

# Uncertain Supply Chain Management

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## The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry

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### ABSTRACT

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Nowadays, global technologies, especially digital things, have become an important tool for businesses to maintain feasible partnerships and build a great value connection with other companies. New digital technologies that are emerging every day are on their way to affect nearly all business processes and activities. This study investigates the effect of the digital supply chain on the supply chain and organization performance in the Malaysia manufacturing industry. This paper also further assesses the mediating effect of supply chain performance in the relationship between the digital supply chain and the organizational performance in the Malaysia manufacturing industry. The objectives are achieved via quantitative research design. The researchers emailed the online survey questionnaire to 1160 manufacturing companies listed in the Federation of Malaysian Manufacturers (FMM) directory via stratified sampling technique and received 63 responses. 7 incomplete responses have been deleted and 56 usable responses representing 5.43% of the response rate used for data analysis. The data was analyzed by using the Partial Least Square Structural Equation Modeling (PLS-SEM). Three hypotheses are not supported and seven hypotheses are supported, which includes all the hypotheses of moderating effect. The manufacturing companies in Malaysia can consider adopting the DSC in the business process to remain reliable in the competitive market by providing good supply chain performance and best organizational performance as a whole. The implication of the study is given to academics and practitioners, specifically manufacturing companies. The limitations and the recommendation for future study have been highlighted.

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## 1. Introduction

Nowadays, people worldwide prefer to use digital tools and devices to communicate and interact with their relatives, friends and all. Market forecast by Bearing Point (2015) presents that a quarter of the world population now connects to the internet, whereas half of these people are actively on a social media platform. Besides, 43% of companies also already apply sophisticated big data analytics as based in business operations. For instance, in 2015 global retailer Alibaba invested a tremendous amount of money in digital technologies such as drones used for deliveries, introducing robotics in the goods handling process, and new apps to optimize and maximize its asset-light delivery services in numerous cities. In fact, since

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2002, a study from Barnes stated that in today's multi-layered digital market, it is pretty challenging to thrive and provide sufficient service to customers without deploying these digital technologies.

Additionally, lower computing costs, cheaper storage, and less expensive broadband that has been offered have driven the investment in digital technologies widely (Mussomeli, Gish, & Laaper, 2015). Deloitte AG (2015) mentioned that the companies could only boost their productivity, e.g., lower operational costs, high customer satisfaction, and client retention, by integrating modern technology into businesses. It also significantly leads to an effective, agile and responsive supply chain where the lead-time can be reduced, and the availability of products can increase. According to Lindgren (2015), the bravery to the recklessness of the legacy operating models is one of the most critical requirements to achieve success. It is worthy of being open-minded towards changes and always cogitating about the upcoming without any hypotheses. So, it is crucial for every business's owner to have comprehensive and extensive academic knowledge and practical skills concerning digital technologies and their related use cases. Developing and implementing tailored digital manufacturing strategies helps business executives always ensure that the business is compatible enough to compete in the fast-changing and demanding market and build a substantial market area.

Based on Bughin et al. (2018) studies, many digital technologies help improve the supply chain of any industry, such as Big Data, the Internet of Things, Blockchain, Cloud Computing systems, Artificial Intelligence, Man-Machine Learning and many more applications. These have been classified as digital supply chain (DSC) technologies supporting some companies to obtain a step-change in performance in more complicated areas. Tahiduzzaman (2017) explained that DSC in supply chain management (SCM) is a supply chain constructed on an internet-empowered competencies core. A DSC has a unique embedded system and techniques that controls and oversees the real-time inventory levels, helps to have excellent customer interaction with items, acts as a location and equipment provider, and assists in the planning process and executes an overall company performance. All in all, digital technologies are significantly affecting the processes in the supply chain. It creates a more precise and transparent supply chain, which supports the manager of the company to have superior power over the business manoeuvre in general. Also, instead of perceiving digitalization just as an apprise of the present business model, it must be seen as a significant aspect that facilitates the entire new operating models. In contrast, it will have a big impact on the organizational performance of a company. However, digitalization is not at all times can act as a stress-free process, nevertheless, the possibilities it brings can occasionally be strange and remain mysterious to numerous businesspersons.

### *1.1 Contemporary Issues*

According to Büyüközkan & Göçer (2018), there is still a lack of research on the industrial real case applications regarding digital supply chain (DSC), especially in manufacturing companies. Büyüközkan & Göçer (2018) also mentioned that Companies from different trade contexts have particular policies, approaches and practices for DSC. Therefore, future research is needed to develop sub-frameworks of DSC for each industry to enhance the critical trends for future DSC. According to few studies, most researchers stated that digitalization tends to resolve the way of supply chain operation. Therefore, it is essential to have a proper guideline and framework to assist in implementing DSC. In addition, Lehtisalo (2018) suggested conducting a study on DSC in a long-term research format. Since the development of technologies is constantly increasing, it is essential to have a study specifically on DSC implementation in any industrial sector. Besides, most of these studies are established in western literature. Only very few studies have examined the relationship between implementation of DSC toward the performance of supply chain and overall business organizational performance, which focus on the manufacturing company in Malaysia. Therefore, this paper investigates the effect of the digital supply chain on the supply chain and organization performance in the Malaysia manufacturing industry. This paper also further assesses the mediating effect of supply chain performance in the relationship between the digital supply chain and the organizational performance in the Malaysia manufacturing industry.

## **2. Literature review**

Zhong et al. (2017) described the manufacturing industry as an industry comprising creation, manufacture, assembly, and handling of raw materials or semi-finished items that pamper in either the formation of new goods and services or value-adding. It is mainly classified into several sectors: construction, electric, electronic, chemical products, textile, food and beverage, energy, plastic, telecommunication, and metalworking industries. The industrial revolution that began initially in the 18th to 19th century dramatically affected the business process in manufacturing companies worldwide, especially with the emergence of the fourth industrial revolution (IR 4.0). The broad practising of smart ICT-based machines, systems and networks in smart production has become a standard in the manufacturing sectors. In industry 4.0, the manufacturing system is an updated process that benefits from enhanced information and manufacturing technologies since it has traditionally played a massive role in the growth of the economy in numerous developing countries. All is to reach a flexible, smart and reconfigurable manufacturing activity. The manufacturing industry is now seen as part of the solution to the trauma inflicted by the financial services sector. The influx of new digital technologies helps the manufacturing industry be more competent in freely swapping and reacting to information. In contrast, manufacturers create tremendous opportunities for growth and transformation to manage the industrial production processes (Alzoubi, Vij, Vij, & Hanaysha, 2021; Hanaysha et al., 2021;

Zhong et al., 2017). However, Jung et al. (2016) discussed that most manufacturers are still absent with a strong methodology and concrete approach to delineate their revolution roadmap and select and highlight emerging technologies that help in the formation of smart manufacturing systems and factories. On top of this, manufacturers must apply organizational and process improvements to recognize full advantages from these technologies. Globally, the manufacturing industry is continuing to nurture, and it now occupies approximately 16% of global gross domestic product (GDP) and 14% of the employment rate. Indeed, 72% of manufacturing companies surveyed by (PwC Network, 2018) highlighted that these worldwide companies are drastically growing their level of digitalization and are expected to be able to commit US\$907 billion per year toward greater connectivity and smart factories.

