

## Article

# Impacts of Product Variety and Supply Chain Networks on the Influx of Information Exchange in Industry Applications

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**Abstract:** Managing product variety is a challenging problem given the increasing complexity of supply chain networks. To overcome this complexity, managing integration in the supply chain is essential for companies to coordinate effectively. By managing the influx of information exchange between the various entities involved in the supply chain network, integration can be achieved successfully. In this paper, we are targeting research questions regarding the impact of the influx of information exchange on product variety and supply chain networks and the key factors influencing its exchange from different industries' perspectives. To investigate our research questions and to conduct a case study across different industries and companies, this study aims to explore the impact of supply chain network complexity, which causes an influx of information exchange due to increasing product variety through qualitative research. In our results, by categorizing the raw interview data, we visualize correspondent opinions to facilitate deep analysis, including factors such as product variety, supply chain networks, and information exchange. The key factors that can influence the influx of information exchange from different industries' and companies' perspectives are presented in our results to provide valuable insights into the significant factors affecting the success of the smart business.

**Keywords:** product variety; supply chain network; supply chain complexity; information exchange; qualitative research; industry; case study



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## 1. Introduction

As the rapid development of the digital economy offers unlimited opportunities for innovation, especially in the manufacturing industries, many companies are competing with each other to create innovative products to achieve more profitable market share and to win the business competition with global competitors based on customer preferences for existing product trends [1–5]. By increasing the variety of products according to demand, quality, style, function, packaging, and size, many companies believe that owning various products will raise the potential profits of these companies [6–10]. Although in a real-world situation, the enhancement of product variety usage is believed to yield a considerable return, it cannot completely contribute to the profitability of companies [2,3,11]. Managing the product variety and anticipating the potential negative consequences from uncontrollable product variations are essential to realizing the company's profitability [1,4,8,11–15]. Additionally, introducing new product variation strategies will increase the number of materials needed by the company and the interdependence or relationship between materials to produce the products [7–9,16]. In addition, managing product variety is a challenging problem, especially considering the increasing complexity of supply chain networks [8,13,17].

A supply chain network consists of multiple businesses working together to move products or services from their origin to the final customer. Those processes are based on

the flow of materials, information, and financial transactions from upstream to downstream supply chains [17–20]. The upstream supply chain refers to the process of obtaining raw materials from suppliers and transforming them into finished products closer to the source of goods. In contrast, the downstream supply chain involves distributing and selling the finished products to the end consumer, typically at the end of the supply chain network, where the goods are delivered to the final customer. In other words, a supply chain network can be defined as a complex system composed of various interconnected activities. These activities involve planning and managing the entire process of moving products or services from their origin point to the end consumer, including integration between the company and its channel partners within uncertain conditions [6,17,21–25]. Uncertain changing conditions are constantly evolving, and the supply chain network is constantly adapting to them, making it a dynamic and challenging system to be managed. An important element in managing the supply chain network is the intensive integration between various functions and activities [25–30]. Maintaining integration among all entities involved in the supply chain is a crucial component to ensure the effectiveness and efficiency of its operation. Its integration can help minimize delays, errors, and other disruptions, improving the supply chain's overall performance. Integration within the supply chain network is a crucial factor enabling the company and its various components to work together as a cohesive and interdependent entity [17,31,32]. It is generally viewed from three perspectives: suppliers, customers, and the combined perspective of both parties [26,33–36]. The supplier–customer perspective involves considering the needs and expectations of both parties, as well as the processes and activities within the supply chain to address their needs. Examining the supply chain from this perspective allows for a more comprehensive understanding of the system and potential opportunities for optimization and improvement. To accomplish supply chain integration, it is important for the company to focus on collaboration and coordination within the supply chain network to enhance supply chain performance [30–32,36–38]. One key aspect to successfully achieving effective supply chain integration is managing information exchange among the various entities involved in the supply chain network.

Information exchange can be defined as information sharing between parties in the supply chain network, significantly impacting the success of collaboration and coordination strategies among partners in the supply chain network [17,26,27]. This exchange includes all types of data affecting collaboration and coordination among supply chain partners, such as information demand, inventory status, production schedules, purchase orders, and shipment schedules [17,26]. To facilitate the information exchange between supply chain partners, an influx of information exchange has to be handled effectively and efficiently due to increasing supply chain network complexity. In this paper, we aim to bridge the gap by investigating two key research questions: is there any impact from the influx of information exchange on product variety and the supply chain network? What are the key factors that can influence the influx of information exchange from the perspective of different industries? To answer this research question, we perform qualitative research based on a case study on various industries and companies through major and minor propositions in which the high supply chain complexity causes an influx of information exchange due to increasing product variety. To summarize, our key contributions are as follows:

- This paper uses qualitative research based on a case study to investigate and answer our research question, using both major and minor propositions to highlight the impacts of product variety and supply chain networks on the influx of information exchange.
- This paper categorizes and visualizes correspondent opinions to facilitate deep analysis, including factors such as product variety, supply chain network, and information exchange.

- This paper analyzes our case study results, including factors such as product variety, supply chain networks, and information exchange by categorizing the interview raw data.
- This paper discusses the important key factors that can influence the influx of information exchange from the perspective of different industries.

This paper comprises several sections to comprehensively explore the topic at hand. In Section 2, we delve into the fundamental concepts underpinning the work presented in this paper, such as product variety, supply chain network, and information exchange. We then provide a detailed description of our proposed study, highlighting both our major and minor propositions, in Section 3. In the following Section 4, we present the experimental results and their analysis obtained from our study, along with a thorough examination of the data collected from multiple industries. A more in-depth discussion and conclusion of these results are presented in Section 5. Then, Section 6 considers the implications of our findings and explores the impact of product variety and supply chain networks on the influx of information exchange. Section 7 discusses the study's limitations and outlines potential research directions for future work.

## 2. Related Work

This section explains more comprehensively the previous work that supports this study. There are only a few studies that have thoroughly analyzed in-depth information exchange in both theory and practice [21–24,26], while other studies only mention the vital role of information exchange in the supply chain network and focus on the relationship between product variety and the supply chain network [7,8,28,33–35].

### 2.1. Qualitative Research

Qualitative research is the most appropriate approach when dealing with a research problem that requires exploration and has limited information about the variables involved [39–42]. This is particularly true when there is a lack of information in the existing study literature, as we can gain insight from correspondents through exploration. There are several types of interviewing style: narrative [43–45], semi-structured [46–49], and in-depth interviews [50–54].

Narrative interviews involve the correspondent sharing their own stories using their own words while being prompted by the interviewer. A narrative or unstructured interview aims to gather in-depth and detailed information that can be analyzed qualitatively in order to discover what kinds of events are occurring rather than focusing on predetermined frequencies of events already expected to occur [43–45]. In this interview technique, the topics have been listed for the correspondents to discuss. However, the questions are phrased differently and ordered in various ways based on their responses, as the correspondent's stories shape the interview process.

Unlike narrative interviews, semi-structured interviews involve a set of main questions used consistently for each interview; however, the order and level of probing may differ. This interviewing technique can be applied when we understand the research topic, allowing for a more flexible approach to gathering data [46–49]. The questions have been adjusted to fit the flow of the conversation with the correspondent. This technique, however, must be controlled to avoid losing the meaning of the interview questions, although open-ended questions should be used to prevent scripted responses. Encouraging correspondents to share their attitudes, beliefs, and values can be valuable. Still, it can also be difficult for individuals who lack self-awareness or who are not used to expressing their thoughts and feelings. Furthermore, broaching delicate subjects during an interview could expose the correspondents.

The last technique is in-depth interviews, which aim to gain a more thorough and detailed understanding of the research topic. This technique follows an ethnographic approach and complements the correspondent's observation or action research methods. In in-depth interviews, we probe the correspondent's experiences, behaviors, emotions,

and attitudes to identify underlying concepts that can be analyzed to create a theory about the research topic [50–54]. Unlike narrative interviews, in-depth interviews are more structured in terms of directing the conversation and typically do not involve life histories or stories. However, in-depth interviews allow correspondents to communicate more freely and provide more detailed descriptions than semi-structured interviews. On occasion, disclosing all the details of the research question during in-depth interviews may not be done; instead, during the recruitment and consent process, the correspondent is informed about the broad interview topic, and this guides the conversation based on the correspondent's answers.

### 2.2. Product Variety

Modern business's fast-paced and competitive nature requires companies to continually innovate and offer a wide range of products to stay relevant and profitable [1–4]. Product variety refers to the diversity of products available within a particular market or offered by a single company. The wide range of options available to customers is essential for companies to carefully consider the level of product variation they offer to increase their chances of success in the competitive market and achieve profits [4,6,20,55,56]. However, offering a wide range of products also means serving more customer groups and competing with more businesses, which can be overwhelming, especially when using multiple channels for distribution. Companies must combine all data from various channels to deeply understand and analyze their target markets and identify market trends to be effective.

