari et al., 2015). Better collaboration and communication are also facilitated by information technology, which ultimately increases production flexibility (Singh & Kumar, 2020; Willis et al., 2016). Collaboration systems enable companies to communicate smoothly between departments, make decisions more quickly, and complete information (Fayezi & Zomorodi, 2015). Production flexibility can increase operational efficiency and enable companies to remain competitive in the dynamic global market (Siagian et al., 2021). Utilization of company information technology with increased supply chain resilience ensures companies have increased

competitiveness and continue to develop in a rapidly changing business environment (Setiawan et al., 2023; Abeysekara et al., 2019; Carissimi et al., 2023).

Effective purchasing strategies are essential in increasing supply chain responsiveness (Frederico et al., 2021). A company's ability to respond quickly and efficiently to changes in market demand, supply disruptions, or changes in company operations (Yu et al., 2019). In a rapidly changing business environment, having a responsive supply chain is the key to maintaining competitiveness and customer satisfaction (Huo et al., 2024). Flexible purchasing strategies allow companies to adapt to market needs but can also be caused by suddenly changing company operational conditions (Shukor et al., 2021; Basana et al., 2023). Companies can quickly switch from one supplier to another if disruptions or sudden changes in demand occur (Yu et al., 2018). This flexibility allows companies to respond quickly to changes without sacrificing quality or delivery time (Sarkar & Seo, 2021). An effective purchasing strategy can include responsive stock management to suit fluctuations in demand (Tarigan et al., 2020a; Tarigan & Siagian, 2021; Christian et al., 2024).

Effective purchasing strategies play an essential role in strengthening supply chain resilience, ensuring that companies can face and overcome various disruptions that may occur, both internally and externally (Frederico et al., 2021). Supply chain resilience is a company's ability to respond, adapt, and recover quickly from disruptions (Munir et al., 2022; Carissimi et al., 2023). The company's capabilities for business continuity can continue smoothly (Yuan & Li, 2022). A well-planned purchasing strategy is critical to achieving this resilience (Tarigan & Siagian, 2021; Wungkana et al., 2023). Purchasing strategies focusing on supply chain resilience should include proactive supplier risk monitoring (Frederico, 2021). Companies can assess and identify risks that may arise from suppliers (Ali et al., 2023).

Production flexibility impacts supply chain resilience in ensuring company sustainability and competitiveness amidst the uncertainty of change (Chowdhury & Quaddus, 2016; Tiwari et al., 2015). Production flexibility refers to a company's ability to adjust production schedules according to market demand or changing operational conditions (Sarkar & Seo, 2021; Fayezi et al., 2015). The flexibility that occurs can also be caused by amended orders in product volume and quality by changes provided by customers (Siagian et al., 2022). Production flexibility is essential in supporting supply chain resilience because it allows companies to adapt quickly to disruptions (Yuan & Li, 2022; Dubey et al., 2019; Harianto et al., 2024). If a company experiences a disruption in the supply of raw materials from its leading supplier, it can quickly communicate with other suppliers (Nenavani & Jain, 2022; Yoon & Moon, 2019). The information technology companies use can impact supply chain resilience to increase competitiveness (Tan et al., 2023; Setiawan et al., 2023; Sadha et al., 2024). Companies can also change the type of raw material or adjust the production process by minimizing the direct impact on operations as a form of response (Singh & Kumar, 2020). This flexibility helps companies continue to meet customer demands even when faced with situations that are not ideal, thereby increasing supply chain resilience (Chowdhury & Quaddus, 2016; Tiwari et al., 2015; Chunsheng et al., 2020).

Collaboration and transparency in the supply chain are also crucial in purchasing strategies supporting supply chain resilience (Gu et al., 2021; Zhao et al., 2023). This collaboration allows all parties to be more responsive to sudden changes (Orlando et al., 2021; Tarigan et al., 2020b), such as demand fluctuations or logistics operational disruptions (Panahifar et al., 2018; Huo et al., 2024). Companies can anticipate problems earlier and coordinate solutions more efficiently (Asamoah et al., 2021; Azadegan et al., 2019). The research objectives can be divided into four broad lines based on the explanation above. The first is to find out the magnitude of the role of information technology in influencing purchasing strategy, production flexibility, and supply chain responsiveness. Second, get the magnitude of the influence of purchasing strategy on production flexibility, supply chain responsiveness, and resilience. Third, determine the magnitude of the influence of production flexibility on supply chain responsiveness and resilience. Finally, the fourth found the magnitude of the influence of supply chain responsiveness on increasing supply chain resilience.

2. Literature Review

2.1 Information Technology

Information technology contributes to company efficiency, innovation, and competitiveness (Zhao et al., 2023; Basana et al., 2024). Information technology has become a strategic enabler that transforms organizations to operate and compete in increasingly competitive markets (Tan et al., 2023). Information technology is widely used in data processing, reporting, inventory management, and integrated planning (Ju et al., 2021). Currently, information technology has opened up new opportunities for organizations to develop innovative business models, accelerate the innovation process, and respond more quickly to market changes (Asamoah et al., 2021; Ateş et al., 2018; Soesetyo et al., 2024). Companies have widely used information technology to help production processes that are implemented well according to needs, such as cloud computing, big data, and artificial intelligence, which are opportunities for many companies to increase their competitiveness (Hartono et al., 2023). Implementing information technology enables companies to increase operational efficiency and effectiveness (Abeysekara et al., 2019). Organizations can coordinate operations more efficiently and determine decisions quickly and better based on accurate and up-to-date data (Chaudhuri et al., 2018).

Information technology allows companies to collect and analyze customer data more effectively (Anastasia et al., 2024), which is then used to develop more personalized and targeted marketing strategies (Ju et al., 2021). Information technology allows companies to understand customer needs and preferences better (Tarigan et al., 2021). Companies can provide better service and build stronger long-term customer relationships (Willis et al., 2016). Information technology increases visibility and transparency in supply chains, which in turn reduces costs and increases efficiency (Wang & Yang, 2022). Information technology helps companies create value through product and service differentiation, strengthening positions in increasingly competitive markets (Zhao et al., 2023). The successful implementation of information technology is highly dependent on effective change management and adequate employee training (Pirmanta et al., 2021). Information technology has become essential for managers in formulating more effective and responsive business strategies (Ben-Daya et al., 2017).

The role of information technology as the primary driver of digital-based business models (Alvarenga et al., 2023). Companies that successfully adopt and integrate information technology in all operational aspects tend to be more competitive and innovative (Tarigan et al., 2020a; Siagian et al., 2021). Adopting this technology must be accompanied by strong policies to avoid potential risks to survive (Yuan & Li, 2022). Information technology's role is vital in supporting organizations' growth and sustainability in the digital era to increase robustness (Alvarenga et al., 2023). The development and use of information technology for organizations can face future changes and uncertainty (Yu et al., 2018). With all its potential, information technology is a supporting tool and a major driver of innovation, efficiency, and competitiveness (Tan et al., 2023).