### 2.1 Manufacturing Industry in Malaysia

Since the early 1980s, the manufacturing sector began to grow speedily in Malaysia. The Malaysian manufacturing business is varied but still has shown long-standing supremacy in the processing and managing rubber and palm oil and pharmaceuticals, medical technology and electronics, among others. However, in 2000 the country began to see the shift from the agricultural economy to an industry-based one, which reduced the reliance on commodity wages. The Malaysian government decided to implement a strategy to focus on economic activities with higher added value so that the country can improve diverse it's economy widely (UK Essays, 2018). Based on the 2017 Best Countries Report, Malaysia is ranked first among 80 countries in a survey regarding the best nations to capitalize, which is at the forefront of its regional competitors such as Singapore, India, Thailand, and Indonesia. The Department of Statistics Malaysia DOSM (2018) reported that due to the increase in value sales mainly in electrical and electronic products (9.2%), petroleum, chemicals, rubber and plastic products (7.3%), and non-metallic metal products (6.0%). The Malaysia manufacturing sales have been expanding from RM62.3 billion in 2017 to RM67.1 billion in June 2018. In addition, the number of workers employed in the manufacturing sector was 2,214,883 people with salaries and salaries paid to amount to RM74.9 billion. In December of 2018, Malaysia's manufacturing production kept increasing to 4.40% over the same month in the previous year. With the reinforcement by export-oriented industries, in 2019, it is forecast to expand to 4.7% year-on-year, and in the long-term, Malaysia's production output is expected to increase by 6.90% (DOSM, 2018).

### 2.2 Digital Supply Chain (DSC)

In literature, there are several definitions of the Digital Supply Chain (DSC). Schrauf and Berttram (2016) stated that behind the huge potential of DSC is Industry 4.0, there is the fourth industrial revolution. An alteration or so-called revolution in production and the introduction of automation was first introduced with the invention of steam and waterpower, known as Industry 1.0, followed by electrification establishment in Industry 2.0. The digital computer was launched as a part of Industry 3.0 before Industry 4.0, which was exposed to the market based on digital and alpha numeric. DSC is also perceived as a process of company alignment with customer satisfaction through e-commerce, digital marketing, social media, and the customer experience itself. DSC adoption's only business aspiration is to deliver and supply the right products at the right time. Table 1 shows the industrial revolution phases.

**Table 1**  
Industrial Revolution Phases

| 1800   | 1900   | 1970s   | 2015+   | 2030+  |
|--|--|---|---|--|
| <b>Industry 1.0</b>                                      | <b>Industry 2.0</b>  | <b>Industry 3.0</b>   | <b>Industry 4.0</b>   | <b>Digital ecosystem</b>   |
| Innovation in motorized production using water and steam | Implementation of an electrical-powered machine and combustion engines for mass production | Advance automation of production by using electronic, IT, and industrial robotics | Digital supply chain (DSC)<br>Smart manufacturing<br>Data analytics | Flexible and integrated value chain networks<br>Computer generated for customer experience |

Note. Adopted from Schrauf and Berttram (2016)

A study of Bhargava et al. (2013) stated that DSC is a combination of systems that back communications and dealing processes between global distribution organizations and the partners' activities in supply chains. This statement has also been supported by Cecere (2016). In placing more emphasis, Kinnet (2015) believes that DSC is a fast, smart, and value chain. With new technology and analysis, it is approaching new forms of revenue, returns and profits. Schrauf and Berttram (2016) also claimed that apart from turning the supply chain into more valuable digitalization also could change the supply chains to provide more accessible and affordable services. These studies have found similar results with the study by Israelit et al. (2018), in which those companies who assimilate digital technologies into their supply chain can speedily enrich the service levels. Even though installing a digitalized and fully integrated supply chain network, businesses can react and respond fast to customer demands with highly effective, efficient, and ultimately improving productivity. McKinsey Digital (2015) stated that DSC allows manufacturers to keenly understand and well-defined the customer behaviour and establish a distinct position within a more complex ecosystem of partners, suppliers and customers. However, these claims can be contended by Motors (2017), who indicated that the growth of DSC in manufacturing is crucial. It disregards silos that have dictated a manufacturer's operations instead of providing complete visibility into a company's desires, needs and challenges. The DSC

is only workable if the company correctly plans to deliver the valuable information along all stops within a networked system in real-time. Companies, especially in Europe, are heavily capitalizing on digitalization in their business models (Kearney, 2015). For example, Amazon, Alibaba, Lufthansa, BMW, DHL DB Schenker are investing in digitalization. Automaker BMW is thriving on getting a fully digitalized factory and data analytics-driven supply-chain division for inbound parts.

### *3.2.1 Digitalization*

A study from Porter and Heppelmann (2015) stated that digitalization is expected to play an increasingly important role in the management and design of global chain supply primarily to companies vigorously involved in value-adding activities, including those involved in production and logistics systems. According to Büyüközkan and Göçer (2018), digitalization is the first process of DSC. Digitalization is described as using digital technologies and shifting the regular business to digital business, which leads to the transformation of new income. Digitalization is a technological force that enhances globalization in economic and cultural ways (Isaksson, Wennberg, Se, & Se, 2016). Digitalization can be composed of three crucial stages: digitalization strategy, digital organization and culture, and digital operations (Corver & Elkhuizen, 2014). Digitalization strategy focuses on setting up the digital goals and formulates and implements the digital strategy. At the same time, digitalization organization and culture analyse current organization and culture, manage the digital organization and culture, and transform it into digital organization and culture. In comparison, digitalization operations emphasized worker enablement, digital operations management, and digital operations implementation.

