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Assessing the role of green supply chain management on operational performance: mediating role of information technology infrastructure, internal and external integration Indonesian manufacturing

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Manufacturing companies constantly strive to build sustainable performance to survive fierce business competition. Besides, the company should be committed to protecting the environment by paying attention to the role of supply chain members. Companies should collaborate with external partners, enabling them to fulfill customers' needs for environmentally friendly products. This study explores the effect of green supply chain management on operational performance with the mediating role of information technology infrastructure, internal integration, and external integration. This study surveyed manufacturing companies in Indonesia using structured questionnaires designed with a five-point Likert scale. The questionnaire is designed using Google Forms, and the links are distributed to respondents through email, WhatsApp, and other social media. As many as 245 responses were obtained and valid for analysis. The data processing used SmartPLS software version 4.0. The hypothesis test results found that green supply chain management influences information technology infrastructure, internal integration, external integration, and operational performance. Information technology infrastructure impacts improving internal integration, external integration, and operational performance. Internal integration has an impact on external integration and operational performance. External integration has an impact on improving operational performance. The research contributes to managerial practice by adopting the ISO 14001 standard in green supply chain management. for companies to make improvements. These findings also enrich the current research in supply chain management theories.

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1. Introduction

Global leaders are very concerned about the planet's protection against environmental pollution and destruction. Fortunately, the company's leaders are trying to follow up on these concerns by adopting environmental protection practices such as the ISO 14001 management standard. However, this adoption is still under debate, asking for the benefit of the companies, bearing in mind that green supply chain management requires intensive capital. Fortunately, many previous studies have shown that many manufacturing companies have adopted green practices. The company has tried to protect the environment by conducting green programs to produce environmentally friendly products (Çankaya & Sezen, 2019). Products are produced by involving external partners to pay attention to their role by applicable policies and regulations in preserving the environment (Famiyeh et al., 2018; Woo et al., 2016). The company carries out various innovations by regulations in the green environment (Sahoo & Vijayvargy, 2021). Innovation of new environmentally friendly products in various industries that compete to produce products that meet customer needs (Gölgeci & Kuivalainen, 2020; Novitasari & Tarigan, 2022). Environmental problems are increasing, such as global warming, rapid depletion of natural resources, loss of biodiversity, and environmental pollution, causing a deterioration of the ecological balance (Chand et al., 2018; Çankaya & Sezen, 2019). The

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company approaches by paying attention to customer needs to produce products that can compete (Rahmani et al., 2021). Increasing competition puts companies under tremendous pressure to innovate and improve their operating strategies and processes to stay competitive and meet changing market requirements (Kusi-Sarpong et al., 2019). Moreover, manufacturing companies are starting to involve suppliers and manufacturing processes to focus on green to respond to customer demand for the products produced (Famiyeh et al., 2018). Manufacturing companies respond to demand by producing eco-friendly products with processes that do not significantly impact environmental damage (Green et al., 2019). Supply chain management brings suppliers, manufacturers, warehouses, and other storage areas so that products can be produced and distributed in the correct quantity, at the right time, and in the right location to meet customer needs (Al-Shboul et al., 2017). Companies must restructure and adapt their supply chains to future business challenges (Nayal et al., 2022). The manufacturing industry involves suppliers and customers in making green innovations to sustain the company's competitiveness (Siagian et al., 2022; Novitasari & Tarigan, 2022). The company's ability to use Industry 4.0 and circular economy impacts sustainable supply chain operations with green products and energy efficiency (Kumar et al., 2021). Companies can use technology to produce products with high efficiency and low waste for the environment (Lerman et al., 2022). The company strives to pay attention to the environment by involving suppliers and customers in the flow of supply chain management members (Hartono et al., 2023) to produce products on time with a small impact on environmental damage is a policy of green supply chain management (Green et al., 2019; Famiyeh et al., 2018). Manufacturing companies are trying to change the supply chain structure to adapt to new technology and innovate, so a reconfiguration of infrastructure technology is required (Dolgui & Ivanov, 2020). Changes made to manufacturing companies can adjust demand to the capacity of the company so that it can determine the right strategy (Gölgeci & Kuivalainen, 2020). Innovative technology in manufacturing companies can design product technology to produce digital processes and adjust to customer needs as external integration (Meindl et al., 2021).

Besides, digital technology in companies can increase the flow of products and information internally and externally, which supports the implementation of supply chain management (Lerman et al., 2022; Siagian & Tarigan, 2021). Manufacturing companies, especially in countries with high cost levels, need independence from high labor costs through new technologies (Buer et al., 2021). Bag et al. (2021) stated that using big data analytics (BDA) could be one of the alternatives to help build more sustainable strategies and procedures for the company's SCM process. The combination of today's rapidly evolving technological developments, including IoT, Internet of Services (IoS), CPS, augmented reality, artificial intelligence (AI), and big data analytics, can be described as a technological push (Buer et al., 2021). Going digital and going green have become the main points of global economic recovery, which is also the direction of supply chain development (Yin et al., 2022). The company implements green supply chain management (GSCM) to increase the company's competitiveness by paying attention to the company's environmental conditions to improve operational performance (Famiyeh et al., 2018; Zhu et al., 2013). Most manufacturing companies are still in the early stages of implementing the technology and are thus at a more fundamental level of use of information technology than is usually associated with Industry 4.0 (Buer et al., 2021; Benitez et al., 2022). Digital infrastructure is a foundation for companies to develop digital innovation and technology in providing service facilities that improve the company's operational performance (Yin et al., 2022). Information technology in suppliers and customers impacts increasing external integration with changes in the system and process integration of import and export companies (Yu et al., 2021). The company's information technology must be usable by employees and can be developed to be updated continuously for supply chain members (Oliveira-Dias et al., 2022). Information communication and technology impact internal and external integration to improve performance in small and medium enterprise companies (Amoako et al., 2020). Digitalization in the supply chain has changed rapidly so that it can be integrated with suppliers and customers to create competitive value (Nasiri et al., 2020). By adopting customer relationship management to collect market information and a website system, information technology helps integration. It impacts supply chain integration with an increase in frequent contact with each customer (Sundram et al., 2020). Supply chain integration impacts green supply chain practices to improve firm performance (Hartono et al., 2023). Internal technology capability influences firm performance using supply chain practices (Siagian & Tarigan, 2021). Flexible information technology and data assimilation have an impact on internal and external integration to increase company competitiveness (Irfan & Wang, 2019).

In addition, implementing GSCM will be accessible when information technology that is integrated internally and externally can be implemented in the company (Tarigan et al., 2021; Setiawan et al., 2023). External or internal integration defines digital technologies related to GSCM practices (Benzidia et al., 2021). GSCM practices in companies can impact sustainable performance with internal environment management and cooperation with customers (Sahoo & Vijayvargy, 2021; Hsu et al., 2016). Implementing upstream green supply chain integration requires collaboration with suppliers, building adequate communication, and forming strong teamwork (Lo et al., 2018). GSCM in the company is the result of the company's external pressure from customers so it has an impact on the company's internal communication with the ability of supplier integration in providing environmentally friendly resources (Kim et al., 2021). Eco-design created in companies is supported by a green information system and a process showing that green floor manufacturing impacts manufacturing operational performance (Wungkana et al., 2023). Supply chain integration, which consists of internal integration in understanding product flows and processes, impacts increasing external integration, shown by increased information sharing and joint decision-making (Demeter et al., 2016; Tukamuhabwa et al., 2021). Internal integration in the hotel industry influences downstream and upstream integration to improve green hotel performance (Basana et al., 2022b). Internal integration formed in companies to increase green innovation impacts external integration (supplier and customer integration) in increasing company competitiveness (Siagian et al., 2022). Internal integration formed in the company by sharing information between

departments and joint decision-making with purchasing can have an impact on external integration related to suppliers, namely sharing information with key suppliers, while customer integration with increasing developing collaborative revenue sharing (Munir et al., 2020; Chaudhuri et al., 2018; Wungkana et al., 2023). Companies can integrate with cross-functional by establishing internal and process integration, improving operational performance with efficient operation and quality products (Huo et al., 2014; Ståhle et al., 2019). Internal Integration is related to supplier and customer integration, which increases organizational flexibility in changing delivery schedules and product scope (Shukor et al., 2021). Internal integration in manufacturing companies in Malaysia can impact supplier integration and customer integration, which impacts agility performance (Jajja et al., 2018).

