

Uncertain Supply Chain Management

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The effect of supply chain collaboration on supply chain performance through production technology, new product development and product knowledge

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ABSTRACT

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Manufacturing companies are trying hard to anticipate a disrupted supply chain. Internal changes are encouraged to adapt to external conditions. Partnerships with external parties through supply chain collaboration are needed to improve supply chain performance and increase competitiveness. This research examines the effect of supply chain collaboration on supply chain performance by adopting new product development, product knowledge, and production technology. The study surveyed 148 manufacturing companies at managerial level using questionnaires. Data processing using SmartPLS software version 4.0. The results show that supply chain collaboration positively influences production technology, product knowledge, new product development, and supply chain performance. Production technology positively impacts product knowledge, new product development, and supply chain performance. The results also show that supply chain performance is influenced by product knowledge and new product development. In addition, production technology, new product development, and product knowledge mediate the indirect influence of supply chain collaboration on supply chain performance. This study contributes to enriching supply chain management theory. The practical contribution is to enlighten the company's managerial to run supply chain collaboration in generating performance and competitiveness.

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1. Introduction

The world economy's pace, especially at the end of the first quarter of 2020, is a very detrimental phenomenon for all humankind in various countries and the worsening economic conditions. Furthermore, the rapid changes in the business world require companies to adapt technological developments and improve internal performance to compete in the market (Chae et al., 2018). Competitiveness is the core of a company's success or failure, so strategic thinking is needed for every business actor to maintain their business and compete in the business world and maintain their competitive position against competitors (Siagian et al., 2022a). Each company must win the competition by displaying the best products and meeting consumers, which are constantly evolving and changing (Stanton & Cook, 2019). The company always strives to understand the market's needs and communicate quickly with suppliers. To achieve a competitive advantage, the company not only relies on its resources but also innovates efforts in creating a sustainable competitive advantage which requires supply chain collaboration efforts (Baah et al., 2022a; Mishra et al., 2022) and focuses on improving financial performance (Salam, 2017). A company's ability to build collaboration and maintain collaborative relationships is critical to improving long-term competitiveness and success (Baah et al., 2022b) Companies must collaborate on business with various parties, such as suppliers, distributors, and consumers (Pirmanta et al., 2022). This condition is mainly faced by companies that want to expand their activities to international or global markets. The company's ability to survive competition requires collaboration with suppliers to understand customer needs and technology requirements (Tarigan et al., 2020). Technology adoption makes product cycles short and timely, and interaction with suppliers and customers is better (Salehi et al., 2021). Research shows that information

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and communication technology used in industry can increase integration between companies as a form of collaboration with suppliers (Mehdikhani & Valmohammadi, 2019; Salehi et al., 2021).

Collaboration with external parties can provide benefits in the form of access to markets, technology, innovation opportunities, knowledge creation, and improving the capabilities of human resources and organizations (Basana et al., 2022b). Collaboration between the company and its partners or collaborations supply chain will have a positive effect (Tarigan et al., 2020; Um & Oh, 2020). The use of technology in enterprise products can be applied in the form of information technology aimed at reducing costs and increasing the company's production efficiency and firm performance (Salehi et al., 2021; Chae et al., 2018; Tarigan et al., 2019). Faced with evolving technologies, the wide range of service options in many industries has expanded the scope of service innovations of certain companies. Hence information technology provides a significant opportunity for the digitization of substantial technology-based service innovations into the innovation of their service products (Tsou, 2012; Siagian & Tarigan, 2021). Manufacturing companies must rethink their strategies towards more innovative practices to enable them to create higher value and ultimately improve their competitive position (Ferreira et al., 2020). The innovation needs support by knowledge of the product that includes the overall accurate information obtained by consumers as their perception of the product because today's customers need more variety of products and services, shorter lead times, and lower prices in addition to high quality and more customization (Bratianu et al., 2022).

New knowledge to create new products or change products, processes, and services that have a unique value for customers with innovation will increase financial efficiency (Tsou, 2012; Tarigan, 2018). The innovation needs support by knowledge of the product that includes the overall accurate information obtained by consumers as their perception of the product because today's customers need more variety of products and services, shorter waiting times, and lower prices in addition to high quality and more customization (Sangtani & Murshed, 2017). Implementing SCM and selecting suitable suppliers make the company superior to other companies (Gallear et al., 2012; Pirmanta et al., 2022). However, in reality, few implemented supply chain collaboration strategies do not work. This finding is due to a lack of insight into the factors that influence the success of the collaboration. Based on the results of previous research, no one has discussed simultaneously the capabilities of production technology, new product development, and product knowledge that companies can achieve through supply chain collaboration to improve supply chain performance. This article is written with several sections, namely the second section on literature review and the relationship between concepts, the third section on research methods, the fourth section on analysis and discussion, and the fifth is the conclusions and implications of the research.

2. Literature Review

2.1 Supply Chain Management

The supply chain is a chain or network that connects companies with their suppliers to produce goods that are then sent to customers (Kotzab et al., 2015). The supply chain management from upstream to downstream (downstream) and then processed and distributed to consumers at a lower cost (Basana et al., 2022b). Coordination of the overall supply chain management activities is designed most effectively and efficiently, starting from planning, arranging, and scheduling the flow of raw material products and ending with distribution to consumers (Siagian et al., 2022b). Supply chain integration is a set of activities related to coordinating product flows between supply chain partners, including transactions, material movements, procedures, customer service, and optimization processes (Basana et al., 2022b; Birasnav & Bienstock, 2019). The product processes aim to minimize costs and achieve the desired service level through an appropriate production process in quantity, time, and place accuracy (Baah et al., 2022a). Supply chain management is vital to business processes from consumers through suppliers who provide products, services, and information that add value to customers and other stakeholders by optimizing the time, location, and quantity flow of different materials (Birasnav & Bienstock, 2019). Developing an integrated supply chain usually considers three perspectives: strategic, tactical, and operational. As an effective method for supply chain management, supply chain integration has been vital to improving performance and creating value critical to the success of individual companies and the entire supply chain (Santoso et al., 2022; Pirmanta et al., 2022). Selecting suitable suppliers to implement SCM will impact the company's advantages. Collaboration in supply chain management includes producers and suppliers, distributors, warehouses, and even consumers (Mehdikhani & Valmohammadi, 2019). Therefore, it is necessary to apply supply chain performance optimally (Chand et al., 2020; Tarigan et al., 2020).