### *2.2.2 Supply Chain Management (SCM)*

Council of Supply Chain Management Professionals (CSCMP) defined a supply chain as SCM that encompasses the planning and managing all activities involved in sourcing and procurement, conversion, manufacturing operation, and logistics management activities. It also includes the coordination and collaboration with the channel partners, which can be supplier, intermediary, 3rd party logistics provider and customer. SCM integrates supply and demand management within and across companies. Chopra and Meindl (2006) described SCM as a party involved in satisfying customer demands by composing all functions occupied in receiving, fulfilling, and satisfying customer requests. A recent study by Leong et al. (2012) highlighted that SCM integrates trading partners' key business processes from initial raw material extraction to the final or end customer, including all intermediate processing, transportation and storage activities and final sale to the end product customer. This statement also is supported by Büyüközkan and Göçer (2018). SCM is defined as a series of crossed activities encompassing the management, synchronization, arrangement and monitoring of the products and services between two or more parties. Sahin and Robinson (2005) proposed three major processes in SCM: supply chain integration, supply chain automation, and supply chain analytics. Supply chain integration focuses on information sharing, coordination and resource sharing, and organizational linkages. At the same time, supply chain automation focused on robotics technology, automation, and intelligent processes. In comparison, supply chain analytics emphasized the corporate and supply chain network reconfigurations.

### *2.2.3 Technology Implementation*

Büyüközkan and Göçer (2018) stated that technology implementation is a process of leveraging the technology enablers in DSC. Büyüközkan and Göçer (2018) also claimed that these enablers could help to exploit the business profits and unfasten the new practice of value for the future. Besides, Büyüközkan and Göçer (2018) also highlighted that an exemplary process of technology implementation consists of three main components which are: the relationship between human and technology, formulation of technology frame, and technology enablers. The relationship between human and technology refers to user training, human and technology interaction, and human and technology collaboration. At the same time, the formulation of the technology frame refers to the organization infrastructure and process and product infrastructure. In comparison, technology enablers refer to process enablers, product enablers, and technology solutions. A study from Schmidt et al. (2015) has observed that several common digital business technologies directly affect SCM and bring a big after-effect to the manufacturing and retailing industry. This study has found similar results where Pereira & Romero (2017) described DSC as a support for a new paradigm and concept that covers the number of technology enablers. The technology enablers include the Cyber-Physical System (CPS), Internet of Things (IoT), Augmented Reality (AR), Cloud Manufacturing, Smart Factory (3D printing, robotics, sensors), etc. (Al Kurdi, Alshurideh, & Salloum, 2020; Alshurideh, 2019; Alshurideh, Al Kurdi, & Salloum, 2020; Alzoubi et al., 2021; Ghazal et al., 2021; Ghazal et al., 2021; Pereira & Romero, 2017; Schmidt et al., 2015; Turki, Barween, Ra'ed, 2021). CPS is a system that permits the management of interconnected systems to integrate the physical and computational environments (Lee & Lee, 2015). IoT is a network that connects physical objects with sense and monitors them digitally. It enables the whole company to work together and support the supply chain process to be consistently agile, visible, and easy to control (Ben-Daya, Hassini, & Bahroun, 2019). AR is known as the view of a physical real-world in a direct/indirect time that has been enriched with the addition of virtual computer-generated information (Carmigniani & Furht, 2011). Cloud manufacturing is a computing and service-oriented manufacturing model that developed from existing advanced manufacturing models. It enables convenient and on-demand network access to a shared pool of configurable manufacturing resources (Gomes et al., 2018). The smart factory is a composition of new integrative real-time

intercommunication among each manufacturing resource that can create an intelligent environment to achieve flexible and adaptive processes throughout the supply chains (Pereira & Romero, 2017).

### *2.3 Supply Chain Performance*

Performance is the measurement that organizations have used to identify whether the task or activities are achieving their goals. In short, performance is measuring the failure and success of all tasks, including productivity and profitability. Agami et al. (2012) believed that performance measurements in SCM can be regarded as an access process as to whether the supply chain companies have increased or lowered. Thus, short network supply performance can be streamlined as an approach to evaluate the performance of the supply chain system. Since the late '90s, performance rating issues at SCM have attracted many researchers and companies around the world (Beamon, 1999). However, measuring network supply performance is a complicated task, mainly due to the many factors included in the network supply. The study by Gunasekaran et al. (2004) mentioned that SCM plays a big responsibility in gaining a competitive advantage to enhance organizational productivity and profitability. Therefore, it is necessary to have an effective performance measurement. Gunasekaran et al. (2004) added that nowadays, many firms are constantly overlooked in continuous improvement in the supply chain. One of the reasons some businesses cannot succeed in exploiting their supply chain's perspective is failing at the first place to outline the performance metrics and indicators. In 1999, Beamon (1999) creates a framework for performance measures in the supply chain, and it includes three types of performance measures of flexibility, resources and outputs. However, Ibrahim & Ogunyemi (2012) believed that there is still no single statement among previous researchers regarding the best supply chain performance measures. For example, Jeong & Hong (2007) adopted delivery reliability, responsiveness, flexibility, cost, and efficiency as indicators to measure supply chain performance. Meanwhile, Lee et al. (2007) used cost containment and reliability indicators to perform the same measurement in the same year. Sezen (2008) measured supply chain performance by looking at flexibility, output, and resource performance. And also, Vanichchinchai and Igel (2009) preferred to use the variable of cost, flexibility, relationship, and responsiveness to measure supply chain performance. In line with this literature, researchers decided to adopt three supply chain performance indicators. Firstly, resource measures related to the efficiency of using resources in network supplies such as cost and inventory levels. Next is the production outputs such as filling rates, timely delivery time, customer response time, and flexibility measures.