Finally, green supply chain integration consisting of green suppliers, internal greens, and green customers in manufacturing companies can impact sustainable performance (Xi et al., 2023; Han & Huo, 2020). Supplier integration, as part of external integration, can provide efficiency and effectiveness for company performance (Ellström, 2015; Laari et al., 2016). Supplier integration in manufacturing companies with collaboration influences green purchasing and performance (Tarigan et al., 2020; Basana et al., 2022a; Siagian et al., 2023). Internal and external integration simultaneously impact operational performance by increasing product differentiation and decreasing product costs (Demeter et al., 2016). The company's ability to innovate products and processes in floor manufacturing can affect the improvement of operational performance (Tarigan, 2018). Supplier and customer systems integration as a form of external integration in import and export companies impacts operational performance (Yu et al., 2021). Joint decision-making, electronic data interchange, and information sharing in manufacturing companies in Malaysia influence operational performance (Shahbaz et al., 2018). External integration with customer integration improves the company's economic performance, but supplier integration has a negative impact (Fernández, 2022). Extensive data analysis can improve internal and external integration, affecting operational performance (Chen & Chen, 2022).

The above discussion has shown that many studies have focused on green supply chain management. However, there is still doubt about how green management practices can benefit the companies, considering that this approach requires intensive capital, such as using new production technology and environmentally friendly raw materials and processes. This study focuses on exploring the adoption of green supply chain management with the adoption of information technology infrastructure to integrate the company's internal and external partners. Hence, this study raises four research questions as follows. First, to determine the influence of green supply chain management on IT infrastructure, internal integration, external integration, and operational performance. Second, IT infrastructure affects internal integration, external integration, and operational performance. Third, internal integration affects external integration and operational performance. Finally, the fourth is external integration, which affects operational performance.

2. Literature Review

2.1. Green supply chain management

Supply chain management is implemented to bring suppliers, warehouses, entrepreneurs, and other storage areas together. This will continue until the product can go through the production process and be distributed in the correct quantity, accurate location, and time while reducing costs and meeting customer needs (Al-Shboul et al., 2017). Green supply chain management (GSCM) aims to improve environmental performance because this practice can minimize environmental damage (Green et al., 2019; Zhu et al., 2013). GSCM, known as environmentally friendly supply chain management, is an approach or strategic application in the supply chain industry that prioritizes long-term practices in all aspects of the supply chain (Çankaya & Sezen, 2019). The green supply chain approach to the process encourages the use of resources more efficiently and impacts environmental performance (Benzidia et al., 2021). The GSCM practice aims to reduce all kinds of waste in the supply chain process that can adversely impact the environment (Lerman et al., 2022). Xi et al. (2023) stated the practice of GSCM as reducing excessive and unnecessary materials, reducing the frequency of refilling, introducing reusable and remanufactured parts in material inventory, minimizing waste, reintegrating material and information flows in SCM, reducing transportation lead time, environmental risk-sharing, and increasing the efficiency of resource consumption. The company's strategy aims to meet market needs by paying attention to environmental aspects and making supply chain integration essential in achieving it (Siagian et al., 2022). GSCM handles waste reduction, realizing a minimum impact on the environment and using more efficient raw materials, so companies will indirectly continue to innovate and adopt new processes (Tarigan et al., 2021). The practice of GSCM consists of internal and external management, which impacts environmental, social, and financial performance. The company always strives to improve the environment and society to protect the environment (Kim et al., 2021). Green supply chain practice is essential for manufacturing companies to improve operational performance concerning the environment (Basana et al., 2022a; Siagian et al., 2023).

GSCM is an operational management approach in companies that uses optimization methods to reduce environmental impact during the cycle of environmentally friendly products, starting from green purchasing, green distribution, and reverse logistics (Woo et al., 2016). According to Xi et al. (2023), This is measured through the extent to which the company contributes to maintaining environmental sustainability and how the company supports employees to maintain environmental sustainability. Companies must have experts in this matter in order to be able to design products and services according to customer wishes

to preserve the environment (Laari et al., 2016). In addition, the company has a stable and cooperative relationship with partners in maintaining environmental sustainability (Han & Huo, 2020). Green supply chain management is measured by adopting the research of Xi et al. (2023), contributing to maintaining environmental sustainability, supporting employees in maintaining environmental sustainability, having experts in designing environmentally friendly products, and having good cooperative relationships with partners who care about the environment.

2.2. Internal Integration

Internal integration refers to the relationship between various departments to facilitate communication, interaction, and collaboration between functions in achieving company goals (Tarigan et al., 2021). Building strong relationships between functions such as inventory and supply is an example of function-based internal integration (Munir et al., 2020). Shukor et al. (2021) stated that internal supply chain integration refers to integration within and between internal supply chain functions. Through internal integration, a company can coordinate resources to restore the supply chain in a consistent condition because things that can be obstacles can be detected more easily (Tarigan et al., 2021). Integration with suppliers and customers in knowledge sharing improves the company's operational performance (Demeter et al., 2016; Liu et al., 2018). The company builds internal integrations to create collaboration and synchronization between departments tailored to suppliers and customers (Huo et al., 2014; Demeter et al., 2016; Basana et al., 2022b). Internal integration is used to collaborate and synchronize functions in the company in setting forecasting, scheduling, and sharing information (Jajja et al., 2018; Chaudhuri et al., 2018). Therefore, internal integration means bringing together functions and processes within the company, especially in inventory management, purchasing, warehousing, transportation, demand planning, and production (Munir et al., 2020). In integrating internal operations, companies need structure on cross-function because cross-functional input requires reviewing how coordination and integration can be maintained across intra-organizational relationships (Tukamuhabwa et al., 2021; Ståhle et al., 2019). This can be achieved with an appropriate organizational structure with fewer formalities, more empowerment, and a team of work. Building consistency and simplifying work processes are two of the things that can improve integration (Shukor et al., 2021; Lockström & Lei, 2013). Companies can digitize their work processes, especially in today's digital era, for companies still using traditional methods are being replaced by the increasingly digital economy and artificial intelligence (Chen & Chen, 2022). The entire production process must go through feedback from the company's customer requests to ensure that all processes run consistently and stably to maximize absorption capacity (Gölgeci & Kuivalainen, 2020).

The research adopts Shukor et al. (2021) measurement items, such as integrated company data between departments, integrated information technology applications between departments, inventory data that can be accessed by all departments in real-time, and demand/order data that can be accessed by all departments in real-time.