2.2 Supply Chain Collaboration

Supply chain collaboration is a form of partnership or sharing between two or more company parties that form a cooperation bond based on agreement and mutual need to increase capacity and capability to obtain better results that are beneficial in improving company performance (Tarigan et al., 2020). The results of the research of Nagashima et al. (2015) state that cooperation with suppliers, consumers, and cross-functions within the company will be able to improve the company's performance. Supply chain collaboration is designed to enhance each participating organization's strategic and operational capabilities to help them achieve significant sustainable benefits (Salam, 2017). Collaboration emphasizes long-term direct associations and encourages joint planning and problem-solving efforts (Ferreira et al., 2020; Mishra et al., 2022).

Collaboration enables organizations to work more effectively with several important suppliers willing to share responsibility for the success of product offerings and benefit the company's performance.

The strategic collaboration built by the company and its partners is a bridge that connects various forms of exchange and exchanges regarding resources that have expertise and competence in each company (Mehdikhani & Valmohammadi, 2019). The company and its partners coordinate with each other and work together to achieve mutually agreed goals (Basana et al., 2022b). Strategic plan to anticipate threats from competing companies, namely the presence of superior products from new companies, the presence of replacement products that are more valuable to sell, the supplier offers, and customer offers that compete in price, and competition between companies in the same industry. For this reason, strategic thinking is needed in collaborating with other companies, and good cooperation is necessary to have a higher competitive position in facing competition. Supply Chain Collaboration is measured by building strategic collaborations with external partners (SCC1), sharing product planning information with partners (SCC2), sharing benefits with partners (SCC3), and coordinating with partners in meeting demand and creating added value for consumers (SCC4).

2.3 Production Technology

A company or organization can create more value than any other company by creating products or services provided to consumers at a lower cost than the company or organization achieves a competitive advantage (Siagian et al., 2022a). Selecting the product design desired by customers can encourage companies to innovate offers based on competitive advantage to win specific market segments and maximize that competition to win its edge. For products that have the proper usability and aesthetic value, the consumers can make a purchase process. The more customers have a high acceptance of a product they will buy, it will bring benefits to the company and can be a product with prominent advantages because customers are interested in the product (Kotzab et al., 2015). Competitive advantage grows from the value or benefits a company can create for its buyers, which is more than the cost it has to spend to make it (Wouters et al., 2016). Buyers will dare to pay more if there is a high-value product with equivalent benefits or a product offering with unique benefits that exceed the price offered (Siagian & Tarigan, 2021). The use of technology in the company's production process can involve all components in carrying out company activities related to design, product customization, installation of technological equipment, and using specialized equipment as a process or company activity continuously (Karagouni, 2018). The use of technology can involve a variety of sophisticated machines connected to computerized systems (Chae et al., 2018). Production technology is the participation of all components in supply chain management (AlMulhim, 2021). The role of suppliers is to provide quality goods that will be converted into finished products per customer requests. Production technology increases production and productivity and can be widely applied in manufacturing and service industries. Production technology can be said to be a skill or advantage that the company has in creating tools to help solve various problems in the company's production area (Karagouni, 2018). Technology production can be defined as a tool used in producing products by utilizing machine technology to produce efficiency, effectiveness, and increased productivity (Basana et al., 2022b). The use of technology in enterprise products can be applied in the form of information technology aimed at reducing costs and improving the company's production efficiency (Salehi et al., 2021). Information technology provides significant opportunities for the digitization of service innovation and management. As more and more companies incorporate important technology-based components into service product innovation (Tsou, 2012), there is a growing interest in understanding how the current technological context in which an enterprise's service product innovation is embedded affects its behavior and performance. Manufacturing companies must rethink their strategies towards more innovative practices to enable them to create higher value and ultimately improve their competitive position (Ferreira et al., 2020). Four indicators measure Production Technology: the company's efforts to use technology to produce products (PT1), rely on the internet network to run operations (PT2), have integrated information system facilities between the internal functions (PT3), and adopt the upgraded information technology facilities following the latest requirement (PT4).

2.4 New Product Development

Information technology is the reference basis of various company activities used in the implications of innovation for product development, including in the new product development process stages (Wouters et al., 2016; Fantazy & Salem, 2016). For example, Trott (2017) mentioned that a company with strong competitiveness capabilities uses information technology (IT) devices in each process of the NPD stage, including the new product planning stage, product design process, implementation of business analysis, and product development. Innovation is already fundamental in manufacturing companies and is no longer an option, so manufacturing companies must inevitably follow innovation changes (Bratianu et al., 2022). Companies are also required to strive to create more value for consumers by creating a new product or product also at the stage of the production process to be more competitive (Tarigan, 2018). The design of a new product is the result of innovation (Fantazy & Salem, 2016). Developing new products is, in principle, a process of changes made to existing products and finding innovation to add value to old goods by converting them into those products and becoming more competitive business opportunities (Trott, 2017). Using the internet or IT tools is essential in improving the quality and speed of conducting validation testing, business analysis, and evaluating the effectiveness and efficiency of new product development (Liao et al., 2010). Five indicators measure new product development: having a unique product that is better than competitors and can meet consumer needs (NPD1), being able to develop new products according to consumer needs (NPD2), involving consumers

through relevant departments in new product development (NPD3), being able to increase creativity in producing new products (NPD4) and being able to respond to customer requests quickly and develop new products (NPD5).