Numerous previous studies [4,57–60] have shown that most companies prefer to manage and minimize the complexity of the production process and the level of product varieties to cost reductions in this process. However, this is not in line with marketing philosophy, which aims to successfully meet the diversity of customers' needs and increase market share by expanding the range of products. To maximize long-term profits, companies must balance their income with the benefits gained by the impact of the costs of product variety. In addition, due to the high uncertainty of consumer interest and the needs of products, companies cannot rely on large-scale production of standard products. Still, they must be more flexible in meeting consumer trends with product diversity. In this case study, we aim to understand the critical factors of product variety that influence the influx of information exchange.

### 2.3. Supply Chain Network

The supply chain is a network within an organization where each node is interconnected with various processes and activities to produce value in the form of a product or service [17,61]. In other words, the definition of supply chain network can be simplified as the flow complexity of the supply chain in which its network involves various components and aspects interconnected with one another [7] and comprises multiple components working together to create value in the form of products or services. In the context of supply chain analysis, the level of the supply chain network is referred to as the position of the different components within the chain. These components can be divided into two broad categories: upstream and downstream [7,21,62–64]. Upstream components are the earlier steps closer to the source raw materials or inputs, while downstream components are the end steps closer to customers. The number of tiers in a supply chain refers to the existing levels or stages between these two points, representing the current steps and layers between sourcing raw materials and reaching the final customer. Essentially, the number of tiers reflects the complexity and length of the supply chain process, from the beginning stages of raw material sources to the end stages of customer delivery. There might be multiple tiers in a more complex supply chain, with intermediate stages such as manufacturing, distribution, and wholesale. Understanding the supply chain network is important because it significantly impacts the coordination and communication process between partners to mitigate the risks and uncertainties involved [65,66]. For example, a supply chain network with fewer tiers may be more efficient because it has fewer points of interaction and fewer

opportunities for delays or disruptions. In addition, a supply chain network with more tiers may offer more flexibility and customization, as there are more opportunities to adapt to changing customer needs or market conditions.

In our previous study [67], we suggested that supply chain complexity is a multi-dimensional phenomenon based on various influencing factors. These factors can be distinguished based on the parts' or segments' scope and specification [7]. Ref. [61] splits the nature of supply chain complexity into two categories: the direct supply chain and the extended supply chain. The direct supply chain consists of companies, suppliers, and customers involved in the flow of products or services, finances, and information from upstream to downstream. An extended supply chain refers to the network of organizations, people, activities, information, and resources that produce and distribute a product or service. This includes the primary participants in the supply chain, such as manufacturers, distributors, and retailers, and a wide range of supply chain partners, such as suppliers, logistics providers, and service providers. The extended supply chain can also include customers, regulators, and other stakeholders who impact the supply chain process. The term "extended" refers to the fact that the supply chain extends beyond the traditional boundaries of an organization and includes a broad range of participants and activities.

#### *2.4. Information Exchange*

Information exchange refers to exchanging information between two or more parties. It enables the management of coordination activities across the supply chain, accelerating decision-making and helping companies achieve their goals [68]. The application of information technology can enable faster and more efficient information exchange and allow for tracking and monitoring information exchange, making it easier to manage and control the information flow [26,29,69–71]. Information technology is essential to modern business and communication and can evolve and improve the lead time of information exchange between supply chain partners. In general, applying information technology in the industry worldwide is one of the business strategies that helps companies improve their business operation productivity [72,73]. In the supply chain network context, the influence of information technology exchange can be categorized into two aspects: supply chain integration and supply chain performance [17,25,27,73].

Supply chain integration is the key to success in the supply chain network; one important factor is increasing coordination and collaboration among supply chain partners [25,74,75]. To integrate the entire interaction process throughout the supply chain network, companies must pay attention to the aspects of sharing and access [17,26,70,71]. Sharing and access in this context mean that the supply chain network must fully cooperate in exchanging significant information and allow the supply chain network to access the data so that the company can realize a more responsive, effective, and efficient supply chain network [74,76]. In realizing the creation of these two aspects, information technology exchange is needed to provide methods for addressing problems related to the increasingly rapid flow of information exchange in the supply chain network. Implementing information technology in the company will improve the quality of the information received by each partner more effectively and efficiently so that the application of supply chain integration can find the optimal solution [27,70,77]. With the sharing and accepting aspects prominent in the supply chain network, the process of collaboration and coordination among supply chain partners can achieve success in terms of supply chain integration [75].

On the other hand, supply chain performance refers to the effectiveness and efficiency with which a supply chain delivers goods or services to customers [78,79]. It is a measure of how well the supply chain meets the needs and expectations of customers, as well as the internal goals and objectives of the organization. Key factors impacting supply chain performance include cost, speed, flexibility, quality, and sustainability [32,36,80,81]. Companies can track and measure supply chain performance using a variety of metrics, such as on-time delivery, order accuracy, inventory turnover, and customer satisfaction [36,79–81]. The design and structure of the supply chain network can significantly impact supply

chain performance. In that case, the company can gain many benefits, such as an improvement in supply chain performance and the company's business process [69,73,82]. A performance improvement in the company's supply chain can be defined as the company's ability to manage its business processes more effectively and efficiently, where an improvement in supply chain performance is synchronized with increasing revenue and profit for its company.

Previous studies [27,29,82] show that information technology directly affects supply chain performance, demonstrated by implementing information technology, facilitating information exchange within the company, and ultimately leading to an improvement in supply chain performance. In addition, there is limited research on the impact of product variety and supply chain networks on the influx of information exchange.

### 3. Methodology

Our work is based on a case study to thoroughly investigate our research questions and reach well-informed conclusions. As a part of this study, we used both major and minor propositions to describe and understand our research investigations clearly. Both major and minor propositions, together with the process of our study, are depicted in Figure 1. First, the major proposition started with our literature study [67] to identify the current issue and ended with designing the conceptual modeling framework of product variety, supply chain network, and information exchange. Then, our minor proposition is to break each domain down into the attributes and elements to support our interview questions.

#### 3.1. Major Proposition

Major propositions are the fundamental assumptions, beliefs, and values guiding the research process and shaping the interpretation of the results. These propositions are the foundation for our research and provide a framework for examining our research questions to reach well-informed conclusions. From our literature study [67], we identify the initial assumptions of our qualitative-based research. This study helped us identify the current problem and understand the existing knowledge on our topic. Then, we formulate our research investigation from three interconnected domains: product variety, supply chain network, and information exchange. By considering the major proposition carefully, we can better understand the implications of our findings for the impact of product variety and supply chain network on the influx of information exchange and draw out meaningful attributes and elements to support our interview questions in this case study.

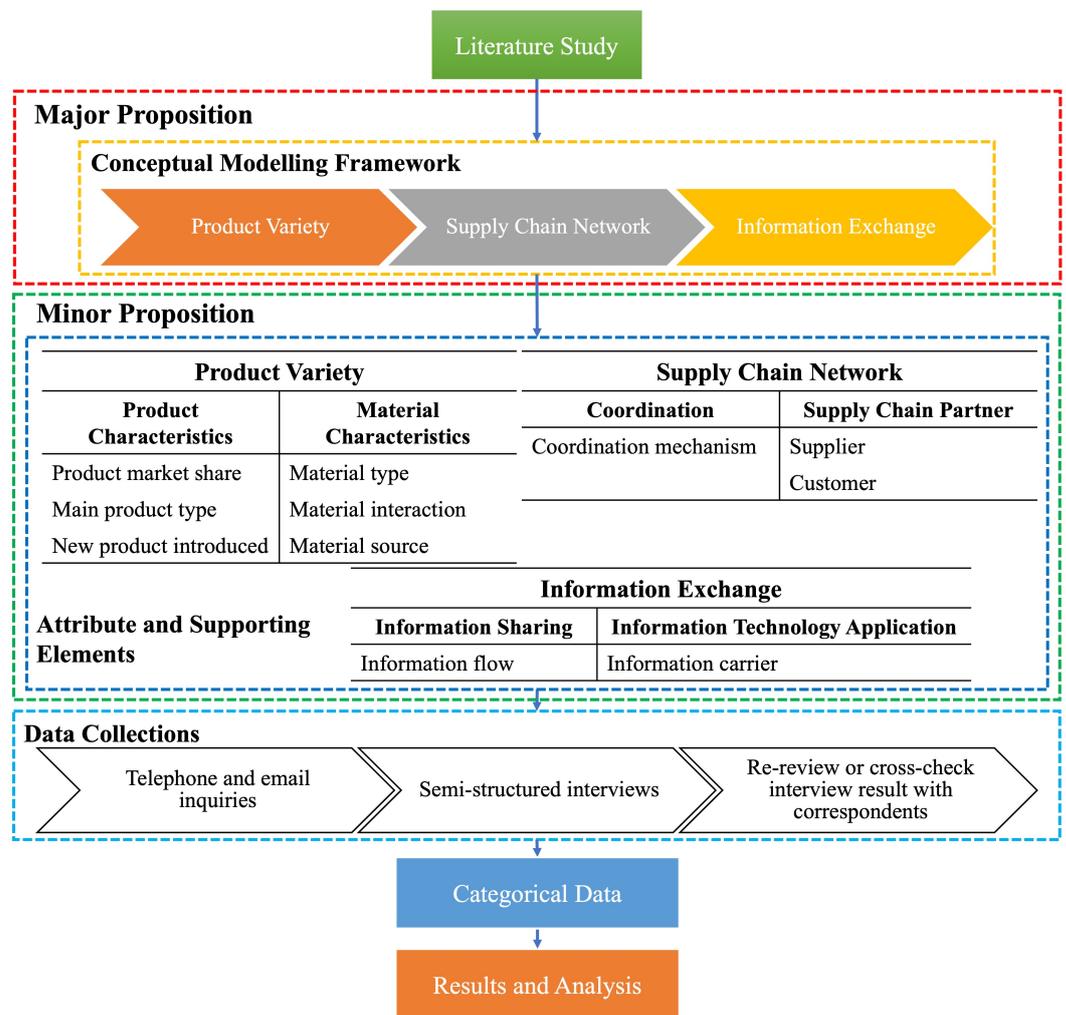
The starting point for our major proposition is to identify the impact of product variety and supply chain networks on the influx of information exchange. We aim to demonstrate that an increase in the number of product varieties owned by a company will affect the supply chain network and information exchange. In other words, we summarize our major proposition as follows:

1. A high degree of product variety correlates with increased supply chain network complexity.
2. A high level of product variety and supply chain complexity is associated with an increased frequency of the influx of information exchange within the supply chain network.

#### Conceptual Modeling Framework

In Table 1, the conceptual modeling framework shown is a comprehensive explanation related to the leading theory used for synthesizing the results of our study [67] and for developing an idea about the problem being studied. It provides a structured way to understand and represent the research topic's relevant key concepts, relationships, and processes. Furthermore, the domain of our conceptual modeling refers to the specific area or subject matter being studied. It is the context in which the conceptual modeling framework is applied to formulate our propositions. Analysis of the correlations of those domains generally aims to describe the situation or condition of our research objective

in general. In this analysis, the information obtained is still in the initial stage, which is only a general description or domain of the studied object. Identifying the domain is recommended to conduct a related analysis connecting categories [39]. Based on previous research [6–8,17,21–23,26,27,33,35,36,57,67,83,84] connected to the effect of product variety in the supply chain network and the influx of information exchange, a conceptual modeling framework is formulated to combine and correlate product variety, supply chain network, and information exchange. This conceptual modeling framework has been summarized in our literature study [67], which both theoretically and empirically shows a strong relationship with information exchange in the supply chain network, particularly in helping companies with their integration related to product variety.



**Figure 1.** This is the process of our case study in multiple industry applications to examine our propositions and reach a well-informed conclusion. Our major propositions start with our literature study [67] to identify the current issue and end with designing the conceptual modeling framework of product variety, supply chain network, and information exchange. Then, our minor proposition is to break each domain down into the attributes and elements to support our interview questions.

**Table 1.** Conceptual modeling framework based on several literature studies and defining attributes for each domain to support the factors.

Domain	Literature Studies	Attributes
Product Variety	[6–8,17,21,22,26,33,35,36,57,83]	Product Characteristics Material Characteristics
Supply Chain Network	[7,8,17,21–24,26,33,35,36,83]	Coordination Supply Chain Partner
Information Exchange	[7,8,17,21–24,26,27,33,36,83,84]	Information Sharing Information Technology Application

### 3.2. Minor Proposition

To support and elaborate on our research questions in the major propositions, we considered these minor propositions alongside the major proposition to gain a more detailed and nuanced understanding of the relationship among product variety, supply chain network, and information exchange. We found that these three domains are closely interrelated and that the minor propositions provide essential insights into which factors influence the flux of information exchange. By carefully considering the minor propositions, we can draw meaningful conclusions from our interview data and discuss the factors influencing the influx of information exchange from the perspective of different industries.

#### 3.2.1. Attribute and Supporting Elements

In creating practical interview questions for a case study, attributes can be a valuable tool because they help to identify the key pieces of information that need to be gathered from correspondents. It is achieved by understanding the definitions of attributes from our literature study [67] and domain analysis. The attributes are derived from domain analysis and represent the research topics. Each attribute has several supporting elements that can help to gain a deeper understanding of the subject before the interview begins. By carefully considering these attributes and their related elements, well-informed and targeted interview questions can be developed, allowing for the extraction of valuable insights.

#### Product Variety Domain

Product variety, or the number and types of products a company offers, is influenced by the complexity of product and material characteristics. Product characteristics refer to the features and attributes of a product that differentiate it from other products, such as the materials used in production, design, appearance, and any special features or functions it possesses [6–8,57]. On the other hand, material characteristics refer to the properties and characteristics of the materials used in producing a product, including material type, material interactions, and material sources [7,8]. The complexity of these characteristics can impact a company's ability to produce a diverse range of products and subsequently affect the overall product variety offered because, when a company makes more products, the materials used in the production process become more complex. As the number of products increases, the company may need to use a broader range of materials to meet its customers' diverse needs and preferences. Additionally, as the company expands its product line, it may need to use materials with more advanced properties or characteristics to meet its products' technical and performance requirements [6,57]. As a result, the complexity of the materials used in the production process increases as the company produces more products. In our minor proposition, we aim to identify and describe the factors that significantly impact fluctuations in the increase of product variety.

#### Supply Chain Network Domain

Establishing a well-organized and systematic supply chain network performing effectively and efficiently is crucial for a company to focus on coordinating and collaborating with supply chain partners [17,26]. Optimizing the performance of the supply chain is

necessary for all members of the chain to work together in a coordinated and collaborative manner. This performance involves coordinating production, transportation, distribution, and sharing information and resources to enhance efficiency and effectiveness throughout the supply chain [17,35]. By prioritizing coordination and collaboration among supply chain partners, a company can create a strategic and systematic supply chain network that is both effective and efficient. In our minor proposition, we seek to analyze the coordination strategies that have the most impact on supporting the success of the supply chain network.

### Information Exchange Domain

In a more complex supply chain collaboration, the information exchange between supply chain partners becomes more difficult [21,22]. Therefore, the role of information technology is to facilitate, communicate, and coordinate the exchange of information within the supply chain network [27,84]. Information technology can help to streamline and optimize the flow of information within the supply chain, enabling more efficient and effective collaboration among supply chain partners. Our minor proposition is to investigate which factors are considered the most influential on the influx of information exchange within the supply chain and the implementation of information technology.

### 3.3. Data Collection

To collect data through an interview in our case study, we follow three main procedures: contacting potential correspondents by phone or email, conducting semi-structured interviews, and reviewing and cross-checking the results. These steps help us gather comprehensive information about our case study and ensure the accuracy of the collected data.

#### 3.3.1. Telephone and Email Inquiry

Both telephone and email inquiries can be valuable methods for collecting data through interviews. Telephone inquiries involve contacting correspondents by phone and asking them to answer interview questions over the phone. In contrast, email inquiries involve sending correspondents an email with a link to an online interview or a set of interview questions they can respond to via email. In our research, we often send interview questions to targeted companies and follow up with phone interviews. Both telephone and email inquiries have strengths and limitations, and carefully considering the method most appropriate for qualitative-based research beforehand is essential.

#### 3.3.2. Semi-Structured Interviews

In our research, we use semi-structured interviews as a method of data collection to gather detailed information about a specific case or phenomenon. These interviews involve semi-structured conversations with the correspondents to understand the topic better. A semi-structured interview allows us to follow a general outline of topics and also allows for flexibility to follow up during the conversation. We often send the interview questions to the correspondents beforehand to give them more time to consider the questions and better understand the topics. Through these interviews, we aim to gather detailed, qualitative data to gain a more nuanced understanding of the experiences and perspectives of the correspondents.

#### 3.3.3. Re-Review or Cross-Checking Interview Results with Correspondents

We re-review or cross-check the interview results with correspondents to ensure the accuracy and completeness of the data we have collected. This process involves reviewing the results of our interviews and comparing them to the responses of the correspondents to verify that the data are accurate and consistent. This procedure may involve following up with correspondents to clarify any confusion or discrepancies during the interview process. By re-reviewing or cross-checking our interview results with the correspondents, we can ensure that we have collected reliable data that accurately reflect the experiences and perspectives of the correspondents.

### 3.4. Categorical Data

After the interview data have been collected, the subsequent process is data categorization. This categorization process aims to extract the maximum amount of information from the correspondents. However, before the data can be categorized, a challenge may arise to standardizing the correspondents' perceptions to categorize the data effectively. This challenge is that correspondents may express similar ideas but with different styles of explanation, which can create confusion when categorizing the data. Additionally, correspondents may have different levels of understanding or expertise in the discussed topic, further complicating the categorization process. To elaborate further, data categorization involves grouping the interview responses into different categories based on their meaning or subject matter similarities. Furthermore, it is important to approach data categorization critically, considering the nuances and complexities of the interview responses, so that we can ensure the resulting categories accurately capture the key themes and ideas expressed by the correspondents, providing a rich source of information for further analysis and interpretation.

