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Exploring how Industry 4.0 technology affects the buyer-supplier relationship in the Peruvian context

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To my beloved family and Fiorella. You have been my fundamental pillar and most significant source of unconditional support throughout this research process.

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RESUMEN

Esta tesis presenta una exploración de cómo las tecnologías de la industria 4.0 afectan las relaciones entre compradores y proveedores en el contexto peruano. Para ello, se utilizó un enfoque empírico de investigación cualitativa y un diseño de estudio de casos múltiples, seleccionando cuatro empresas peruanas de diferentes sectores como casos de estudio. Para obtener la información requerida para el análisis, los datos fueron recopilados mediante entrevistas semiestructuradas y se realizó un análisis cualitativo para identificar patrones. Luego del análisis, los hallazgos revelan que las tecnologías de la industria 4.0 tienen un impacto en aspectos clave de la relación entre compradores y proveedores, como la confianza, cooperación y colaboración, comunicación e intercambio de información, y duración de las relaciones.

Aunque existen limitaciones en términos del tamaño de la muestra y el enfoque de la investigación desde la perspectiva del comprador, este estudio sienta las bases para futuras investigaciones en este campo poco explorado en un contexto en desarrollo como el peruano.

Palabras clave: Industria 4.0, Relación Comprador-Proveedor, país en desarrollo.

ABSTRACT

This thesis explores how Industry 4.0 technologies affect buyer-supplier relationships in the Peruvian context. An empirical qualitative research approach and a multiple-case design were employed, selecting four Peruvian companies from different sectors as case studies. Data was collected through semi-structured interviews, and a qualitative analysis was conducted to identify patterns. The findings reveal that Industry 4.0 technologies impact key aspects of buyer-supplier relationships, including trust, cooperation and collaboration, communication and information sharing, and relationship duration.

Despite limitations in sample size and the buyer-focused research approach, this study lays the groundwork for future investigations in this underexplored field within a developing country like Peru.

Keywords: Industry 4.0, Buyer-Supplier Relationship, developing country.

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INTRODUCTION

Topic Description

Industry 4.0 can be attributed to the fourth industrial revolution if we define it from its historical dimension (Hoyer et al., 2020). This means that, according to the definition of the industrial revolution from the Cambridge Dictionary Online (2022), in the context of Industry 4.0, we will experience periods of significant changes in various sectors of industry and society, thanks to new technologies and their applications, just as previous revolutions did with the steam engine, electricity for mass production, and automation (Liao et al., 2017).

The term "Industry 4.0" was first mentioned in Germany at the Hannover Messe Fair in 2011. According to Rauch and Matt (2021), it was not until 2015 that the first initiatives and national plans (mostly linked to financial support or tax relief) for implementing and introducing the concept in industrial practice emerged, especially in Europe. At the same time, competence centers and research laboratories for the transfer of advanced technologies from research to practice have also been established. Since then, there has been a clear trend where academics, companies, and governments have recognized the high potential of this concept. They view Industry 4.0 and its related technologies as potentially disruptive and beneficial for generating profit (Caiado et al., 2022; Mohamed, 2018; Sony et al., 2021).

From the government's perspective, some of them have created political-economic strategies in response to this phenomenon. This is the case for developed countries such as France, with "La Nouvelle France Industrielle," the United States (US) with the "Advanced Manufacturing Partnership," the United Kingdom (UK) with the "Future of Manufacturing," Sweden with "Smart Industry," Japan with the "Super Smart Society," and European countries with "Factories of the Future" (Jamwal et al., 2021; Liao et al., 2017). These initiatives promote technologies and mechanisms in different ways to enhance the competitiveness of each country.

On the side of emerging countries, some of them have implemented political programs to promote technologies and created roadmaps to take advantage of the implications of this phenomenon. An example of this is the program designed by Brazil called "Rumo à Indústria 4.0," which aimed to disseminate the concept and technologies related to Industry 4.0 to industries. It also aimed to assess Brazilian companies' maturity level to define a more appropriate roadmap for achieving projects and actions that enable Industry 4.0 technologies. Mexico is another example, as it has launched government initiatives to raise awareness and accelerate the adoption of digital technologies (Cortés et al., 2017). From Asian countries, it is not surprising that the Chinese

government has been making efforts to achieve technological independence and autonomy (Agarwala & Chaudhary, 2021). In fact, as early as 2015, Prime Minister Li Keqiang launched the "Made in China 2025" strategy in response to the Industry 4.0 concept and the global reindustrialization trend (Li, 2018).

Regarding developing countries, Colombia has also made efforts to understand the impact of information and communications technologies. It has implemented a national development plan called "Pacto por Colombia, Pacto por la equidad," which includes several aspects directly related to the digitalization of the economy and Industry 4.0.

In the Peruvian case, there have been government efforts related to Industry 4.0 in recent years. An example is the national plan called “Plan Nacional de Competitividad y Productividad 2019 – 2030”, which aims to develop capabilities for innovation, technology adoption, and transfer. There is also a law “Law No. 30309 - ley que promueve la investigación Científica, Desarrollo tecnológico e Innovación tecnológica” and its modifications, which promote scientific research, technological development, and technological innovation. Additionally, other science, technology, and innovation programs provide funding and support to entrepreneurs, scientists, and businesses. All these efforts reflect the recognition of the importance of digital transformation and the adoption of advanced technologies for the country's economic development and competitiveness. However, despite these efforts, when combined with economic and social problems and political instability in the country, they are insufficient to integrate Industry 4.0 technologies in businesses and, therefore, to fully embrace Industry 4.0 in Peru (Huang et al., 2019).

Moving towards the academic aspect, there is also much to be said in this regard. Research interest in Industry 4.0 and its related technologies has grown in recent years. As highlighted by Ghobakhloo et al. (2021), the number of publications written in English on Industry 4.0 has been steadily increasing, doubling each year since 2016. The authors categorized the articles based on their main topics and the geographic distribution of contributing authors and publications, among other factors. The investigation revealed that Germany, Italy, the UK, India, and the US are the nations with the highest number of publications, followed by China, Brazil, and Spain. They also concluded that there is a growing interest in shifting the focus of research from defining Industry 4.0 and understanding the concept primarily from the perspective of manufacturing to understanding it from the perspective of value chain digitalization.

Delving into the theoretical implications of Industry 4.0, the impact of Industry 4.0 and its related technologies on various aspects of engineering management within companies has been studied. These include production and maintenance management (Fasuludeen Kunju et al., 2022; Koh et

al., 2019), supply chain management (Ghadge, Er Kara, et al., 2020), project management (Kanski & Pizon, 2023), organizational processes (Fettig et al., 2018), environmental sustainability (Oláh et al., 2020), and innovation (Sarbu, 2022). Particularly in the field of supply chain management, much research has been conducted on the topic (Majiwala & Kant, 2023). However, one particular area that drew the attention of J. W. Veile et al. (2020) is the existence of a research gap from a Buyer-Supplier Relationship point of view. In other words, how Buyer-Supplier Relationship is characterized in an Industry 4.0 context (J. M. Veile et al., 2020) is unknown. The term Buyer-Supplier Relationship refers to the cooperative inter-organizational dyadic relationship designed to leverage strategic and operational capabilities to achieve benefits for each party, such as enhancing supply chain synchronization, reducing total costs, improving quality and cycle time, and strengthening overall competitive position (Monczka et al., 1998; Vanpoucke et al., 2014; J. W. Veile et al., 2020).

Throughout this research, it has been concluded that there is literature investigating the Buyer-Supplier Relationship and Industry 4.0 separately, as well as the technologies of Industry 4.0 and the Buyer-Supplier Relationship. However, there is no research conducted specifically in Peru, as it has mainly been conducted in developed countries. Therefore, the results found in studies conducted in developed countries may not be directly comparable or applicable to the context of developing countries like Peru. This is due to the specific characteristics of emerging countries, including institutional and financial barriers, divergent policies, and distinct economic goals (Bogoviz et al., 2019; Erboz et al., 2022; Raj et al., 2020; Treviño-Elizondo & García-Reyes, 2020).

Problem statement

The existing literature on buyer-supplier relationships and Industry 4.0 has primarily focused on studies conducted in developed countries, neglecting the specific context of Latin America. Therefore, the applicability and comparability of the findings from these studies to the Peruvian context, which is characterized by institutional and financial barriers, divergent policies, and distinct economic goals, are uncertain. This research gap creates a need to investigate the relationships between buyer-supplier relationships and Industry 4.0 technologies within the Peruvian context. To address this gap, this study aims to answer the following research question:

RQ. How does the implementation of Industry 4.0 technologies affect the buyer-supplier relationship in the Peruvian context?

The selection of the approach and perspective is a crucial decision in research as it can greatly impact the study's findings and conclusions. That being said, in this particular study, the focus

will be on the role of buyers. Analyzing from the buyer's perspective is important because it contributes to understanding how industry 4.0 technologies have affected the buyer-supplier relationship. It also helps to understand why the relationships between buyers and suppliers have changed after implementing Industry 4.0 technologies. On the other hand, buyers play a critical role in shaping the supply chain as they are responsible for sourcing and procuring goods and services from suppliers. Furthermore, buyers often lead the adoption of advanced technologies, giving them a stronger position and greater influence in this dyadic relationship (J. W. Veile et al., 2020). Finally, analyzing the buyer's perspective can provide insights into these relationships' emotional and relational aspects, which are crucial for building trust and facilitating effective collaboration between buyers and suppliers (Morsy, 2017).

Objectives

This thesis aims to explore how Industry 4.0 technology affects buyer-supplier relationships in Peruvian companies. The specific objectives are as follows:

- Conduct a theoretical study on the buyer-supplier relationship and Industry 4.0.
- Identify the characteristics of the buyer-supplier relationship applied to Industry 4.0.

Propositions

Four propositions will be examined to assess the characteristics of the Buyer-Supplier Relationship after the implementation of Industry 4.0 technologies.

Proposition 1: Cooperation and collaboration between buyers and suppliers are reinforced after the implementation of Industry 4.0 technologies.

Proposition 2: Communication and information exchange between buyers and suppliers become more frequent after the implementation of Industry 4.0 technologies.

Proposition 3: The desire for long-term relationships between buyers and suppliers increases after the implementation of Industry 4.0 technologies.

Proposition 4: Trust between buyers and suppliers is strengthened after the implementation of Industry 4.0 technologies.

Methods Used and Instruments

The following methods and instruments are used in this study:

- The methodology of this study adopts a qualitative research approach in combination with a multiple-case design to explore the effects on the Buyer-Supplier Relationship after the implementation of Industry 4.0 technologies in Peruvian companies. Qualitative research is chosen because it allows for an in-depth understanding of the phenomenon and the meanings individuals attribute to it. The research question necessitates new exploratory research due to limited prior studies in the Peruvian context. The qualitative approach enables the exploration of complexities and context-specific insights, shedding light on interpersonal dynamics and cultural and social factors that influence Buyer-Supplier Relationships after the implementation of Industry 4.0 technologies.

- In the case of multiple-case design, it is preferred because it provides the opportunity for direct replication and the examination of contrasting situations. Analytic conclusions derived from multiple cases hold more significance and bolster the findings compared to a single-case study. This design enhances the thorough exploration of the phenomenon and improves the overall quality of the case study (Yin, 2018).

- Convenience sampling is employed in this study due to the limited availability and accessibility of key personnel. Despite its limitations in generalizability, convenience sampling enables the collection of valuable data for analysis. Four research participants, selected based on willingness, availability, and relevance to the Peruvian industry, are included. While the small sample size restricts generalizability, the study's findings can still inform future research and have applicability in other contexts.