2.5 Product Knowledge

Product knowledge is a collection of various information about a product, including product categories, brands, product terminology, product attributes, or features (Sangtani & Murshed, 2017). Besides, product prices and beliefs about the product and its function as a consumer will determine whether the product purchased is appropriate, following the needs and expectations for a product. Somethings related to knowledge about product characteristics, product benefits, the risks of consumer products, and the satisfaction of finishing products (Dastaki et al., 2022). Knowledge of products has a significant positive effect on media search, where the strong influence of product knowledge will encourage consumers to learn and combine new information more easily. Product knowledge is consumer knowledge related to knowledge of the characteristics or characteristics of the product, the consequences of using the product, and the value (level) of satisfaction to be achieved by the product (Singh et al., 2021). Product knowledge is knowledge of various things related to product characteristics, benefits of a product, information about the risks of using a product, and knowledge of satisfaction with a product (Bratianu et al., 2022). The search for product information is a stage carried out by consumers in determining which products are suitable for purchase (AIMulhim, 2021). Previous studies concluded that product knowledge significantly affects consumers' purchasing decisions. Product Knowledge is measured by providing technology following the characteristics of the product produced (PK1), being able to respond quickly to consumers' understanding of the product needed (PK2), being able to describe the information and benefits of the product produced clearly (PK3), and conducting periodic and controlled product analysis and monitoring (PK4).

2.6 Supply Chain Performance

The company's performance is the real result or output produced by a company which is then measured and compared with the expected results or outcomes (Siagian et al., 2022a). In general, researchers define corporate performance based on the idea that a company is a collection of deliberately formed productive assets, including human, physical, and capital resources, aimed at jointly achieving a goal. A company produces Supply Chain Performance or performance within a certain period or by referring to established standards that describe the empirical conditions of a company and can be measured by market-oriented and financial goals (Chand et al., 2020; Tarigan et al., 2019). Improved Supply Chain Performance contributes to competitive advantage by increasing customer satisfaction, flexibility in meeting customer needs, controlling organizational costs, and accelerating new product launches, thus, gaining market share and driving greater business success (Chand et al., 2020). Company performance measurements that are often used in empirical research are financial performance, operational performance, and market-based performance (Stanton & Cook, 2019). In this study, the highlight active performance-based performance measurement, where aspects can measure performance when the available information about opportunities already exists but has not been realized financially. This operational performance can be measured using measurements consisting of market share, new product launches, quality, marketing effectiveness, and customer satisfaction (Tarigan et al., 2019; Siagian et al., 2022b; Santoso et al., 2022).

Company performance is the overall performance or condition of the company within a certain period of time-related to the results or achievements of the company's operational activities in utilizing the resources owned. Performance is an organization's entire action or activity in a certain period concerning existing standards and operational costs based on efficiency (Santoso et al., 2022). Company performance refers to how well a company is oriented toward the market and its financial goals (Ilmiyati & Munawaroh, 2016). Supply chain performance is measured by establishing regular planning (SCP1), having a more effective and efficient product lead time (SCP2), producing quality products (SCP3), delivering products on time (SCP4), providing adequate services for customers (SCP5) and being able to reduce production costs and be more competitive (SCP6).

2.7 Relationship between Research Concepts

2.7.1 Supply Chain Collaboration and Supply Chain Performance

The research surveyed 278 Managers from manufacturing companies affirms that supply chain collaboration by creating competitive strategies significantly affected company performance. It also showed that restructuring supply chain collaboration to advance environmental collaboration had a major impact on environmental and financial performance (Baah et al., 2022a). In addition, information sharing is key to improving competitive advantage and superior supply chain performance (Baah et al., 2022b). Surveying 150 managerial levels in South Korea shows that development through contractual collaboration drives effectiveness, efficiency, and innovation, yielding substantial benefits. In addition, it enables shorter cycle times, lower inventory, reduced costs, accurate delivery, and innovative results, allowing the company to enjoy a competitive advantage (Um & Oh, 2020). In addition, a survey conducted on the supply chain managers of fast-moving consumer goods (FMCG) companies in Thailand indicated that trust and technological capabilities are significantly related to supply chain collaboration and operational performance. Besides, technology benefits the company in terms of cost efficiency,

and improved customer service will create a sustainable competitive advantage (Salam, 2017). Effective collaboration will result in superior performance and allow for faster new product development, quality improvements, lower production costs, shorter cycle times, and better customer service. Successful collaboration by working with partners to plan, coordinate activities, solve problems, find standard solutions, set company planning, common goals, and performance measurement to align operations and improve relationships by building trust (Teng et al., 2022). Supply chain visibility significantly affects collaboration, agility, and performance, while supply chain collaboration and agility substantially impact supply chain performance (Baah et al., 2022b). The description established based on the above explanation are:

H₁: *Supply chain collaboration affects supply chain performance.*

2.7.2 Production Technology and Supply Chain Collaboration

Supply chain management involves the management of an interconnected business network covering the products and services that customers need, including transportation, raw material storage, and production process phases. For example, information and communication technology used in sugarcane industry companies in Khuzestan province with 34 senior managers in large companies was able to remove barriers to cooperation with suppliers to produce timely communication and adequate collaboration (Salehi et al., 2021). The use of technology in manufacturing companies in Thailand, totaling 181 companies in the form of FMCG (Fast Moving Consumer Goods), can increase supply chain collaboration significantly. The technology implemented by the company can remove obstacles in companies with suppliers and their customers so that there is enthusiasm for strategic partnership in all components of the supply chain (Salam, 2017). Measurement of the utilization and improvement of information technology and adequate knowledge can overcome business challenges and strategic collaboration relationship agreements (Tarigan et al., 2020). Furthermore, the management of relevant information flows in supply chain sets can be improved with technological advancements, and knowledge transfer and information integration can serve as strategic competencies worthy of development (Nagashima et al., 2015).