2.3. Information Technology Infrastructure

Supply chain in companies requires information technology infrastructure for digital technology innovation, blockchain, and the Internet of Things to remain sustainable (Dolgui & Ivanov, 2020). IT infrastructure is a series of technological components that enable the operation of information systems and management in a company (Al-Shboul et al., 2017). Information technology infrastructure is the basis for companies in developing digital systems and business innovation (Yin et al., 2022). IT supports various business activities through organizational communication interactions and operational processes (Yu et al., 2021), and influences firm performance (Siagian & Tarigan, 2021). IT improves supplier and customer relationships by sharing information (Setiawan et al., 2023) and supporting business processes such as sourcing, procurement, and order fulfillment (Oliveira-Dias et al., 2022). Smart manufacturing can focus on schedules using technology in the life cycle process (Zheng et al., 2021). The technology behind smart supply chains allows real-time information sharing to accelerate decision-making and company transactions (Lerman et al., 2022; Holmström et al., 2019). Bag et al. (2021) stated that aspects such as cluster computing and digitization of warehousing facilities enable real-time SCM and data analysis with less time and space demands. Fundamental techniques in technology regulation are a way to control technology that is useful for cross-functional SCM activities such as big data analytics, the Internet of things, blockchain, cloud, and artificial intelligence (Frank et al., 2019; Nasiri et al., 2020). Moreover, the company's information technology system will provide benefits for the company, including coordination between departments or functions, accurate and fast data access and data transfer, faster communication, reduction in paper use for the company, and data that can be accessed in real-time (Tarigan et al., 2021). Once the resources represented by IT have been identified and appropriately combined, they can be used to create new competencies (Oliveira-Dias et al., 2022). Information technology helps to review the company's inventory availability to know the right supply strategy to avoid the risk of imbalance between the amount of demand and the amount of raw material supply that may occur so that when there is an unexpected surge in demand, management utilizes information technology to identify alternative sources of supply and replenish the required inventory (Tarigan et al., 2021). IT infrastructure in operational functions includes providing information management, accessibility, visibility, material handling, or input quality control in supply chain operations (Frank et al., 2019). Meindl et al. (2021) stated that technology optimizes supply chain processes, where real-time monitoring of supply chain processes, such as status in inventory, delivery, and production, facilitates interaction between customers and suppliers. Technology is also used to manage and support supply chain operations such as order and inventory management, tracking systems for automatic identification on smart packaging machines or sensors, ensuring logistics

specifications, and avoiding damage to goods (Birkel & Müller, 2021). An intelligent supply chain brings together all these perspectives to improve supply chain capabilities through adopting digital technologies, specifically core digital technologies, i.e., broader digital technologies used in various applications and industries (Lerman et al., 2022).
Technology that supports smart supply chains enables the exchange of information in real time to speed up the decision-making process and corporate transactions. The measurement items are adopted from the research of Lerman et al. (2022), namely that the company provides a digital system, provides an adequate data collection system, has a system that can share information with partners, has a system that creates a strong communication network, and has a system that is directly connected to partners.

2.4. External Integration

In the current high number of changes and uncertain conditions, companies must recognize the benefits of integrating with the company's SCM partners (Fernández, 2022). External integration is a collaboration between the buyer company and the related supplier in a process where the supply from the supplier enters the buyer company for results that meet the standards and needs of both parties (Tarigan et al., 2021). This integration encompasses cooperation in decision-making processes to achieve an efficient flow of resources among supply chain members (Demeter et al., 2016; Tarigan et al., 2020). In addition, it also involves consistent strategic adjustments in developing and implementing policies to improve organizational performance among companies and their business partners (Jajja et al., 2018). External integration involves incorporating physical information between customers, manufacturers, and suppliers (Liu et al., 2018). Integration with suppliers improves stability in the supply of materials and strengthens the partnership relationship between companies and suppliers (Siagian et al., 2022; Basana et al., 2022b). The integration process in supply chain management is reflected in suppliers and buyers, where external integration can provide flexibility to manufacturing companies (Chaudhuri et al., 2018). Short-term goals include increased productivity and decreased lead time and inventory while thriving and effective integration is a key part of long-term goals (Sundram et al., 2020). Activities include selecting products to sell, deciding on how to price and market the product, and ensuring that the product is delivered to the company on time (Ellström, 2015). Supplier integration aims to create a fast supply network structure so that the company's ability to integrate with suppliers can provide efficiency in raw material procurement, timely delivery of raw materials, company flexibility, and improve company performance (Tarigan et al., 2021).

External Integration is measured by adopting the research of Shukor et al. (2021), namely, external partners can use the company's information system, external partners can connect directly to the company's information system, external partners can place orders quickly through the company's information system, and the company actively communicates with external partners.

2.5. Operational Performance

Sahoo and Vijayvargy (2021) stated that Operational Performance refers to how quickly and efficiently a company can produce and transport products to its customers. Operational performance in manufacturing companies is determined by quality products, timely product delivery, and product variety according to customer orders (Tarigan, 2018). Supply chain ecosystems' interaction is complex and driven by feedback and linkages between supply chains, the environment, society, and the economy (Nayal et al., 2022). Previous research has stated that operational performance is described as a measure of production cost per unit, speed of new product introduction, quality, adaptability, inventory turnover, and supply reliability (Trattner et al., 2019; Kusi-Sarpong et al., 2019). Adaptation is the ability that must be carried out in a company to face significant changes and affect the company's management system (Tarigan et al., 2021). Machine learning modeling, game theory, and data mining increase operational transparency (Bag et al., 2021). Sharing information with suppliers through digital platforms can help companies develop green digital procurement (Setiawan et al., 2023), provide reliable and accurate new information about suppliers, and explain how to implement green practices in the supply chain (Birkel & Müller, 2021). Companies strive to effectively and efficiently produce performance improvements (Shahbaz et al., 2018; Basana et al., 2022a). Operational performance is determined using manufacturing cost, quality product, inventory level and turnover, new product development, and flexibility (Trattner et al., 2019).

Assessing a company's performance involves evaluating its operations and overall performance. According to research by Sahoo and Vijayvargy (2021), operational performance is measured by the company's increased product quality, on-time product delivery, decreased inventory, well-organized production line, and increased production capacity.

2.6. The relationship between research concepts

2.6.1. Hubungan Green Supply Chain Management IT Infrastructure

Information system management is measured by sharing defects on the company's production floor, production schedules with relevant departments, and information about machine breakdowns with relevant departments (Tarigan et al., 2021). Digital transformation, one of which is technology such as robots in production and logistics or virtual reality and augmented

reality, can help identify and reduce waste. It can help improve recycling and operational efficiency in the supply chain (Lerman et al., 2022). Digital transformation and GSCM are aspects that, when combined, can deepen the understanding of how to develop a Smart GSCM system (Holmström et al., 2019). Artificial intelligence technology is needed by companies to build green supply chain collaborations that have an impact on environmental performance (Benzidia et al., 2021).

Digital infrastructure for companies can be the foundation for green and digital innovation in protecting the environment (Yin et al., 2022; Novitasari & Tarigan, 2022). This system improves the GSM system with the power of smart technology, better known as digital. In the context of digital transformation, it can play an essential role because it can help gain visibility and predict supply chain behavior on environmental actions and their effects that companies must pay attention to to improve green performance (Benzidia et al., 2021). In addition, companies can work together to improve collective recycling systems, encourage the development of environmentally friendly products, and improve recycling technologies (Rahmani et al., 2021). Digital transformation strategies can create new business models that offer companies a new green perspective to use the generated data for a strategic position as an environmentally friendly player in the market (Birkel & Müller, 2021). Companies can achieve a higher competitive advantage in terms of sustainability when combining corporate efforts to implement an intelligent supply chain and GSCM simultaneously (Lerman et al., 2022).

H_1: *Green Supply Chain Management affects IT Infrastructure*.