2.2 Purchasing Strategy

A purchasing strategy is a planned approach used by a company to obtain goods, services, and raw materials needed for its operations in the most efficient and effective way (Tarigan et al., 2020b). This strategy covers various aspects ranging from supplier selection, price negotiation, and managing relationships with suppliers to risk management in procurement (Nenavani & Jain, 2022). The purchasing strategy ensures that the company obtains adequate material quality and availability (Yoon & Moon, 2019). One of the important components of a purchasing strategy is supplier selection (Tarigan et al., 2020a). When a company chooses the right supplier, it not only depends on the price offered but also on the quality, timeliness of delivery, and the supplier's ability to consistently meet its needs. Companies usually apply specific criteria in evaluating suppliers following the requirements set by the company (Tarigan & Siagian, 2021). This selection process is very important because the supplier selected will directly impact the smooth operation and quality of the company's final product (Basana et al., 2022). The communication companies build with suppliers in effective negotiations impacts the company's ability to obtain more competitive prices, reduce costs, and increase profit margins (Hartono et al., 2023). Effective purchasing strategy negotiations are carried out based on strong data and a deep understanding of the market so that companies can reach profitable agreements with suppliers (Ateş et al., 2018).

A company's ability to build supplier relationships is also integral to its purchasing strategy (Fayezi & Zomorodi, 2015). Good relationships with suppliers provide flexibility in delivery arrangements, access to raw materials to meet new product needs, and collaboration in innovation (Ateş et al., 2018; Fayezi et al., 2015; Tarigan et al., 2020b). The purchasing strategy that is built must include efforts to build and maintain long-term relationships with key suppliers (Chaudhuri et al., 2018; Basana et al., 2024). This collaborative approach often results in mutually beneficial partnerships, where both parties work together to achieve common goals (Yu et al., 2019). An effective purchasing strategy also considers optimal inventory management (Ateş et al., 2018). Good inventory management ensures that the company has sufficient raw materials and components to meet production demands without high storage costs. Determining optimal inventory levels requires tight coordination with suppliers and careful management to prevent stock shortages that can disrupt production (Nenavani & Jain, 2022). Purchasing strategies must be aligned with the company's long-term business objectives (Tarigan et al., 2020a). Purchasing strategies must include sourcing environmentally friendly raw materials and working with suppliers who have sustainable practices (Wungkana et al., 2023; Soesetyo et al., 2024). Technology allows companies to integrate data better (Siagian et al., 2021) so that the supporting data needed for purchasing can be provided and make faster and more precise decisions based on accurate and up-to-date information (Siagian et al., 2022). Purchasing strategy to remain flexible and adaptive to market changes (Fayezi et al., 2015; Basana et al., 2022). This flexibility allows companies to adjust their purchasing strategies according to changing market conditions (Chowdhury & Quaddus, 2016; Yu et al., 2018). The success of a purchasing strategy relies heavily on effective involvement and coordination between the purchasing department and other departments within the company (Siagian et al., 2022). Collaboration between departments ensures that purchasing decisions support the overall business strategy (Adobor & McMullen, 2018). Purchasing strategies can be designed to support achieving overall company goals (Tarigan & Siagian, 2021). This strategy must continue to be evaluated and adapted to changing market conditions and business goals to remain resilient and responsive to future challenges (Asamoah et al., 2021).

2.3 Production Flexibility

Production flexibility is a company's ability to quickly and efficiently adjust its production process according to changes in market demand (Chowdhury & Quaddus, 2016). This capability becomes increasingly important in a dynamic business

environment where changes in customer demand are rapid (Siagian et al., 2021). The flexibility that companies have and are supported by technology can help them adapt quickly to economic conditions so that operations usually run smoothly (Sarkar & Seo, 2021; Harianto et al., 2024). Production flexibility allows companies to maintain operational continuity to meet customer needs and remain competitive in an ever-evolving market (Shukor et al., 2021; Azadegan et al., 2019). Production flexibility is the ability to change the type and quantity of products produced with little or no disruption in the production flow (Siagian et al., 2022). Companies producing various products in one production line must be able to switch from one product to another quickly without sacrificing efficiency or quality (Willis et al., 2016). Information technology supports production flexibility (Yu et al., 2018; Tiwari et al., 2015). Using an integrated production management system, companies can monitor production processes in real time and adjust them quickly based on the latest data (Chunsheng et al., 2020). The company's ability to respond more quickly can reduce product waiting times for customers (Munir et al., 2022; Willis et al., 2016). The company's flexibility can increase efficiency and maintain customer satisfaction (Shukor et al., 2021; Chaudhuri et al., 2018).

The flexibility that companies have can quickly adjust production (Adobor & McMullen, 2018). Companies need flexible supply chains to ensure the availability of raw materials (Basana et al., 2023) and necessary components so that supplier capabilities match changing production needs (Nenavani & Jain, 2022; Dubey et al., 2019). Strong collaboration with suppliers helps ensure that changes in production can be accommodated without major disruptions in the flow of raw materials (Tarigan et al., 2020b; Yu et al., 2019; Yoon & Moon, 2019). Production flexibility also allows companies to respond to external disruptions, anticipating changes due to regulations, natural disasters, or supply disruptions (Singh & Kumar, 2020). Many companies can switch from the production side to products that are much needed by customers (Tiwari et al., 2015). Companies must ensure they have the necessary systems to support fast and efficient changes in production processes as a form of flexibility (Fayezi & Zomorodi, 2015). The capabilities of a company, especially human resources, can create a culture that supports innovation and openness to change (Yu et al., 2018). Production flexibility can be increased by good collaboration, communication, and coordination in the supply chain, which can help avoid scenarios of excess stock in the supply chain (Fayezi et al., 2015; Siagian et al., 2021).

2.5 Supply Chain Responsiveness

Supply chain responsiveness is the ability of a company's supply chain to respond quickly and efficiently to changes in demand, disruption, or market conditions (Munir et al., 2022). Fast-moving changes in business make responsiveness one of the critical factors in determining a company's success and competitive strength (Yu et al., 2019). Changes in consumer preferences have an impact on companies to have supply chains that are responsive and adaptable better and faster than competitors (Ju et al., 2021). Supply chain responsiveness is the speed in responding to changes in customer demand to suit consumer preferences and needs in a short time (Yu et al., 2023). Responsive companies are able to adjust production and distribution conditions according to rapid changes. The company's ability to respond to a surge in demand for certain products improves the production or delivery process (Cheng & Lu, 2017). Responsive companies can increase production quickly and reorganize logistics to ensure the product reaches customers on time (Willis et al., 2016). Information technology plays a major role in increasing supply chain responsiveness (Gu et al., 2021). An integrated supply chain management system provides benefits for companies to be able to monitor data in real-time with quick decisions based on the latest information (Pirmanta et al., 2021). The company's ability to respond quickly to change and minimize the negative impact of disruptions or sudden changes (Azadegan et al., 2019). Strong collaboration with suppliers and other supply chain partners is also critical in increasing responsiveness (Nenavani & Jain, 2022). Companies can ensure that all parties in the supply chain are ready to adapt to change (Hartono et al., 2023). This ability is demonstrated when a sudden change in market demand impacts the need for raw materials. Companies can quickly contact suppliers who collaborate well to adjust the delivery of raw materials according to the company's needs (Tarigan et al., 2020b). Increasing the company's response speed by involving members in the supply chain can avoid excess or inventory shortages, which can disrupt operations in lean production (Christian et al., 2024). A responsive company will always look for ways to expand its supplier base by ensuring it has alternatives ready if needed (Nenavani & Jain, 2022). Effective inventory management allows companies to avoid unnecessary stock overstocks or shortages that could disrupt production. By adjusting inventory in real-time based on market data, companies can ensure they are always ready to meet customer demand. Success in supply chain responsiveness depends on the company's ability to manage and integrate data from various departments and supply chain members (Tarigan et al., 2020a). The use of data allows companies to predict demand trends and respond quickly. Supply chain responsiveness makes companies move quickly, with agility and flexibility in facing change (Singh & Kumar, 2020; Asamoah et al., 2021). Companies that have high responsiveness can maintain competitive advantages and better meet customer needs (Cheng & Lu, 2017).