Collaboration built supply chain management based on trust and commitment, in which case information technology has played an enabling role in all these collaborative practices (Um & Oh, 2020). There is a clear development path in the capabilities and sophistication of the underlying technology infrastructure supporting collaboration. Salehi et al. (2021) argue that collaboration can be achieved through trust and electronically mediated exchanges, ultimately improving buyer-supplier operational performance that might result from increased efficiency. However, manufacturing companies show supply chain collaboration positively affects technological innovation and that collaboration with external agents encourages incremental and radical innovation. Information technology indirectly improves both types of product innovation through supply chain collaboration (Jimenez-Jimenez et al., 2019). A hypothesis is formulated based on the explanation above as follows:

H₂: *Supply chain collaboration affects production technology.*

2.7.3 Supply Chain Collaboration and New Product Development

Strategic collaborations built by two or more independent companies in each business enable the creation and development of new product development (Trott, 2017). It will also impact the development of knowledge, technology, human resources, and market sharing, which will help companies to increase their innovation capacity. As a result, they bring new products to market, which can improve performance and competitiveness and quickly adapt in a competitive business environment (Ferreira et al., 2020). Nagashima et al. (2015) empirically analyze how adaptive collaboration in supply chain management impacts product life cycle stages and product categories. The intensity of supply chain collaboration improves the accuracy of market demand forecasts, and the implications of product maturation increase short-term product cycle forecasts. And vice versa, the findings show that the absence of collaboration harms the accuracy of forecasts, product cycles, and product categories. Kou et al. (2018), on 235 projects, product and supply chain managers of computer electronics and communications manufacturers focused on product launches, proving that IT resources enable effective improvement of NPD activities with their suppliers. NPD activities are crucial in moderating the relationship between IT-based supply chains and new product performance, lean product launches, product innovation, and product development capabilities. Therefore, they have an essential role in achieving competitive advantage, and product development ability, as it leads to superior product performance.

Manufacturing companies need to constantly update their product offerings to better and more competitive customer needs, with increasing product introduction, understanding the characteristics of the supply chain, and developing new products effectively and efficiently (Fantazy & Salem, 2016). Such product development decisions must be designed to consider the targeted cost, time, and quality factors. The alignment of new product development with supply chain management (SCM) should enable manufacturing companies to address product launch-related issues, increase the effectiveness of new product introductions and improve company performance (Pero et al., 2010). The implementation of innovation strategies and collaboration capability (CC) allows companies to improve new product performance (NPP) in the face of global competition (Chen, 2022). Based on the explanation above, the third hypothesis is determined.

H₃: *Supply chain collaboration affects new product development.*

2.7.4 Supply chain collaboration and product knowledge

Collaboration is a type of relationship that instills trust, open communication, and commitment to relationships, creates an ever-increasing fit between competence and its customers, and creates more excellent added value by creating new product development capabilities (Valdez-juárez et al., 2016). Collaboration competence and partner compatibility are positively related to KIM (Knowledge Integrated Mechanism) and positively associated with e-service innovation (Tsou, 2012). Knowledge sharing is an essential strategy not only physically but also a shared understanding of the knowledge transmitted across departments that span the supply chain. There is a significant link between knowledge sharing and organizational performance. Supply chain collaboration and knowledge sharing affect the performance of pharmaceutical companies from a developing country perspective. Data were taken from questionnaires shared with 415 executives in Bangladesh (Haque & Islam, 2018).

Strategic decisions are needed in the supply chain when packaging is a crucial and complex problem due to the increasing consumer awareness of environmental performance and the need for short lead times that positively impact the economic and environmental performance of supply chain actors. Furthermore, knowledge of packaging logistics also emphasizes the need for organizational support to manage packaging trade-offs to secure logistics performance. Besides, packaging organizations in product development companies must have strong relationships with logistics and product development through external collaboration (Pålsson & Sandberg, 2020). However, manufacturing companies show supply chain collaboration positively affects technological innovation and that collaboration with external agents encourages incremental and radical innovation. Information technology indirectly improves both types of product innovation (incremental and radical) through supply chain collaboration (Jimenez-Jimenez et al., 2019). The collaboration strategy provides a broader perspective with supply chain actors; achieving a sustainable supply chain requires the development of the right tools to align with Internal knowledge sharing and external knowledge sharing (Mehdikhani & Valmohammadi, 2019). The fourth established hypothesis is:

H₄: *Supply chain collaboration affects product knowledge.*

2.7.5 Production technology and product knowledge

New knowledge is applied to the company to improve employees' capability and competence to generate new ideas related to the company's products and be further able to apply and exploit by producing innovative products and attracting market interest (Byukusenge and Muene, 2017). In today's business world, various innovations are needed that can transform knowledge into new products, process efficiency, and service development (Tarigan, 2018). Manufacturing companies participated in development projects over two years to identify and analyze the integration of knowledge in manufacturing technology development projects to build a competitive advantage (Dastaki et al., 2022). The contribution of such research is the analysis of the knowledge integration process that contributes to the construction of competitive advantages by developing unique manufacturing technologies and new knowledge (Ahlskog et al., 2017). The application of technology, project complexity, and improvisation to the success of new product launches impact the efficiency of new products' financial performance (Gross, 2014; Liao et al., 2010). The development of innovative production technologies is significantly related to manufacturing and engineering knowledge, including design and technology, production systems, and skills (Gift, 2018). Based on the relationship between these concepts, the following hypothesis is established:

H₅: *Production technology influences product knowledge.*

2.7.6 Production technology and new product development

The influence of strategic collaboration and exploration and exploitation capabilities on innovation and new product development, knowledge sharing, and the mediating role of exploration and exploitation as dynamic capabilities in the company, and there is a positive relationship between strategic alliances, innovation, and new product development (Ferreira et al., 2020). New knowledge of strategic approaches that SMEs can apply to create new product development (NPD) capabilities. These findings show that SMEs use innovation to create new product development (NPD) capabilities through various strategies (Valdez-juárez et al., 2016). The results of other studies show a direct positive influence of strategic collaboration on innovation and the development of new products and mediates the impact of exploration and exploitation with the role of knowledge-sharing moderation (Ferreira et al., 2020). Partnerships with technology centers, consumer ratings for specific products, and store floor layouts are customizable and highly relevant for product customization (Leite & Braz, 2016). The sixth hypothesis established is:

H₆: *Production Technology impacts New Product Development.*

2.7.7 Production technology and supply chain performance

Improving company performance (Supply Chain Performance) depends on how optimally innovation is applied and the agility of resources in developing innovation implementation (Tarigan et al., 2019). Innovations in products and processes can result

in superior performance (Tarigan, 2018). This can be measured through sales achievement performance, market share conditions, and profitability levels. An understanding of product innovation also can predict strong performance improvement and significantly influence the performance, survival, and competitiveness of the organization. On the other hand, some studies conclude that digital transformation does not significantly impact company performance. Still, production technology is a highly effective mediator that connects digital transformation with company performance to design appropriate strategies to implement digital solid supply chain management and corporate performance and increase the productivity and resilience of SMEs in Saudi Arabia (AlMulhim, 2021). The findings suggest that using cloud-enabled logistics is vital in achieving better business outcomes in a lean production environment. Lean production is known to have a stronger direct and indirect effect on performance through cloud-backed logistics and supply chain integration generated by this technology. Supply chain integration was also found to mediate the performance relationship of Cloud-backed Logistics (Novais et al., 2020). In addition, Industry Technology 4.0 paves the way for improved production efficiency and worker safety while optimizing resource utilization and enhancing sustainability. Industry 4.0 technology is applied in almost all sectors, but little research explores industrial 4.0 technology in agriculture. The food agriculture sector has experienced an upward trend in digitization projects. Digital food farming supply chains will assist in autonomous decision-making processes, leading to increased visibility in agricultural food supply chains through real-time traceability solutions, thus improving food quality. Industry 4.0 technology in the food agriculture supply chain is expected to impact climate change disruptions and increase the uneven distribution of resources in the agricultural sector. The study highlights various industry 4.0 technologies and their applications in the food agriculture supply chain. Based on findings from a literature review, the study established ten key performance indicators that will be beneficial for decision-making in a data-centric digital environment (Novais et al., 2020). Therefore, in this journal, the author has the following hypotheses:

H7: *Production technology affects supply chain performance.*

2.7.8 Product knowledge concept and supply chain performance

Product knowledge has a positive and significant influence on performance, and innovation has a positive and significant impact on performance (Singh et al., 2021). Knowledge management has a positive and significant effect on innovation, and knowledge management has a positive and significant impact on performance through innovation mediation variables. Product knowledge is the best strategy to increase competition because knowledge becomes a strategic resource that allows companies to increase competitiveness and innovation (Kou et al., 2018; Li, 2020). The findings suggest that using cloud-enabled logistics is vital in achieving better business outcomes in a lean production environment. Lean production is known to have a more substantial direct and indirect effect on performance through cloud-backed logistics and supply chain integration generated by this technology (Novais et al., 2020). In addition, to other studies (Lin et al., 2022), companies optimize their supply chain resources to develop big data capabilities that contribute positively to company performance. The hypothesis of Zhang et al. (2018), which has been empirically tested from data from 300 Chinese manufacturers and 200 Indians, found that intellectual capital improves the performance of product innovation either directly or indirectly through the integration of supplier knowledge. In particular, the direct influence of intellectual capital on product innovation performance is significantly higher in China than in India. Intellectual capital indirectly improves product innovation's performance through the integration of supplier knowledge only in India. The authors also found that the integration of supplier knowledge improves product innovation performance indirectly through the adaptability of supply chains in China and India. Therefore, in this journal, the author has the following hypotheses:

H8: *Product knowledge on supply chain performance.*

2.7.9 Relationship of New Product Development Concept with Supply Chain Performance

Innovative work behavior is an individual behavior that aims to reach the stage of recognition or seeks to introduce ideas and processes (Kou et al., 2018). Innovation is also one way for companies to take advantage of employees' ability to create and develop ideas to create new products and better service processes, which will further have an impact on significantly improving the company's performance. Innovation is seen as one of the company's keys to being able to compete and the company's renewal strategy (Parker & Collins, 2010). The analysis has been carried out based on data collected from 175 Canadian small and medium-sized manufacturing companies (SMEs). The findings show that there is a direct positive influence of strategy on new product development flexibility (NPDF), and a direct positive relationship between NPDF and performance. Furthermore, they show that the total effect (direct and indirect) has a positive impact on performance (Fantasy & Salem, 2016). In addition, research on managers from the supply chain of manufacturers of computer and electronics companies in Taiwan shows that IT advancements influence new product development (NPD) activities, and the role of resources is essential, which affects the performance of new products. Study focuses on product launch and innovation because it plays a vital role in achieving competitive advantage; and product development capabilities, as they lead to superior product performance (Kou et al., 2018). New product development is a formal form of access to experience, knowledge, and expertise in creating new products, encouraging innovation that increases customer value (Valdez-juárez et al., 2016). Therefore, in this journal, the author has the following hypotheses :

H₉: New Product development influences supply chain performance.