- The research focuses on the buyer's perspective as it plays a crucial role in shaping the supply chain and understanding the impact of Industry 4.0 technologies on the buyer-supplier relationship. Semi-structured interviews are conducted to gather data, combining open-ended questions with pre-defined questions in an interview guide. This approach allows for a deeper exploration of themes and perspectives, even when multiple interviews with participants are not feasible. Audio recordings and field notes are used to capture essential information during the interviews.

- The data analysis process involves transcription and coding the interviews using a comprehensive coding scheme developed through deductive and inductive approaches. Deductive coding is guided by existing literature, while inductive coding identifies emerging themes. The analysis is conducted systematically, ensuring thoroughness and meaningful findings. Summary memos are created to synthesize the information, and Saldaña (2021) and Silbey (2022) recommendations are followed for interview development and data coding.

- The interpretation of the results involves synthesizing the analyzed data, identifying key themes, and developing theoretical insights. The findings are compared with relevant literature and analyzed through a cross-case analysis to generate conclusions.

Relevant Conclusions

The implementation of Industry 4.0 technologies in Peruvian companies has had a significant impact on Business-Supplier Relationships. This impact is evident in various important aspects of BSRs, including trust, cooperation, collaboration, communication, information sharing, and the duration of relationships.

The impact of Industry 4.0 technologies on supplier relationship characteristics is consistent across manufacturing, retail, and service companies. This comparison highlights the universal effects of these technologies on BSRs, regardless of the industry sector.

BSR adapts and evolves based on the demands brought about by the integration of each new Industry 4.0 technology into the processes.

The outline of the thesis

This thesis is structured into five comprehensive chapters. Chapter I lays the groundwork for the investigation by delving into theories that have previously been applied in the field of Industry 4.0 and the Buyer-Supplier Relationship. This chapter also introduces propositions designed to facilitate answering the research question. Chapter II elaborates in detail on the research methodology and provides an overview of the selected firms to be studied. Chapter III presents the results, examining each case through the lens of the conceptual model. Each proposition is analyzed in Chapter IV, leading to a comprehensive response to the research question. Lastly, Chapter V provides both general and specific conclusions and recommendations, offering a thoughtful wrap-up to the research.

CHAPTER I: LITERATURE REVIEW AND PROPOSITIONS

1.1. Industry 4.0

1.1.1. Definition

After the term "Industry 4.0" was initially introduced in Germany in 2011, it has become widely used by academics, politicians, and business professionals to discuss new technologies and future trends in manufacturing (Gilchrist, 2016). However, there is a misconception regarding its understanding, associating Industry 4.0 solely with novel technologies or the manufacturing field due to the lack of consensus in its definition. This term has sparked debates concerning its relevance, potential, and future impact on the economy and society (Hoyer et al., 2020).

From the academic side, scholars have encountered challenges in defining Industry 4.0, with earlier definitions focusing on the digitalization of manufacturing processes. However, recent literature has adopted a more comprehensive perspective over time, defining Industry 4.0 from a value chain standpoint that encompasses multiple industries, not just a single company (Ghobakhloo et al., 2021; Nosalska et al., 2020). This broader definition implies that Industry 4.0 creates an environment facilitating information sharing, collection, and processing across the supply chain, enabling companies to be more responsive and resilient to external influences (Hoyer et al., 2020). Moreover, it fosters the development of new business models driven by customer needs and mass customization requirements (Nosalska et al., 2020).

The current literature supports the notion that Industry 4.0 is a paradigm shift within industrial value chains, encompassing the digitalization of value creation and delivery processes at the micro (equipment), meso (intra-organizational), and macro (value network) levels (Ghobakhloo et al., 2021). This hyper-connected system involves smart materials, components, equipment, focal factories, suppliers, distribution channels, and even customers, extending beyond the boundaries of the manufacturing industry. In fact, Industry 4.0 has significant implications for various sectors such as construction, healthcare, transportation, and energy (Ghobakhloo et al., 2021).

1.1.2. Industry 4.0 technologies

The integration of various technologies is essential in the context of Industry 4.0, making it challenging to identify them individually due to the multitude of technologies associated with the concept proposed by different authors (Klingenberg et al., 2021). Therefore, describing these technologies as a collective set is more appropriate than focusing on them individually. This approach provides a comprehensive view and prevents oversimplification by solely associating Industry 4.0 with specific technologies.

Based on the bibliometric analysis, Ghobakhloo et al. (2021) propose a categorization of technological trends related to Industry 4.0 into two clusters: core technologies and facilitating technologies (see Table I). The main difference between them is the novelty in the sense of years of development and sufficient maturity to be commercially available in the last decade. In contrast, the facilitating are mature technologies that enable core technologies to integrate, operate, and function properly.

Table I. Categorization of technologies associated with Industry 4.0.

Category	Technologies
Core	Internet of Things, Cyber-physical systems, Cloud computing, Industrial robotics, Data analytics, Augmented reality, Digital twin technology, Big Data, Simulation, Additive manufacturing, Cybersecurity, Industrial internet of things, Virtual reality, Semantic technologies, Blockchain, Internet of people, Internet of services, Internet of everything, and Internet of Data.
Facilitators	Industrial actuator and sensor, Machine and process controller, Automated guided vehicle, Intelligent enterprise resource planning, Communication interface, High-performance computing, Smart wearable/gadget, Predictive analytics, Smart manufacturing execution system, Industrial embedded system, and Computer numerical control system.

Source: Ghobakhloo et al. (2021)

In order to provide a better understanding of the technologies that will be mentioned later in this research, their definitions are presented below.

1.1.2.1. Big Data

According to De Mauro et al. (2016), Big Data encompasses the aspects of 'Volume,' 'Velocity,' and 'Variety' to describe the characteristics of information. It involves handling a large volume of data that is generated and processed at a high velocity, coming in various forms and formats. Specific 'Technology' and 'Analytical Methods' are required to utilize this information effectively. These technologies and methods enable the storage, processing, and analysis of Big Data, allowing organizations to extract meaningful insights and derive value from it. The ultimate goal of Big Data is to transform information into valuable insights that can create economic value for companies and society. This notion of 'Value' highlights the importance of leveraging Big Data to make informed decisions, drive innovation, and gain a competitive edge.

1.1.2.2. Cloud Computing

According to Diaby and Rad (2017), Cloud Computing (CC) is a modern and flexible delivery model that has revolutionized the provision of IT resources. It represents the evolution of traditional on-premises computing, moving from aggregated and multi-vendor outsourcing to a more streamlined and advantage-rich approach. With cloud computing, organizations can effortlessly increase their capacity and capabilities without the need for additional infrastructure, personnel training, or software licensing.

This technology offers significant promise, enabling businesses to effectively manage resource limitations with minimal capital investment while efficiently meeting dynamic demands. By adopting cloud computing, organizations gain access to a deployment architecture that addresses vulnerabilities commonly found in traditional information systems. However, it's important to note that the dynamic nature of cloud computing can pose challenges to traditional security measures (Diaby & Rad, 2017).

1.1.2.3. Internet of Things

The Internet of Things (IoT) is defined as “a network of physical objects that are digitally connected to sense, monitor, and interact within a company and between the company and its supply chain enabling agility, visibility, tracking, and information sharing to facilitate timely planning, control, and coordination of the supply chain processes.” (Ben-Daya et al., 2019). The authors also mentioned that the definition encompasses four key features. These features include the digital connectivity of physical things in the supply chain, proactive connectivity allowing for data storage, analysis, and sharing, communication processes within and between organizations covering major supply chain processes, and facilitating planning, control, and coordination of supply chain processes.

1.1.2.4. Industrial Robots

Industrial robots refer to robots that are specifically designed and utilized for industrial automation applications. They are programmable, actuated mechanisms performing intended tasks in a structured environment. These robots operate autonomously, without the need for human intervention, and are commonly used in factories to enhance productivity, improve product quality, and reduce production costs. Industrial robots are confined to a predefined space and typically perform repetitive actions, limiting the flexibility and reconfigurability of production lines. With the integration of Industry 4.0 technologies, industrial robots can be part

of a smart factory that automatically reconfigures itself to meet individual customer demands, enabling efficient and customizable production processes (Fassi et al., 2020).

1.1.2.5. Mobile Robots

Mobile robots (MR) are robotic systems capable of autonomous movement in unpredictable and partially unknown environments. These robots can navigate without disruption and avoid obstacles within their confined movement area. They operate with minimal or no human intervention and can follow predefined paths in both indoor and outdoor environments. MR relies on sensors such as sonar, laser range finders, and inertial measurement units to perceive their surroundings and make informed decisions. They are commonly used for logistics and material transportation tasks in smart factories (Fassi et al., 2020).

The next generation of mobile robots, known as autonomous mobile robots (AMRs), operate without human intervention to perform tasks in an unpredictable environment. These robots possess the ability to navigate autonomously, avoiding obstacles and following predefined paths. They rely on a range of environmental sensors, either mounted on the robot or positioned within the environment, to perceive their surroundings and make informed decisions. AMRs are equipped with advanced features and technologies to ensure smooth and efficient movement, such as floor plan mapping, sonar sensing, and inertial measurement units. They are utilized in various applications, including logistics, material handling, and transportation, in industries such as manufacturing and warehousing. AMRs are an integral part of Industry 4.0, as they contribute to the development of smart factories with increased productivity, flexibility, and automation (Alatise & Hancke, 2020).

1.2. Buyer-Supplier Relationship

1.2.1. Definition

The concept of the Buyer-Supplier Relationship (BSR) was studied many years ago by academicians and has changed over time. Terpend et al. (2008) talked about findings in academic journals since 1986, evidencing an evolution of the concept. To name a few: until 1991, the studies revealed that researchers had a special interest in operational improvements (e.g., quality, cost, delivery, and inventory), going by a focus on integration-based value until 1995 (e.g., improved cooperation, collaboration, and performance). From 1996 to 2000, researchers began to focus on factors that affect how buyers capitalize on suppliers' capabilities (e.g., international experience, continuous improvement, and environmental capabilities) and buyer-supplier mutual efforts (e.g., communication and information sharing, and trust-related factors). From 2001 to

2005, the buying firm's financial performance was considered in the investigations. This showed that it is positively affected by buyer-supplier integration practices. The evolution of the BSR concept results from a chain of correlated factors that have been putting pressure on businesses to improve quality, delivery performance, and responsiveness over time (Kannan & Choon Tan, 2006).

Thereby, based on the literature review, a broad definition of BSR can be understood as a cooperative inter-organizational dyadic relationship that, with proper management such as maximizing trust and cooperation, minimizing opportunism and risk, and collaborating on setting and accomplishing goals, could result in benefits for each party, such as enhancing supply chain synchronization, reducing total costs, improving quality and cycle time, and strengthening overall competitive position (Monczka et al., 1998; Obal & Lancioni, 2013; Vanpoucke et al., 2014; J. W. Veile et al., 2020). BSR involves long-term cooperative relationships between buyer and supplier designed to leverage their strategic and operational capabilities to achieve benefits for each party (Monczka et al., 1998; Morsy, 2017; Vanpoucke et al., 2014; J. W. Veile et al., 2020). It involves strategic planning and multiple interdependencies between actors (J. W. Veile et al., 2020). Thus, the BSR concept moved beyond individual firms or merely buyer-and-seller contractual relationships to value-creating networks, which is a broader concept (Kothandaraman & Wilson, 2001).

1.2.2. Characteristics of BSR

In this regard, it is better to list the most common BSR characteristics to mark a starting point.