2.5 Supply Chain Resilience

Supply chain resilience is a critical or minimal capability that a company has to survive and recover from disruptions in the supply chain by involving members (Munir et al., 2022; Setiawan et al., 2023). Changes in demand and the environment in companies with increasingly complex and interconnected global supply chains provide changes for companies (Huo et al., 2024; Siagian et al., 2022; Nik & Moazami, 2020). The pandemic that has occurred has had an impact on economic changes

and geopolitical events, which have increased in impact on the continuity of company operations, thereby impacting supply chain resilience (Frederico et al., 2021; Alvarenga et al., 2023; Zhao et al., 2023; Bag et al., 2021; Alvarenga et al., 2023; Zhao et al., 2023; Bag et al., 2021; ., 2023). A company's ability to build a resilient supply chain is essential in maintaining business continuity and ensuring that the company can adapt to changing conditions regardless of service levels (Li et al., 2017; Cheng & Lu, 2017; Ju et al., 2021). The basis of supply chain resilience lies in the company's ability to generate flexibility (Chunsheng et al., 2020; Chowdhury & Quaddus, 2016; Fayezi et al., 2015). A resilient supply chain must adapt quickly to sudden changes (Bag et al., 2023). The flexibility that a company has is useful for ensuring that the supply chain can continue to function according to the company's needs (Adobor & McMullen, 2018; Siagian et al., 2021). Supply chain resilience is the ability of the supply chain to recover quickly from disruptions in order to maintain company sustainability (Zhao et al., 2023; Tan et al., 2023). Supplier resilience determines company resilience by maintaining supply continuity and ensuring the integrity of upstream structures and functions (Nenavani & Jain, 2022). Customer resilience is an embedded capability among companies to meet customer demands (Abeysekara et al., 2019).

The company's ability to maintain supply chain resilience requires real-time data about supply chain operations to detect potential problems early (Alvarenga et al., 2023). Companies with resilient supply chains often gain a competitive advantage, as they can continue to serve customers and maintain market share (Carissimi et al., 2023). Supply chain resilience supports the sustainability of company processes by enabling them to adapt to changing environmental and regulatory conditions (Zhao et al., 2023; Orlando et al., 2021; Sadha et al., 2024). In the face of increasing uncertainty, companies can build supply chain resilience as a strategic priority for many organizations (Huo et al., 2024). Companies that invest in resilience are better prepared to face future challenges and take advantage of opportunities from changing market conditions (Yuan & Li, 2022).

2.6. Relationships Between Concepts

2.6.1 Relationship between concept information technology and purchasing strategy

Information technology has an impact on purchasing strategies in the industry (Tarigan et al., 2020a). Information technology advances have changed how companies manage purchasing by providing automation systems, resulting in greater efficiency, transparency, and analytical capabilities (Luthra & Mangla, 2018). Information technology makes the purchasing process automated, reduces the occurrence of errors, and can speed up transactions (Anastasia et al., 2024). The e-procurement system used by the company can automate the payment process, which reduces cycle time and operational costs. Data integration between departments within a company means that information can flow more smoothly, and decisions can be made more quickly (Yoon & Moon, 2019). Information technology supports better decision-making through in-depth data analysis with accurate data (Ju et al., 2021). Decisions made by companies are based on data, thereby helping companies manage risks and increase efficiency (Ali et al., 2023). Information technology formed in companies can strengthen relationships with suppliers through more effective communication and better collaboration (Cao & Zhang, 2010; Ateş et al., 2018). Information technology-based collaboration platforms enable companies and suppliers to share information in real time (Panahifar et al., 2018; Basana et al., 2024). This is important in purchasing strategies because it allows companies to work more closely with suppliers to develop innovative solutions and improve overall performance (Ambekar et al., 2020). Based on the explanation, the first hypothesis can be determined

H₁: *Information technology influences on the company's purchasing strategy.*

2.6.2 Relationship between concept Information technology and production flexibility

Information technology is essential in increasing flexibility and maintaining a company's competitiveness in a dynamic market (Azadegan et al., 2019; Dubey et al., 2019). A company's production flexibility refers to the ability to quickly adjust production processes in response to changes in customer demand related to product variations, product quantities, and delivery schedules (Siagian et al., 2022). Delivery flexibility in companies continuously adjusts product distribution quickly and efficiently according to customer needs or market conditions (Chowdhury & Quaddus, 2016; Fayezi & Zomorodi, 2015). Information technology supports production flexibility through process integration, enabling companies to manage and automate various stages in the supply chain flow (Basana et al., 2023; Siagian et al., 2021; Chunsheng et al., 2020). Integration in companies can quickly change production schedules, adjust output according to market demand, or switch to new products without disrupting ongoing operations (Gu et al., 2021; Willis et al., 2016). This automation also allows companies to reduce setup times and production changeovers, which ultimately increases efficiency and responsiveness (Sarkar & Seo, 2021).

Information technology allows data to increase production and delivery flexibility (Fayezi & Zomorodi, 2015; Tiwari et al., 2015; Putri et al., 2024; Harianto et al., 2024). Companies can predict demand trends and adjust production and delivery accordingly (Chaudhuri et al., 2018). Owned information technology allows companies to fulfill demand timelily, reduce costs, and deliver products according to actual market needs (Fayezi et al., 2015). These technologies also enable the personalization of products and services, which is increasingly becoming a trend in many industries (Yu et al., 2018).

Information technology in delivery allows companies to provide flexibility by making deliveries scheduled and tailored to customer preferences (Singh & Kumar, 2020). Company information technology can manage inventory and material flows more effectively, ensuring that products are delivered on time without having excessive inventory (Chaudhuri et al., 2018). The company's information technology can optimize delivery routes, monitor delivery status in real time, and provide accurate information to customers about order status (Shukor et al., 2021; Willis et al., 2016).