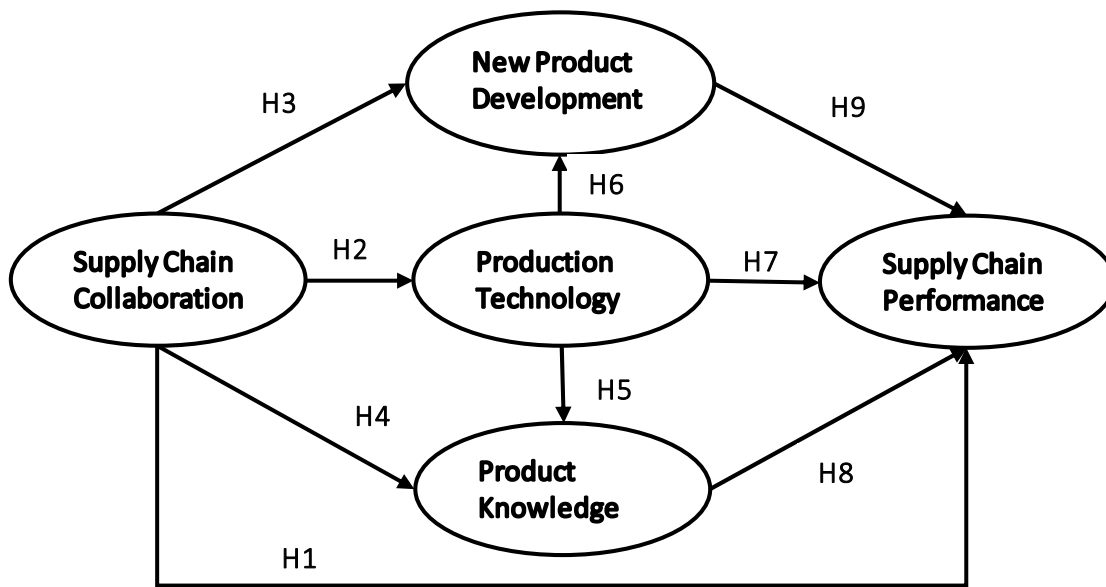


Fig. 1. Research Models

Based on Fig. 1, the intervening hypothesis can be determined, namely:

H₁₀: Supply chain collaboration affects supply chain performance through Production Technology.

H₁₁: Supply chain collaboration affects supply chain performance through New product development.

H₁₂: Supply chain collaboration influences supply chain performance through product knowledge.

H₁₃: Supply chain collaboration influences supply chain performance through production technology and new product development.

H₁₄: Supply chain collaboration influences supply chain performance through production technology and product knowledge.

3. Research Methods

This study used a quantitative research method. Quantitative research is a research method based on factual data in the form of numbers that will be analyzed using a statistics calculation to examine the proposed hypotheses to produce a conclusion (Sugiyono, 2018). The population of this study is 5818 manufacturing companies in East Java, categorized as medium and large scales, with employees above 20. The samples of this study are 148 respondents from 148 manufacturing companies. The respondents have more than one year of experience working and being involved at the managerial or supervisor position level in any field or division in the East Java manufacturing company. This respondent criterion is based on the consideration that the respondents are knowledgeable in company policy, such as company planning, objectives, and the company's collaboration with its partners on technological capabilities, product knowledge, and the creation of new products to improve the overall performance of the supply chain. Researchers spread a google form link with a WhatsApp link, email, and other social media to respondents working in a manufacturing company.

Data analysis used Smart Partial Least Square (SmartPLS) software 4.0 for data processing and analysis. The respondents' profiles are divided into five positions. The respondents with the position of general manager/director totaled 17 respondents (11%), managers 52 respondents (35%), supervisors 50 respondents (34%), staff officers 11 respondents (7%), and senior staff 18 respondents (12%). This result shows that most respondents are managers and supervisors; they know the company's condition from a technical and strategic point of view. Characteristics of respondents based on length of work in the company show that respondents had a working experience of fewer than three years ten respondents (7%), 3 to 5 years five respondents (3%), and 5 to 7 years, five respondents (3%). More than seven years were 128 respondents (86%). This result shows that most respondents have worked for a long time and are considered to understand the company's condition well and have the ability and adequate work experience in the company's operations. The Validity test shown with the loading factor for all measurement items exceeds 0.50. In contrast, the reliability test is demonstrated with a composite reliability value: the Cronbach's Alpha exceeds 0.7, and the AVE is above 0.50 shown in Table 1.

Table 1
Validity and reliability of the indicators and construct

Item Measurement	Loading	Composite Reliability	Cronbach Alpha	AVE
Supply Chain Collaboration				
Building strategic collaborations with external partners (SCC1)	0.726	0.853	0.772	0.779
Share product planning information with partners (SCC2)	0.814			
Sharing benefits with partners (SCC3)	0.722			
Coordinate with partners in meeting demand and creating added value (SCC4)	0.812			
Production Technology				
Technology to produce products (PT1)	0.861	0.912	0.871	0.672
Internet network to run operations (PT2)	0.759			
Integrated information system facilities between functions (PT3)	0.889			
Information technology facilities are in accordance with the latest needs (PT4).	0.884			
New Product Development				
Product uniqueness (NPD1)	0.895	0.946	0.929	0.722
New products according to consumer needs (NPD2)	0.881			
Engaging consumers in new product development (NPD3)	0.869			
Creativity in producing new products (NPD4)	0.879			
Able to respond to new product requests (NPD5).	0.888			
Product Knowledge				
Providing technology according to product characteristics (PK1)	0.880	0.891	0.836	0.593
Consumer understanding of the required product (PK2)	0.746			
Description of the resulting product information and benefits (PK3)	0.864			
Periodic and controlled product evaluation (PK4).	0.783			
Supply Chain Performance				
Planning regularly (SCP1)	0.849	0.907	0.877	0.622
More effective and efficient product lead time (SCP2)	0.773			
Quality products (SCP3)	0.652			
Timely delivery of products (SCP4)	0.806			
Adequate service for customers (SCP5)	0.829			
More competitive production costs (SCP6)	0.807			

Based on Table 2, the measurement item has validity that meets the minimum factor loading value requirements of 0.50. Besides, all five constructs satisfy the minimum reliability value of 0.70. Structural models in PLS are also assessed using R-square for dependent variables and predictive measurements of whether or not Q-square values exceed 0.