1.2.2.1. Trust

According to Doney and Cannon (1997), trust can be defined as the perceived credibility and benevolence of a target of trust. It encompasses two dimensions: objective credibility, which is the expectation that the partner's word can be relied on, and benevolence, which refers to the partner's genuine interest in the other's welfare and joint gain. Trust is a fundamental norm in business-to-business relationships, impacting the performance of both buyers and suppliers (Terpend et al., 2008).

Combining the perspectives of Doney and Cannon (1997) and Kwon and Suh (2005), trust can be seen as the perceived credibility and benevolence of a target of trust, encompassing objective credibility and genuine interest in the other party's welfare and joint gain. It involves a willingness to take risks and rely on an exchange partner driven by confidence in their reliability and integrity. Trust is influenced by factors such as credibility, reliability, intimacy, and a lack of self-

orientation. It leads to open communication, reduced transaction costs, and improved overall performance in business relationships.

1.2.2.2. Cooperation and collaboration

Cooperation and collaboration in the buyer-supplier relationship have long been recognized as important factors in achieving competitive advantages. Researchers such as Corsten and Felde (2005) emphasize that collaboration involves joint action and purposeful cooperation between buyers and suppliers. It is seen as a form of relational exchange to create value together. Collaborative efforts, particularly in product and process development, can result in various benefits, including higher quality, lower costs, improved delivery and logistics service performance, expanded offerings, and risk sharing. However, it is important to note that not all collaborative endeavors lead to positive outcomes. The literature highlights potential drawbacks, such as increased vulnerability to opportunism, foregone economies of scale, dependence on a single supplier, and loss of internal capabilities. Therefore, collaboration success depends on careful assessment and consideration of the specific context and potential risks involved in the BSR.

It is important to note that in the present study, delving into technicalities and precise distinctions between the terms collaboration and cooperation will be avoided. It is acknowledged that there are more specific differences between both concepts, but in this study, a general perspective to facilitate understanding and practical applicability in the context of BSR will be adopted. In other words, it will be considered that the terms cooperation and collaboration share common elements and overlap in the BSR context.

1.2.2.3. Communication and information sharing

Communication and information sharing play a crucial role in BSRs, as Morsy (2017) and Terpend et al. (2008) emphasize. Effective communication is a precursor for trust, commitment, and successful relationship outcomes. It involves frequent and meaningful interaction between buyers and suppliers, driven by the perceived benefits of the relationship. The frequency of communication influences the level of information shared and the governance structure adopted. Higher frequency leads to greater information exchange and reduces opportunistic behavior, promoting collaborative practices. The literature highlights the positive impact of communication and information sharing on various performance measures, such as operational performance, cycle time reduction, financial performance, supplier commitment, buyer's competitive position, and supplier selection. Therefore, fostering communication and information-sharing practices is essential for enhancing BSRs and achieving performance improvements.

1.2.2.4. Relationship duration

The duration of the BSR is a critical aspect that influences various dimensions of the relationship. As Morsy (2017) and Chen and Paulraj (2004) discussed, relationship duration signifies the level of experience, established behaviors, norms, and relationship-specific assets between buyers and suppliers. Trust plays a fundamental role in determining the duration of the relationship. As trust strengthens, the parties engage in collective actions, invest in each other's capabilities, solve problems collaboratively, and align their plans. This fosters a longer and closer relationship, enabling the sharing of risks and rewards.

Moreover, long-term contracts and strategic relationship management contribute to the extended duration of buyer-supplier relationships, as Chen and Paulraj (2004) highlighted. Close relationships promote risk-sharing and a willingness to maintain the relationship over time. Companies benefit from consolidating their business with fewer suppliers through long-term contracts, improving coordination and supplier performance. A long-term perspective enhances buyer-supplier coordination and strengthens the competitiveness of the entire supply chain. Thus, cultivating long-term supplier relationships becomes a strategic initiative for buying firms.

1.3. Conceptual Framework

The evolution of the BSR concept goes hand in hand with the advance of technology. For example, BSR requires open and extensive communication and information sharing but as technology continues to advance and increment its complexity, the communication channels between the parts are changing too (Kagermann et al., 2013; Obal & Lancioni, 2013). With new technologies associated with Industry 4.0 added to the equation and the migration from a competition based on individual companies to a competition between value creation-networks, the complexity and cooperation in BSR are expected to increase (Hoyer et al., 2020; Kothandaraman & Wilson, 2001; J. W. Veile et al., 2020). Another example is that Industry 4.0 asks for more comprehensive data collection, processing, and analysis, which in turn, this information can be shared across the value chain to facilitate the integration of firm functions and supply chain members. It implies not only the investment and implementation of new individual technologies in the company to fulfill this but also a high level of buyer-supplier collaboration to maximize the positive impact of these individual technologies on supply chain performance (Ardito et al., 2019; Caridi et al., 2014; Flynn et al., 2010; Patrucco et al., 2022; J. W. Veile et al., 2020). Given that, we can infer that those digital technologies impact BSRs, and companies that learn how to deal with these changes and new technologies will be more likely to reduce costs, improve quality and increase the ability to supply.

From a theoretical perspective, Industry 4.0 and related technologies support and enhance individual BSR and the supply chain ecosystem (J. W. Veile et al., 2020) since it demands comprehensive horizontal and vertical integration within the supply chain network (Ghadge, Kara, et al., 2020). The combination of these concepts will bring implications for the organizational future at three levels: employee, management, and organizational level. Diving into the intricacies of this transformation involving every actor in the supply chain system, Bartodziej (2017); Bienhaus and Haddud (2018); Ghadge, Er Kara, et al. (2020); Hoyer et al. (2020); J. W. Veile et al. (2020) key driving forces and underlying factors that facilitate the adoption of Industry 4.0. As a result, this improves BSR within an Industry 4.0 context by enhancing its characteristics.

Table II. Drivers and causes which will transform and enhance BSR.

Factors	Characteristics
Market dynamics	Meet customers' needs (higher quality, flexibility, agility, process transparency, reliability, and individuality), market dynamics (volatility of markets and sustainable and secure supply of raw materials and energy), aggressive characteristics of competitors, new market players, and difficult product differentiation.
Macroeconomic influences	Technology development, the base of the Industry 4.0 revolution, pushes the transformation of organizations and supports supply chain integration. Macroeconomic influences involve the need for establishing the regulatory foundations (political support) for collaboration, keeping in mind the environment, security (information technology standardization), privacy, and property. Moreover, a new skill set is required, causing a shortage of specialists in more complex global value chains.
Differentiation	Optimizing processes and transactions, and increasing flexibility, represent a great starting point for differentiation from competitors. Also introducing new or improved value offers that attract customers willing to pay and enhance competitiveness. Innovation is another driver because of closer work between actors. New business models could emerge because of this continued pursuit of differentiation.
Profitability and ability to compete	Relentless pursuit of profit and staying competitive in the marketplace (pressure to adapt) trigger businesses to reduce costs, run cheaper and increase efficiency through processes optimization which in turn reduces monotonous work, improves resource allocation, and stock reduction to name a few.

Source: Bartodziej (2017); Bienhaus and Haddud (2018); Ghadge, Er Kara, et al. (2020); Hoyer et al. (2020); J. W. Veile et al. (2020)

1.3.1. Cooperation and collaboration in Industry 4.0

The adoption of Industry 4.0 technologies is expected to have a significant impact on the cooperation and collaboration between buyers and suppliers in supply chains. In support of the

aforementioned statement by Ghadge, Er Kara, et al. (2020), research conducted by Patrucco et al. (2022) emphasizes that the benefits of adopting innovative technologies such as Industry 4.0 technologies and pointed out that organizations should be mindful of the impact that these technologies could represent for them. The authors emphasize that fostering strong collaboration between buyers and suppliers can amplify the effectiveness of these technologies in enhancing supply chain performance.

Furthermore, Patrucco et al. (2022) highlight the importance of digital technologies, such as big data analytics and cloud computing, in facilitating collaborative BSRs. These technologies increase the availability of knowledge and information, making supply chains more transparent and less complex and enabling reliable decision-making.

In line with these findings, J. W. Veile et al. (2020) mentioned that one of the reasons why BSR gets more intense is because of close forms of cooperation. Cooperative partnerships and collaborations will take the lead, focusing on providing support for Industry 4.0 implementation and jointly solving common problems. Moreover, there will be a greater focus on expediting collaboration with suppliers, both operationally and strategically.

Then, we posit the first proposition (p1): *Cooperation and collaboration between suppliers and customers are reinforced after the implementation of Industry 4.0 technologies.*

1.3.2. Communication and information sharing in Industry 4.0

Industry 4.0 technologies are expected to significantly impact the communication and exchange of information between buyers and suppliers. According to J. W. Veile et al. (2020) investigation, analog and manual processes are gradually being digitized and automated, resulting in significant changes in communication and data exchange methods. The adoption of Industry 4.0 technologies allows for data collection, processing, and analysis across the value chain, leading to a shift in human roles towards strategic tasks rather than operational ones. As a result, personal contact and interaction at the operational level in BSRs are expected to decrease. In contrast, strategic-level personal contact may retain its importance, especially for decision-making, building relationships, and monitoring activities. Additionally, J. W. Veile et al. (2020) found that the increase in process and data transparency reduces the reliance on personal contact for obtaining relevant data.

Furthermore, J. W. Veile et al. (2020) found that, with the digitization, automation, and interconnection of processes, the frequency of personal contact is anticipated to decrease significantly. While personal contact remains essential for establishing a strategic framework, it becomes less necessary when value-creation processes are developed within an established framework. Additionally, the increase in process and data transparency reduces the reliance on

personal contact for obtaining relevant data. Consequently, there will be an increase in the frequency of data exchange facilitated by real-time data sharing across the value chain.

Then, we posit the second proposition (p2): *Communication and information exchange between suppliers and customers become more frequent after the implementation of Industry 4.0 technologies.*

1.3.3. Relationship Duration in Industry 4.0

As previously mentioned, inter-organizational relationships, which refer to long-term cooperative relationships between buyers and suppliers, are established to improve the operational performance of both parties involved. The integration of Industry 4.0 technologies further strengthens these long-term partnerships, resulting in intensified BSRs (Vanpoucke et al., 2014; J. W. Veile et al., 2020). This viewpoint is corroborated by Bienhaus and Haddud (2018), who underscore the significance of fostering long-term BSRs built upon transparency within the context of Artificial Intelligence and Big Data-driven digital transformation.

Then, we posit the third proposition (p3): *The desire for long-term relationships between suppliers and customers increases after the implementation of Industry 4.0 technologies.*

1.3.4. Trust in Industry 4.0

Industry 4.0 will significantly impact trust between actors from supply chains and, consequently, become BSR more intense (J. W. Veile et al., 2020). Research conducted by Bienhaus and Haddud (2018) found that transparency and traceability within the supply chain ecosystem, facilitated by technologies from Industry 4.0 such as Artificial Intelligence and the IoT, already strengthen BSRs and the level of trust. The study also highlighted that despite digitization, people and "face-to-face" meetings remain important for building trust and relationships, particularly for products that exhibit high complexity and a low level of standardization and products in the design phase prior to mass production (J. W. Veile et al., 2020).

In support of this, Ghadge, Er Kara, et al. (2020) emphasized that Industry 4.0 technologies such as IoT also enable increased transparency and collaboration among supply chain partners, leading to stronger relationships and increased trust. J. W. Veile et al. (2020) also mentioned that in the context of Industry 4.0, BSR is becoming more intense. This is based on improved bonds of trust and an enhanced relationship caused by close forms of cooperation, increasing reliability, and long-term oriented partnerships.