H₂: *Information technology influences production flexibility.*

2.6.3 Relationship between concept information technology and supply chain responsiveness

Information technology allows the supply chain to respond to changes in market demand quickly and efficiently (Asamoah et al., 2021). Information technology enables companies to change quickly and ensure supply chains remain adaptive and responsive (Gu et al., 2021). Companies can obtain real-time data on stock, delivery, and production status at various points in the supply chain through information technology optimization. Companies can detect and respond to problems or changes quickly, reducing the disruption risk and ensuring products arrive on time (Zhao et al., 2023). Information technology can provide companies with fast data that can be shared with external partners to build collaboration (Yu et al., 2023). The company's ability to utilize integrated information technology has an impact on increasing supply chain responsiveness (Yu et al., 2019; Tarigan et al., 2021). This enhanced collaboration speeds up the decision-making process and allows quicker adjustments to changes in customer demand or market conditions (Pirmanta et al., 2021). A company's ability to optimize information technology can reduce waiting times and increase delivery speed, which ultimately increases supply chain responsiveness (Ju et al., 2021).

H₃: *Information technology influences supply chain responsiveness*

2.6.4 Relationship between concept purchasing strategy and production flexibility

Production flexibility refers to a company's ability to adjust production processes quickly according to changes in demand, which is largely determined by material availability (Siagian et al., 2022). The company's appropriate purchasing strategy can ensure the availability of the required raw materials (Tarigan et al., 2020a; Wungkana et al., 2023). The owned purchasing strategy allows the company to adjust production without experiencing delays (Dubey et al., 2019). Purchasing strategies can increase production flexibility (Fayezi & Zomorodi, 2015). Companies with reliable material suppliers can reduce the risk of delays to overcome supply disruptions (Chunsheng et al., 2020). Collaborative purchasing strategies can quickly overcome sudden changes because companies can switch to alternative suppliers (Chaudhuri et al., 2018). Purchasing strategies prioritizing long-term supplier relationships also contribute to production flexibility (Chowdhury & Quaddus, 2016). Strong relationships with suppliers enable better communication and closer collaboration in the face of changing production needs (Sarkar & Seo, 2021). Suppliers who understand a company's needs and priorities can adjust raw material deliveries more quickly or provide additional volumes if needed (Yu et al., 2023). This allows companies to respond to changes in demand more quickly and efficiently (Tarigan et al., 2020b). Purchasing strategies that support dynamic inventory management are critical in maintaining production flexibility (Azadegan et al., 2019; Nik & Moazami, 2020). Companies can manage inventory more effectively to ensure the availability of raw materials when needed without holding excessive inventory (Chaudhuri et al., 2018). Purchasing strategies that consider the quality of raw materials also impact supply chain flexibility (Shukor et al., 2021; Tiwari et al., 2015). Consistent, high-quality raw materials ensure that the production process runs smoothly without technical obstacles that can slow down production or require repeated adjustments as a form of flexibility (Fayezi et al., 2015). Companies can keep production flexible and responsive to changes while maintaining high product quality standards (Singh & Kumar, 2020; Yu et al., 2018).

H₄: *Purchasing strategy influences production flexibility.*

2.6.5 Relationship between concept purchasing strategy and supply chain responsiveness

Purchasing strategies have an essential role in increasing supply chain responsiveness by responding to customer requests and overcoming disruptions quickly (Asamoah et al., 2021). With an effective purchasing strategy, companies can ensure that the necessary raw materials and components are always available on time, which supports the company's ability to meet dynamic market demand (Siagian et al., 2022). A good purchasing strategy can provide raw materials on time and in the quantities needed (Frederico et al., 2021). Companies can use multiple suppliers to reduce the risk of supply disruption if one supplier experiences problems (Tarigan et al., 2020a). A purchasing strategy with long-term relationships with suppliers so that companies can provide materials relatively quickly and cope with sudden changes to increase supply chain responsiveness (Nenavani & Jain, 2022). Strong long-term relationships between companies and suppliers improve communication (Tarigan et al., 2020b; Wungkana et al., 2023). Purchasing strategies formed by companies with effective collaboration can increase responsiveness because they can face change (Yu et al., 2019). The company's purchasing strategy of building good relationships with suppliers tends to be more flexible and faster in responding to additional requests or changes in specifications in the procurement of tools and raw materials (Fayezi et al., 2015; Fayezi & Zomorodi,

2015). Purchasing strategies that consider risk management are essential in increasing supply chain responsiveness (Yu et al., 2018). The company's ability to manage risks proactively, such as delivery delays and material price fluctuations, can be quickly informed to customers as a form of responsiveness (Setiawan et al., 2023). A good purchasing strategy can maintain the continuity of company operations and enable the company to maintain consistent service to customers despite disruptions (Tarigan & Siagian, 2021). Purchasing strategies also contribute to supply chain responsiveness (Ateş et al., 2018). By optimizing inventory levels and reducing replenishment times, companies can ensure that raw materials are available on time (Chaudhuri et al., 2018). Purchasing strategies allow companies to respond quickly to changes in market demand without sacrificing operational efficiency (Dubey et al., 2019).

H₅: *Purchasing strategy influences supply chain responsiveness.*

2.6.6 Relationship between concept production flexibility and supply chain responsiveness

Production flexibility can provide rapid adaptation to market changes and disruptions in operations to increase supply chain responsiveness (Chowdhury & Quaddus, 2016). The company's ability to make changes in demand for raw materials from customers has an impact on production flexibility, which can meet customer demands for quantity and product variety in order to increase supply chain responsiveness (Nenavani & Jain, 2022; Dubey et al., 2019). Production flexibility refers to a company's ability to adjust its production process to changes in volume, product variety, and production time in response to dynamic needs in the market (Sarkar & Seo, 2021; Chaudhuri et al., 2018). Production flexibility is an essential component of supply chain responsiveness because flexibility in production allows companies to meet changing demand (Singh & Kumar, 2020; Shukor et al., 2021). Companies can anticipate when there is a surge in demand for certain products, so companies with high production flexibility can quickly increase output (Fayezi et al., 2015; Siagian et al., 2022; Willis et al., 2016). Substantial production flexibility allows the supply chain to remain responsive to customer needs, maintain satisfaction, and maintain competitive advantage (Siagian et al., 2021; Chunsheng et al., 2020). A successful operational strategy cannot separate supply chain responsiveness and production flexibility (Asamoah et al., 2021; Yu et al., 2018).

H₆: *Production flexibility influences supply chain responsiveness.*

2.6.7 Relationship between concept purchasing strategy, production flexibility, and supply chain responsiveness on supply chain resilience