Table 2
Nilai R-square

Research Variables	R-Square
New Product Development	0.379
Product Knowledge	0.551
Production Technology	0.143
Supply Chain Performance	0.748

A Q-Square value greater than zero indicates that the model has adequate predictive relevance. The structural mode fit can be seen from Q-Square. With the result of the value of R-Square. Value of $Q^2 = 1 - [(1 - R_1^2) \times (1 - R_2^2) \times (1 - R_3^2) \times (1 - R_4^2)]$ adalah $Q^2 = 1 - [(1 - 0,379) \times (1 - 0,551) \times (1 - 0,143) \times (1 - 0,748)] = 0,9398$. This result shows that 93.98% of the changes given by supply chain collaboration as independent variables to new product development, product knowledge, production technology, and supply chain performance as dependent variables.

4. Result

4.1 Statistical Analysis and Discussions

Based on the results of tests conducted using partial least squares (PLS), the value of the path coefficient of the inner model is demonstrated in Fig. 2 and Table 3.

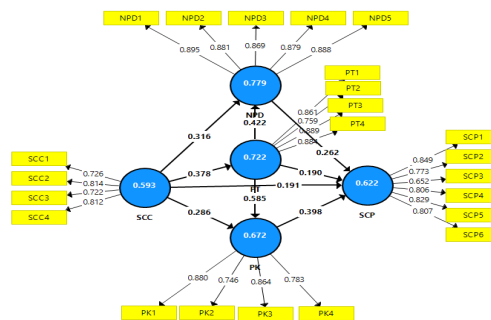


Fig. 2. Path Coefficient Test Results

Table 3
Direct Effect Hypothesis Test Results

Direct Effect	Path Coefficient	T Statistics	P Values
NPD → SCP	0.262	3.055	0.002
PK → SCP	0.398	3.851	0.000
PT → NPD	0.422	6.127	0.000
PT → PK	0.585	9.939	0.000
PT → SCP	0.190	3.118	0.002
SCC → NPD	0.316	3.197	0.001
SCC → PK	0.286	4.419	0.000
SCC → PT	0.378	3.605	0.000
SCC → SCP	0.191	2.262	0.024
SCC → PK → SCP	0.114	3.123	0.002
SCC → NPD → SCP	0.083	2.023	0.043
SCC → PT → SCP	0.072	2.493	0.013
SCC → PT → PK → SCP	0.088	2.336	0.020
SCC → PT → NPD → SCP	0.042	2.116	0.034

The effect coefficient of supply chain collaboration on supply chain performance is 0.191 with a t-statistic of 2.262, exceeding the t-statistic of 1.96. Supply chain collaboration has a significant influence on supply chain performance in manufacturing companies in East Java. The company's ability to build collaboration with suppliers by sharing product planning information with partners and the company's ability to coordinate with partners in meeting demand and creating added value for consumers can impact supply chain performance. As a result, the company establishes planning regularly and can provide adequate service to customers. This relationship demonstrates that supply chain collaboration with information sharing can increase competitive advantage and superior supply chain performance. This research is in line with research that states that supply chain collaboration affects supply chain performance (Salam, 2017; Baah et al., 2022a; Teng et al., 2022; Um & Oh, 2020; Baah et al., 2022b).

Testing on the second hypothesis, the effect of supply chain collaboration on production technology was 0.378, which had a t-statistic of 3.605, exceeding the t-statistic of 1.96. There is a significant influence of supply chain collaboration and production technology in manufacturing companies in East Java. The company can build collaboration by sharing product planning information with each other and coordinating with partners in meeting demand so that it impacts supply chain collaboration. This relationship can be seen that the company has an integrated information system between adequate internal functions and provides information technology facilities that follow the latest needs. Good utilization and use of technology can improve the company's collaboration with partners and efficiency. This research is in line with research that states that Supply Chain Collaboration affects Production Technology (Jimenez-Jimenez et al., 2019; Salehi et al., 2021; Chae et al., 2018; Nagashima et al., 2015; Regards, 2017).

The third hypothesis of the effect of supply chain collaboration on new product development was 0.316, which had a t-statistic of 3.197, exceeding the t-statistic of 1.96. The third hypothesis can be concluded that supply chain collaboration affects new product development in manufacturing companies in East Java. The company's ability to build collaboration with suppliers is demonstrated by sharing product planning information with partners and the company's ability to coordinate with partners in meeting demand and creating added value to improve new product development. This relationship shows that the company's new product development has a better product uniqueness than competitors by meeting consumer needs, and the company can respond to customer requests quickly. This influence suggests that the intensity of supply chain collaboration can improve the accuracy of market demand forecasts, the product implications that enable the creation and development of new products, and the forecasting of short-term product cycles. This research is in line with research that states that Supply Chain Collaboration affects New Product Development (Ferreira et al., 2020; Nagashima et al., 2015; Pero et al., 2010; Tsou, 2012; Kou et al., 2018; Gallear et al., 2012).

The fourth hypothesis is the effect of supply chain collaboration on product knowledge of 0.286 which has a t-statistic of 4.419, exceeding the t-statistic of 1.96. Supply chain collaboration has a positive influence on product knowledge in manufacturing companies in East Java. The company's ability to build collaboration with suppliers is demonstrated by sharing information and coordinating with partners to meet demand and creating added value for consumers can increase product knowledge. It can be seen that the company provides technology following the characteristics of the products produced, and the company can describe the information and benefits of the products produced clearly have an impact on product knowledge. Supply chain collaboration is a relationship that instills trust and open communication and creates conformity with knowledge sharing to create greater added value through the ability to create new products. This research is in line with research that states that supply chain collaboration affects product knowledge (Tsou, 2012; Haque & Islam, 2018; Jimenez-Jimenez et al., 2019; Pålsson & Sandberg, 2020).