Then, the fourth and final proposition is (p4): *Trust between suppliers and customers is strengthened after the implementation of Industry 4.0 technologies.*

Based on the presented theory, a conceptual model is designed to analyze the BSR after the implementation of Industry 4.0 technologies. As shown in Figure I, this model starts by considering the time before and after the implementation of Industry 4.0 technologies. Prior to the adoption of these technologies, companies relied on manual processes or outdated technologies. After the implementation, the BSR is enhanced as it is affected in its four most common characteristics: trust, collaboration and cooperation, relationship duration, and communication and information sharing.

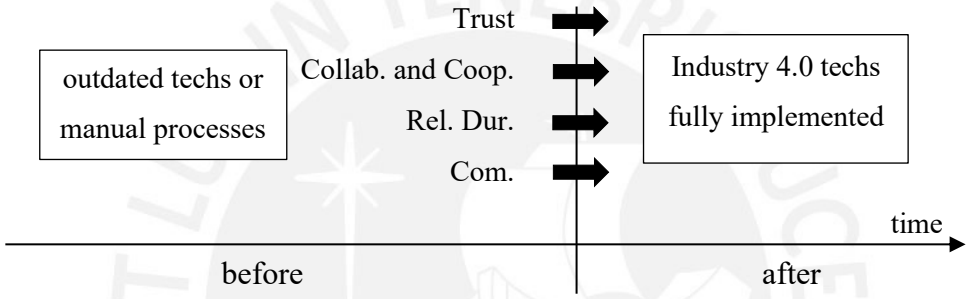

Figure I. A conceptual model for BSR before and after, and propositions.

CHAPTER II: METHODOLOGY

2.1. Research design

A qualitative research approach and multiple-case design is employed to address the research question. Qualitative research is commonly used in social science to interpret phenomena based on the meanings individuals attribute to them (Denzin & Lincoln, 2017). This approach focuses on collecting and analyzing words rather than numerical data, as done in quantitative research (Bryman, 2012). Several compelling reasons support the use of a qualitative approach to investigate the research question.

Firstly, Industry 4.0 is a relatively new and intricate phenomenon, and qualitative research can provide in-depth insights into emerging topics with limited prior research (Creswell, 2013). Therefore, a qualitative approach can help identify and explore the complexities of Industry 4.0 technologies and their implications for BSRs in Peru, which may not be fully understood through quantitative methods alone.

Secondly, a qualitative approach is particularly suitable for exploring new and complex topics, such as the BSR in the context of Industry 4.0 (Hoyer et al., 2020), as it allows for in-depth investigations and the generation of rich, context-specific insights. Given the limited existing research on this topic in the Peruvian context, a qualitative approach can facilitate a deeper understanding of the unique dynamics and challenges present rather than relying on generalizations from other contexts (Creswell, 2003).

Finally, qualitative research can shed light on the interpersonal dynamics, and social and cultural factors that affect BSRs after the implementation of Industry 4.0 technologies (Creswell, 2013). By examining the experiences and perspectives of individuals involved, qualitative research can provide insights into these relationships' emotional and relational aspects and formulate hypotheses for further analysis.

In the case of multiple-case design, according to Yin (2018), multiple-case designs are preferred over single-case designs when given the choice and resources. By incorporating multiple cases, the study can benefit from the potential for direct replication and the emergence of contrasting situations. Analytic conclusions drawn from multiple cases carry greater weight and strengthen the findings compared to those from a single-case study alone. This design allows for a more robust exploration of the phenomenon, enhancing the overall quality of the case study.

It is important to mention that as the primary parameter of investigation of this study, the unit of analysis is "the BSR after the implementation of industry 4.0 technologies in Peruvian companies".

2.2. Case selection

The research method employed in this study involved the use of a convenience sampling technique. Convenience sampling was chosen for three main reasons. Firstly, as Johnson and Christensen (2014) noted, it involves selecting individuals who are available, willing to participate, or easily recruited into the sample. Secondly, due to the novelty of the topic, especially in Peru, limited information and resources were available to identify potential participants. Lastly, convenience sampling was considered a cost-effective and efficient way to identify and recruit participants for the study and collect data.

In this study, four firms were selected based on their willingness, availability, and relevance to the Peruvian industry. While the small sample size may limit the generalizability of the findings to the entire population, the use of convenience sampling allowed for valuable data collection that could still inform the research and be applicable to other contexts in Peru. It is important to acknowledge that this study serves as a starting point for future research on the topic, and the findings can guide future sampling techniques and expand the sample size for a more comprehensive study.

For confidentiality reasons, it is not possible to disclose the names. Still, it can be stated that they are the Peruvian companies leading their respective sectors based on the ranking of companies by activity published by the Lima Stock Exchange (BVL) as of May 2023. As leaders in their industries, these companies often drive market trends due to their competitiveness and desire to maintain their market leadership.

The individuals selected for this study are those who hold positions ranging from middle to upper management and have worked in the same company before and after implementing Industry 4.0 technologies. Therefore, they were expected to provide insights into the effects they had observed in the relationships between the company and its suppliers. Additionally, it was preferred that the interviewed individuals have an academic background in engineering, as it was necessary for them to have intermediate knowledge of Industry 4.0 technologies to describe them during the interviews. They were also expected to possess intermediate knowledge of processes within the operations and maintenance area, enabling them to identify potential patterns of change in these processes resulting from the implementation of Industry 4.0 technologies. The interviews were

conducted in Spanish between April and May 2023, with each interview lasting between 40 and 60 minutes. Table III gives an overview of the selected cases.

Table III. Selected cases

Companies	A	B	C	D
Sector	Manufacturing – Food	Retail – Pharmacy	Manufacturing – Dairy	Banking
Headquarters	Peru	Peru	Peru	Peru
Ranking according to net worth	Top 30	Top 5	Top 50	Top 5
Number of employees	>4,000	>20,000	>1,800	>17,000
Industry 4.0 technologies implemented	Industrial robots with IoT functionality	MRs with IoT and CC functionality and WMS and WCS integration	Industrial Robots, Machines with IoT and CC functionalities	CC, Big Data and IoT
Current position of the interviewee	Production Engineer	Project Manager	Project Manager	Technology and Engineering Architecture Manager
Company tenure in years	10	3	23	23
Industry tenure in years	14	12	27	23
Degree	Chemical Engineer	Industrial Engineer	Mechanical-Electric Engineer	Systems Engineer
Interview duration	01h 00m 19s	01h 09m 25s	00h 43m 06s	01h 00m 50s

2.3. Data collection

Most of the relevant information in this research is in the minds of the employees involved in Industry 4.0 technology projects. In this research, the primary sources of data were semi-structured interviews to gain an in-depth picture. This technique combines open-ended questions with pre-defined questions (i.e., interview guide), making it suitable for situations where there is no chance to interview someone more than once due to the interviewee's busy schedule or excessive bureaucracy in accessing the interview (Bernard, 2017). Additionally, the technique is well-suited for the purpose of this study because it allows for a deeper exploration of the themes

and perspectives of the research participants. The flexible and adaptable nature of this technique also enables detailed and nuanced information to be obtained about the topic under study. It is important to mention that the data from semi-structured interviews were complemented by secondary sources from innovation surveys and publicly available information such as news, interviews, and web home pages.

The development of the interview guide involved three steps. Initially, a brainstorming technique was used to generate a list of relevant questions, considering the conceptual framework necessary for the investigation. This list was then refined to include the most essential questions, considering the limited interview time available. The interview protocol was also rehearsed with colleagues to eliminate redundant, ambiguous, or potentially problematic questions, ensuring smooth and meaningful conversations during the interviews. Appendix A contains the interview guideline. Most of the questions were open-ended, making capturing rich and informative data about the specific research question possible.

Participants were provided with detailed information about the study's purpose and procedures, and their informed consent was obtained prior to their involvement. They were also made fully aware of their right to withdraw from the study at any point without facing any negative consequences.

Stringent measures were implemented to protect the confidentiality and anonymity of all participants, including the companies and any related actors involved. Pseudonyms were assigned to individuals and organizations to ensure their identities remained anonymous. Additionally, all data collected during the research process were securely stored and accessible only to authorized researchers. These ethical considerations serve as a foundation for conducting rigorous and responsible research, fostering trust with the participants, and upholding the principles of research ethics and integrity.

2.4. Data analysis

After transcribing the interviews, the data were analyzed using a Qualitative Data Analysis Software tool (i.e., NVivo) to facilitate the coding process. The specific methods used for the coding stage were a combination of provisional, holistic, and descriptive coding methods found in Saldaña (2021). Based on the first interview with Company A, the first version of the codebook was created. Subsequently, this codebook was taken into consideration for the remaining interviews, with edits made as new concepts emerged in the subsequent interviews (in some cases, recoding was necessary).

Once the editing and coding process of the codebook for all interviews was completed, the first version of the codebook was obtained. Subsequently, a second coding process for each interview was carried out, considering the codes from the first version of the codebook. This procedure was carried out to ensure that no code remained unassigned to its corresponding text due to not being initially included in the first version of the codebook. Finally, since coding is a cyclical process that necessitates a careful examination of the patterns and meanings that arise from human experience (Saldaña, 2021), the coding process was once again conducted, this time considering the principal characteristics and concepts derived from the propositions, and exploring the data to uncover relevant information (see the final version of the codebook in Appendix B). Meanwhile, text and audio conversations were conducted with interviewees from Companies A, B, and D to clarify ideas that arose during the coding processes. Memo writings were prepared throughout this process. These documents contained ideas and conclusions from reading and coding the interviews.

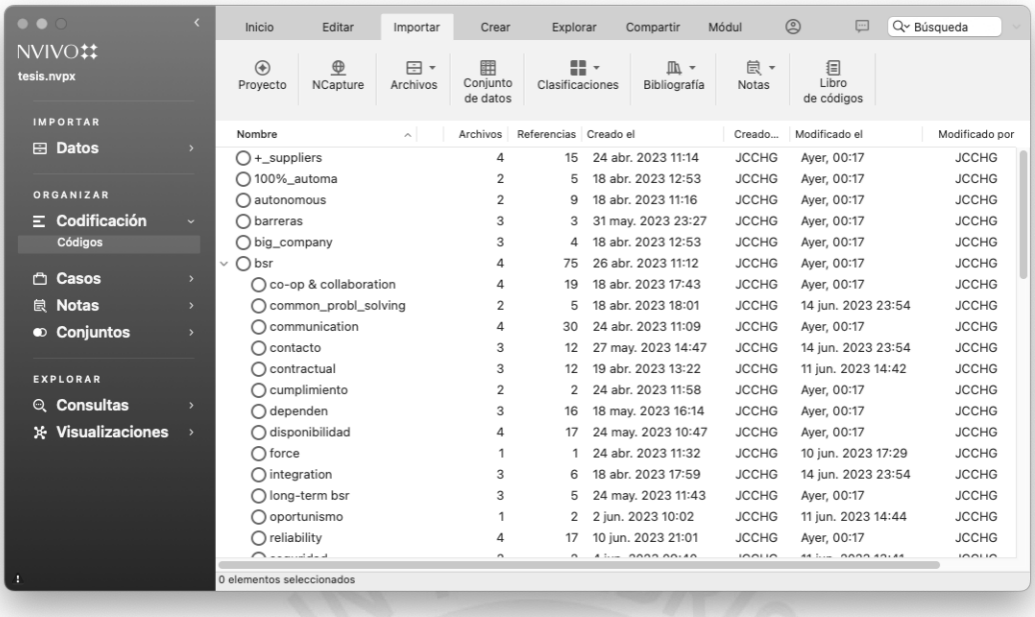

Figure II. A screenshot excerpt from NVivo v. 1.7.1 displaying the codes list.