Formulating a strategy for categorizing the data can help us visualize and analyze the data for future research when our survey contains rich attributes and perceptions. By categorizing the data, we can identify patterns and trends in the responses, which can help us understand the experiences and perspectives of the correspondents. This strategy can help us better understand the major and minor propositions and identify areas for further investigation. Additionally, visualizing the data in this way can make it easier to communicate our findings and draw meaningful conclusions from the data. Overall, categorizing the results of our interview is a valuable tool for data analysis and visualization to assist in interpreting the results and informing future research.

## 4. Results and Analysis

The results of our interviews provide valuable insights into the various factors influencing the success of a business. We conducted a thorough and detailed experiment to support our major and minor propositions for each domain, including product variety, supply chain network, and information exchange. Based on an inductive analysis used for responses from diverse correspondents, we identified trends and patterns to inform our understanding of these complex and interconnected issues, characterized by [85] as a "series of empirical cases to identify a pattern from which to make a general statement."

Through this process, we provided a more nuanced and comprehensive understanding of how these domains interact and influence one another, ultimately leading to better decision-making and improved business outcomes.

### 4.1. Characteristics of the Correspondents

In our study, we interviewed 49 correspondents from 26 different companies within 3 industries about various characteristics shown in Table 2. Data collection took place from November 2021 to November 2022 in Indonesia. The distribution of company sectors involved in this research includes 59% manufacturing industry, 29% commerce, and 12% service. Those sectors include 75% of make-to-stock (MTS), 19% make-to-order (MTO), and 6% service. Our correspondents in this interview work in various divisions ranging from marketing, engineering, production, to sales. The correspondents were chosen to represent a range of working experiences, from those with 1–6 years in the industry to those with more than 32 years of experience, to gather a diverse range of perspectives on their industry.

**Table 2.** Expert insights: The defining characteristics of the correspondents. In our study, we interviewed 49 correspondents from 26 different companies.

Respondent Characteristics	Freq.	Respondent Characteristics	Freq.	Company Characteristics	Freq.
<b>Gender</b>		<b>Division</b>		<b>Industry sector</b>	
Man	39	Marketing	30	Manufacturing Industry	29
Woman	10	Sales	4	Commerce	14
<b>Age (in years)</b>		Production	3	Service	6
21–30	12	Bakery	2	<b>Production strategies</b>	
31–35	7	IT	2	MTS	37
36–40	7	Administration	1	MTO	9
41≤	23	Business	1	Service	3
<b>Education</b>		Consultant	1	<b>Total employees (in people)</b>	
Bachelor's degree	28	Distributor	1	≤10	9
Senior high school	17	Electric	1	11–20	8
Associate's degree	2	Engineering	1	21–50	4
Master's degree	2	Instructor	1	51–100	3
<b>Working experience (in years)</b>		Fishery	1	101≤	25
1–6	18	<b>Job title</b>		<b>Volume of sales</b>	
7–11	5	Sales	12	≤1000	8
12–16	3	Owner	11	1001–10,000	7
17–21	10	Manager	10	10,001–100,000	8
22–26	6	Staff	6	100,001–1,000,001	3
26–31	5	Supervisor	6	1,000,001≤	23
32≤	2	Director	2		
		Account Officer	1		
		Teacher	1		

#### Correspondent Indicators and Eligibility

To ensure the scientific validity and reliability of data collected to assess a company's readiness for implementing information technology, it is important to carefully consider the criteria for selecting the correspondents. Considering these criteria ensures that the correspondents thoroughly understand the company's business processes and current use of information technology in their companies. Ensuring the correspondents' eligibility is one approach to include individuals with diverse knowledge and understanding of the company's operations. It is also essential to consider the role and responsibilities of the correspondents within the company. Their insights and perspective may be valuable in understanding the potential impact of information technology implementation on their business. By carefully selecting correspondents based on these criteria, it is possible to ensure the scientific validity and reliability of the collected data and use it to assess the company's readiness for information technology implementation accurately.

#### 4.2. Data Visualization and Analysis

This section presents a visual representation of the data gathered from our interviews, organized according to the three domains we focused on: product variety, supply chain network, and information exchange. We then examine the relationships and correlations among these domains and provide a detailed analysis of the important critical factors identified in our research. Through this process, we aim to demonstrate the validity of our minor and major propositions and provide insight into how these factors influence the overall effectiveness of the company's operations.

##### 4.2.1. Product Variety

The definition of product variation is the increasing variety of products the company offers to the public within a particular time. It also can be interpreted as the number of products the company offers to the public with various versions at one point. Product variation also includes activities such as product innovation by the company, including planning the offered product characteristics and the materials used in the production

process. Product and material characteristic attributes are in the domain of product variation. Each attribute has supporting elements to describe the most influential factors in the fluctuations of changes in the product variation domain.

Product Characteristics

Product characteristics refer to the various attributes or features that define a particular product. These characteristics can include aspects such as the product type, performance, design and appearance, intended use, and any additional features or offered benefits. A thorough understanding of their product’s characteristics is essential for companies because it enables them to effectively target and appeal to their market share through marketing and positioning strategies. It also helps them identify opportunities for product innovation and development. Based on the definition of product characteristics, we indicate that three supporting elements—product market share, main product type, and new product introduced—can be used for determining the interview question instrument.

Market share plays a significant role in a company’s business process, which can be achieved by consistently fulfilling customer needs. Based on the results of our interviews shown in Table 3, most companies in the manufacturing industry, service, and commerce sectors focus on individual and industrial market share. This statement applies not only to large companies but also to medium-sized companies. Only a few companies focus solely on individual customers, typically those with limited capacity and scope for whom the individual market is more beneficial. By understanding a company’s market share, we can gain valuable insights into market positioning and strategies for success.

Table 3. Data collected from correspondents based on product characteristics in the product variety domain.

Product Market Share		Main Product Type				New Products Introduced	
Instrument Questions	Freq.	Instrument Questions	Freq.	Instrument Questions	Freq.	Instrument Questions	Freq.
<b>Market share</b>		<b>Main product type</b>		<b>Main product</b>		<b>New products (in years)</b>	
Individual customer	47	FnB	29	Instant noodle	17	≤5	10
Industrial customer	39	TCLF	4	Seasonings	13	6–10	31
		Grocery Store	4	Groceries	6	11≤	8
		Tobacco	3	Tobacco	3	<b>Influenced factor</b>	
		Pulp and Paper	2	Clothing & footwear	2	Price	33
		Bank	1	Leather wallet	2	Advertisement	22
		Consultant	1	Pastry and bakery	2	Product Quality	19
		Daily Newspaper	1	Printing business	2	Taste	12
		Electrical Equipment	1	Restaurant	2	Demand	8
		Material Warehouse	1	Agricultural consumer product	1	Packaging	7
		Tutoring Institution	1	Bank	1	Supply	3
		Wood-Based and Furniture	1	Building Material	1	Competitor	2
		<b>Seasonal production</b>		Consultant service	1	Innovation	2
		No	37	Fish food	1	Time	2
		Yes	12	Fruits & vegetables	1	Efficiency	1
				Furniture	1	Material	1
				Machine	1	Technology	1
				Newspaper	1		
				Tutoring institution	1		

Another strategy that companies often use to gain a larger market share is introducing new products. Companies can benefit from introducing innovations that are well-received by the public and taking over the market from their competitors. Based on our interview results, on average, companies introduce their latest innovations 6–10 times per year. As companies introduce new products yearly, they increasingly focus on understanding their customers’ characteristics to meet their market share’s diverse needs and preferences. In this case, small- and medium-sized enterprises and service companies tend to have a more diversified range of products to suit the preferences of each customer.

There are many considerations for companies when introducing their new product to the public, including seasonal events, which are seen as significant factors in the launch of new products. Previous interviews have indicated that seasonal events do not significantly impact most companies, with a significant difference between the number of companies influenced by seasonal events and those not, especially for fast-moving consumer goods (FMCG) companies, such as the food and beverage (FnB), tobacco, and grocery sectors, where seasonal events do not affect production because these companies continuously produce their products. Besides seasonal events, companies consider many other factors when innovating and introducing new products. Various factors have been identified based on responses from correspondents, such as price, advertisement, product quality, taste, demand, and packaging. According to our interview results, two of the factors chosen by the most prominent companies are price and advertisement. Price is the highest factor taken into consideration by companies when introducing a new product. Advertisement is the second factor to impact the company in introducing its product. In this modern age, advertisement plays a significant role in companies achieving their market share and determining factors in introducing new products. Through various offline and online platforms, companies can learn about current popular trends in public sectors, enabling them to develop new products aligned with current preferences. Through advertisement, companies can also appeal to the entire public for a new product, which is undoubtedly beneficial.