Furthermore, the fifth hypothesis test result indicated the value of the path coefficient of influence of production technology on product knowledge is 0.585. The t-statistic of 9.939 exceeds the t-statistic of 1.96. There was a significant influence between production technology and product knowledge in east java manufacturing companies. Companies that have integrated or connected information system facilities between adequate internal functions and can provide information technology

facilities that are under the latest needs have an impact on providing technology by the characteristics of the products produced, and the company is also able to describe the information and benefits of the products produced clearly. This relationship shows that companies that apply new knowledge to improve employees' capabilities and competencies will be able to generate new ideas that will further increase exploitation by producing innovative products and attracting market interest. This research is in line with research that states that production technology affects product knowledge (Byukusenge and Muene, 2017; Ahlskog et al., 2017; Gift, 2018; Gross, 2014).

The sixth hypothesis has the value of the path coefficient that the influence of production technology on new product development is 0.422, which has a t-statistic of 6.127, exceeding the t-statistic of 1.96. This hypothesis can be concluded that there is a significant influence between production technology on new product development in manufacturing companies in East Java. Companies with integrated information system facilities between internal functions can provide information technology facilities that follow the latest needs, influence the company to have a better product uniqueness than competitors to meet the needs of consumers, and the company can develop new products. This condition shows that the company's ability to explore and exploit innovation and share knowledge will allow change to create new product development. This research is in line with research that states that Production Technology affects New Product Development (Ferreira et al., 2020; Leite & Braz, 2016; Nagashima et al., 2015; Pero et al., 2010).

Hypothesis seventh with the value of the path coefficient of influence of production technology on supply chain performance of 0.190, which has a t-statistic of 3.118, exceeding the t-statistic of 1.96. It can be concluded that there is a significant influence between production technology on supply chain performance in manufacturing companies in East Java. Companies that have integrated information system facilities between adequate internal functions and can provide information technology facilities that are following needs can improve supply chain performance. This can be seen that the company carries out planning regularly and can provide adequate customer service. This condition indicates that the development or implementation of innovations in products and production processes carried out by manufacturing companies will increase superior supply chain performance. This research is in line with research that states that production technology affects supply chain performance (AlMulhim, 2021; Novais et al., 2020; Baah et al., 2022b; Pero et al., 2010).

Eight hypotheses' tests indicated a path coefficient value of 0.398. The product knowledge influences the supply chain performance, with a t-statistic of 3.851, exceeding the t-statistic of 1.96. There is a significant influence of product knowledge on supply chain performance in manufacturing companies in East Java. The company's ability to provide technology in accordance with the characteristics of the products produced and companies that can describe the information and benefits of the products produced clearly impact supply chain performance. The company establishing planning regularly and providing adequate customer service is a form of supply chain performance. This condition shows that product knowledge is the best strategy to increase competitiveness and innovation, which positively affects supply chain performance. This research is in line with research that states that Product Knowledge affects supply chain performance (Kou et al., 2018; Li, 2020; Novais et al., 2020; Lin et al., 2022; Zhang et al., 2018).

The ninth hypothesis, with the value of the path coefficient, namely the influence of new product development on supply chain performance of 0.262, has a t-statistic of 3.055, exceeding the t-statistic of 1.96, so the hypothesis is accepted. There is a significant influence of new product development on supply chain performance in manufacturing companies in East Java. The company's ability to have a unique product better than competitors to meet consumer needs and respond to customer requests quickly in providing new products affects supply chain performance. This condition shows that the implications of innovation are one way to develop ideas to create new products and service processes for the better, which will have an impact on significantly improving the company's performance. This research is in line with research that states that New Product Development affects Supply Chain Performance (Kou et al., 2018; Parker & Collins, 2010; Fantasy & Salem, 2016; Kou et al., 2018; Valdez-juárez et al., 2016).

The data processing results in this study show the value of the path coefficient Effect of Supply chain collaboration on supply chain performance through production technology of 0.072 and has a t-statistic of 2.493, exceeding the t-statistic of 1.96. Based on this information, supply chain collaboration significantly and indirectly influences supply chain performance through production technology. The data processing results in this study show the value of the path coefficient. The effect of supply chain collaboration on supply chain performance through new product development was 0.083 and had a t-statistic of 2.023, exceeding the t-statistics of 1.96. Based on this information, supply chain collaboration has a significant indirect influence on supply chain performance through New product development in manufacturing companies in East Java.

The data processing results in this study show the value of the path coefficient. The effect of supply chain collaboration on supply chain performance through production technology and new product development is 0.042 and has a t-statistic of 2.116, exceeding the t-statistics of 1.96. This information proved there is a significant indirect influence of supply chain collaboration on supply chain performance through production technology and new product development in manufacturing companies in East Java. Furthermore, the results also show that the path coefficient value of supply chain collaboration influence on supply chain performance through production technology and product knowledge is 0.088 with a t-statistic of 2.3, exceeding the t-

statistics of 1.96. Based on this information, supply chain collaboration significantly and indirectly influences supply chain performance through production technology and product knowledge.

5. Conclusion

Several conclusions can be withdrawn from the research result on the effect of supply chain collaboration on supply chain performance through production technology, new product development, and product knowledge. First, supply chain collaboration positively impacts production technology, new product development, and product knowledge. Supply chain collaboration is performed with partners by sharing product planning information. The company's ability to coordinate with partners to meet demand and create added value for consumers impacts supply chain performance. Production technology, shown by integrated information system facilities between adequate internal functions and able to provide information technology facilities that are following needs, can improve new product development, product knowledge, and supply chain performance. Product knowledge with the company's ability to provide technology in accordance with the characteristics of the products produced and companies that can describe the information and benefits of the products produced clearly impact supply chain performance. New product development with the company's ability to have a unique product in response to customer demand is better than competitors and can improve the supply chain performance. This condition shows that the implications of innovation are one way to develop ideas to create new products and service processes for the better. This research provides insight to practitioners for collaborating with the supplier to produce quality raw materials to support product knowledge and new product development according to customer needs. This study enriches the current supply chain management theory regarding the supply chain's role in increasing product knowledge and new product development.

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