### *2.4 Organizational Performance*

A study from Silvio (2001) mentioned that an organizational performance evaluation system needs to be focused on results, which the interest of stakeholders should guide. From the point of view of team management, performance organization is defined as an assessment activity that allows organizations to make judgments and comparisons on goals, patterns, past decisions, and other processes and products. Consequently, the essence of organizational performance is the formation of value. As far as the value generated from the contributed assets is equal to or greater than the value expected, the assets will remain available to the organization. The organization is relevant to stay alive and continue to survive in the market. Therefore, value creation plays a significant role as a crucial thing in overall performance criteria for any organization. Previously, most of the researchers have measured organizational performance by using both financial and non-financial elements, including the market criteria such as return on investment (ROI), market share, the profit margin on sales, the growth of ROI, the growth of sales, the growth of market share, and overall competitive position (Stock, Greis, & Kasarda, 2000). Abu-Jarad et al. (2010) added that even though organizational performance has become the most important issue for every organization for both profit and non-profit, it's still not easy to conceptualize the performance measurement. In line with the above literature, two types of organizational performance, financial and non-financial performance, will be adopted in this study. Since the late '80s, the majority of the researchers and consulting firms have highlighted the necessity of putting and applying non-financial indicators in the measurement process of organization performance. Therefore, it strengthens the reason for implementing both indicators in this paper. Financial performance is measuring the change in the financial state of an organization. It can also be understood as the financial outcomes that result from management decisions and the execution of those decisions by members of the organization. Meanwhile, Non-financial returns to owner-managers would include lifestyle benefits towards employees and the environment, including work location, work duration, social interactions (Al Kurdi et al., 2020; Al Shebli et al., 2021; Alameeri et al., 2020; AlShehhi et al., 2021; Alshurideh et al., 2020; Alsuwaidi et al., 2021; Kaplan & Norton, 2009; Kurdi et al., 2020; Lebas & Euske, 2007).

### *2.5 Hypotheses Development*

The most necessity of adopting a digital supply chain (DSC) is not just investing in the latest digital technologies. However, it is more than that. The company must know how to align the existing digital initiatives with its supply chain objectives (Raab & Griffin-Crya, 2011). Every organization nowadays realises the potential of the newest technology in DSC. It may offer businesses an opportunity to enhance organizational performance and create a strong foundation to compete and outperform rivals near and far (Srivastava & Sushil, 2013). Meanwhile, the company needs to adopt the digital methodology in the supply chain system to achieve the potential of having an excellent level of organizational performance (Degroote & Marx, 2013). The analysis study from Alicke et al. (2017) showed that many companies are determined to improve the supply chains, but the quantity of digital technologies being applied is small. Even though most firms believe that the adoption of

DSC would help them raise the earnings before interest and taxes (EBIT) by up to 3.2% with annual revenue of 2.3%, almost 98% of these companies are still doubtful to set supply chains as their primary targets in digital strategies. Therefore, three hypotheses that lie under the relationship between DSC and organization performance are proposed:

**H<sub>1</sub>:** *Digitalization positively affects organizational performance.*

**H<sub>2</sub>:** *Supply chain management positively affects organizational performance.*

**H<sub>3</sub>:** *Technology implementation positively affects organizational performance.*

A study by Alicke et al. (2017) predicted that DSC generally delivers good prospects for future SCM. Digitalization in the supply chain helps the firm be faster, flexible, granular, accurate and efficient in their processes. With the advanced development of forecast methods such as predictive analytics, firms can efficiently predict customers' needs. One of the most significant advantages of adopting DSC in SCM is that businesses get an opportunity and chance to get closer and quickly respond to customer needs. For example, DSC helps Amazon, the world's biggest online retailer company, predict customers' preferences by recommending the products to its customers through the gathered data analyzed by digital recommendation engines (Marr, 2021). Therefore, three hypotheses that lie under the relationship between DSC and supply chain performance are proposed:

**H<sub>4</sub>:** *Digitalization positively affects supply chain performance.*

**H<sub>5</sub>:** *Supply chain management positively affects supply chain performance.*

**H<sub>6</sub>:** *Technology implementation positively affects supply chain performance.*

According to Li et al. (2006), effective supply chain performance provides valuable potential for a competitive advantage. It leads the organization in improving their performance, especially for both financials and non-financials dimensions. In addition, Wu (2006) believed that excellent supply chain performance takes the lead in increasing an organization's market share, return on investment, and overall organizational performance. In short, firms with high levels of supply chain performance will have high levels of organizational performance. Based on the above, it is hypothesized that:

**H<sub>7</sub>:** *Supply chain performance positively affects organizational performance.*

Since technological enablers increasingly drive the market, most businesses need to apply the most recent innovative solutions in the supply chain (Schrauf & Berttram, 2016). Therefore, the organisation's overall level includes management processes, human and technology relationships, and infrastructure technologies must participate actively in this process since this is a continuing process with various changes day by day (Al-Zu'bi et al., 2012; Alnuaimi et al., 2021; Alzoubi & Ahmed, 2019; Alzoubi et al., 2020; Alzoubi & Aziz, 2021; Hanaysha et al., 2021). In particular, the presence of digitalisation in the supply chain leads to increased supply chain performance and improves overall organizational performance (Ali et al., 2021; AlShurideh et al., 2019; Alzoubi et al., 2022; Alzoubi et al., 2021; Joghee et al., 2021; Rachinger et al., 2018; Shamout et al., 2022). Therefore, three hypotheses are proposed:

**H<sub>8</sub>:** *Supply chain performance positively mediates the relationship between digitalization and organizational performance.*

**H<sub>9</sub>:** *Supply chain performance positively mediates the relationship between SCM and organizational performance.*

**H<sub>10</sub>:** *Supply chain performance positively mediates the relationship between technology implementation and organizational performance.*

### 3. Methodology

This is a quantitative study. Thus, a survey questionnaire is used for data collection. The questionnaire has been constructed in 4 sections. Section A is related to the demographic profile of respondents. While sections B, C, and D, the respondents are requested to tick the five-point Likert scale. This scale is widespread use of which requires respondents to determine the level of the agreement through a series of statements regarding this study. The independent variable is Digital Supply Chain (DSC), and it consists of three constructs; digitalization (DG), supply chain management (SCM), technology implementation (TI), with a total of 25 items. The dependent variable in this study is organizational performance (OP), with ten items. While the mediating variable, supply chain performance (SCP), with 15 items. Refer to Appendix A for a list of measurement items used in this study. The questionnaires provide close-ended questions in an online platform by using the Google-Form application. Based on records provided by the Federation of Malaysian Manufacturers FMM Directory (2017), Malaysia's manufacturing companies' population is 3019. Stratified sampling is the most suitable for this research because the choosing process of the sample is based on the characteristics that are needed to be the sample instead or random. In this study, the target respondents are those who are responsible for a company's supply chain or one in a higher position that has control over the business's operation. This study also will use G\*Power Analysis in order to determine the size of the sample. Mayr et al. (2016) stated that G-power Analysis as an excellent freeware program. It computes the power values for given sample sizes, effect sizes, and alpha and allows high-accuracy of power and sample size analysis. The result of G\*Power shows that the minimum sample size needed in this research is 85. The researchers distributed the questionnaires through email to the

manufacturing companies listed under the FMM Directory (2017). In this study, Excel will be used to analyze responses in Section A. the researcher uses Excel to perform data entry of respondent's demographics and perform descriptive analysis. In addition, Partial Least Squares Structural Equation Modelling (PLS-SEM) is used for the data analysis with the support of SmartPLS software to analyze the reliability, validity, convergent validity, composite reliability (CR), discriminant validity, Heterotrait-Monotrait Ratio (HTMT), and hypotheses testing.