#### Material Characteristics

Material characteristics are essential when selecting materials for a particular product or component. By understanding the material characteristics such as content quality, bill of material, and material dependency, which are essential for a particular application, manufacturers can select the suitable materials to produce their product and guarantee its quality and reliability. In addition, the material procurement process is the main activity serving as the backbone of a company's business process for creating high-quality products and is critical to supporting a company's business operations. A sufficient supply of materials to meet the business's needs is ensured through its implementation. The raw material procurement strategy must be carefully planned, from determining the materials needed to identifying where to obtain them. Based on the importance of materials to support a company's business process, three supporting elements are used to determine the attributes of material characteristics: material type, material interaction, and material source.

Material type includes the material requirements needed to carry out production processes and the importance level of these materials for the companies. As shown in Table 4, FnB ingredients are commonly used by the correspondents with FMCG in their companies. It is important to note that the level of importance of materials for each company is indicated as 100%, which means that all companies, regardless of company type, believe that materials are crucial for the smooth operation of the company's business process.

That statement also aligns with production material dependency as the supporting element in material interactions. According to the production material dependency, all correspondents reported that every material required in the production process has a very high level of interdependence with others. This issue makes the company pay more attention to it because, if any of these materials are not obtained, the company will not be able to carry out its production process, which will negatively impact the operation and sustainability of the business process. Therefore, the correspondents provide alternative strategies to address the problem of dependence on a material. The most frequent strategy used by companies is to maintain the inventory. Maintaining a materials supply in inventory is the safest way to prevent uncertainty about the availability of materials and address lead time-related issues. This strategy is usually used by medium- to large-scale MTS company types, which can store their material supply. However, this strategy requires the company to have sufficient inventory space and capacity to store all the necessary materials, and managing this inventory can also be a challenging problem. The second strategy chosen by the company to overcome dependence on materials is to find alternative

suppliers. For companies with limited storage capacity, this strategy is considered the most suitable for the company, especially if the business conditions are the MTO company type. These companies rarely have material stock, with limited inventory capacity. Therefore, this strategy has a reasonably high level of uncertainty, as the company relies heavily on the supplier. Suppose that the supplier is unable to provide the materials needed by the company; in that case, the production process cannot continue until the company finds an alternative supplier to provide the necessary materials.

**Table 4.** The data collected from correspondents are based on material characteristics in the product variety domain.

Material Type		Material Interactions		Material Source	
Instrument Questions	Freq.	Instrument Questions	Freq.	Instrument Questions	Freq.
<b>Material Importance</b>		<b>Production–Material Dependency</b>		<b>Alternative Suppliers</b>	
Very Important	49	High dependency	49	Fixed	29
<b>Bill of Materials</b>		<b>Dependency Material Solution</b>		Depend on	20
FnB ingredients	26	Keeping stock raw material	19	<b>Raw Material Origins</b>	
Groceries	7	Alternative supplier	15	Domestic	49
Paper	3	Finding best supplier	10	Import	18
People	3	Target fulfillment	3	<b>Supplier Specifications</b>	
Tobacco	3	Production sharing	1	Quality	40
Leather	2	Raw material substitution	1	Price	35
Textile	2			Availability	20
Building material	1			Delivery time	2
Iron	1				
Stainless	1				
Wood-based ingredients	1				

Alternative suppliers providing the source of the materials are closely related to the company's production process. The supporting element of the material source in Table 4 explains the origin of the materials obtained by each correspondent company and alternative suppliers to overcome the problem of the level of dependence on the material. The supplier plays a crucial role in the selection of materials because, as the source of the materials, the company will use them in its production process. The quality and availability of the materials supplied by the supplier can impact the efficiency and effectiveness of the production process. Based on our identification results, the company's suppliers are not only the domestic market. For large-scale companies, most companies mention that the materials obtained are from domestic sources and are imported from diverse countries. To obtain the materials from those sources, these companies must diversify the suppliers' range to ensure a consistent supply. Meanwhile, most medium-sized enterprises prefer to use the domestic market as their source for material supplies. In addition to determining from where the materials are obtained, it is vital for the companies to carefully consider which supplier is the best fit in terms of providing high-quality raw materials for their needs. It has been previously mentioned that finding alternative suppliers is a strategy for addressing issues with reliance on a single source of materials. Most companies also have a fixed supplier to supply the materials needed for production due to establishing a good relationship with the supplier. However, as many as 20 correspondents explained that if they cannot maintain the stock of material in the inventory or obtain the material in the production process, the alternative supplier strategy will be chosen as the best strategy.

The process of selecting a supplier, whether a permanent or alternative, is done to identify the best supplier to fulfill the company's material requirements. There are certain factors to consider in selecting a supplier, including the capacity of goods available, the quality of goods, the consistency of deliveries, and the negotiation of prices offered by the supplier. These factors align with the correspondents' statements about the characteristics of the supplier that the company considers when making a decision, including the supplier's availability, delivery time, price, and quality. In our results, quality is the company's top priority when selecting a supplier. By choosing a supplier providing high-

quality materials, the company can also create high-quality products, allowing it to compete with other companies regarding product quality. The next most frequently considered factor in the selection process is price. Most companies will encounter issues deciding the price of materials because that price will affect the price of the final products offered by these companies. Therefore, price negotiations are necessary to obtain high-quality raw materials at a price within the company's budget. When selecting a supplier, the company should consider the availability and shipping time of the necessary raw materials. These factors relate to lead times, where the certainty of the material availability is essential for the company to carry out its production process on schedule. If the raw materials needed for production are unavailable or there are delays in their delivery, this can cause disruptions in the business process and impact overall sustainability.

#### 4.2.2. Supply Chain Network

The supply chain network is the connecting system of the supply chain flow that builds a connection with the supply chain partner systematically and strategically. It aims to help the company increase its competitive advantage and partner loyalty more effectively and efficiently. To create a supply chain network aligned with the company's business processes, the company needs to consider the coordination of the supply chain network. Coordination between supply chain networks is a determining factor in achieving integration among the supply chain partners involved in the supply chain network to improve supply chain performance. In the domain of supply chain networks, there are coordination and supply chain partner attributes. Each attribute has supporting elements to describe influential factors for supporting the coordination of the supply chain network.

##### Coordination

Coordination is crucial in a supply chain network because it allows the various parts of the supply chain to collaborate efficiently. To facilitate effective and efficient coordination within the supply chain network, companies must ensure certain key factors, including maintaining communication among supply chain partners, managing activities within the supply chain network, and implementing strategies to address any arising issues. Effective coordination of the supply chain network helps to ensure that the different parts of the supply chain operate efficiently and effectively, leading to improved supply chain performance. Companies can enhance supply chain network coordination by focusing on effective communication and collaboration among all parties in the supply chain, proper management of activities within the supply chain, and implementation of strategies to address potential issues.

Furthermore, communication is essential to coordinating a supply chain, so any issues within the supply chain can be resolved more effectively and efficiently. Communication between supply chain networks is not only done through face-to-face interaction but can also be done online using information technology (IT) systems. Most of the correspondents' answers in Table 5 explain that communication between supply chain partners, both upstream and downstream, is done online to save time and is perceived as more effective and efficient. Most companies, especially mass production manufacturers, have implemented enterprise resource planning (ERP) systems to maintain coordination and communication between supply chain partners. Our results show that 24 correspondents provided information on supporting ERP systems to facilitate communication within their supply chain network. However, even though most companies have used systems to support their communication coordination process, companies are not exempt from using traditional communication methods, such as text messaging. Text messaging allows companies to reach their entire supply chain network from upstream to downstream more easily. Several companies, especially micro, small, and medium enterprises (MSMEs), use social media to coordinate their supply chain network, especially with customers. Social media is seen as the most efficient and cost-effective way to reach the company's entire market share. Additionally, many companies continue to use face-to-face or direct communication, likely influenced by the

company's characteristics, and this impacts the coordination and communication process. This communication is perceived by companies, especially MTO and service company types, to be more adaptable and to meet the needs of different customer characteristics.