2.6.2. The relationship between Green Supply Chain Management, Internal Integration and External Integration

Green Supply Chain Management (GSCM) is a supply chain concept in the procurement of materials, the company's production process, and the distribution of the company's products by paying attention to the company's environment to be able to maintain the company's sustainability (Sundram et al., 2018; Al-Ghwayeen et al., 2018). The level and quality of internal integration affect the position of a company in the eyes of customers; the higher the internal integration of a company, the better the company's performance (Lo et al., 2018). Internal integration allows companies to share information between cross-functional departments to improve change response quickly (Ståhle et al., 2019). Internal integration allows collaboration across internal boundaries and facilitates interaction while allowing communication to be carried out quickly in green design (Liu et al., 2018). Internal integration by the company can connect and develop its resources so that internal capabilities can create expertise and knowledge beyond the boundaries of a department or functional area (Amoako et al., 2020). The application of just-in-time (JIT) principles has been enhanced with the support of the Internet and web-based technologies to improve delivery times and reduce customer waiting times (Oliveira-Dias et al., 2022). JIT, which is an improvement program that aims to eliminate wasteful forms from the supply, production, and delivery processes and promote the optimal use of resources in the process, supports the use of environmentally friendly supply chain management practices (Green et al., 2019). The main goal of JIT is to reduce and eliminate waste (Oliveira-Dias et al., 2022). Green et al. (2019) revealed that this series of GSCM and JIT practices complement each other and are essential to assess their combined impact on environmental sustainability as measured by environmental performance.

Adopting GSCM practices allows manufacturing companies to maintain sustainable supply chains (Tarigan et al., 2021; Basana et al., 2022a). GSCM integrates companies to pay attention to the environment in supply chain flow activities related to product design, material procurement, supplier selection, company manufacturing processes, delivery of finished products to customers, and final products after use (Al-Ghwayeen et al., 2018). The focus of GSCM is the procurement of environmentally friendly materials that impact the company's business performance related to providing products and services (Lo et al., 2018). Khan et al. (2023) stated that the impact of improving the performance of GSCM implementations such as green procurement, green design, green information systems, and green manufacturing shows that these applications improve product quality and flexibility while reducing operational costs, thereby increasing the company's operational efficiency (Hsu et al., 2016).

GSCM integrates environmental issues into the supply chain, configuring traditional operational processes such as manufacturing, purchasing, and relationships with partners into sustainable practices (Laari et al., 2016). Companies rely on the interconnection of internal and external activities to obtain green performance (Birkel & Müller, 2021). Lerman et al. (2022) stated that reducing resource and energy consumption must be aligned with the purchasing, manufacturing, and packaging processes to achieve better results. However, this will also depend on the quality of input received from the supply. GSCM practices demand that companies have close relationships with suppliers and customers (Fang & Zhang, 2018; Kim et al., 2021). This makes it easier for companies to implement a continuous improvement strategy to direct companies to produce better performance (Sahoo & Vijayvargy, 2021; Frank et al., 2019). Companies need to develop new digital strategies that improve data flow, adopt basic technologies such as cloud services to facilitate information among enterprise processes and adopt user interface technologies to improve processes (Han & Huo, 2020). Improving environmental conditions and reducing accidents can improve the company's product quality and delivery efficiency (Fang & Zhang, 2018).

Green supply chain management has become a crucial issue for the industry in achieving market profitability by reducing environmental risks and improving efficiency (Chand et al., 2018). Green supply chain management is a company's innovation that pays attention to environmental issues in overall supply chain management from suppliers, producers, consumers, and

logistical feedback (Famiyeh et al., 2018). The company's Green Supply Chain Management practices include selecting and evaluating suppliers, submitting to suppliers to manage the company's inventory, ecodesign, packaging, reverse logistics, and building active cooperation with suppliers. Integration with suppliers provides stability for companies in procuring materials and strengthens their partnerships with suppliers (Tarigan et al., 2021). Green manufacturing can be implemented under pressure from suppliers and customers for companies to focus on maintaining environmental sustainability (Zhu et al., 2013), which allows the creation of consistent practices to integrate and adapt sustainable manufacturing with GSCM (Lerman et al., 2022).

H_2: *Green supply chain management affects internal integration.*
H_3: *Green supply chain management influences external integration.*

2.6.3. The relationship of IT infrastructure and internal and external integration

Information technology increases companies' intensity in sharing information and shows how well the organization communicates critically (Tarigan et al., 2019). The latest technology eliminates traditional information systems' weaknesses, improving customer service quality (Bag et al., 2021). Internal integration and information technology enable individuals across the supply chain to share information about flexible information technology resources, and data gap provides power (Irfan & Wang, 2019; Siagian & Tarigan, 2021). The company's internal integration provides excellent communication and collaboration between the synchronization process, synchronization in meeting customer needs, and synchronization with suppliers in material procurement (Sundram et al., 2018). This internal integration and information technology allows managers to collect, coordinate, and disseminate data about supply chain risks and then use that information to manage the balance between supply and demand (Tarigan et al., 2021). Information technology allows companies to share information, which has an impact on internal and external integration (Woo et al., 2016).

Several technological advances that can have a significant positive impact on manufacturing logistics processes and activities have to do with the management of internal logistics flows required for product manufacturing, including innovations in existing technologies, as well as the development of entirely new technologies (Buer et al., 2021). Recent technological developments such as cloud computing, internet-of-things, big data, blockchain, robotics, and artificial intelligence help integrate isolated SC developments into intelligent and connected systems (Nayal et al., 2022). Smart manufacturing with technology applications in companies used in product design technology and manufacturing assembly can be used to increase manufacturing efficiency as internal integration and meet customer inquiry as an external customer integration application (Meindl et al., 2021). Emerging technologies allow companies to effectively manage large amounts of data that were previously unmanageable (Bag et al., 2021). Big data analytics helps managers get timely, fast, and reliable answers compared to traditional business process solutions. Digital information in companies making it a digital supply chain is important in collaborating internally and externally to share information and data collection (Nasiri et al., 2020). Information communication technology in companies can increase internal and external integration (Amoako et al., 2020).

Supplier integration is an integration built to collaborate between suppliers and companies in formulating both organizations' material procurement strategies, implementation, and behavior to improve company performance (Woo et al., 2016). This integration refers to adopting and applying technologies and processes to coordinate between members in the supply chain (Siagian et al., 2022). This leads to smooth exchange channels for materials, information, and finished products (Sundram et al., 2020). Supplier integration measures the extent to which a company shares a master production schedule with key suppliers, determines common goals with key suppliers, identifies and defines new markets together with key users, always shares new ideas with key suppliers, and shares best practices with key suppliers (Lockström & Lei, 2013). Smoother product flow and more transparent operations are made possible by an integrated supply chain that minimizes the time between receipt and delivery of customer orders (Sundram et al., 2020). BDA is one example of a technology that is expected to provide benefits (Sivarajah et al., 2017), such as greater integration between supply chains, efficient inventory, and asset management, successful relationships between producers and suppliers, and efficient execution of demand-driven operations (Bag et al., 2017). al., 2021). Providing information using digital platforms with suppliers can help companies develop green digital purchasing, offer reliable and accurate new information about suppliers, and explain how to implement green practices into the supply chain (Birkel & Müller, 2021; Narayanamurthy & Tortorella, 2021).

H_4: *IT infrastructure affects internal integration.*
H_5: *IT infrastructure affects external integration*.