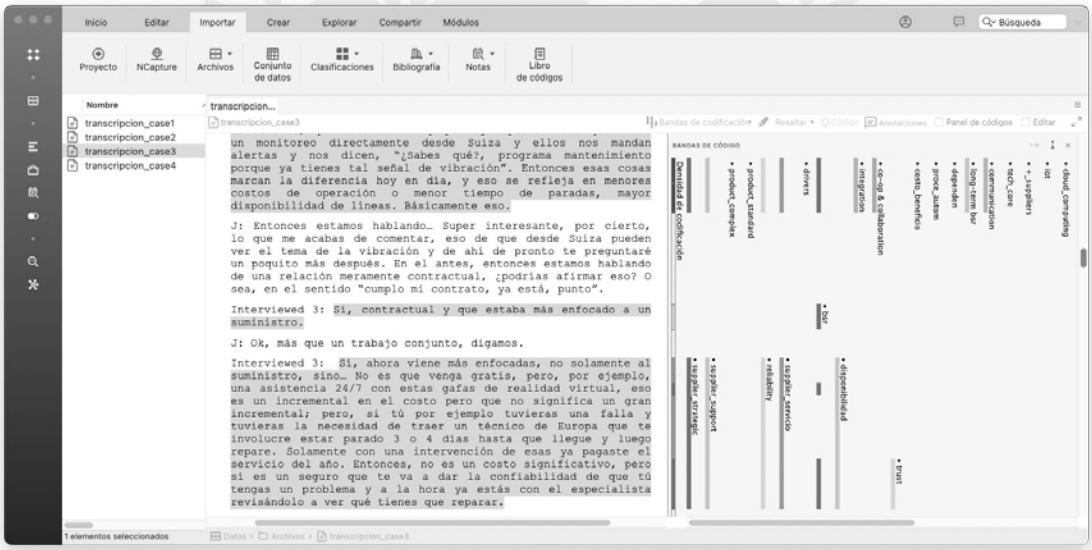

Figure III. A screenshot excerpt from NVivo v. 1.7.1 audio transcription analysis.

The interpretation of the results involved synthesizing the analyzed data to develop theoretical insights. This process entailed identifying key themes within the data using codes, summary memos, and field notes. It is important to emphasize that the process was based solely on qualitative data, seeking all possible evidence to avoid vulnerability to alternative interpretations. Ultimately, the findings were analyzed in conjunction with relevant literature on the topic and compared against the propositions using a cross-case analysis to generate conclusions in this regard.

2.5. Limitations of the study

Although this study serves as a valuable starting point in the field of BSR in the Peruvian context, it is important to acknowledge the limitations imposed by the small sample size of only four participants, which may restrict the generalizability of the findings to a larger population. Therefore, it is crucial to interpret the study's findings as providing insights into the specific cases studied rather than making broad generalizations.

Moreover, relying solely on interviews as the primary method of data collection introduces potential biases, such as social desirability bias or participant interpretation bias. To mitigate these, efforts were made to establish rapport with the participants, create a comfortable environment, and employ probing questions to delve deeper into their experiences and perspectives. However, it is important to acknowledge that these biases may still have influenced the collected data despite these measures.

Furthermore, the study's focus on the buyer's perspective, with only one representative per company, may limit the comprehensive understanding of the phenomenon, as it does not incorporate other perspectives from suppliers or include multiple employees within each company. Future research should consider involving a broader range of stakeholders to obtain a more holistic understanding of the complexities at play.

Despite these limitations, this study lays the groundwork for future research on this topic, offering valuable insights into the experiences and perspectives of buyers in the context of Industry 4.0 technologies in Peru. The findings can inform future sampling techniques and justify the need for a more extensive sample size, including a diverse range of participants and contexts, to comprehensively understand how BSR is affected by Industry 4.0 technologies in the Peruvian context.

2.6. Description of the selected firms

2.6.1. Company A

Company A is one of the most important food manufacturing companies in Peru. According to the BVL, as of May 2023, it ranked in the top 30 out of 207 companies based on its net worth. Founded in Peru in 1997, it currently has an international presence in four countries in the region and operates 37 industrial plants. It also has four business lines (consumer goods, B2B, aquafeed, and crushing) and 150 proprietary brands and has received several national awards in the areas of management, reputation, leadership, and strategy. In 2021, it initiated a process of integrating

sustainability objectives throughout the company, aligning them with its corporate strategies (Bolsa de Valores de Lima, 2023; Superintendencia del Mercado de Valores, 2023).

The analysis focuses on one of their industrial plants in Peru, specifically in the cookie production line, in the case-packing and palletizing process. Seven years ago, the company encountered a series of issues in its final production lines, which were being carried out manually. Firstly, the company had undergone strikes that caused significant disruptions in its operations. Secondly, repetitive tasks resulted in physical exertion and injuries among employees due to repetitive manual processes. Thirdly, the company had difficulties in renewing its workforce and finding skilled personnel. They had to constantly hire and train new employees, which became a challenge over time. Fourthly, the company sought to reduce occupational diseases associated with manual work. These problems motivated the search for industrial automation solutions. Despite the significant initial investment required, the implementation of new technologies was considered a long-term cost-saving measure due to these issues.

At that time, the relationship with standardized product suppliers such as boxes and adhesive tapes was limited to the delivery of the supplies and on the suppliers' side, to not losing the contract with the company. The company, in turn, focused solely on its own interests and was willing to quickly switch to new suppliers if their needs were not met. There was no suppliers' development program, and the relationship between the parties was primarily contractual, with little incentive for cooperation. Additionally, there was competition among these suppliers to stay relevant and avoid losing contracts, giving buyers significant bargaining power.

After evaluating the situation, the company decided to implement technologies such as industrial robots and more modern conveyors to address the existing problems. These technological changes brought about effects on various aspects of the relationship with suppliers. Firstly, it is reported that the number of suppliers has increased, especially in the maintenance area when there were large projects, resulting in a 20% to 30% increase in the number of suppliers compared to the past. For industrial robots, particularly, the company responded to the shortage of spare parts in Peru by intensifying its collaboration with local suppliers for the manufacturing of these parts. This was necessary to ensure a steady supply of the required parts. Specifically, they increased their cooperation with local manufacturers to produce the spare parts and supplies that were not readily available in the country. It involved an incrementation in collaboration between local suppliers and the company. Moreover, immediate communication with local suppliers is usually necessary in urgent situations to avoid workflow disruptions, even outside of business hours. In these circumstances, suppliers tend to be willing to respond to such needs. To reach this level of availability, the company has been meticulously selecting over time those suppliers it can rely on

in these critical situations, now placing more value than ever on those that show readiness to handle these demands.

2.6.2. Company B

Company B is part of the corporate conglomerate called Corporate 2, one of the most important in Peru. Established in 1997, it ranks in the top 5 out of 207 companies according to the BVL ranking published in May 2023. This conglomerate encompasses financial, retail, education, and healthcare companies. Company B was formed through the merger of two major pharmaceutical retailers in Peru, enabling it to cover just over 14% of the total private pharmacies in the country. It currently employs over 20,000 people and has more than 2,000 locations throughout the country (Bolsa de Valores de Lima, 2023; Superintendencia del Mercado de Valores, 2023).

The study examines one of Company B's warehouses. A few years ago, the picking processes were carried out manually. Operators used small carts and followed instructions from the system through radio frequency devices to collect products according to the indicated locations and quantities. The warehouse had racks and workstations where order trays were prepared, resulting in a repetitive and completely manual process, depending on the efficiency of the operators.

Company B decided to modernize the picking area as part of its annual plan to improve efficiency and speed in the aforementioned processes. MRs were implemented and integrated with the Warehouse Management System (WMS) and Warehouse Control System (WCS) to achieve this. This implementation automated the movement of goods within the warehouse, as this Industry 4.0 technology has the capability to autonomously navigate, pick, and transport order trays to the corresponding workstations. As a result of these improvements, time was optimized, human errors were reduced, and operators were freed from this task, allowing them to focus on receiving and dispatching products delivered by the MRs.

Regarding relationships with suppliers, before the implementation of these technologies, it was not necessary to establish close collaboration with them, especially with maintenance suppliers, as the operators handled the process, and the company tried to resolve issues internally. However, with the implementation, the company had to work in collaboration with the robot manufacturers. Initially, there was close and constant support and assistance, although it decreased as the implementation progressed, and Company B gained more knowledge about Industry 4.0 technology. Also, it happened because the company tends to maintain its maintenance operations internally to reduce dependence on external suppliers, minimize costs, and increase availability. But, despite training maintenance and IT staff to solve problems, there are still levels of knowledge and access to information about the robots, as well as the WMS and WCS software

that connect to them, which Company B does not have access to. As a result, for more advanced modifications, despite the existence of direct communication channels with the suppliers, there is still a dependence on their availability. However, Company B does not consider this dependency entirely negative for two main reasons. Firstly, Company B trusts its technology suppliers to the extent of considering them partners. Secondly, Company B works with reputable companies in the field of industrial automation, which gives it the perception of a high level of commitment and adherence to rules and agreements, despite initially struggling to understand this aspect.

2.6.3. Company C

Founded over 80 years ago, Company C is a leading Peruvian company in the industrialized milk market. It ranks in the top 50 out of 207 companies according to the BVL ranking published in May 2023. In 2022, Company C reported net sales of over 3 billion soles and a net profit of over 147 million soles. It currently operates three industrial plants located in the northern, central, and southern regions of Peru and has a presence in 7 countries in the region (Bolsa de Valores de Lima, 2023; Superintendencia del Mercado de Valores, 2023).

The investigation focuses on Company C's dairy production plants which, in the past, operated manually with processes that relied more on human intervention. Machines worked independently, and operators had to exert significant physical effort to carry out certain activities. However, due to changes in Peruvian legislation over the years and the necessity to optimize productivity and maintenance to respond more efficiently to the demand, a process of production line automation was initiated, especially in the end-of-line area. Industrial Robots were implemented to handle palletizing, packaging, and labeling, along with machines with CC and IoT functionalities and WMS, ensuring traceability and efficient handling of product information.

The implementation of Industry 4.0 technologies has brought several changes to the company. Firstly, there has been a transition towards a more automated, centralized, and connected operation, where production lines are seen as interconnected systems rather than individual machines. Process and productivity information is collected and sent to cloud servers, allowing for greater availability of information, generation of reports, and relevant data to measure productivity, maintenance, and downtime.

Regarding the relationship with suppliers, according to the interviewee, suppliers not only provide equipment but also become strategic, operational partners. Company C seeks suppliers offering after-sales services and technical support, such as 24/7 online assistance, real-time production parameter generation, and remote equipment performance monitoring. These additional services

are considered crucial factors when selecting suppliers as they provide greater reliability, efficiency, and performance.

Based on the interviewee's statement, the relationship with suppliers remains contractual, with the primary objective of ensuring the establishment of contracts that include clauses guaranteeing after-sales support and additional services. Moreover, Company C actively promotes continuity in its business relationships, as suppliers also provide proposals for modernization and technological updates that bring benefits to Company C. Additionally, Company C seeks to collaborate with suppliers who offer flexible technological solutions and open software, allowing for the involvement of local partners in maintenance and technical support. This approach helps reduce dependence on foreign parent companies.

2.6.4. Company D

Company D is one of the country's most important financial institutions, ranking in the top 5 out of 207 companies according to the BVL ranking published in May 2023. It offers financial services to corporations, large companies, small businesses, and individual clients. Founded in Peru in the late 19th century, it reported over 12 million customers in 2022, total revenues (financial and non-financial) of over 19 billion soles, and a net profit of over 4 billion soles (Bolsa de Valores de Lima, 2023; Superintendencia del Mercado de Valores, 2023).