**4. Data analysis and results**

The researcher managed to receive a 63 return response from the distribution of the online survey questionnaire to 1160 manufacturing companies. It is representing 5.43% of the response rate. However, out of 63 responses, there are only 56 that are valid to be analyzed. Seven responses have to be deleted due to invalid answers, and some of the questionnaires are not entirely answered.

*4.1 Descriptive Analysis*

In this study, descriptive analysis is used to measure each construct's mean and standard deviation in the measurement model. There are a total of 5 constructs which are digitalization (DG), supply chain management (SCM), technology implementation (TI), supply chain performance (SCP), and organizational performance (OP). Table 2 shows the descriptive statistics of this study. The highest mean for the construct is SCM, followed by DG and TI, which is 3.796, 3.718 and 3.702, respectively. At the same time, the mean for SCP is 3.668, and the mean for OP is the lowest, at 3.437.

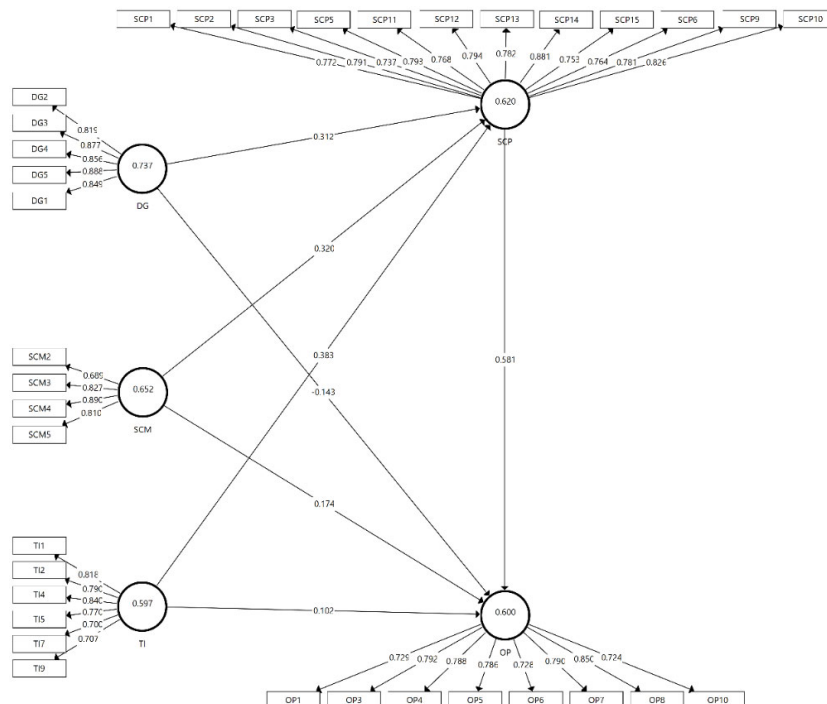
**Table 2**  
Descriptive Statistics

| Constructs | N  | Mean  | Std. Deviation |
|------------|----|-------|----------------|
| DG         | 56 | 3.718 | 0.906          |
| SCM        | 56 | 3.796 | 0.820          |
| TI         | 56 | 3.702 | 1.054          |
| SCP        | 56 | 3.668 | 0.852          |
| OP         | 56 | 3.437 | 0.888          |

Note. DG – digitalization; SCM – supply chain management; TI – technology implementation; SCP – supply chain performance; OP - organizational performance

*4.2 Measurement Model Assessments*

In this study, the researcher uses PLS-SEM to analyze the data. Therefore, this study applied two types of validity, convergent validity and discriminant validity, to assess the measurement model. Fig. 1 shows the modified PLS path model.



**Fig. 1.** Modified PLS Path Model

Note. Deleted 15 items, which include the DG (DG6, DG7, DG8, DG9, DG10), SCM (SCM1), TI (TI3, TI6, TI8, TI10), SCP (SP4, SCP7, SCP8) and OP (OP2, OP9)

#### 4.2.1 Internal Consistency

The acceptable value for outer loading must be above 0.50 (Hair et al. (2016)). Therefore, the factor loading less than 0.50 should be considered to be deleted. In this study, 15 items with factor loading lower than 0.50 have been deleted to achieve dimensionality among the measurement items in the model. As shown in Table 4.2, the construct of SCM (supply chain management) is only one item deleted out of a total of four items, followed by OP (organizational performance) with two items deleted out of 10 items. Next is SCP (supply chain performance), with three items deleted out of a total of 15 items, TI (technology implementation) and lastly is DG (digitalization) with five deleted items out of a total of ten items.

#### 4.2.2 Convergent Validity

The researcher assessed the convergent validity by considering the factor loading, average variance extracted (AVE) and composite reliability (CR). Convergent validity is a measurement model that clarifies an item's variance by using the construct that converges in its indicator. Elements incurred under convergent validity are AVE and CR. AVE value should be greater than 0.50 so that a satisfactory model has been achieved (Fornell & Larcker, 1981). Higher AVE values indicate that the construction in the model measurement is more than 50% of the respective item variance (Hair et al., 2012). Furthermore, according to Henseler et al. (2015), to reach the level of confirmatory, the acceptance value of CR must be more than 0.7. CR value equal to or greater than 0.80 is considered good for confirmatory research, while greater than 0.90 represent high reliability. Table 4.2 shows that the value for every AVE fell between 0.597 to 0.737, which exceeds the suggested value of 0.50. While, all CR fell in between 0.881 and 0.951, which exceeds 0.7, which means that all the constructs are high reliability. Although Ketchen (2013) indicates CR value above 0.90 as not desirable because there is a potential of all indicator variables measuring the same phenomenon. However, the researchers believe that there is a possibility of the respondents being distracted or careless while answering the questions, which lead the answer questions to be blocked by higher internal consistency (Ringle et al., 2015). All in all, this means that all constructs have achieved the requirement of achieving the level of satisfaction for convergent validity. Table 4.2 shows the results summary of the measurement model.