Supply chain resilience refers to the supply chain's ability to adapt and operate effectively despite disruptions, primarily determined by the company's purchasing strategy (Zhao et al., 2023; Adobor & McMullen, 2018). Due to global uncertainty, companies must build supply chain resilience, which is crucial for business continuity (Huo et al., 2024). When supply chains are disrupted by various factors such as natural disasters, economic crises, or geopolitical disruptions, companies that have resilient supply chains can minimize losses and speed up operational recovery (Yuan & Li, 2022; Cheng & Lu, 2017). A purchasing strategy can involve various decisions related to sources of supply, choice of suppliers, and managing relationships with suppliers (Nenavani & Jain, 2022; Wungkana et al., 2023; Yoon & Moon, 2019). The right purchasing decisions can ensure the availability of raw materials and components needed (Tarigan & Siagian, 2021; Ateş et al., 2018), even in unstable situations, thereby increasing supply chain resilience (Siagian et al., 2022). Effective purchasing strategies contribute directly to supply chain resilience by maintaining the smooth flow of materials and goods (Frederico et al., 2021). Managing relationships with suppliers as a purchasing strategy is essential in supporting supply chain resilience (Huo et al., 2024). Establishing solid and collaborative relationships with suppliers allows companies to be more flexible in dealing with changing market conditions or other disruptions (Carissimi et al., 2023; Cheng & Lu, 2017; Yu et al., 2018; Chaudhuri et al., 2018). Good communication by sharing information and making continuous process improvements can increase adaptability to produce strong supply chain resilience (Tan et al., 2023; Ju et al., 2021; Ali et al., 2023). Production flexibility refers to the ability of a production system to adapt and can increase supply chain resilience (Munir et al., 2022; Siagian et al., 2021; Chunsheng et al., 2020). Production flexibility is essential to strengthen supply chain resilience because it can maintain normal company operational functions (Chowdhury & Quaddus, 2016; Azadegan et al., 2019; Sarkar & Seo, 2021). Supply chain resilience can enable companies to adapt and recover from unexpected disruptions with solid support from production flexibility (Adobor & McMullen, 2018). The combination of production flexibility and supply chain resilience allows companies to respond quickly to market dynamics and external challenges (Asamoah et al., 2021; Li et al., 2017; Fayezi et al., 2015). Rapid production flexibility can enable companies to respond to disruptions in the supply chain more effectively (Tan et al., 2023; Singh & Kumar, 2020; Shukor et al., 2021). When companies face sudden disruptions in the supply of raw materials, company leaders try to overcome them quickly by coordinating recovery by adjusting their production processes to overcome these obstacles (Siagian et al., 2022; Dubey et al., 2019; Tarigan et al., 2020a). Adapting and responding to changes in a company can reduce the risk of external disruptions and ensure operational continuity, strengthening supply chain resilience (Huo et al., 2024; Nik & Moazami, 2020; Sadha et al., 2024). Supply chain responsiveness is essential in increasing supply chain resilience (Munir et al., 2022). A supply chain that can respond quickly to changes in demand and overcome disruptions can be minimized (Asamoah et al., 2021). Companies can overcome problems quickly if there is a disruption to external partners by increasing supply chain responsiveness (Nenavani & Jain, 2022). Companies can choose alternative suppliers or divert supply flows quickly to overcome disruptions, increasing

supply chain resilience (Li et al., 2017; Ali et al., 2023). This capability reduces the risk of long-term disruption and accelerates the recovery process, which is the core of supply chain resilience (Bag et al., 2023; Abeysekara et al., 2019).

A supply chain management system that uses adequate integrated information technology can monitor supply chain conditions in real time and analyze data quickly, making more appropriate decisions (Yu et al., 2019). Information technology allows companies to respond to disruptions efficiently, thereby increasing supply chain resilience by adjusting company conditions (Yuan & Li, 2022; Huo et al., 2024; Carissimi et al., 2023; Frederico, 2021). Integrating information technology can increase supply chain responsiveness and contribute to overall resilience (Zhao et al., 2023; Siagian et al., 2021; Setiawan et al., 2023).

H7: *Purchasing strategy influences on supply chain resilience.*

H8: *Production flexibility influences supply chain resilience.*

H9: *Supply chain responsiveness influences supply chain resilience.*

Based on the explanation in the introduction and the Relationship between concepts, a research framework can be established in Fig. 1.

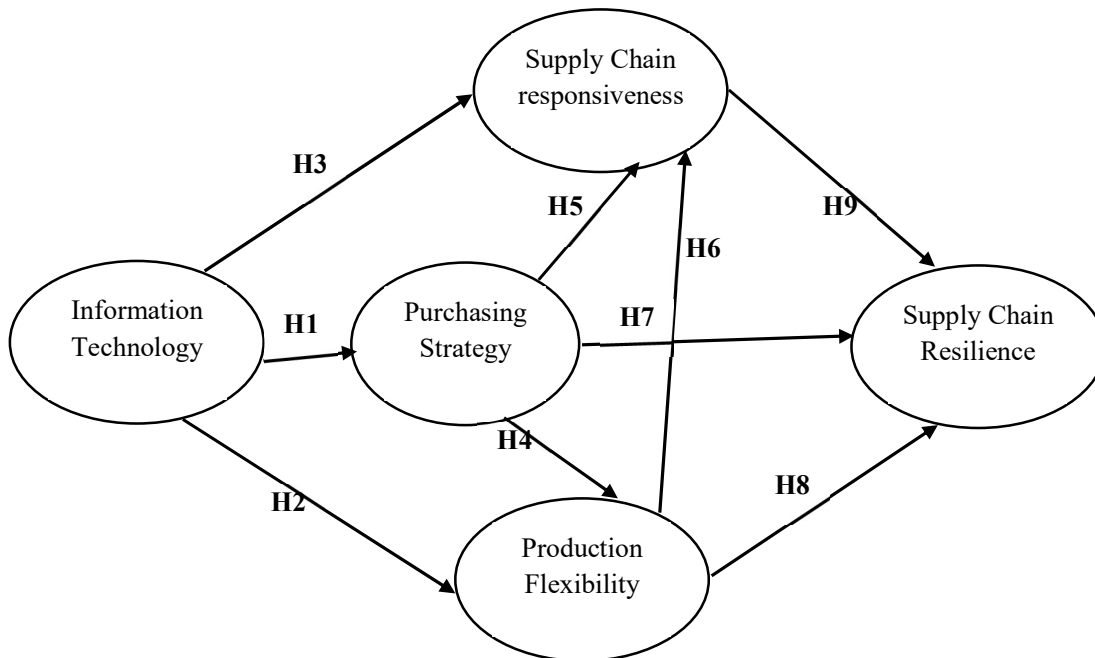


Fig. 1. Research conceptual framework

3. Research Methods

This research process was carried out through several systematic stages. The first stage is the preparation stage, which includes preparing a research proposal, submitting a research permit, and creating a questionnaire instrument. After preparations, the data collection stage continues, distributing questionnaires to selected respondents. The questionnaire was distributed over two years to ensure adequate participation. After the data is collected, the data processing stage is carried out. This research uses a quantitative research design by providing a descriptive explanation of the characteristics of the respondents and providing a mean value for each indicator and research variable. This research is also causal by calculating the influence between research variables. A quantitative design was chosen because it is suitable for measuring the Relationship between variables that have been determined statistically in the research conceptual framework. A descriptive approach provides a clear picture of the phenomenon under study, while a causal approach is applied to identify cause-and-effect relationships between independent and dependent variables. The research determined the population of manufacturing companies in East Java that have implemented enterprise resource planning as an integrated implementation of information technology. A judgmental sampling technique was used to obtain a representative sample. The criteria set are that the manufacturing company has implemented enterprise resources planning for more than three years so that departments have stable data integration. Another criterion is that respondents have 2 years of work experience and are permanent employees. Data collection in research by collecting questionnaires was designed with 24 question items in total as closed questions consisting of five variables to measure them. A 5-point Likert scale was used to measure respondents' responses, where a scale of 1 indicates "strongly disagree", and a scale of 5 indicates "strongly agree". This approach was chosen to make measuring respondents' perceptions and attitudes towards the variables studied easier.