**Table 5.** Data collected from the correspondents based on the supply chain network domain.

Coordinations		Supply Chain Partner			
Coordination Mechanism		Supplier		Customer	
Instrument Questions	Freq.	Instrument Questions	Freq.	Instrument Questions	Freq.
<b>Coordination Communications</b>		<b>Supplier Distance (km)</b>		<b>Customer Distance (km)</b>	
Application	24	11–100	20	11–100	49
Text message	21	101–1000	35	101–1000	40
Direct coordination	11	1001≤	25	1001≤	35
Social media	10	<b>Supplier Resources</b>		<b>Customer Locations</b>	
<b>Coordination Activities</b>		Local supplier	49	Local customer	49
Inventory management	35	International supplier	10	International customer	25
Price negotiation	30	Offline store	7		
Manage collaboration	25	Company	2		
Product quality	15	Online store	2		
<b>Challenging</b>					
Price agreement	28				
Availability	25				
Distance	15				
New Product	10				
Competitor	7				

There are various activities that companies carry out with their supply chain partners in the coordination process. These activities maintain coordination between supply chain networks and ensure all processes can operate more effectively and efficiently. Based on the interview results, correspondents explain activities in the coordination process, including inventory management, managing collaboration, price negotiation, and product quality. Inventory management involves tracking and managing inventory levels to ensure sufficient materials and products are available to meet demand. In our table, inventory management plays a significant role in the coordination activities conducted by the company based on the answers of 35 correspondents. They explained that the activities of inventory management frequently conducted include communication processes related to the availability of products to meet customer demand and the availability of materials for production processes to suppliers. The next activity of inventory management is price negotiation. Thirty correspondents explained that the price negotiation process is the most challenging in coordinating activities and is considered a core activity by most correspondents from various companies. Price negotiation is a crucial aspect of coordination in a supply chain, as it helps to ensure that the prices for materials and products are fair and reasonable, thereby promoting the efficient and profitable operation of the whole supply chain. The company must confirm that the prices are fair and reasonable while maintaining positive relationships between supply chain partners and ensuring that both parties can compete with competitors requiring expertise and experience. In addition to inventory management and price negotiation, managing collaboration is the most common activity carried out by companies with their supply chain network partners. Out of the correspondents, 25 chose, as the most important to consider, the maintenance of open lines of communication and working closely with the supply chain partner to ensure that all parts of the supply chain were working together effectively. Therefore, the company needs to maintain communication and collaboration activities to ensure that the coordination process between supply chain networks runs optimally and benefits both parties.

Regarding coordination activities in the supply chain, it is impossible to ignore problems that occur. To maximize profits, companies must address and manage these issues effectively. As shown in the Table 5, we can explain that the correspondents, during their work for the company, often encounter various problems related to price agreements, availability, new products, competitors, and distance. As mentioned earlier, many corre-

spondents explain that price agreement is a common problem to be managed. To address this issue, the company must consider a range of strategies while also considering elements such as company profit, market share, competitors, cost of production, customer value, and the relationship with the supplier. Another issue the company needs to pay attention to is the problem of product or material availability, which can significantly impact the production process. Most companies believe that the key to ensuring the business process runs efficiently is providing the availability and quality of materials in the production process. The MTO company type relies heavily on the availability of materials from suppliers to operate efficiently. The limited inventory of materials means that any disruptions in their supply can have severe consequences for the company's operations. The company must have a well thought out strategy to solve the problem of material availability, as explained in the previous section on material characteristics regarding alternative suppliers.

### Supply Chain Partners

In a supply chain network, a supply chain partner is a company or organization that plays a vital role in the supply chain operation. These partners can be connected through various forms of coordination (supplier–customer perspective) and can be involved in many parts and stages of the supply chain. One factor companies must consider when coordinating with supply chain partners is the distance between them. Based on information from our correspondents, the data on their customers and suppliers and the average distance among them are presented in Table 5. Ensuring timely and cost-effective shipping of materials and products to the destination is essential for the company to manage. Managing the distance between supply chain partners can significantly impact the efficiency of the company's operations. In terms of suppliers, companies typically strive to obtain materials from the closest suppliers to minimize transportation costs and delivery times. To minimize transportation costs and shipping times, companies typically seek to obtain materials from local suppliers as much as possible. In this study, all companies reported obtaining materials from local suppliers, which they consider a strategy for reducing shipping costs. Most companies believe that local suppliers offer competitively priced and high-quality raw materials. However, it is common for companies to import raw materials to address shortages or difficulties in obtaining certain materials or to compensate for deficiencies in the availability of materials.

In contrast to the company's strategy to find local suppliers to minimize transportation costs and shipping times, the company may aim to serve customers at a broader range of distances to increase customer satisfaction and loyalty. By expanding its customer base, the companies can potentially increase their profits. This is reflected in the fact that the average distance between the company and its customers is generally higher than the average distance between the company and its suppliers. Substantial companies may also serve international markets, whereas other companies report that their customers are located within and outside the country.

### 4.2.3. Information Exchange

Information exchange in the supply chain network refers to the communication and sharing of data and information among the various entities involved in the supply chain network. The goal of information exchange is to improve the performance of the supply chain network by providing real-time visibility and transparent information about products, materials, shipping, delivery time, and other information for each supply chain partner. Information technology (IT) implementation can be the best alternative to facilitate the exchange between partners in the supply chain network. IT implementation in a supply chain refers to using various IT systems and tools to facilitate communication and coordination among the different parts of the supply chain. It can help improve supply chain integration by providing real-time information to improve the accuracy of information exchange and increase customer satisfaction and profitability. The information exchange domain contains information sharing and IT application attributes. Each attribute has supporting

elements to describe in detail the type of information often exchanged between companies and suppliers or customers, along with information related to IT implementation by the company.

### Information Sharing

Information sharing in the supply chain refers to exchanging information among the various parts of the supply chain. Effective information sharing is essential to coordinate a supply chain and ensure efficiency. According to our results in Table 6, all companies believe that information exchange is the most critical factor significantly affecting the company's business process. By maintaining coordination and collaboration in the information exchange between the company and the supply chain partners, the company can avoid losses due to miscommunication between suppliers and customers. The intensity of information exchange can also be a considered factor, especially with increasing complexity of the supply chain network conditions and expanding product varieties. The intensity of information exchange at the company can be used as a reference for the complex supply chain network. The company needs to identify the level of information exchange to optimize its intensity. According to the interview results, 34 correspondents reported that their company engages in high levels of information exchange, especially for medium-sized to large enterprises, having various branches of supply chain networks to manage. MTO company types typically encounter more complex information exchange activities than MTS company types. This is because MTO company types must tailor their products to meet the individualized demand of their customers, requiring more extensive information exchange in their business processes.

**Table 6.** Data collected from correspondents based on the information exchange domain.

Information Sharing		Information Technology Application	
Information Flow		Information Carrier	
Instrument Questions	Freq.	Instrument Questions	Freq.
<b>Information Exchanges</b>		<b>IT Applications</b>	
Important	49	Social media	49
<b>Information Exchange Intensity</b>		ERP	25
High intensity	34	<b>Real-time Accessibility</b>	
Depends	15	No	27
<b>Information exchange on suppliers</b>		Yes	22
Availability of material	43	<b>IT Implementation Factors</b>	
Price	41	Information exchange	46
Material specification	25	Digital technology	37
Delivery schedule	20	Coordination	28
Program promotion	17	Market share	18
<b>Information Exchange on Customers</b>		<b>IT Implementation Impact</b>	
Price	45	Expanding market share	48
Product availability	42	Effectiveness and efficiency	46
Product specification	35	Increasing profitability	35
Program promotion	19	Flexibility	20
Delivery schedule	18		
New product	10		

By discussing further factors related to the information exchange between companies and supply chain partners, the importance levels of the information type are often exchanged between companies and supply chain partners. From the supplier's side, the exchange of information plays a crucial role in the company sustaining business processes related to the operation of materials procurement. By maintaining the information exchange between the company and the supplier, the company can establish a long-term relationship and create a more effective and efficient material procurement process. Based on data provided by correspondents related to this information exchange, the essential information to be exchanged is related to the availability and price of materials. The availability of materials is the first information that will be exchanged among them. The company will plan material requirements to process the material procurement for production planning.

If all components of the material have been set, the company will contact the suppliers to ensure the availability of the materials. However, if the material is unavailable from the first supplier, the company must identify an alternative supplier from which to obtain the material requirements. Therefore, the exchange of information related to the availability of materials is crucially considered by companies, especially the MTO company types, heavily depending on the availability of materials from suppliers to carry out the scheduled production process. In the following process, the company will negotiate the price for each material to be purchased if all the materials are available from the supplier. The exchange of information in reaching an agreement on the price of materials between the two parties includes the terms and conditions of the material to be purchased. The information exchange on price agreements aims to establish a clear understanding of the terms and conditions under which materials will be purchased and to ensure that the company and supplier align with these terms. The company usually asks for the supplier's promotion program to support the price negotiation process. Our result mentions that several correspondents also state the promotion program affects the determination of the price of the material to be purchased.

Regarding the information exchange on negotiating material prices with suppliers, the material procurement terms and conditions are also related to the specification of the material to be purchased by the company. The majority of correspondents consider the need to communicate clearly the material specifications. The information exchange regarding the material specifications in the material procurement process includes the information exchange of the detailed description of the characteristics of the materials being procured. The process of exchanging information about the material specifications in the procurement process aims to ensure that the material being procured meets the company's material requirement planning in the production process and that the quality of the material will perform as expected. For companies with non-permanent suppliers, information related to material specification is crucial to verify that the received material conforms to the agreement. Therefore, many companies avoid alternative suppliers because they have established trust in the supplier, avoiding failures in the terms and conditions.