**Table 2**  
Results Summary of Measurement Model

| Construct | Total No of Items | Remain items | Factor Loading* | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|-----------|-------------------|--------------|-----------------|----------------------------|----------------------------------|
| DG        | 10                | DG1          | 0.849           | 0.933                      | 0.737                            |
|           |                   | DG2          | 0.819           |                            |                                  |
|           |                   | DG3          | 0.877           |                            |                                  |
|           |                   | DG4          | 0.856           |                            |                                  |
|           |                   | DG5          | 0.888           |                            |                                  |
| SCM       | 5                 | SCM2         | 0.689           | 0.881                      | 0.652                            |
|           |                   | SCM3         | 0.827           |                            |                                  |
|           |                   | SCM4         | 0.890           |                            |                                  |
|           |                   | SCM5         | 0.810           |                            |                                  |
| TI        | 10                | TI1          | 0.818           | 0.898                      | 0.597                            |
|           |                   | TI2          | 0.790           |                            |                                  |
|           |                   | TI4          | 0.840           |                            |                                  |
|           |                   | TI5          | 0.770           |                            |                                  |
|           |                   | TI7          | 0.700           |                            |                                  |
| SCP       | 15                | SCP1         | 0.772           | 0.951                      | 0.620                            |
|           |                   | SCP10        | 0.826           |                            |                                  |
|           |                   | SCP11        | 0.768           |                            |                                  |
|           |                   | SCP12        | 0.794           |                            |                                  |
|           |                   | SCP13        | 0.782           |                            |                                  |
|           |                   | SCP14        | 0.881           |                            |                                  |
|           |                   | SCP15        | 0.753           |                            |                                  |
|           |                   | SCP2         | 0.791           |                            |                                  |
|           |                   | SCP3         | 0.737           |                            |                                  |
|           |                   | SCP5         | 0.793           |                            |                                  |
|           |                   | SCP6         | 0.764           |                            |                                  |
|           |                   | SCP9         | 0.781           |                            |                                  |
|           |                   | OP           | 10              |                            |                                  |
| OP10      | 0.724             |              |                 |                            |                                  |
| OP3       | 0.792             |              |                 |                            |                                  |
| OP4       | 0.788             |              |                 |                            |                                  |
| OP5       | 0.786             |              |                 |                            |                                  |
| OP6       | 0.728             |              |                 |                            |                                  |
| OP7       | 0.790             |              |                 |                            |                                  |
| OP8       | 0.850             |              |                 |                            |                                  |



Note. DG (Digitalization), SCM (Supply Chain Management), TI (Technology Implementation), SCP (Supply Chain Performance), OP (Organizational Performance). \* Factor loadings for remain items. Deleted 15 items due to the low loading factor, which include the DG (DG6, DG7, DG8, DG9, DG10), SCM (SCM1), TI (TI3, TI6, TI8, TI10), SCP (SP4, SCP7, SCP8) and OP (OP2, OP9)

#### 4.2.3 Discriminant Validity

Once convergent validity is completed and has been established, discriminant validity is done to measure the average correlation of indicators throughout the model. As proposed in the study of Henseler et al. (2015), the researcher decided to select Heterotrait-monotrait (HTMT) instead of Fornell-Larcker criterion because HTMT can better detect discriminant validity. Henseler et al. (2015) added that the discriminant validity could be established between a given pair of reflective constructs if and only when the HTMT value is below 0.90. Table 3 shows that all the constructs have achieved the requirement of discriminant validity.

**Table 3**

Heterotrait-Monotrait (HTMT)

|     | DG    | OP    | SCM   | SCP   | TI |
|-----|-------|-------|-------|-------|----|
| DG  |       |       |       |       |    |
| OP  | 0.507 |       |       |       |    |
| SCM | 0.624 | 0.613 |       |       |    |
| SCP | 0.833 | 0.707 | 0.773 |       |    |
| TI  | 0.841 | 0.592 | 0.602 | 0.864 |    |

#### 4.3 Structural Model Assessments

In this study, there are a total of seven directional hypotheses that are being tested. The testing for hypotheses of this study was run by Bootstrapping in SmartPLS Version 3. Hypotheses testing has been conducted using a one-tailed t-test with a 0.05 significance level (Garson, 2016). To achieve the level of acceptance, the t-value on the one-tailed test of statistical significance must be greater than 1.645. Meanwhile, the p-value must be smaller than 0.05. Table 4.4 shows the results of hypothesis testing.

H1 predicts that digitalization (DG) positively affects organization performance (OP). At the same time, the results show that it is statically insignificant at (t-value = 0.926 and p-value at 0.177). H2 that predicts supply chain management (SCM) positively affects OP also shows statically insignificant at (t-value = 1.327 and p-value at 0.093). In addition, H3 that foresee technology implementation (TI) positively affects OP also shows statically insignificant at (t-value = 0.606 and p-value at 0.272). In short, all hypotheses that predict a positive effect between all three independent variables (DG, SCM and TI) and dependent variables (OP) are not supported. However, there are statically significant tests of H4 that predict DG positively affects supply chain performance (SCP) at (t-value = 2.148 and p-value = .016). The testing for H5 between SCM and SCP also shows statically significant at (t-value = 2.467 and p-value = 0.007). H6 that predicts the TI positively affects SCP also shows statically significant at (t-value = 3.801 and p-value = 0.000). H7 that predicts SCP positively affects OP also shows statically significant at (t-value = 3.012 and p-value = 0.001). In summary, for the seven hypotheses testing for the direct relationship, four hypotheses are supported, and three are not supported.

Next, in this study, the effect sizes ( $F^2$ ) also have been observed.  $F^2$  is needed to know how exogenous latent construction (whether weak, simple, or substantial) affects the construction of endogenous latencies. The  $F^2$  value of 0.35 signifies a large effect, 0.15 represents a medium effect, while 0.02 means a small effect (Gefen, Rigdon, & Straub, 2011). Table 4.4 shows that four (i.e., H1, H3, H6, H7) had a medium effect from all seven hypotheses, and the remaining three (i.e., H2, H4, H5) had small effects.