This study examines the headquarters of Company D, where all decisions are usually made. Before implementing IoT, CC, and Big Data technologies, the company had a traditional technological infrastructure. They used local servers, relational databases, and monolithic systems such as the Mainframe, primarily supplied by Proveedor 9, which offered robustness, reliability, and security. They also had suppliers like Proveedor 10 for office tools and Proveedor 6 for servers.

The business relationships between Company D and its suppliers were purely contractual, rooted in a more rigid asset acquisition business model. The company had to make significant upfront investments to acquire specific hardware and software and also relied on ongoing support and maintenance from a limited number of suppliers.

However, as time passed and in line with technological advancements, the managers made the decision to optimize their processes with new technologies. Thus, after the implementation of IoT, CC, and Big Data, the company underwent significant changes. With the adoption of CC, the company began migrating its technological infrastructure toward cloud services, resulting in a reduction in the acquisition of physical assets. Instead of buying and maintaining local equipment, the company started consuming cloud services provided by specialized suppliers in

this area. This led to a shift in the relationship with suppliers as the dependency on asset acquisition decreased. Instead of having a relationship based on the purchase of specific equipment, the company started having a relationship centered around the consumption of cloud services. This allowed for greater flexibility and scalability in the use of emerging technologies, as the company could adjust and adapt its service consumption according to changing needs.

Regarding IoT, sensors and facial recognition technologies were implemented in a pilot banking agency, requiring collaboration with specialized suppliers in these areas. As for Big Data, a Data Lake was implemented within the company's own data centers, using products from Proveedor 8 for data processing. However, due to costs and the advantages offered by cloud service suppliers, it was decided to migrate the Data Lake to the cloud, thus integrating CC with Big Data.

Overall, as a result of the implementation of these technologies, Company D seeks to establish direct, intermediary-free, and more strategic relationships with suppliers, with the aim of having their support in the proper adoption of these technologies. Approximately five years of long-term contracts are established for this purpose. These contracts go beyond simply acquiring the technological solution, as they also include work sessions, specialized consultancy, and dedicated hours for exploring new initiatives. Regarding supplier dependence, Company D works with suppliers that are standardized to allow for seamless supplier migration.

CHAPTER III: RESULTS

3.1. Cases

Building upon the conceptual model discussed in the previous chapter, each element of the model was analyzed in relation to the collected cases using information obtained from semi-structured interviews and secondary data sources.

3.1.1. Case 1 – Company A

The implementation of Industry 4.0 technology has had a significant impact on the trust between Company A and its local suppliers. Before the Industrial Robots, a certain level of trust was already established, particularly regarding product quality and reliability. However, the introduction of industrial robots raised Company A's expectations for defect-free boxes and timely deliveries. This was crucial because a high percentage of faulty boxes would cause a 3-minute halt in the packaging line. This higher standard put the local suppliers to the test, requiring them to improve their technology and invest in additional equipment to meet the company's increased demands. Consequently, trust was challenged, and the suppliers had to demonstrate an unwavering commitment to maintaining a reliable supply. Even today, despite the supplier's improved failure rate, they are still striving to enhance this indicator for the benefit of Company A. In this regard, the interviewee acknowledges that they have transitioned from a relationship that was limited to minimal involvement beyond order fulfillment to a relationship with greater interaction, where collaboration and communication between both parties prevail to prevent plant shutdowns caused by input issues.

Additionally, with the implementation of industrial robots and the need for more maintenance and technical support, closer collaboration between Company A and its maintenance suppliers has become essential. The company has established dedicated maintenance teams consisting of mechanical, electrical, and instrumentation experts who work alongside the Industrial Robots suppliers' representative and local maintenance suppliers to promptly resolve issues and ensure the smooth operation of the new technologies. Particularly, the interviewee highlights the exceptional performance of the manufacturer of Industrial Robots. These suppliers consistently demonstrate punctuality in meeting agreed-upon dates without any delays, showcasing their unwavering dedication to fulfilling their obligations. According to the interviewee, this raises the level of trust toward the manufacturer.

On the other hand, the interviewee emphasizes the willingness of the local suppliers to handle emergencies, even outside of regular working hours. There has been an increase in communication between Company A's internal teams and the suppliers' technical experts,

enabling effective problem-solving and troubleshooting of the automated processes. This enhanced communication ensures that both parties are well-informed about challenges and work collaboratively to find suitable solutions. Furthermore, it is important to note that, according to the interviewee, the local suppliers currently engaged with Company A have been selected through a rigorous screening process, ensuring that only those who exhibit the highest level of availability and consistent communication with the company have been chosen. This selection criterion includes their willingness to support Company A's urgent needs, even outside of regular working hours.

Finally, the interviewee acknowledges that while they may not have specific knowledge about the existence of formal long-term contracts or long-term cooperation strategies, the reality is that the company has established enduring relationships with suppliers who consistently meet their needs. These relationships have stood the test of time, spanning several years, which indicates a clear preference for working with reliable and committed suppliers. It can be inferred that these long-term relationships have emerged as a result of increased trust and mutual satisfaction between the company and its suppliers. The evolution of collaboration has strengthened these relationships, fostering a continued desire to work together and a commitment to addressing the new demands and urgencies introduced by the implementation of new technologies at Company A. The interviewee emphasizes that the company's suppliers have demonstrated a willingness to adapt and support Company A in fulfilling its requirements and addressing emerging needs. This commitment and willingness to evolve align with the company's objectives and ensure a continued partnership based on trust and mutual benefit.

Table IV. Case 1 main characteristics.

	Case 1
Industry 4.0 technologies	Industrial robots with IoT functionality.
Suppliers	Technology supplier: An international supplier was the original technology manufacturer, and a local supplier was responsible for electrical installation or maintenance. Production supplier: A local supplier of boxes.
Drivers for Industry 4.0 technology adoption	Strike-related disruptions, repetitive movements and occupational injuries, workforce stability and recruitment challenges, occupational health concerns, and long-term cost savings.

3.1.2. Case 2 – Company B

The interviewee perceives that the company maintains a strong trust relationship with its strategic suppliers. The implementation of MRs technology and their integration to WMS and WCS has required the company to establish trust with globally recognized suppliers. They have contracted a new service with the supplier who sold them the robots to ensure proper support and maintenance. Initially, there were some challenges with software deficiencies, but the supplier provided assistance during the implementation phase. Over time, the company relies less on the supplier's support as the system becomes stable. However, for critical issues or complex configurations, the company still depends on the expertise and support of the supplier, fostering a gradual trust-building process. Additionally, the interviewee highlights that working with globally recognized suppliers, some of which are among the top five automation suppliers worldwide, implies that these suppliers have a solid reputation and high standard procedures, which reduces the likelihood of facing serious issues such as disruptions or contract breaches. According to the interviewee, this creates a sense of trust in Company B.

Furthermore, the strong trust relationship with one of these suppliers is emphasized. This supplier is a local representative of a global supplier who also works with Company B to provide support for MR. This relationship has been strengthened over the years, and this supplier is considered a key partner of the company. This trust has been built thanks to their extensive knowledge of Company B's operations and is based on direct communication and ongoing advisory.

On the other hand, the implementation of new technologies has resulted in increased collaboration between the company and its suppliers. The company has received training from the robot supplier, enabling its internal maintenance team to handle Level 1 support and basic checklists. In terms of preventive maintenance, the supplier visits once or twice a year, while the internal team takes care of day-to-day maintenance tasks. The collaboration between the two parties ensures effective maintenance activities and smooth operation of the robots. Similarly, for IT-related issues beyond Level 1 support, the company collaborates with specialized IT providers to resolve more complex problems.

Regarding the implementation phase of the MRs project, the joint work and collaboration between Company B and the supplier evolve as the project progresses. Initially, there is a 100% collaboration and joint effort, which gradually decreases as the project becomes self-sustaining. This does not necessarily mean that the relationship between the buyer and supplier deteriorates; it simply means that the buyer, in an effort to reduce dependence on the supplier, gradually distances itself and attempts to handle things in-house as they learn to solve problems.

Finally, during the implementation phase, the company carries out thorough testing and debugging in a controlled environment. However, unforeseen issues and specific scenarios arise when the system becomes operational. In these instances, the company engages in communication with the supplier to address the identified problems and request necessary adjustments or fixes. Consistent communication and the exchange of information are crucial to ensure stable and efficient system performance. Moreover, the company engages with IT providers who offer support beyond Level 1, which requires effective communication and trust in order to communicate the specific details of the issues and collaborate on their resolution, even if it means temporarily halting operations.

Table V. Case 2 main characteristics.

	Case 2
Industry 4.0 technologies	MRs with IoT and CC functionality and WMS and WCS integration (already implemented in Company B).
Suppliers	Technology supplier: An international supplier was the original technology manufacturer (Proveedor 19). A second international supplier for integrating the Industry 4.0 technology with WCS and WMS and its local subsidiary (Proveedor 5 y 6).
Drivers for Industry 4.0 technology adoption	Improve picking process.

3.1.3. Case 3 – Company C

The utilization of Industry 4.0 technologies has fostered a sense of trust between Company C and its suppliers. The company has provided its suppliers with access to previously confidential information in exchange for operational benefits. This exchange of information has strengthened the communication channels and established a higher level of trust between the parties involved. Furthermore, well-negotiated contracts have contributed to building a sense of trust, as they have ensured ongoing support and specific services, 24/7 assistance, upgrades, and improvements.

Incorporating CC and IoT, in particular machines, has greatly enhanced collaboration and cooperation and revolutionized communication and information sharing between Company C and its supplier. Online platforms have facilitated the sharing of information, enabling the company to communicate more effectively with its supplier. Remote monitoring of the production process and remote assistance in case of failures have streamlined communication channels and reduced

response times. While personal contact and verbal communication remain crucial in certain key aspects, the availability of online communication tools has greatly enhanced overall communication and information sharing between the company and its supplier.

In general terms, the interviewee mentions that their suppliers have evolved from merely providing equipment to becoming operational partners, offering additional services beyond just supplying machinery. These services include round-the-clock online technical support, remote equipment monitoring as well as fault detection and troubleshooting (as with machines featuring IoT and CC functionalities). Suppliers are now actively involved in equipment maintenance and optimization, delivering personalized after-sales services. This shift towards a more collaborative approach has enhanced the equipment's reliability, efficiency, and overall operational performance.

Lastly, implementing Industry 4.0 technologies and establishing well-negotiated contracts have paved the way for long-term relationships between Company C and its suppliers. The company now considers its suppliers as partners, particularly those providing complex or technological equipment. Through good negotiations and purchase contracts, the suppliers of these technologies are recognized as long-term partners. This strategic approach emphasizes the importance of selecting reliable suppliers and aligning with the company's technological trend when choosing partners, thus ensuring sustainable and mutually beneficial relationships.

Table VI. Case 3 main characteristics.

	Case 3
Industry 4.0 technologies	Industrial Robots, Machines with IoT and CC functionality and integration with WMS (already implemented in Company C).
Suppliers	Technology supplier: An international supplier was the original technology supplier and local suppliers responsible for maintenance.
Drivers for Industry 4.0 technology adoption	Increase of productivity and the Peruvian regulations updates aimed at improving work conditions for employees.

3.1.4. Case 4 – Company D

The implementation of new Industry 4.0 technologies has changed the dynamics between Company D and its suppliers. Previously, relationships with suppliers were more limited and relied on established contracts. There were few suppliers, giving them more negotiation power, which sometimes led to friction. However, significant changes have occurred with the advent of new technologies like CC and Big Data.

The shift from traditional licensing models to CC has allowed for more visibility and transparency in terms of consumption and costs. With billing based on actual usage, customers better understand charges. This provides more visibility and avoids unpleasant surprises during contract renewals. According to the interview, it increases trust in the supplier relationship. Additionally, more supplier options foster competition and compel suppliers to offer added value.