After negotiating the price and specifications of the material, the next step in the information exchange between the company and the supplier is coordinating the schedule for delivering the materials. The information exchange on the delivery schedule includes the planned delivery dates of the previously purchased material. Coordination of the information exchange related to the delivery schedule is crucial for ensuring all previously purchased materials are delivered to the company on time. The delivery schedule will significantly affect the production process schedule to be carried out by the company, where any problems with the delivery will obstruct the production process and cause losses.

In the supply chain network, the customer is considered a key stakeholder, as the customer's requirements and preferences influence the demand for products and services. Supply chain partners may work together to develop and implement strategies to meet the needs and preferences of the customer, such as offering a wide range of products or services, providing high-quality products, and ensuring timely delivery. Based on the previous explanation, it is essential for the company to always coordinate and collaborate with its customers to ensure that the company has met the customers' demands and achieved the expected level of customer satisfaction. Much information is exchanged in the coordination and collaboration to meet the customer's desires. The information most frequently exchanged among them based on our table relates to price, product availability, product specification, delivery schedule, promotion program, and new products introduced.

The company plays the critical role of a supplier offering its products to the customer, while the customer will request the product from the company. The first step in the information exchange involves the customer inquiring about the product's availability. Each company may have different conditions for this process. The MTS company type will check the availability of the products in the inventory. Meanwhile, this company will record product orders to forecast and plan the material procurement and production process. The

company will then provide product specifications to the customer. This process includes all detailed information about the product to be ordered by the customer. Its company type will provide information about the products in stock in terms of fixed and readily available. In contrast, the MTO company types will provide general product information and allow customers to customize their orders. Therefore, exchanging information in the order fulfillment process is crucial for the MTO company types because these companies must always align the production process with each customer's specific order.

Once the entire information exchange process regarding availability and specifications is complete, the next process is to negotiate the product price. Based on our data, most companies have applied a fixed price system for each product. However, it is common for companies to negotiate prices, such as offering different prices for new products, products with specific specifications, or purchases of a certain quantity. Substantial companies will frequently give promotional programs to customers with terms and conditions, such as customer loyalty level and achievement of sales targets for retailers. The next step in the information exchange involves coordinating the product's delivery schedule. This process is relevant for companies delivering products directly to their customers. This information is essential for coordinating the logistics and distribution of products and ensuring they are delivered to customers on time.

Based on the opinion of correspondents, it is essential to maintain coordination of the information exchange between the company, suppliers, and customers to ensure all business processes operate more effectively and efficiently, especially for manufacture-type companies where the production process is dependent on the reliability of their suppliers and customers. The production process depends on the supplier, and the sales order process also highly depends on the customer. In addition, commercial companies significantly depend on suppliers and customers to distribute their products to carry out the business process. Therefore, maintaining coordination of the information exchange with suppliers and customers plays an essential role in managing the effective and efficient upstream and downstream integration of the supply chain.

#### Information Technology Application

IT implementation in the supply chain is a business strategy to help companies improve the productivity of their business processes. IT can be an alternative solution to help companies achieve the success of supply chain integration and support them in more effective and efficient decision-making processes. To share information between companies and their supply chain partners, IT provides ways to address the rapid flow of information exchange between supply chain networks. Implementing IT in a company is also considered in order to improve the quality, effectiveness, and efficiency of the information received by each supply chain partner. According to the data regarding IT implementation in companies, Table 6 shows that most companies understand the role of IT in assisting their business processes. However, only a few large companies have fully implemented ERP systems to support their business processes. Companies that have integrated ERP systems into their business processes report that all data are centralized and can be accessed in real time. On the other hand, several companies, especially MSMEs, use online social media to support the information exchange between the company and suppliers or customers. For MSMEs, the company uses online social media as an affordable intermediary for exchanging basic information, such as text messages and telephone calls, with its supply chain partners. However, the data owned by the company are not immediately accessible, and more effort, such as traditional methods, is required to exchange this information.

All companies believe that the fundamental factor of IT implementation is facilitating the exchange of information with supply chain partners. According to the results, all companies mention that the main factor for IT implementation is facilitating the exchange of information between the company and the supply chain network partners. The importance of IT in the information exchange will affect the coordination and collaboration process in creating a more effective and efficient supply chain integration. By creating more effective and efficient

coordination conditions, every company's business process related to supply chain partners, such as procurement, production, sales, and distribution, can operate optimally.

Digital technology is the next factor for IT implementation in a company currently rapidly developing in society. The company must stay current with technological developments to compete with competitors and increase market share. One example of implementing digital technology for a company is expanding market share through social media advertising. Social media advertising is a digital marketing strategy to promote products or services to customers through social media platforms. The company can achieve more valuable profits by implementing digital technology, especially social media advertising. This is because advertising through social media tends to have relatively lower costs than traditional media advertising. In addition, the company can increase engagement and brand awareness, so many customers are interested, and it is easier to remember and recognize the products offered.

Many factors are generally not mentioned in correspondence related to the IT implementation in a company, such as the company type and business condition. However, this information is implicitly known if it is related to the characteristics of the company shown in Table 2. The MTS company type will have different IT implementation demand than the MTO company type. The scale of the company, especially in the MSME company, has a considerable influence on IT implementation. The company's information exchange also differs based on each company's characteristics. The information exchange in the MTO company type will be much more intense than in the MTS company type. A larger-scale company will also exchange more complex information compared to an MSME. All conditions must be balanced to meet the need for IT implementation genuinely suitable to the company to support its business processes.

## 5. Conclusions and Discussion

The main focus of this paper is to shed light on the interconnection between product variety, supply chain networks, and the influx of information exchange. Specifically, we state that increased product variety within a supply chain can lead to increased complexity within the supply chain network and the influx of information exchange. In this section, we summarize our findings from major and minor propositions to add knowledge about the correlation between product variety and supply chain networks on the influx of information exchange. Our first major proposition investigates the correlation between product variety in Section 4.2.1 and supply chain networks in Section 4.2.2. From those sections, we state that high product variety correlates with increased supply chain network complexity. In the context of a supply chain network, the level of the supply chain network is referred to as the position of the different components within the chain. These components can be divided into two broad categories: upstream and downstream. Upstream components refer to the source of the material (suppliers), and downstream components refer to the end stage of the supply chain (customers).

From the downstream supply chain perspective, increasing the number of product variations in "Product Characteristics" (main product type, new product introduced, and market share) may affect the broader market share coverage of the company in "Supply Chain Partner" (customer). Our findings reveal that the broader the market share coverage of the company and the further the distance between the company and the customer, the more complex the product distribution process becomes. In our interview data shown in "Product Characteristics", some companies serve not only individuals but also industrial customers. The company has to manage and supply its products to distributors, resellers, wholesalers, or end customers to ensure they appropriately distribute products. Most companies supply the customer demand domestically and internationally to broaden their market share coverage to increase profits and customer loyalty, as shown in "Supply Chain Partner". Derived from our findings, new product introduction influences not only individual customers but also industrial customers. There is interdependence among the company, industrial customers, and individual customers for introducing innovative

products. Individual customers significantly influence product marketing, societal trends, and customer demand, which may influence the level of industrial customers. Based on our correspondents in “Product Characteristics”, companies consider several factors influencing the production of new products, such as price, advertisement, product quality, trend, packaging, innovation, and technology. These processes may increase the complexity of the supply chain because the more complex the customer demand for a new product, the more information exchange is needed to meet all demands. In addition, the increasing demand for products may influence the material required to produce the finished product and material procurement to supply the material, where this process is related to the upstream supply chain (supplier).

In the upstream supply chain context, as a company’s product variety and new product innovation increase, the bill of materials and the interdependency between the materials will also increase. Our minor propositions show that the attributes affecting the upstream supply chain are in the “Product Characteristics” (main product type and new product introduced), “Material Characteristics” (material type, material interactions, and material source), and “Supply Chain Partner” (supplier), where the higher the material required to produce finished products, the more complex the supply chain network. We confirm that the company must develop more effective and efficient resource planning strategies to meet its high demand for raw materials, analyzed in “Material Characteristics” (material interactions and material source), where it uses various strategies to fulfill its high demand. Adopting the correspondents’ opinion, keeping stock of materials is considered the most effective strategy for maintaining material requirements in production. However, we found that this strategy has drawbacks, such as the product’s shelf life and storage capacity. To address the aforementioned problem, derived from our findings, alternative supplier strategies and finding the best supplier play a significant role in the material procurement process, when the company not only relies on fixed suppliers but also has various domestic and international alternative suppliers to fulfill its raw material requirement. However, based on our interview data, this strategy has a limitation: if the company has never transacted with the supplier, there is no established trust between the supplier and the company. Therefore, the company should consider several basic specifications in selecting suppliers, such as quality, price, availability, and delivery time based on our interview data in “Material Characteristics”.