Measurement items have been defined for each variable. Information technology is defined as the use of technology in companies that allows it to be integrated internally and externally in the company as the first variable is determined with five measurement items, namely, the company can share information with external partners (Tan et al., 2023; Chaudhuri et al., 2018), data has been integrated in real-time within the company (Tan et al., 2023; Putri et al., 2024), departments can access data in real-time (Chaudhuri et al., 2018), the available data is accurate (Putri et al., 2024) and internal company coordination has prioritized information technology (Chaudhuri et al., 2018; Anastasia et al., 2024).

The second variable purchasing strategy is a planned approach used by the company to obtain the goods, services, and raw materials needed efficiently and effectively. Purchasing strategy is determined by 5 measurement items namely the company has key suppliers (Nenavani & Jain, 2022; Tarigan & Siagian, 2021), the company has long-term relationships with suppliers (Tarigan et al., 2020a; Tarigan & Siagian, 2021; Ateş et al. ., 2018), the company has clear criteria for suppliers (Nenavani & Jain, 2022), the company evaluates suppliers (Tarigan et al., 2020a; Tarigan & Siagian, 2021; Ateş et al., 2018) and the company collaborates strongly with suppliers (Tarigan et al., 2020a). The third variable is production flexibility as the company's ability to quickly and efficiently adjust its production process according to changes in market demand which is determined by 4 measurement items, namely flexibility in procuring raw materials (Chowdhury & Quaddus, 2016; Shukor et al., 2021; Yu et al. ., 2018), flexibility in the use of tools or equipment (Siagian et al., 2021), flexibility in the production process (Chowdhury & Quaddus, 2016; Siagian et al., 2021; Chaudhuri et al., 2018) and flexibility in schedules (Chowdhury & Quaddus, 2016; Shukor et al., 2018; The fourth variable with supply chain responsiveness is the ability of the company's supply chain to respond quickly and efficiently to changes in demand which is determined by 5 measurement items, namely the company can respond to market changes quickly (Munir et al., 2022; Yu et al., 2019; Chowdhury & Quaddus, 2016), companies can respond to changes in orders (Munir et al., 2022; Nenavani & Jain, 2022; Yu et al., 2019), companies can respond to product variations (Asamoah et al., 2021; Nenavani & Jain , 2022), companies can respond to changes in delivery (Asamoah et al., 2021; Yu et al., 2019) and companies can respond quickly in payment methods (Asamoah et al., 2021).

The fifth variable with supply chain resilience is the minimum ability a company has to be able to survive and recover from disruptions in the supply chain by involving supply chain members, which are determined by 5 measurement items, namely the company can detect disruptions well (Munir et al., 2022; Li et al. al., 2017; Abeysekara et al., 2019; Siagian et al., 2021), companies can adapt to sudden changes (Munir et al., 2022; Alvarenga et al., 2023; Ali et al., 2023; Sadha et al., 2024), companies can quickly anticipate disruptions (Chowdhury & Quaddus, 2016; Alvarenga et al., 2023; Li et al., 2017; Siagian et al., 2022), companies have adequate resources to recover from disruptions (Ali et al., 2023; Yuan & Li, 2022; Bag et al., 2023) and companies can return to normal conditions quickly (Munir et al., 2022; Yuan & Li, 2022; Abeysekara et al., 2019; Tan et al., 2023; Adobor & McMullen, 2018). The research instrument used is a questionnaire whose validity and reliability have been tested. Data analysis used partial least squares to test the validity of the data using outer loading to ensure that each item in the questionnaire measured the construct in question. Meanwhile, reliability testing was carried out using the composite reliability coefficient and Cronbach's Alpha to measure the internal consistency of the questionnaire. The next stage is to test the inner model to get answers from the first hypothesis to the ninth hypothesis.

4. Analysis and Discussion

The research uses Google Forms to collect research data. Researchers collected data by giving distribution assignments to 54 survey enumerators by collecting 2 questionnaires, paying attention to different manufacturing companies. Researchers asked the survey enumerator to choose the name of a manufacturing company that had been determined. Each survey enumerator is asked to choose two companies that suit their abilities and have a contact person in the company or close to where the enumerator lives. Based on the student distribution results, the respondents' characteristics were obtained in Table 1.

Table 1
Characteristics of Research Respondents

Characteristics	Description	Qty	Percentage
Gender	Male	41	38 %
	Female	67	62 %
Department	Accounting/Finance	9	8 %
	Operational/Production/ Planning	34	32 %
	Sales & Marketing, Purchasing, Export-Import	48	44 %
	Warehouse and Inventory	17	16 %
Corporate structure position	Manager/Top Management	35	32 %
	Supervisor/Senior Staff	62	58 %
	Staff	11	10 %
Work experience	2-5 Years	19	18 %
	5-7 years	26	24 %
	More than 7 years	56	58 %
IT on ERP Implementation	3-5 years implementation	12	11 %
	6-8 years implementation	27	25 %
	More than 8 years	69	64 %

Table 1 shows that the respondents' characteristics indicate that manufacturing companies have adequate information technology to build data integration internally and externally because 96 companies (89%) have implemented ERP for more than 6 years. There were 82 respondents (82%) who already had work experience in a company, which showed that they had high skills and knowledge because they had more than 5 years of work experience. An examination of the characteristics of the respondents shows that they come from various departments with extensive functions: sales, marketing, purchasing, and export-import, as 48 (48%) always deal directly with customers or suppliers by getting requests for flexibility regarding product delivery. A significant role in quickly providing a solid response for customer satisfaction. The second related department is operations/production/planning, with 34 respondents (32%) directly related to production flexibility. This section is always creative to meet customer requests by changing production routes, and process flows to produce products with variants according to customer needs. Further processing is carried out to obtain the goodness of fit of the measurement items for each variable shown in Fig. 2.

Table 2
Goodness of fit testing of measurement items

Measurement Items	Loading Factor	Reliability	Cronbach Alpha	Mean
Information technology, AVE = 0.573	-	0.870	0.814	4.111
Companies may share information with external partners	0.810			4.167
Data has been integrated in real-time within the company	0.780			3.981
Departments can access data in real-time	0.725			3.917
The available data is accurate	0.724			4.107
The company's internal coordination prioritizes information technology	0.744			4.324
Purchasing strategy, AVE 0.530	-	0.848	0.780	4.024
The company has key suppliers	0.800			4.176
The company has long-term relationships with suppliers	0.846			4.065
The company has clear criteria for suppliers	0.678			3.907
The company evaluates suppliers	0.591			3.648
The company collaborates strongly with suppliers	0.696			4.324
Production flexibility, AVE = 0.807	-	0.943	0.921	4.005
Flexibility in the procurement of raw materials	0.906			3.870
Flexibility in the use of tools or equipment	0.896			4.019
Flexibility in the production process	0.888			4.028
Flexibility in schedule	0.902			4.102
Supply chain responsiveness, AVE = 0.767	-	0.943	0.924	4.124
Companies can respond to market changes quickly	0.880			4.194
The company can respond to changes in orders	0.881			4.139
Companies can respond to product variations	0.886			4.130
The company can respond to changes in Delivery	0.822			4.074
The company can respond quickly to payment methods	0.907			4.083
Supply chain resilience, AVE 0.521	-	0.841	0.769	4.131
The company can detect interference well	0.844			4.167
Companies can adapt to sudden changes	0.765			4.000
Companies can quickly anticipate disruptions	0.755			4.093
The company has adequate resources to recover from disruptions	0.695			4.426
The company was able to quickly restore normal conditions	0.504			3.972