**Table 4**

Hypotheses Testing

| Hypo-theses | Path      | Std Beta | SE    | T-value | P-value | F <sup>2</sup> | Confidence Interval |       | Decision      |
|-------------|-----------|----------|-------|---------|---------|----------------|---------------------|-------|---------------|
|             |           |          |       |         |         |                | 0.05                | 0.95  |               |
| H1          | DG → OP   | -0.143   | 0.154 | 0.926   | 0.177   | 0.013          | -0.365              | 0.087 | Not Supported |
| H2          | SCM → OP  | 0.174    | 0.131 | 1.327   | 0.093   | 0.030          | -0.036              | 0.377 | Not Supported |
| H3          | TI → OP   | 0.102    | 0.169 | 0.606   | 0.272   | 0.007          | -0.191              | 0.379 | Not Supported |
| H4          | DG → SCP  | 0.312    | 0.145 | 2.148   | 0.016   | 0.164          | 0.06                | 0.530 | Supported     |
| H5          | SCM → SCP | 0.320    | 0.130 | 2.467   | 0.007   | 0.289          | 0.126               | 0.546 | Supported     |
| H6          | TI → SCP  | 0.383    | 0.101 | 3.801   | 0.000   | 0.260          | 0.208               | 0.530 | Supported     |
| H7          | SCP → OP  | 0.581    | 1.193 | 3.012   | 0.001   | 0.152          | 0.245               | 0.973 | Supported     |

Note: >t-value (p-value) : >2.58 (\*\*\*p<0.01), >1.96 (\*\*p<0.05), >1.65 (\*p<0.10)

Three mediating effects are being tested to measure whether the mediating variable mediates the relationship between the digital supply chain and organizational performance. Table 4.5 shows the results of the mediating effects. It indicates that the SCP has a meaningful mediating effect between DG and OP (t-value = 1.757 and p-value = 0.040). In addition, the indirect influence of SCM on OP via SCP is meaningful with (t-value = 1.722 and p-value = 0.043). The indirect influence of SCP

on the relationship between TI and OP is significant at (t-value = 2.449 and p-value = 0.007). Therefore, H8, H9, and H10 are supported.

**Table 5**  
Mediating Effects

| Hypo-theses | Path           | Std Beta | SE    | T-value | P-value | Confidence Interval |       | Decision  |
|-------------|----------------|----------|-------|---------|---------|---------------------|-------|-----------|
|             |                |          |       |         |         | 0.05                | 0.95  |           |
| H8          | DG → SCP → OP  | 0.181    | 0.103 | 1.757   | 0.040   | 0.019               | 0.366 | Supported |
| H9          | SCM → SCP → OP | 0.186    | 0.108 | 1.722   | 0.043   | 0.043               | 0.389 | Supported |
| H10         | TI → SCP → OP  | 0.223    | 0.091 | 2.449   | 0.007   | 0.091               | 0.379 | Supported |

Note: >t-value = (p-value) : >2.58 (\*\*\*p<0.01), >1.96 (\*\*p<0.05), >1.65 (\*p<0.10)

#### 4. Discussion and conclusion

The study was conducted to determine the relationship between digital supply chain (DSC), supply chain performance and organizational performance. The DSC consists of three constructs which are digitalization, supply chain management and technology implementation. This research established that the independent variables of DSC discussed early in this paper positively affect the mediating variable of supply chain performance (H4, H5, H6 accepted). This is in line with earlier studies of Srivastava & Sushil (2013) and Alicke et al. (2017). The researchers can conclude that most Malaysian manufacturing industries now realize the positive potential of adopting digital elements in their supply chain. The implementation of DSC can help companies develop their businesses well, improve the level of services in the entire level of supply chains, achieve competitive values in the market, and always stay ahead of the changing industries besides cutting down unnecessary expenses. The structural model assessment also proves that supply chain performance enhances organizational performance (H7 accepted). However, the findings of H1, H2, and H3 are not in line with the literature (Degroote & Marx, 2013; Srivastava & Sushil, 2013). Perhaps, the analysis also demonstrates that mediation effects with the presence of supply chain performance as mediator provide a basis for the inconsistent findings of direct relationships among the independent variables of DSC with organizational performance. In conclusion, the manufacturing companies in Malaysia can consider adopting the DSC in the business process to remain reliable in the competitive market by providing good supply chain performance and best organizational performance as a whole. The readiness to face new challenges of a fast-moving world and rapid development of technology is the main key to keeping the organization moving forward and achieving competitive advantages. This study is in line with the previous study by Rachinger et al. (2018), whereas it mentioned that the implementation of digitalization in the supply chain not only benefits the supply chain performance but in the big picture, it helps the organization to expand and to have an overall good performance. The researcher believes that most manufacturing companies in Malaysia still have no clear views on how DSC can affect their organizational performance via supply chain performance. Most of these companies still lack knowledge, especially on the benefits of adopting DSC in their business operation.

#### 5. Implications of the study

The implication of this research shows that gap issues and knowledge have been utilized to explore the digitalization of the supply chain in manufacturing industries more deeply. There are two implications, which are theoretical and practical. In short, this research study may contribute to the manufacturing industry and for academic purposes. This study contributes to the theory in understanding the digital supply chain (DSC) context that lies in industry 4.0. In terms of theoretical value, this study also aims to fill the research gap in previous studies. Previous researcher has a lack of emphasizing the real application of DSC especially in the manufacturing industry as a whole (Büyükköçkan & Göçer, 2018). This study helps future researchers better understand the effects of DSC on supply chain and organizational performance. Besides, the manufacturing company can use this study as a reference in the decision-making process on DSC adoption. This study benefits organizations, especially the top management, to better understand the effects and advantages of DSC adoption towards the supply chain performance and, of course, organizational performance. Furthermore, it will help the company in the manufacturing industry to have better sight, understandings and can help in boosting their opinions on its adoption. Organizations also have a method to identify the exact time to adopt, which dimension to adopt, and the appropriate way to implement this DSC system. In order to stay relevant and alive in the digitization megatrend, every business manager must ensure that the supply chains have a clear view of the digitization policy and focus on better digitalization capabilities that are going to build (Al Kurdi, 2021; Alhamad et al., 2021; Ali et al., 2022; Alshurideh et al., 2019; Alzoubi et al., 2020; Joghee et al., 2021).