2.6.4. Relationship of IT Infrastructure and Operational Performance

Adopting and using information technology in the supply chain improves operational efficiency and overall performance (Tarigan et al., 2021). Performance is evaluated cost-by-cost, but other financial indicators, such as return on investment, assets, and sales, are added over time (Khan et al., 2023). A thorough review shows that measuring performance must consider all aspects, including financial aspects, of all levels and processes of the supply chain (Shahbaz et al., 2018). Information technology (IT) has been proven to efficiently facilitate collaborative relationships between a network of companies, suppliers,

or customers (Sundram et al., 2020). This information technology helps to review the availability of a company's inventory to find the right supply strategy to avoid the risk of an imbalance between the amount of demand and the amount of raw material supply that may occur (Tarigan et al., 2021). Information technology enables operational efficiency by creating a competitive advantage through superior customer service, efficient operating systems, and more effective workforce management (Al-Shboul et al., 2017). Information technology (IT) is essential at all supply chain stages for more effective customer service and to create a competitive advantage (Siagian et al., 2023). Sundram et al. (2020) also highlighted how IT collaboration fosters cross-functional relationships between supply chain members. Amoako et al. (2020) stated that information communication and technology improve the performance of small and medium enterprise companies. This minimizes the boundaries between the company and the company's departments, allowing for a smoother flow of information. In addition, mature technologies such as e-business technology provide a higher level of automation in executing basic SC tasks, including sales, distribution, and customer order management, thereby reducing waiting times (Oliveira-Dias et al., 2022). This concludes that a smart supply chain is a technological construction resulting from SCM's digital transformation (Benitez et al., 2022).

The relationship between BDA and SCM is expected to provide positive results because it can allow manufacturing companies to access transactional data globally (Bag et al., 2021). With available big data, basic resources, and internet access, BDA can help companies adopt descriptive, prescriptive, and predictive analyses to strengthen SCM and reduce risk (Sivarajah et al., 2017). When companies are unable to carry out SCM functions, BDA can provide support because it can help companies practically manage information related to the purchase and supply chain, which can help reduce operational barriers between countries to be eliminated (Bag et al., 2021). In other words, the mature use of IT empowers the strategic coordination of corporate and supplier resources to improve agility across SC (Oliveira-Dias et al., 2022). Technology impacts further developing production processes, encouraging functional implementation, creating objects, or managing and organizing production networks (Zheng et al., 2021).

H_6: *IT Infrastructure influences operational performance.*

2.6.5. Relationship of internal integration, external integration, and operational performance

In an industrial environment, supply chain integration is seen as a competitive strategy where companies collaborate strategically with partners and manage information, products, and processes intra and between organizations in the supply chain from upstream suppliers to downstream customers (Li & Chen, 2020). Integration aims to increase company value for customers by producing innovative products and processes (Tarigan, 2018). The company integrates departments related to suppliers, distribution, manufacturing, and designated customers by integrating functions within the company to increase competitiveness in the long run (Al-Shboul et al., 2017). Internal integration refers to the extent to which the company compiles internal practices, resources, and procedures in the collaboration of systems and processes that are synchronized and controlled in all functions to meet customer needs (Irfan & Wang, 2019). Internal integration between departments by sharing information and joint decision-making impacts external integration in sharing information with key customers and suppliers (Munir et al., 2020; Chaudhuri et al., 2018).
Companies must improve supply chain flexibility and develop competencies through internal integration, information sharing, and training to address various supply chain risks (Tarigan et al., 2021). Internal integration formed in the company as shown by data and enterprise applications between internal functions impacts operational and financial performance (Huo et al., 2014). Adapting to change is key to survival and excelling in a competitive environment, so the right changes in SCM operations are expected to deliver more sustainable results (Bag et al., 2021). Internal integration in manufacturing companies in Malaysia significantly impacts external integration, namely customer integration and supplier integration (Jajja et al., 2018). The strategic level of an intelligent supply chain consists of the perspective of the digital transformation that companies want to pursue in the SCM system, considering the necessary alignment of supply chain goals with real-time data flows (Benitez et al., 2022). Internal integration impacts external integration and operational performance by increasing product differentiation produced by the company (Demeter et al., 2016; Siagian et al., 2023). Internal integration impacts agility performance in manufacturing companies in Malaysia with increased flexibility, design, and delivery performance (Jajja et al., 2018).

In addition, to deliver eco-friendly products to customers, the company strives to create eco-friendly packaging with minimal materials, supported by sensors connected through the Internet of Things to improve solutions (Kumar et al., 2021; Narayanamurthy & Tortorella, 2021). Green operations can improve a company's performance when driving digital transformation in the supply chain (Lerman et al., 2022). External integration leads to the extent to which the collaboration of the company and its supply chain partners (upstream suppliers and downstream customers) in driving the development of activities in an agile environment (Liu et al., 2018; Irfan & Wang, 2019). By integrating with external supply chain partners to create long-term strategic relationships, companies can identify challenges and communicate quickly to complete design and manufacturing tasks to improve operational performance (Chen & Chen, 2022). Sharing information with suppliers through digital platforms can help companies develop green digital procurement, provide reliable and accurate new information about suppliers, and explain how to introduce green practices in the supply chain (Narayanamurthy & Tortorella,

2021). Supplier collaboration as a form of external integration with suppliers impacts green purchasing and performance (Tarigan et al., 2020).

The company involves partners with external integration through collaboration and joint decision-making to impact operational performance with cost reduction (Demeter et al., 2016; Trattner et al., 2019). Internal integration in companies and external integration (upstream and downstream integration) influences green hotel performance (Basana et al., 2022b). Companies can shorten product distribution and delivery times to improve efficiency, introduce new products to market faster and solve the problem of excessive costs caused by products stored for too long in inventory (Yu et al., 2021). Customer integration by ordering on a computer and often making periodic contact with key customers as a form of external integration impacts economic performance (Fernández, 2022). External integration, consisting of customer and supplier integration with information sharing and joint decision-making, impacts agility performance in manufacturing companies (Jajja et al., 2018). Internal and external integration, such as information sharing, joint decision-making, and electronic data interchange, impact operational performance (Shahbaz et al., 2018).

H_7: *Internal integration affects external integration.*
H_8: *Internal integration affects operational performance.*
H_9: *External Integration Affects Operational Performance.*

A research model can be determined based on the introduction's explanation, the literature review's findings, and the relationship between concepts (Fig. 1).