Based on the validity and reliability tests as goodness of fit tests in Table 2, they have fulfilled the requirements. The validity test is indicated by the loading factor value above 0.500 for all measurement items for the five variables. The lowest item in information technology is found in items where the available data is accurate (IT4), with a value of 0.724. The lowest item in the purchasing strategy is found in the item the company evaluates suppliers (PS4) with a value of 0.591. The lowest item on production flexibility is found in the item flexibility in the production process (PF3), with a value of 0.888. The lowest item on supply chain responsiveness is found in items the company can respond to shipping changes (SCR4) with a value of 0.822. The lowest item on supply chain resilience is found in items the company was able to restore external conditions with a value of 0.504 quickly. Meanwhile, the reliability test for each variable was obtained for each variable with composite reliability and Cronbach alpha values greater than 0.700, so it can be said to meet the requirements. Based on Table 2 for the variables' information technology, purchasing strategy, production flexibility, supply chain responsiveness, and supply chain resilience, the values obtained exceed 0.700, so all variables are satisfactory. The mean value for the information technology variable is 4.111, and the mean item value is 3.917 – 4.324, this shows that the respondents stated that the implementation of information technology in the company has been utilized by management functions in the company and has gone well. The purchasing strategy was obtained with a value of 4.024, and the mean of the measurement items was 3.648 – 4.324. This shows that respondents stated that the planned approach used by the company in procurement ran efficiently and effectively. Production flexibility was obtained with a mean value of 4.005, and the mean item was 3.870 - 4.102, this shows that the company has a production and administration system that can accommodate sudden changes requested by customers. Supply chain responsiveness was obtained with a value of 4.124, and the mean measurement item was at a value of 4.074 - 4.194, this shows that manufacturing companies respond quickly and efficiently to changes in demand. Lastly, supply chain resilience has a mean value of 4.131, and the mean item was

3.972 – 4.426. This shows that the company can survive and recover from disruptions in the supply chain by involving supply chain members. The data processing carried out to answer the research hypothesis is shown in Fig. 2 and Table 3.

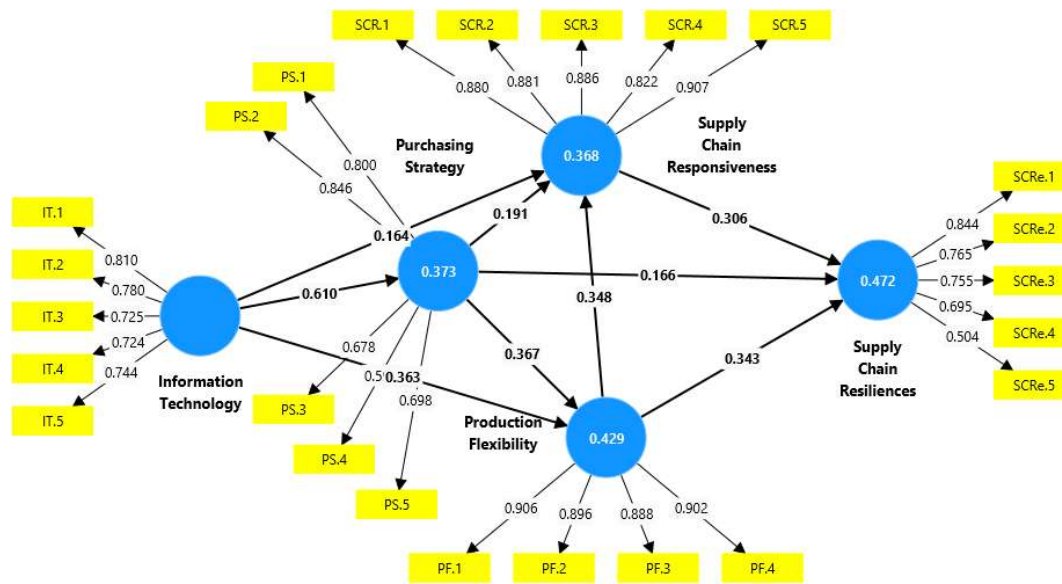


Fig. 2. Analysis Result

Table 3
Path Coefficient and Hypothesis Test

	Direct Coefficient	Original Sample	T statistics	P-values
Information Technology → Purchasing Strategy	0.610	10.003	10.003	0.000
Information Technology → Production Flexibility	0.363	3.736	3.736	0.000
Information Technology → Supply Chain Responsiveness	0.164	1.653	1.653	0.074
Purchasing Strategy → Production Flexibility	0.367	4.006	4.006	0.000
Purchasing Strategy → Supply Chain Responsiveness	0.191	1.801	1.801	0.058
Purchasing Strategy → Supply Chain Resilience	0.166	1.717	1.717	0.063
Production Flexibility → Supply Chain Responsiveness	0.348	3.462	3.462	0.001
Production Flexibility → Supply Chain Resilience	0.343	3.877	3.877	0.000
Supply Chain Responsiveness → Supply Chain Resilience	0.306	2.673	2.673	0.008

Based on Fig. 2 and Table 3, the nine research hypotheses were obtained. The first hypothesis states that information technology has an influence on the company's purchasing strategy of 0.610 with t-statistics of 10.003 (>1.96) and p-value (<0.05). This shows that the first hypothesis is accepted, with the implementation of information technology, the company can share information with external partners, and the available data is accurate, able to prepare for the procurement department to build a purchasing strategy by increasing the company's ability to coordinate with key suppliers and the company can set appropriate criteria. Manufacturing companies in East Java can build adequate coordination with suppliers. The research results support research results which state that the implementation of information technology in companies can improve purchasing strategies (Tarigan et al., 2020a; Ju et al., 2021; Cao & Zhang, 2010; Ateş et al., 2018; Panahifar et al., 2018; Basana et al., 2024; Ambekar et al., 2020). The second hypothesis states that information technology has an influence on the company's production flexibility of 0.363 with t-statistics of 3.736 (>1.96) and p-value (<0.05). These results show that manufacturing companies in East Java, by implementing their information technology can integrate data, and internal coordination of the company prioritizing information technology can increase production flexibility by making it easier to regulate flexibility in production schedules. The research results support research results which state that the implementation of information technology in companies can increase production flexibility (Azadegan et al., 2019; Dubey et al., 2019; Siagian et al., 2022; Chunsheng et al., 2020; Fayezi & Zomorodi, 2015; Tiwari et al., 2015; Willis et al., 2016); The implementation of information technology in manufacturing companies in East Java makes it easier for the planning production inventory control department to reschedule and in real-time it can be understood by the relevant departments in the company.