Furthermore, the adoption of these new technologies has promoted collaboration and cooperation between the company and its suppliers. The availability of a diverse range of cloud service providers has reduced dependency on a single supplier and created competition. As a result, the buyer is more willing to work closely with suppliers, engaging in discussions, sharing information, and collaborating on projects. This collaborative approach enables a more mutually beneficial and cooperative relationship. Additionally, the presence of suppliers' account managers with technical expertise enables effective communication and facilitates knowledge exchange. Suppliers proactively approach customers with new solutions and ideas, enhancing communication and fostering a more dynamic exchange of information.

According to the interviewee, the company seeks more strategic relationships that go beyond commercial aspects, aiming for suppliers to accompany them in the proper adoption of new technologies. Long-term contracts of approximately five years exist, which allow Company D to receive support and consulting from the supplier, enriching their knowledge with upgrades and new technological trends. This indicates a shift towards a more collaborative and mutually beneficial partnership, where the supplier proactively assists the company's technological advancement.

Table VII. Case 4 main characteristics.

	Case 4
Industry 4.0 technologies	CC, Big Data and IoT.
Suppliers	Technology supplier: An international supplier was the original technology supplier.
Drivers for Industry 4.0 technology adoption	Global digital transformation trend (digital services) and the desire to change work model based on asset acquisition and outsource the IT service.

3.2. Synthesis

Upon comprehending each unique case study through the perspective of a theoretical model, a cross-case analysis was performed by consolidating the findings into a singular diagram and illustrating cross-case conclusions about the shift in BSR following the implementation of Industry 4.0 technologies. For this purpose, Table VIII was created, which will aid in extracting and constructing compelling, plausible, and unbiased arguments backed by the data (Yin, 2018).

Table VIII. General table of cases

	Case 1	**Case 2**	**Case 3**	**Case 4**
Sector	Manufacturing	Retail	Manufacturing	Banking
Industry 4.0 technology.	Industrial robots with IoT functionality.	MRs with IoT and CC functionality and WMS and WCS integration.	Industrial Robots, Machines with IoT and CC functionalities.	CC, Big Data and IoT.
Suppliers	Technology supplier: An international supplier was the original technology manufacturer, and a local supplier was responsible for electrical installation or maintenance. Production supplier: A local supplier of boxes.	Technology supplier: An international supplier was the original technology manufacturer. A second international supplier for integrating the Industry 4.0 technology with WCS and WMS and its local subsidiary.	Technology supplier: An international supplier was the original technology supplier and local suppliers responsible for maintenance.	Technology supplier: An international supplier was the original technology supplier.
Collaboration and Cooperation *(number of interactions with suppliers)*	More extensive collaboration became necessary, particularly for maintenance and technical support. Suppliers demonstrated genuine commitment by offering support even outside regular working hours. Similarly, collaboration and cooperation were also undertaken with the box supplier, who demonstrated a willingness to cooperate in providing a product that meets the buyer's demands.	Collaboration increased with the implementation of new technologies, particularly with maintenance activities, IT-related issues, and automation implementation phase (gradual distance as company learns to handle issues in-house).	Collaboration increased significantly with the implementation of advanced technologies, transforming suppliers into operational partners who offered a range of services.	Collaboration was enhanced due to a diverse range of suppliers, fostering a more cooperative relationship. Suppliers proactively offer new solutions and ideas through their account managers. This is perceived as something positive by Company D.

Relationship Duration *(year before or after the implementation of Industry 4.0 technology, where buyer and suppliers started a relationship)*	Long-term relationships established with reliable suppliers that can meet new demands and urgencies. The performance of the box supplier is highlighted, whose relationship with Company A has endured over the years thanks to their adaptation to new demands and their desire to cultivate relationships with Company A.	Relationships with strategic suppliers strengthened, particularly with the local representative of a global supplier. This supplier has managed to adapt and cultivate relationships over the years.	Suppliers are now considered long-term partners, thanks to negotiated contracts and alignment with the company's technological trend.	Relationships evolved towards strategic partnerships, with long-term contracts in place to assist with the adoption of new technologies.
Communication and information sharing (*online and face-to-face communication and information sharing declared by interviewee*)	Communication increased, aiding in troubleshooting and problem-solving of automated processes.	Effective communication and information sharing were necessary during the testing phase and to address unforeseen operational issues to ensure a stable and efficient system.	Online platforms facilitated communication and information sharing, reducing response times, and improving overall efficiency. Personal contact is not ruled out for activities in high complexity teams that are crucial for the operation of the plant.	The adoption of new technologies has improved communication channels, with suppliers proactively offering new solutions and ideas. The presence of suppliers' account managers facilitates knowledge exchange.
Trust	The implementation of new technologies challenged the established trust. Suppliers had to meet higher standards, proving their commitment and reliability. Trust increased as suppliers showed their dedication and adaptability to the changing environment.	Trust was established and strengthened with globally recognized automation suppliers, thanks to their reputation, standard procedures, and ongoing support. A local representative of a global supplier also became a key partner, with trust built on knowledge and consistent communication.	Trust grew as suppliers were given access to confidential information in exchange for operational benefits. Contracts played a role in establishing trust, ensuring ongoing support and services.	Trust improved due to the transparency provided by new technologies, particularly in billing and consumption. Increased supplier options also boosted competition, compelling suppliers to provide added value.

From the cross-case analysis table, it is clear that the implementation of new technologies significantly impacts the BSR in various aspects.

a) Trust has been an integral part of these relationships and is challenged and enhanced with the advent of new technologies. There is more than one way to demonstrate an increase in trust, whether through strengthening collaboration and cooperation, establishing long-term relationships, increasing communication and information exchange, or other particular characteristics inherent to each relationship or involved parties. All of these attributes are interconnected with trust. Therefore, any change in these characteristics that pre-existed in the relationships before the implementation of Industry 4.0 technologies or that emerged after the implementation of such technologies has resulted in all interviewees affirming that they have noticed an increase in trust towards their suppliers. In cases like Company A, trust was put to the test with higher standards set due to technological advancements, prompting suppliers to prove their reliability and commitment. In Company B and C's situations, trust was fortified by global suppliers' reputations, standard procedures, and collaboration for bringing continued support. Company D experienced an increase in trust due to the transparency provided by CC and the introduction of a usage-based billing model. The overall trend suggests a positive shift in trust, reinforcing the importance of reliable and flexible suppliers capable of adapting to the new technological landscape.

b) Collaboration and Cooperation between companies and their suppliers significantly intensified with the advent of Industry 4.0 technologies. Companies A and B saw greater involvement from suppliers, especially in maintenance and technical support roles. In the first case, due to the need for higher input standards, the parties had to cooperate to reach a common goal while protecting their interests. In the second case, collaboration was intensified during the design and implementation stages of the AMR and continues even after the technology has been launched to ensure correct adoption and solve unforeseen issues that were not addressed during the project design stage. For Companies C and D, suppliers transformed into operational partners providing extended services, highlighting the changing nature of supplier roles in the new era. Specifically, Company D noticed a more cooperative relationship due to a diverse supplier range, emphasizing the importance of competition in fostering effective collaboration. Additionally, by engaging with Industry 4.0 technology suppliers that operate globally, Company D gains access to support and innovative solutions that have already been successfully implemented in various locations worldwide. This is due to cooperation agreements established by Company D and the presence of account managers.

c) Effective communication has become crucial in the new technological environment. All companies noted an increase in communication for troubleshooting, problem-solving, and knowledge sharing, facilitated by digital platforms in many instances. Particularly, a combination of face-to-face and online interactions has enabled companies C and D to emphasize the advantages of online communication tools. This shift showcases the vital role of open and constant communication in ensuring smooth operation and maximizing the benefits of new technologies. For the cases of Companies A, B, and C, it is found that the increase in communication with suppliers arises from the need to maintain the operation of their Industry 4.0 technologies and their automated processes in general.

d) The shift towards long-term relationships with suppliers was noticeable too. Company A and B built stronger relationships with strategic suppliers, particularly Company B with a local representative of a global supplier. As a result of implementing Industry 4.0 technologies, Company C began to perceive suppliers as long-term partners, forging relationships based on negotiated contracts and shared objectives. Company D focused on creating strategic partnerships that offer support in adopting new technologies. This trend highlights suppliers' critical role, not just as service or product providers, but as strategic partners in the journey towards technological advancement.

e) The IoT technology was found in all four cases, as well as Industrial Robots, specifically in Cases 1 and 3 (manufacturing companies), and CC in Cases 2, 3, and 4. That means that regardless of whether we are talking about manufacturing companies, retail businesses, or banking services, the technologies of Industry 4.0 are cross-sectoral.

f) In all four cases, Industry 4.0 technologies either integrate with existing technologies or replace outdated ones or manual processes. This integration or replacement changes the pre-existing dynamics between buyers and suppliers and involves new suppliers in the process. These new suppliers introduce new ways of interaction that are characteristic of the implemented technology. In essence, the implementation of Industry 4.0 technologies can have the dual effect of revitalizing existing business relationships and fostering the development of new, technologically driven ones.

CHAPTER IV: DISCUSSION

From the results obtained, we proceed to analyze the propositions. In summary, all the four propositions have been fully corroborated.

p1: *Cooperation and collaboration between buyers and suppliers are reinforced after the implementation of Industry 4.0 technologies.*

There has been a remarkable increase in cooperation and collaboration across all companies we studied following the introduction of Industry 4.0 technologies (Ghadge, Er Kara, et al., 2020). For instance, Company A, after the implementation of these technologies, it is observed a significant uptick in suppliers' involvement, particularly in areas such as maintenance and technical support, as they collaborated in developing spare parts as exposed by the Production Engineer:

"Entonces no nos podemos dar ese lujo, prácticamente lo que tendría que ocurrir son cero fallas porque la caja no te las aguanta, entonces que tuvo que hacer el proveedor, tuvo que mejorar su tecnología, tuvo que comprar otros equipos para que no haya problema o sino íbamos a dejar de comprar a ellos."

"Sí, sí hemos trabajado hay repuestos así, pero básicamente es el área de mantenimiento que trabaja con ellos, en desarrollar, traen, hacen una prueba, un prototipo, lo prueban, no funciona vuelven a hacer modificaciones, cambian de material porque el otro material se gastó, se sacó el gancho rápido, si hay bastante desarrollo en repuestos y el área de mantenimiento con proveedores locales."

A particular supplier also played a key role in creating new packaging to meet evolving customer demands. This transformation led to a shift from a purely contractual relationship to one characterized by mutual cooperation aimed at achieving common goals.

Similar trends emerged in Companies B, C, and D as well. Suppliers evolved from traditional roles to becoming strategic partners offering a wider range of services, signifying a meaningful shift in their roles and a boost in collaboration (J. W. Veile et al., 2020). The excerpt below from Company C's Project Manager supports the stated claim:

"Sí, ahora viene más enfocadas, no solamente al suministro, sino… No es que venga gratis, pero, por ejemplo, una asistencia 24/7 con estas gafas de realidad virtual, eso es un incremental en el costo pero que no significa un gran incremental; pero, si tú por ejemplo tuvieras una falla y tuvieras la necesidad de traer un técnico de Europa que te involucre estar parado 3 o 4 días hasta que llegue y luego repare. Solamente con una intervención de esas ya pagaste el

servicio del año. Entonces, no es un costo significativo, pero sí es un seguro que te va a dar la confiabilidad de que tú tengas un problema y a la hora ya estás con el especialista revisándolo a ver qué tienes que reparar."