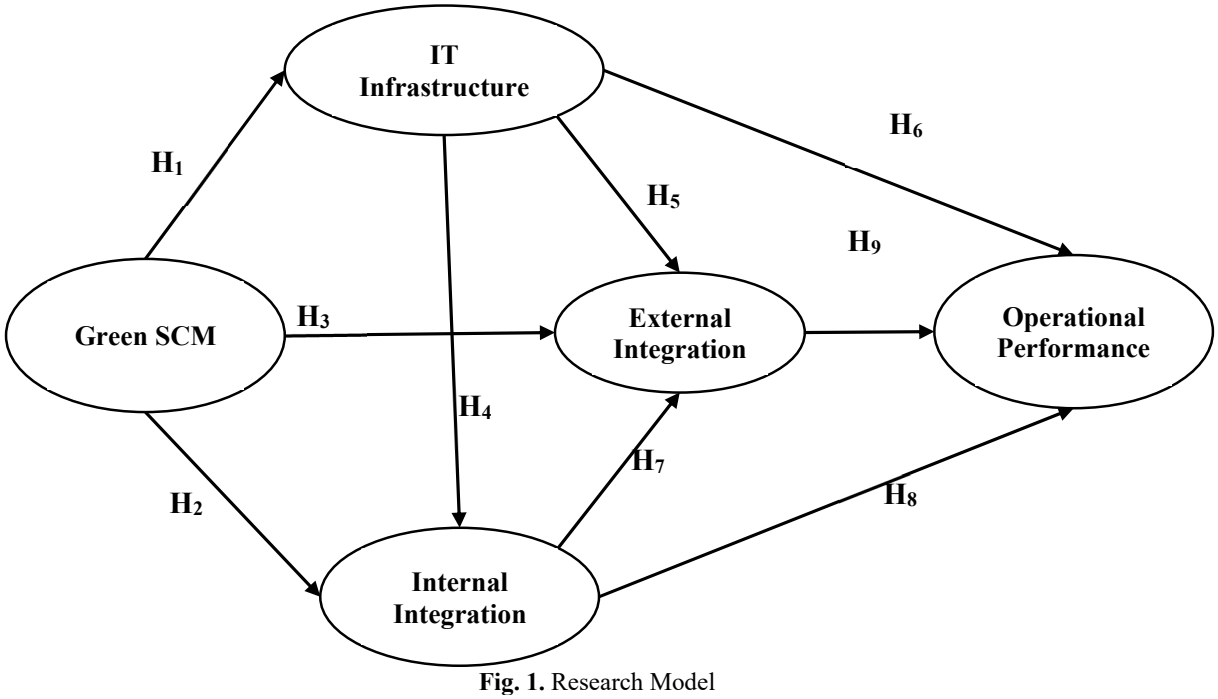

Fig. 1. Research Model

3. Research Methods

This study used quantitative primary data to establish a cause-and-effect relationship between variables. The aim is to understand how changes in one variable can affect other variables. This approach includes measuring research variables and applying statistical analysis to test the measurement validity, reliability, and proposed hypothesis. The data analysis aims to find the influence of green supply chain management on operational performance through the mediation of internal integration, IT infrastructure, and external integration. The population surveyed in this study is manufacturing companies that are already adopting the International Organization for Standardization (ISO) 14001 in Indonesia. The population consists of 2729 medium and large-scale companies that have implemented GSCM for more than “3” years so that the system can be classified as stable by the Ministry of Environment and Forestry. The respondents' criteria for the study sample are supervisor or higher-level positions in charge of the operational, supply chain, purchasing, and information technology sectors, engineering, planning and production, and marketing. As many as 245 questionnaires were obtained and considered valid for further analysis.

Green supply chain management is an operational management method that uses an optimization approach to reduce the environmental impact in the green product cycle, from raw materials to finished products. Xi et al. (2023) stated the practice

of GSCM as reducing excessive and unnecessary materials, reducing the frequency of refilling, introducing reusable and remanufactured parts in material inventory, minimizing waste, reintegrating material and information flows in SCM, reducing transportation lead time, environmental risk-sharing, and increasing the efficiency of resource consumption. The indicators to measure GSCM are GSCM1 (companies contribute to maintaining environmental sustainability), GSCM2 (companies have expertise in maintaining environmental sustainability), GSCM3 (companies support employees to maintain environmental sustainability), GSCM4 (companies have stable and good cooperative relationships with partners in maintaining environmental sustainability) and GSCM5 (companies design products and services according to customer wishes to maintain environmental sustainability).

Internal integration is a process to facilitate interaction, communication, and collaboration between company functions in achieving company goals (Tarigan et al., 2021). Shukor et al. (2021) stated that internal supply chain integration refers to integration within and between internal supply chain functions. Internal integration means bringing together functions and processes within the company, especially in inventory management, purchasing, warehousing, transportation, demand planning, and production (Munir et al., 2020). The indicators in this study are set for internal integration as II1 (data in the company has been integrated between departments), II2 (information technology applications integrated between departments), II3 (all departments can access inventory data promptly), and II4 (logistic data can be accessed by all departments on time). Information technology infrastructure is a tool to support and improve supplier and customer relationships by sharing information and supporting key processes such as procurement and order fulfillment (Yu et al., 2021). The technology used for smart supply chains allows for real-time information sharing to accelerate corporate decision-making and transactions (Lerman et al., 2022). The indicators in this study were determined with IT1 (the company provides a digital system), IT2 (the company provides an adequate data collection system), IT3 (the company has a system that can share information with partners), IT4 (the company has a system that creates a strong communication network), IT5 (the company has a system that is directly connected to partners).

Supply chain integration with partners and customers requires strong coordination and alignment, which includes sharing critical information such as inventory, demand forecasts, and production plans through existing common communication channels (Shukor et al., 2021). The indicators in this study to measure external integration are EI1 (external partners can use the company's information system), EI2 (external partners are directly connected to the company's information system), EI3 (external partners can order quickly through the company's information system) and EI4 (the company actively provides communication to external partners).

Operational performance refers to how quickly and efficiently a company can produce and transport products to its customers (Sahoo & Vijayvargy, 2021). Improving the environmental situation and reducing environmental accidents can improve the company's product quality and delivery efficiency (Fang & Zhang, 2018). The indicators in the study to measure operational performance are as follows: OP1 (the company's product quality has improved), OP2 (product delivery on time), OP3 (the company has decreased inventory), OP4 (the company has a well-organized production line) and OP5 (the company's production capacity has increased). Data collection was carried out using a questionnaire with questions or statements that must be chosen by one of the respondents according to the situation in medium and large companies. The questionnaire was shared as a Google form link via email and social media, including Facebook, line, Instagram, and WhatsApp.

This study uses Smart Partial Least Square (SmartPLS) software for data processing and analysis. Outer model measurements are used to assess the validity and reliability of indicators of latent variables. Further, the measurement of the inner model includes the assessment of the coefficient of determination (R-square) value for the endogenous construct. The value of R-square expresses the percentage of variation in endogenous constructs that exogenous constructs can explain. Another measurement of the inner model is the Q-Square value, which indicates that the model has predictive relevance. The accepted Q-square value is greater than 0. In the PLS analysis approach, the hypothesis test was examined with the t-statistical value generated with a two-tailed t-table value > 1.96), and the p-value value < 0.05, then the alternative hypothesis was accepted.

4. Data Analysis

The respondents' profile of the study samples is presented in Table 1. The characteristics of the respondents in Table 1 show that manufacturing companies in Indonesia with the number of female and male employees are balanced at the staff level. Employees who work in manufacturing companies have been given the same opportunity to occupy all positions based on the assessment and competence of employees. The respondents obtained were at the productive age, and the most at the age of 25-30 years were 69 respondents (28%), followed by fresh graduates at the age of 18-24 years and the age of 31-35 years by 48 respondents (20%). The age of respondents is generally in the position of staff and supervisors in the company who are operationally responsible for implementing the green supply chain and operating information systems to be communicated internally and externally. Of respondents who work in most companies in the production and planning department, 88 respondents (36%) are directly related to the company's production results on the production floor, followed by the marketing department 56 respondents (23%) and warehouse 34 respondents (14%). The respondents' characteristics in this section follow the role of functions in the company related to implementing a green supply chain and integration internally and externally. Work experience in the company was obtained in fresh graduates, namely 2 to 3 years. As many as 104 respondents (43%) have working experience of three to four years in charge of the operation and administration of supply chain functions, followed by respondents with more than ten years of experience. As many as 40 respondents (16.3%) were in manager and

top management positions determining policies adopting green supply chains. The rest are on the supervisor level 204 (83.7%). The study of the education obtained is the largest in undergraduates who have been able to meet the skills and competencies for companies in implementing the set programs, and universities in Indonesia have a large number so that it is not difficult for the industry to get these workers. Manufacturing companies in Indonesia currently prefer to accept employees with postgraduate-educated education, but relatively many still accept undergraduates. The types of companies in Indonesia are primarily found in food and beverage companies at 27% (67 companies), followed by woodworking and furniture companies at 23% (57 companies), and plastics at 10% (25 companies). This type of company is needed in a country with a large population and adequate natural resources.