In summary, the influential factor shown in “Product Characteristics” (main product type and new product introduced), “Material Characteristics” (material type, material interactions, and material source) and “Supply Chain Partner” (supplier and customer) reveals that product variety affects the complexity of the supply chain network, both upstream and downstream. Based on our findings, the upstream supply chain is related to the high number of suppliers the company manages to find to meet the demand for raw materials, while the downstream supply chain relates to the distribution of products to customers that the company must manage. With the increasing number of suppliers and customers that the company has, the number of tiers in the supply chain network will become more complex. The high level of complexity in the supply chain network may influence an increased frequency of information exchange between the company and its supply chain partners.

On the other hand, our second major proposition states that a high level of product variety and supply chain complexity is associated with an increased frequency of information exchange (Section 4.2.3) within the supply chain network (Section 4.2.2). To effectively address the increased complexity of the supply chain network and the intensity of information exchange resulting from an expansion in the variety of products, the company must coordinate and manage a diverse range of products and materials, a significant number of suppliers, customers, and other partners within the supply chain, and an increased intensity of information exchange through careful planning and management.

In the context of coordination of our previous minor proposition in “Coordination” (coordination mechanism), several factors influence the integration of coordination among

supply chain partners, including coordination mechanisms correlated with coordination communications, activities, and challenges. In addition, derived from our findings, we found that the coordination process cannot be separated from the cooperation between companies and their supply chain partners. Based on our minor propositions in “Supply Chain Partner” (supplier and customers), adopting the correspondents’ perspective, supply chain partners play a significant role in the sustainability of a company’s business processes in the supply chain network. These factors (“Coordination” and “Supply Chain Partner”) must work together to create a more effective and efficient supply chain network coordination. To ensure that coordination and collaboration processes can run more effectively and efficiently, the companies should manage their information exchange between companies and supply chain partners. Our findings reveal that information exchange within a company and among supply chain partners plays a crucial factor affecting the company’s business processes, explained in “Information Sharing” (information flow). From the supplier perspective, information exchange focuses on coordination related to material procurements used in the production process. Meanwhile, from the customer perspective, information exchange relates to product demand, marketing, and distribution.

In the explanation for our second major proposition and the domain in the minor proposition in Section 4.2.2 (coordination and supply chain partner and Section 4.2.3 (information sharing), we found that a high level of product variety and supply chain network complexity affect the influx of information exchange between supply chain partners. Derived from our findings, with the increasing product variety offered by the company, the number of suppliers and customers that must be managed also increases, resulting in a more complex supply chain network. In a more complex supply chain network, the information exchange between the company and its supply chain partners will also increase. It is essential for companies to manage information exchange between supply chain partners (suppliers and customers) to support the success of coordination and collaboration processes in the supply chain network based on our recommendation.

Managing the complexity of the supply chain network and the high intensity of information exchange within the company may involve using advanced IT systems. IT systems provide a facility to communicate, coordinate, carefully plan, and manage the supply chain network. While increasing product variety can expand product marketing and enable access to new markets, it is essential to consider the potential impact on supply chain complexity and the need for improved coordination. Our findings reveal that the design of the supply chain network can significantly impact the efficiency and effectiveness of information technology exchange within the supply chain. The various elements of the supply chain that are connected and interact with each other can significantly influence the ability to exchange information. Various factors related to implementing information technology in “Information Technology Application” (information carrier) must be considered to achieve the success of supply chain network integration. Derived from our findings, optimally designed information technology can facilitate more efficient and effective communication and coordination within the supply chain and business process, expanding market share, increasing profitability, and improving overall performance.

## 6. Implications

This section explains the theoretical and managerial implications to speculate how our findings can potentially impact future research and to provide evidence from our paper, respectively.

### 6.1. Theoretical Implications

The primary objective of this research paper is to investigate the impact of product variety and supply chain networks on the influx of information exchange. Several studies [7,8,28,33–35] have acknowledged the importance of information exchange in supply chain networks and have focused on the relationship between product variety and supply chain networks. However, this paper explores the impact of both factors on the flow of information exchange. Unlike previous studies [21–24,26], which have primarily examined

information exchange in theory and practical application, this research paper provides a more comprehensive understanding of the impact of product variety and supply chain networks on information exchange by adopting a perspective encompassing the issue's industry and information technology aspects. This research distinguishes itself from previous studies that have not provided such a holistic view. Our research attempts to fill this gap by providing a more comprehensive and nuanced understanding of the relationships among product variety, supply chain networks, and information exchange.

From a qualitative research perspective, previous studies used qualitative methods with semi-structured and in-depth interviews by following reports for each correspondent's opinions using an inductive analysis approach [46–49]. This study proposed a technique for combining semi-structured interviews and an inductive analysis approach with data categorization processes and coherently summarizing the overall interview results to facilitate a detailed analysis. Categorizing the interview data based on qualitative research is essential when the interview data are more diverse. As a result, we obtained suggestions that can be categorized generally regarding the factors influencing the relationship between product variety and supply chain network regarding the influx of information exchange. Therefore, this research can provide a different perspective to understand the diverse data.

### *6.2. Managerial Implications*

With respect to managerial implications, our findings may suggest exciting implications from industry perspectives for two reasons. First, our paper can be used as input to identify the impact of product variation and company supply chains on information exchange among supply chain partners, which can affect the business process performance of the company. Based on the analysis results through a qualitative case-based study approach, several indicators were obtained that can be used to measure the level of information exchange occurring between companies and their supply chain network partners.

This research involves interviews from 49 correspondents from 26 companies in 3 different industries, which gather diverse business conditions to accommodate the diverse possibilities of significant impacts on company characteristics in IT implementation. IT implementation should consider several indicators following our major and minor propositions. Referring to our findings, diverse companies have a similar perspective regarding the significant influence of product variety and supply chain networks on information sharing between companies and supply chain partners. Therefore, IT implementation plays an essential role in accommodating the coordination process. Furthermore, another factor that companies need to consider in IT implementation is the company's business conditions. Business conditions significantly influence the information technology implementation process [21,26,71]. Based on our findings, most large-scale companies have implemented ERP systems to support their business and coordination process with their supply chain partners. In contrast, MSMEs only use information technology, such as online social media, to exchange information with suppliers and customers. This information can be used as a basis for the company to measure the level of its information technology needs and to align its business conditions before implementing information technology to minimize the failure rate in IT implementation.

The second implication of our finding is that IT implementation in the supply chain not only employs collaboration and coordination among supply chain partners but also plays an essential role in the digital marketing process. Digital marketing significantly impacts marketing products, or services companies offer to reach all customers in various regions. Additionally, with the increasing use of social media recently, companies can utilize the influence of social media to understand the current trends and conditions of society. Trends are a significant factor in developing innovative new products or services companies offer. Therefore, digital marketing is critical for companies to increase the opportunities for product innovation by utilizing digital marketing. However, companies also need to be more careful in determining the new products they offer to manage the complexity of their supply chain network more effectively and efficiently.

## 7. Limitations and Future Work

While we cannot give specific suggestions as to what IT solutions would be most appropriate for a particular company, we can provide an overview of the benefits of IT implementation from the perspective of our correspondents. For example, if a company has a particular set of characteristics and business conditions, we can identify the IT solutions that similar companies have successfully implemented. We have not discussed the results of all supporting elements in this research and have only included the ones most commonly mentioned by our correspondents.

Conducting quantitative research is essential for gaining a deep and comprehensive understanding of the correlation level among product variety, supply chain networks, and the influx of information exchange. This research involves collecting and analyzing numerical data, allowing for a more precise and objective understanding of the relationships among these domains. One of the key benefits of quantitative research is the ability to draw statistically significant conclusions based on the data collected from correspondents. By analyzing these data, we can accurately determine the strength and direction of the correlations among the three domains. This level of understanding is crucial for making informed decisions and effectively addressing any arising issues. In addition, quantitative research allows for advanced statistical techniques, such as regression and multivariate analysis, to further explore the relationships between the three domains. By analyzing the result between a case study and quantitative research, we can better understand the influential factors on product variety, supply chain networks, and the influx of information exchange.

Simulating our findings is another crucial step to understanding the correlation between those domains. This process involves creating a virtual model of the interactions among supply chain partners, allowing us to observe and analyze the simulation results in a controlled environment. One of the key benefits of simulation is the ability to test different scenarios by changing the level of the factors to see how they impact supply chain partners to identify the influential factors quickly. By manipulating the variables for each factor in the simulation, we can gain valuable insight into how the correlation may change under different conditions.

In conclusion, for future work, we can measure a company's readiness for IT implementation from the perspective of product variety, supply chain, and the influx of information exchange based on the collected data from both qualitative and quantitative sources and based on simulations. Using these data, we can also provide an opinion or suggestion on the technology most suitable for the company's current business conditions. It is important to consider the business's current and future needs when determining the most appropriate technology solution. This can involve assessing factors such as the complexity of the company's operations, the level of integration required with existing systems, and the resources and capabilities available to implement and maintain the technology. By carefully evaluating these and other factors, we can help the company make informed decisions about the technology that best supports its business process and objectives.

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