#### 6. Limitations and Recommendations

In this study, there is also a limitation to getting manufacturing-based companies direct contact information in the FMM directory. The details in the directory did not recently update, such as the email and direct phone number. Therefore, the researchers have faced challenges in doing the follow-up. Due to this situation, the researcher had difficulties getting the

minimum sample as suggested by the G\*Power analysis. As a recommendation for future study, the future researchers are suggested to diminish the scope of the investigation into the smaller category in the Malaysia manufacturing industry. It can be the automotive, electric electronic or foods and beverages sector to get more insight on the role of the digital supply chain in the particular sector. For the academic purpose, the future researcher can also explore the benefits and challenges of adopting the digital supply chain in the firms to have a better understanding.

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## Appendix A

### List of measurement items

| Item                              | Questions   | Sources         |
|-----------------------------------|---|-----------------|
| <b>Digitalization</b>             |   |                 |
|                                   | <b>Our company ...</b>  |                 |
| DG1                               | are aggressively pursuing strategies/technologies for "digitalization" in the business process.   | (Digest, 2016;  |
| DG2                               | are aggressively pursuing strategies/technologies for "digitalization" specifically in the supply chain.  | European A.T.   |
| DG3                               | views supply chain digitalization as more operations rather than IT focused   | Kearney,        |
| DG4                               | is successful in dealing with supply chain management (SCM) practices and looking forward to integrating with digitalization.                                     | 2015)           |
| DG5                               | adopt the digitalization in SCM in order to decrease the global competition.  |                 |
|                                   | <b>I believe that digitalization helps our company to ...</b>   |                 |
| DG6                               | increased its SCM flexibility.  |                 |
| DG7                               | lower the inventory and warehousing costs.  |                 |
| DG8                               | lower the supply chain risk.  |                 |
| DG9                               | lower the supply chain complexity.  |                 |
| DG10                              | lower the transport and logistics administration costs  |                 |
| <b>Supply Chain Management</b>    |   |                 |
|                                   | <b>Our company practices supply chain management by ...</b>   |                 |
| SCM1                              | improving the integration of activities across the supply chain by creating a supply chain management (SCM) team that include members from different departments. | (A. R. Ibrahim, |
| SCM2                              | ensure on-time delivery of own purchase materials directly to the firm's point of use.  | Zolait, &       |
| SCM3                              | establishing more frequent contact with members of the supply chain.  | Sundram,        |
| SCM4                              | Reducing response time across the supply chain  | 2010)           |
| SCM5                              | Use of formal information sharing agreements with suppliers and customers   |                 |
| <b>Technology Implementation</b>  |   |                 |
|                                   | <b>The system is a part of our current business process</b>   |                 |
| TI1                               | Electronic interfaces with carriers   | (European       |
| TI2                               | Inventory planning and management   | A.T. Kearney,   |
| TI3                               | Warehouse management system   | 2015)           |
| TI4                               | Transport management system   |                 |
| TI5                               | Electronic freight document handling and archiving  |                 |
|                                   | <b>The technology is very significant to be implemented in our company:</b>   |                 |
| TI6                               | 3D printing and additive manufacturing.   |                 |
| TI7                               | E-platforms for direct carrier selection and transaction.   |                 |
| TI8                               | Processing of paperless freight documents.  |                 |
| TI9                               | New innovative computer software, robots, and autonomous vehicles.  |                 |
| TI10                              | Radio tagging and tracking of goods, packaging and containers   |                 |
| <b>Organizational Performance</b> |   |                 |
|                                   | <b>Financial</b>  | (de Vass,       |
|                                   | <b>Our company always ...</b>   | Shee, & Miah,   |
| F1                                | improve its productivity (e.g. assets, operating costs, labour costs).  | 2018)           |
| F2                                | improve the sales of existing products.   |                 |
| F3                                | improve its financial ratios such as return on assets, return on investment and return on equity.   |                 |
| F4                                | perform a cost-saving during the production process in raw material, energy, water, human, machine and equipment.   |                 |
| F5                                | reduce the cash-to-cash cycle time.   |                 |
|                                   | <b>Non – Financial</b>  |                 |
|                                   | <b>Our company always ...</b>   |                 |
| F6                                | build strong and continuous bonds with customers by improving customer satisfaction and reduce the level of customer complaints.                                  |                 |
| F7                                | gain precise knowledge of customer buying patterns.   |                 |
| F8                                | improve employee satisfaction, including their welfares such as health and safety.  |                 |
| F9                                | reduce the use of energy.   |                 |
| F10                               | improve the return/re-use/recycle process.  |                 |
| <b>Supply Chain Performance</b>   |   |                 |
|                                   | <b>Flexibility</b>  | (Kaliani        |
|                                   | <b>Our company is able to respond and accommodate to ...</b>  | Sundram,        |
| SCP1                              | the demand variations, such as seasonality.   | Chandran, &     |
| SCP2                              | the periods of poor manufacturing performance such as machine breakdown.  | Awais Bhatti,   |
| SCP3                              | the periods of poor supplier performance.   | 2016; Veera     |
| SCP4                              | the periods of poor delivery performance.   | Pandiyani K.S., |
| SCP5                              | to the new products, new markets or new competitors.  | n.d.)           |
|                                   | <b>Resource</b>   |                 |
| SCP6                              | The total cost of resources used in the company, including the held inventory, has been improved.   |                 |
| SCP7                              | The total cost of distribution, including transportation and handling cost, has been improved.  |                 |
| SCP8                              | The total cost of manufacturing, including labour, maintenance and re-work cost, has been improved.   |                 |
| SCP9                              | Improve cost associated withheld inventory.   |                 |
| SCP10                             | The value-added productivity per employee in the company has been improved.   |                 |
|                                   | <b>Output</b>   |                 |
|                                   | <b>Based on the most recent three years performance, our company has ...</b>  |                 |
| SCP11                             | Improve sales.  |                 |
| SCP12                             | Improve order fill rate.  |                 |
| SCP13                             | Improve manufacturing lead time.  |                 |
| SCP14                             | Improve the quality of the product.   |                 |
| SCP15                             | Improve reliability on supply chain delivery includes lower shipping errors.  |                 |



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