Table 1
Respondents' profile

Measurement Item	Description	Frequency	Percentage
Gender	Female	118	48 %
	Male	128	52 %
Age	18-24	48	20 %
	25-30	69	28 %
	31-35	48	20 %
	36-40	39	16 %
	41-45	28	11 %
	46-50	5	2 %
	51-55	4	2 %
	>55	3	1 %
Department on work	Engineering	23	9 %
	Finance & Accounting	6	2 %
	Marketing	56	23 %
	Planning & Production	88	36 %
	Information Technology	3	1 %
	Purchasing/Procurement	13	5 %
	Quality Assurance	21	9 %
	Warehouse	34	14 %
Current position in the company	Top Management (Owners, Director, General	13	5.3 %
	Manager	27	11 %
	Supervisor	205	83.7 %
Work experience	3 to < 4 years	104	43 %
	4 to < 6 Years	45	18 %
	6 to < 8 Years	23	9 %
	8 to < 10 Years	22	9 %
	Above ten years	51	21 %
Respondent's last education	High School Equivalent	68	28 %
	Diploma	22	22 %
	Undergraduate	147	60 %
	Postgraduate	6	2 %
Industry Sector	Food & Drink	67	27 %
	Textiles and Clothing	23	9 %
	Wood and Furniture	57	23 %
	Electronics	12	5 %
	Metal and Machinery	17	7 %
	Paper and Tissue	24	10 %
	Plastic	25	10 %
	Pharmacy	11	5 %
	Automotive	8	3 %

Table 2 shows the results of distributing questionnaires to industrial practitioners in companies that use the Likert scale to measure the outer model for measurement items.

Based on Table 2, the lowest loading factor for the green supply chain management variable is 0.791 in the item where the company designs products and services according to the customer's wishes to maintain environmental sustainability, the information technology infrastructure with the lowest value in the item 0.799 is the company providing a digital system, external integration with the lowest value in the external partner item can use the company's information system at 0.780, Internal integration, the lowest value in data items in the company has been integrated between departments by 0.819. Finally, in operational performance, the lowest value in company items has decreased inventory by 0.773 The loading factor value is above 0.500 to meet the validity test requirements. The test for the reliability value of composite reliability for the research variables was obtained with a value of 0.896 in green supply chain management, 0.902 in information technology infrastructure, 0.895 in external integration, 0.868 in internal integration, and 0.858 in operational performance. The reliability test was obtained to meet the requirements above 0.700.

Table 2
Test outer model result

Item of Research	Factor loading	Cronbach Alpha	Composite Reliability	BIRD
Green Supply Chain Management (GSCM)		0.893	0.896	0.701
GSCM1 (company contributes to environmental sustainability)	0.842			
GSCM2 (the company has expertise in preserving the environment)	0.840			
GSCM3 (the company supports employees to preserve the environment)	0.862			
GSCM4 (the company has a stable and good cooperative relationship with partners in preserving the environment)	0.851			
GSCM5 (the company designs products and services according to the customer's wishes to preserve the environment)	0.791			
Information Technology Infrastructure (IT)		0.902	0.904	0.719
IT1 (company providing digital systems)	0.799			
IT2 (the company provides an adequate data collection system)	0.862			
IT3 (the company has a system that can share information with partners)	0.854			
IT4 (the company has a system that creates a strong communication network)	0.877			
IT5 (the company has a system that is directly connected to the partner)	0.845			
External Integration		0.895	0.894	0.763
EI1 (external partners can use the company's information system)	0.780			
EI2 (external partner directly connected to the company's information system)	0.890			
EI3 (external partners can place orders quickly through the company's information system)	0.919			
EI4 (the company actively communicates with external partners).	0.898			
Internal Integration	0.819	0.868	0.870	0.716
II1 (data in the company has been integrated between departments)	0.841			
II2 (integrated information technology application between departments).	0.857			
II3 (all departments can access inventory data on time)				
II4 (all departments can access logistic data on time).	0.868			
Operational performance		0.801	0.858	0.581
OP1 (the quality of the company's products improves)	0.840			
OP2 (on-time delivery of products)	0.812			
OP3 (the company experienced a decrease in inventory)	0.773			
OP4 (the company has a well-organized production line)	0.817			
OP5 (increase in the company's production capacity)	0.866			

5. Hypothesis Testing and Discussion

Table 3 and Fig. 2 show the data processing results, which obtained test values for all hypotheses determined using partial least squares.

Table 3
Test the inner model hypothesis

Direct path coefficient	Original sample	T statistics	P values
Green Supply Chain Management → IT Infrastructure (H1)	0.727	16.092	0.000
Green Supp. Chain Manag. → Internal Integration (H2)	0.203	2.88	0.004
Green Supp. Chain Manag. → External Integration (H3)	0.321	2.957	0.003
IT Infrastructure → Internal Integration (H4)	0.71	11.047	0.000
IT Infrastructure → External Integration (H5)	0.343	3.242	0.001
IT Infrastructure → Oper. Performance (H6)	0.388	3.608	0.000
Internal Integration → External Integration (H7)	0.213	2.036	0.042
Internal Integration → Oper. Performance (H8)	0.251	2.2	0.028
External Integration → Oper. Performance (H9)	0.187	2.166	0.03

All the hypotheses were supported based on the results in Table 3 and Fig. 2. The first hypothesis states that green supply chain management affects IT infrastructure and has a t-statistics value of 16,092 (>1.96). The green supply chain management adopted by contributing to maintaining environmental sustainability positively impacts IT infrastructure updates by a coefficient of 0.727. The company adopting green supply chain management must provide adequate information technology infrastructure and share information with partners. Hence, the company should continuously upgrade its information technology infrastructure to adjust to its internal needs and external partners. The results of this study confirm the results of previous research, which stated that green supply chain management has an adequate effect on information technology infrastructure (Lerman et al., 2022; Holmström et al., 2019; Benzidia et al., 2021; Yin et al., 2022; Novitasari & Tarigan, 2022; Rahmani et al., 2021). The second hypothesis states that green supply chain management affects internal integration and is supported by a t-statistics value of 2,880 (>1.96). Green supply chain management with expertise in preserving the environment and employees to maintain environmental sustainability positively impacts internal integration by a coefficient of 0.203. Green supply chain management requires the company to establish an internal integration of inventory and logistics data that is accessible to all departments on time. The company's adoption of green supply chain management improves coordination and communication between departments in the cross-functional sharing of inventory and logistics data on an

ongoing basis. The study's results support the study that stated that green supply chain management influences internal integration (Liu et al., 2018; Green et al., 2019; Oliveira-Dias et al., 2022).