Information technology implementation influences supply chain responsiveness of 0.164 as the third hypothesis statement, with t-statistics of 1.653 (>1.65) and p-value (<0.1). This condition results in information technology implementation, which is determined by the department's ability to access data in real time and the company can share information with external partners, influences supply chain responsiveness by increasing the company's ability to respond to changes in orders and product variations. The research results support research results which state that information technology implementation

has a significant effect on supply chain responsiveness (Asamoah et al., 2021; Gu et al., 2021; Zhao et al., 2023; Yu et al., 2019; Tarigan et al., 2021; Pirmanta et al., 2021; Ju et al., 2021). The ability of manufacturing companies to utilize information technology can provide satisfaction to customers because they can use the company's information system. The fourth hypothesis, with the statement that purchasing strategy influences production flexibility is 0.367 with t-statistics of 4.006 (>1.96) and p-value (<0.05). This shows that the purchasing strategy established by the company by having long-term relationships with suppliers and the company collaborating intensely with suppliers can increase production flexibility by providing flexibility in the production process and raw material procurement. The results of this research support research results which state that purchasing strategy influences production flexibility (Dubey et al., 2019; Fayezi & Zomorodi, 2015; Chunsheng et al., 2020; Chowdhury & Quaddus, 2016; Sarkar & Seo, 2021; Yu et al., 2023; Tarigan et al., 2020b; 2020; Yu et al., 2018). The company's ability to build good collaboration internally and externally as a form of purchasing strategy. The fifth hypothesis, with the statement that purchasing strategy influences supply chain responsiveness is 0.191 with t-statistics of 1.801 (>1.65) and p-value (<0.1). The company's purchasing strategy, which can evaluate suppliers and collaborate strongly with suppliers, can impact supply chain responsiveness by increasing the speed of response to market changes and changes in delivery schedules. Manufacturing companies in East Java have long built good collaborations with key suppliers in providing raw materials according to needs with a high level of flexibility so that they can carry out production flexibility to meet high responses to customer and market demands. The research results support previous research which states that purchasing strategy influences supply chain responsiveness (Asamoah et al., 2021; Siagian et al., 2022; Nenavani & Jain, 2022; Yu et al., 2019; Yu et al., 2018; Setiawan et al., 2023; Ateş et al., 2018). The sixth hypothesis (H6) states that purchasing strategy has an effect on supply chain resilience of 0.166 with t-statistics of 1.801 (>1.65) and p-value (<0.1). The purchasing strategy established by the company by having key suppliers, long-term relationships with suppliers, and evaluating suppliers has an impact on increasing supply chain resilience. The company can demonstrate supply chain resilience with the ability to detect disruptions well and be able to adapt to sudden changes. The research results support research that states purchasing strategy influences supply chain resilience (Chowdhury & Quaddus, 2016; Nenavani & Jain, 2022; Dubey et al., 2019; Sarkar & Seo, 2021; Chaudhuri et al., 2018; Singh & Kumar, 2020; Shukor et al., 2021).

The seventh hypothesis states that production flexibility has an impact on supply chain responsiveness of 0.348 with t-statistics of 3.462 (>1.96) and p-value (<0.05), so the hypothesis can be accepted. Manufacturing companies in East Java try to adapt to external changes to maintain high competitiveness. Production flexibility is one of the adjustments made with flexibility in raw material procurement, which involves purchasing strategies that impact supply chain responsiveness by increasing the company's ability to respond to changes in orders and product variations. The research confirms the results of previous research which states that production flexibility has an impact on supply chain responsiveness (Munir et al., 2022; Zhao et al., 2023; Adobor & McMullen, 2018; Yuan & Li, 2022; Nenavani & Jain, 2022; Wungkana et al., 2023; Yoon & Moon, 2019; Siagian et al., 2021; Production flexibility has an impact on supply chain resilience of 0.343 with t-statistics of 3.877 (>1.96) and p-value (<0.00), so the hypothesis can be accepted. Manufacturing companies can build production flexibility by maintaining flexibility in the production process, flexibility in schedules, and flexibility in the use of tools or equipment, which can have an impact on increasing supply chain resilience. Manufacturing companies can build a strong production flexibility system to produce the company's ability to detect disruptions well, adapt to sudden changes, and quickly anticipate disruptions. This research supports previous research which states that production flexibility has an impact on increasing supply chain resilience (Munir et al., 2022; Tan et al., 2023; Ju et al., 2021; Ali et al., 2023; Munir et al., 2022; Siagian et al., 2019); The ninth hypothesis (H9) states that supply chain responsiveness has an influence of 0.306 on supply chain resilience with t-statistics of 2.673 (>1.96) and p-value (<0.008), so the hypothesis can be accepted. Manufacturing companies that have been able to respond quickly to market changes and respond quickly in payment methods can have an impact on increasing supply chain resilience. This condition can be seen from the fact that the resources available are adequate to recover from disruptions, and the company is able to return to normal conditions quickly. Manufacturing companies in East Java always try to be able to respond to changes in orders, product variations, and changes in delivery in order to provide high customer satisfaction so that they can detect disruptions well and adapt to sudden changes. The research results support previous researchers who stated that supply chain responsiveness influences supply chain resilience (Huo et al., 2024; Nik & Moazami, 2020; Sadha et al., 2024; Munir et al., 2022; Asamoah et al., 2021; Li et al., 2017; Ali et al., 2023;

Research shows that companies with well-implemented information technology can support a strong purchasing strategy. The synergy that occurs internally and externally by building collaboration through a purchasing strategy can increase production flexibility and provide an excellent response to customers. Manufacturing companies can produce adequate customer needs to increase high supply chain resilience. The research provides practical contributions for industry practitioners to be willing and carefully analyze information technology investments for department managers. Practical contribution for purchasing managers to be able to build purchasing strategies to use information technology so that they can make a strong contribution in determining production flexibility and a strong response to customers. The theoretical contribution from the research results can strengthen the theory about resilience for companies and enrich the theory of supply chain strategy.

5. Conclusion

Adopting information technology for companies has become mandatory in increasingly global strength competition and dynamic changes. Companies striving to be competitive always pay attention to speed, effectiveness, and efficiency in the supply chain flow. Practical adoption of information technology as a form of implementation can increase resilience to sudden changes. Implementing information technology formed in companies with real-time integrated data within the company can make internal company coordination strong and impact purchasing strategy, production flexibility, and supply chain responsiveness. Owned information technology allows companies to collaborate strongly with suppliers and quickly evaluate suppliers as a form of purchasing strategy, which impacts increasing production flexibility, supply chain responsiveness, and resilience. The purchasing strategy that has been formed can provide flexibility in procuring raw materials and schedule flexibility to produce production flexibility. Conditions with high production flexibility have an impact on increasing supply chain responsiveness and supply chain resilience. Companies can respond quickly to market changes by making changes to orders, product variations, and changes to delivery schedules, which have an impact on increasing supply chain resilience. Companies can produce supply chain resilience by having adequate resources to recover from disruptions and being able to detect disruptions well to adapt to sudden changes. East Java manufacturing companies have been able to increase their resilience to changes that occur, and this was proven when the company was able to face the disruption caused by the pandemic. The company's ability to rely on production flexibility to be able to respond to market changes that occur suddenly, but can survive and grow again to produce highly competitive products

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