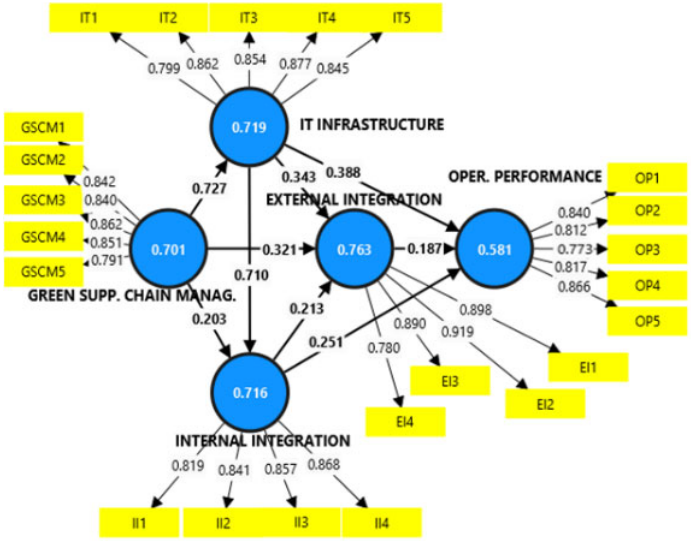

Fig. 2. Analysis of research results

The third hypothesis that green supply chain management affects external integration has a t-statistics value of 2,957 (>1.96), which was accepted. A stable cooperative relationship with partners in maintaining environmental sustainability and designing products and services according to customer wishes impacts external integration by 0.321. The results confirm the previous studies (Al-Ghwayeen et al., 2018; Lo et al., 2018; Hsu et al., 2016; Laari et al., 2016; Fang & Zhang, 2018; Kim et al., 2021; Famiyeh et al., 2018; Tarigan et al., 2021; Zhu et al., 2013). Moreover, the fourth hypothesis, which states that IT infrastructure affects internal integration, was supported with a t-statistics value of 11,047 (>1.96). Information technology infrastructure in companies that are updated to provide digital systems and adequate data can positively improve internal integration by a coefficient of 0.710. Manufacturing companies can improve cross-functional integration as a form of solid internal integration. For example, inventory data can be accessed by all departments that need it promptly. The results confirm the studies which state that information technology infrastructure affects internal integration (Tarigan et al., 2019; Irfan & Wang, 2019; Siagian & Tarigan, 2021; Sundaram et al., 2018; Tarigan et al., 2021; Woo et al., 2016; Amoako et al., 2020).

Further, the fifth hypothesis states that IT infrastructure affects external integration. This hypothesis was significantly supported with a t-statistics value 3,242 (>1.96). The information technology infrastructure enables companies to share information with partners. The IT infrastructure system establishes a strong communication and coordination network that supports external integration. The integration with external partners can be improved using the company's information systems. This coordination between the company and external partners can run well and sustainably to increase the company's competitiveness. The result confirms the previous studies stating that information technology infrastructure improves external integration (Woo et al., 2016; Meindl et al., 2021; Nasiri et al., 2020; Siagian et al., 2022; Lockström & Lei, 2013; Sundaram et al., 2020; Birkel & Müller, 2021). In addition, the sixth hypothesis states that IT infrastructure affects operational performance, and it was supported by a t-statistics value of 3,608 (>1.96) and a path coefficient of 0.388. When the company's information technology infrastructure is updated regularly, it allows it to share information with partners, impacting the operational performance. The company can improve operational performance by decreasing inventory, creating well-organized production lines, and delivering products on time. The results confirm the results of the study (Tarigan et al., 2021; Sundram et al., 2020; Tarigan et al., 2021; Al-Shboul et al., 2017; Siagian et al., 2023; Amoako et al., 2020).

Besides, the seventh hypothesis, stating that internal integration affects external integration, was accepted with a t-statistics value of 2.036 (>1.96) and path coefficient of 0.213. Internal integration with integrated data using information technology between departments can impact and enhance external integration. External integration is indicated by having external partners directly connected and can place orders quickly through the company's information system. The results of the study have confirmed the results of the study stating that internal integration affects the improvement of external integration (Li & Chen, 2020; Al-Shboul et al., 2017; Irfan & Wang, 2019; Munir et al., 2020; Chaudhuri et al., 2018; Jajja et al., 2018; Huo et al., 2014; Demeter et al. 2016; Siagian et al., 2023). Moreover, the eighth hypothesis was supported, stating that internal integration affects operational performance with a t-statistics value of 2,200 (>1.96) and a coefficient value of 0.251. The internal integration with integrated data between departments can impact increasing operational performance. It enables the organization to have a well-organized production line, improves the quality of products, and increases the company's production capacity. The results of the study have confirmed the results of the study which stated that internal integration influences improving operational performance (Huo et al., 2014; Bag et al., 2021; Demeter et al., 2016; Siagian et al., 2023;

Basana et al., 2022b; Shahbaz et al., 2018). Finally, the ninth hypothesis was supported with a t-statistics value of 2.166 (>1.96), and a coefficient value of 0.187. External integration positively affects operational performance. Integration between the company and external partners enables the external partners to order quickly through the company's information system. The results of the study have confirmed the results of past studies which stated that external integration influences improving operational performance (Chen & Chen, 2022; Narayanamurthy & Tortorella, 2021; Tarigan et al., 2020; Demeter et al., 2016; Trattner et al., 2019; Basana et al., 2022b; Fernández, 2022; Jajja et al., 2018; Shahbaz et al., 2018).

The managerial implication of these findings can be highlighted as follows. Green supply chain management adopted by Indonesian manufacturing companies is typically indicated by having an ISO 14001 certification. The company continuously improves competitiveness amid the increasing globalization of imported products and foreign labor in Indonesia. The company should try to upgrade the existing system to strengthen it in manufacturing quality products qualified for export to other countries. Besides, the company should continuously conduct internal and external audits in the context of adopting green supply chain management. The consequence is upgrading the information technology infrastructure and other resources needed to maintain the ISO certification. Green supply chain management in companies necessitates information technology infrastructure. Adopting green supply chain management demands more robust integration within the company by synergizing data that all departments can access in real time. Green supply chain management results in intensive communication and coordination between the company's internal and external partners to maintain environmental sustainability in producing products according to customer needs. Internal integration and external integration driven by information technology infrastructure can improve operational performance by increasing the quality of the company's products, timely product delivery, decreasing inventory, well-organized production lines, and the company's production capacity. Manufacturing companies should be committed to improving the supply chain by involving all members to increase competitiveness. The limitation of this study is its focus only on manufacturing companies in Indonesia with data distribution that cannot accommodate all provinces, and the majority of data is still obtained on the island of Java.

6. Conclusion

The study has assessed the role of green supply chain management on operational performance with the mediating role of IT infrastructure, internal and external integration in Indonesian manufacturing companies. Nine hypotheses were proposed, and the result of the study is highlighted as follows. Green Supply Chain Management affects IT Infrastructure. Companies, when adopting green supply chain management, need to upgrade their information technology infrastructure. The green supply chain management affects internal integration. Green supply chain management influences external integration. IT infrastructure affects internal integration. IT infrastructure affects external integration. Internal integration affects external integration. Internal integration affects operational performance. External Integration affects Operational Performance. Green supply chain management, formed by preserving the environment and having a stable cooperative relationship with partners in maintaining environmental sustainability, can impact internal integration, external integration, and operational performance. Updated information technology infrastructure for its software and hardware enables companies to support digital systems and provide and share adequate data, and has an impact on improving internal and external integration and operational performance. The company's ability to build internal solid integration between departments is shown by the application of integrated information technology, inventory, and logistics data that can be accessed by all departments promptly. Internal integration has an impact on improving external integration. Supply chain integration, which consists of internal and external integration, can improve operational performance by increasing the quality of the company's products and decreasing inventory and production capacity. Manufacturing companies in Indonesia that are already running can adopt green supply chain management by providing consequences for information technology and supply chain integration in improving operational performance. The practical contribution of the research is shown by increasing the strong commitment of top management to adopting green supply chain management by considering investment in updating information technology infrastructure to maintain strong internal and external integration and increase the company's competitiveness. The study results provide insight for managers in adopting a green supply chain with the ISO 14.001 standard to meet international standards recognized by various countries. The findings provide a theoretical contribution of research in improving sustainable performance by paying attention to the economic environment and social performance.

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