Company D presents a specific example worth noting. Thanks to the introduction of CC technology, the availability of information vastly improved (Patrucco et al., 2022). This technological upgrade sparked a desire for partners who could assist the company in properly adopting new technologies, system upgrades, staff training, and other benefits. These changes foster a more cooperative and supportive relationship between the company and its suppliers, further strengthening their partnerships. The following excerpt made by the Technology and Engineering Architecture Manager evidence the aforementioned statement:

"...sí debemos considerarlos socios estratégicos, precisamente por eso, porque logramos una convivencia y ganar-ganar entre ambos. Y ellos también lo entienden así, digamos su mindset también ha cambiado bastante, ellos también lo ven como socios estratégicos, ven que ellos tratan de siempre decir, "Somos tu socio estratégico, estamos tratando de encontrar mejores opciones para ayudarte a encaminar hacia generar mayor valor en tu core". Entonces, sí hemos visto ese cambio."

Thus, the empirical evidence gathered throughout this study aligns with the findings by Ghadge, Er Kara, et al. (2020); Patrucco et al. (2022); J. W. Veile et al. (2020) and supports the proposition.

p2: *Communication and information exchange between buyers and suppliers become more frequent after the implementation of Industry 4.0 technologies.*

Again, the findings from the companies confirm this proposition. All companies reported an increase in communication for troubleshooting, problem-solving, and knowledge sharing, facilitated by digital platforms. Taking Company A as a case in point, the introduction of industrial robots pushed the need for robust, timely, and more frequent communication. To prevent plant shutdowns, the buyer and its suppliers found themselves interacting more frequently, ensuring that emerging issues were addressed promptly. Further, the need for maintenance and technical support fostered a closer collaboration with suppliers work in harmony with suppliers to resolve issues, highlighting the importance of communication in successful operation. The excerpt below from the Production Engineer supports the stated claim:

"Y de confianza sí puede ser porque siempre te contestan el teléfono, siempre están disponibles a poderte atender en una emergencia así sea de noche."

Company B's experience corroborates this idea. The introduction of MR technology required a trust-building process with globally recognized suppliers. The supplier, having been involved in the implementation phase, was continually in touch with Company B, assisting them in overcoming software deficiencies. As the system stabilized, the need for supplier support reduced but didn't vanish completely. For critical or complex issues, the company still resorts to the expertise of the supplier, indicating a sustained level of communication. This selected passage from the interview confirms the pre-stated notion:

"El área de TI siempre normalmente te maneja hasta un nivel 1 en donde es un checklist que ver que es lo que probablemente no haya pasado, las interfaces, pero llega un momento en el que no es tema simplemente de interfaces si no ya de programación de algo ya interno del hardware entonces ahí es donde llamas a tu proveedor y este le dices oye tengo este problema no lo puedo solucionar y ellos se meten y empiezan a hacerlo ¿no?"

"Claro, la empresa en general ya está acostumbrada pero cuando hicimos el AMR claro ya teníamos que contratar un nuevo servicio con nuestro proveedor que nos vendió los robots para tener este tipo de soporte no? Que nosotros no podemos manejar"

In the case of Company C, the advent of advanced technologies such as CC and IoT revolutionized communication and information sharing. Suppliers transformed from equipment providers to operational partners, offering 24/7 online technical assistance and remote equipment monitoring. This transformation required an open communication channel, fostering a higher degree of collaboration and more frequent information exchange. The Project Manager's subsequent comments corroborate the previously mentioned assertion:

"Mira, ¿cuáles son los principales drivers? Primero, productividad y a eso me refiero a disponibilidad de equipos, me refiero a costos, una atención remota o un contrato de atención virtual 24/7 es mucho más barato que traer técnicos cada vez que tengas un problema."

"...Entonces lo que ha cambiado es lo que teníamos antes proveedores de equipo a partners de operación, o que te ofrezcan estas ayudas que al final te dan mayor confiabilidad de los equipos, mayor eficiencia, mejor rendimiento… Porque ellos en el caso de un equipamiento que tenemos muy muy especializado, que tenemos por ejemplo eso que te comento, que tenemos un equipo muy especializado que tiene un monitoreo directamente desde Suiza y ellos nos mandan alertas y nos dicen, "¿Sabes qué?, programa mantenimiento porque ya tienes tal señal de vibración". Entonces esas cosas marcan la diferencia hoy en día, y eso se refleja en menores costos de operación o menor tiempo de paradas, mayor disponibilidad de líneas."

"...el tratar ya las líneas de producción, no como equipos independientes, sino como líneas enteras de producción donde se tienen intercambios de información y se generan los datos para medir la productividad, los mantenimientos, etcétera."

"[talking about information sharing with suppliers] Uy, ni hablar. Era el secreto de tu empresa.

Company D, too, experienced a similar shift. With the implementation of CC and Big Data, transparency increased, as did the need for continuous communication. Through their account managers, suppliers were now more willing to engage in discussions, share information, and collaborate on projects. Long-term contracts further ensured constant support and consultation from the supplier, amplifying the frequency of communication. The following excerpt made by the Technology and Engineering Architecture Manager evidence the aforementioned statement:

"Sí. Cada cierto tiempo vienen, nos consultan. A veces también les decimos que ya no vengan tanto porque en verdad nosotros también, de alguna manera, estamos enfocados en varias cosas. Pero para serte sincero, sí, o sea, cada… antes también había, antes existía el concepto del account manager, que era el administrador de la cuenta, de parte del proveedor con el cliente. Ese account manager al comienzo, era un account manager… en esa época inicial, era más como pensando en el tema comercial, entonces él era el que de alguna manera te buscaba, no tenía mucho conocimiento tecnológico, sino, básicamente él estaba ahí porque básicamente era para el tema comercial, para la renovación, que cuántas licencias, va por ahí. Digamos, todavía existe el concepto de account manager con los grandes proveedores, pero esos account managers, de alguna manera, ya en mi percepción, los veo mucho más enfocados o predispuestos porque por detrás me imagino que estas grandes empresas han cambiado también su chip y tienen un gran respaldo de diferentes equipos. Vienen con opciones de poder brindarte cosas que ellos han hecho en otros lugares. Entonces, por ejemplo, si te dicen, "Oye, mira, por si acaso, si te interesa Big Data, te puedo traer a los expertos de otros países donde hemos manejado el tema del Big Data", o incluso, bajo predisposición de algún cliente a nivel mundial, "Puedo acercarte a que te comparta sus experiencias, quizá ha avanzado más que tú". Y también a veces nos dicen, "Oye, ¿tienes la disposición para que puedas conversar con algún cliente, para que puedas contarle, porque tú estás más avanzado que él". También puede darse. Sí se están dando esas aperturas, esos espacios, que antes eran un poco más difíciles. Entonces, bacán, eso me parece interesante porque nos enriquece a todos."

In conclusion, all four cases show an uptick in the frequency of communication and information exchange between suppliers and customers after the implementation of Industry 4.0 technologies. This increase appears to stem from the complexities and challenges associated with these

advanced technologies, which require suppliers' continuous support, troubleshooting, and maintenance.

Based on the empirical evidence, the findings resonate with those of J. W. Veile et al. (2020), which suggest that the digitization and automation of processes lead to increased communication and data exchange. It is clear that the proposition holds true.

p3: *The desire for long-term relationships between buyers and suppliers increases after the implementation of Industry 4.0 technologies.*

The empirical evidence obtained from these case studies indeed illustrates a marked inclination towards long-term supplier relationships following the implementation of Industry 4.0 technologies. Company A, for example, demonstrates this trend. It has chosen to cultivate long-lasting relationships with suppliers who consistently meet their increased demands, underlining an affinity for stable, long-term relationships. The excerpt below from the Production Engineer supports the stated claim:

"Si te decía que cuando nosotros teníamos el proceso manual las cajas a veces venían por decir mal troqueladas o sea las cajas ya no se arman así sino venían con un lado que está un poquito más largo entonces."

"...en este caso a Proveedor 1 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos,..."

"Entonces no nos podemos dar ese lujo, prácticamente lo que tendría que ocurrir son cero fallas porque la caja no te las aguanta, entonces que tuvo que hacer el proveedor, tuvo que mejorar su tecnología, tuvo que comprar otros equipos para que no haya problema o sino íbamos a dejar de comprar a ellos."

"...luego el arranque y estas personas con las que hemos trabajado eran personas que siempre montan equipos, eran especialistas en electricidad y mecánica, hemos tenido problemas son los únicos que nos ayudaron a montar otras envasadoras otros equipos en otros lados."

Company B's experience testifies to the need for sustained supplier relationships in the context of Industry 4.0. MR technology led to partnerships with globally recognized suppliers who offer more than just technology. Their continued support and maintenance services persist, even after the system has achieved stability. Moreover, the durable partnership with a local representative that has persisted over many years, deemed as a key partner, underscores Company B's commitment to long-term collaboration. These selected passages from the Project Manager confirm the pre-stated notion:

"...Si, si son buenos y vienen trabajando con nosotros muchos años y la operación se la saben de memoria, entonces o sea es exactamente un equipo en particular que se sabe mucho la operación porque ha implementado las automatizaciones, eh las automatizaciones existentes, entonces ellos saben exactamente qué es lo que tenemos que ver lo que necesitamos nosotros."

"Si, o sea ¿son partners no? Trabajamos con partners y la comunicación es directa claro obviamente hay una facturación de por medio cuando hay un desarrollo en particular, pero como asesoría y como comunicación es todo el tiempo"

"...Entonces ahí es donde el proveedor mete mano y todo eso, cada vez que ya lo implementas y supuestamente ya todo funciona hay una etapa de seguimiento y acompañamiento que tiene que hacer tu proveedor en cualquier implementación es donde te dice ya está funcionando ¿ok? Pero de eso hasta que tu logres una estabilidad yo te tengo que seguir acompañando ¿por qué? Porque las casuísticas empiezan aparecer,..."

Company C's case study lends further credibility to this assertion. With the introduction of CC and the IoT, supplier relationships have changed from transactional to more collaborative and mutually beneficial relationships. Suppliers evolved into operational allies, offering additional services such as 24/7 online assistance. This shift signifies the establishment of more sustained partnerships. The Project Manager's subsequent comment corroborates the previously mentioned assertion:

"...lo común es que dejan de ser proveedores de equipos y se convierten más en partners de operación, eso es muy importante..."

Finally, in the case of Company D, the incorporation of CC and Big Data altered the supplier-customer dynamics, facilitating the formation of lasting relationships. This transformation was particularly catalyzed by the company's need for ongoing guidance in its digital transformation journey, leading to longer-term contracts providing continuous support and guidance from suppliers. The quote that follows from the Technology and Engineering Architecture Manager endorses the prior declaration:

"Sí, básicamente lo que se busca son relaciones mucho más estratégicas con dichos proveedores. No son unas relaciones básicamente comerciales, sino básicamente son estratégicas para que de alguna manera nos acompañen en la correcta adopción de dichas tecnologías. Entonces sí se realizan algunos contratos que normalmente son a largo plazo. Aproximadamente 5 años con cada uno de ellos. Y dentro de ese proceso de contratación, o de ese contrato, aparte de adquirir la solución tecnológica, también se acompaña con apoyo, sesiones, consultoría, y horas que básicamente nosotros requerimos, intercambiamos con ellos

para que de alguna manera pueda haber fluidez en explorar nuevas iniciativas que ellos manejan para que de alguna manera enriquecernos con ese know-how."

The patterns observed across these cases corroborate the proposition, substantiating the insights of scholars like Vanpoucke et al. (2014); J. M. Veile et al. (2020) that Industry 4.0 indeed amplifies the durability of BSRs. Consequently, the proposition stating the desire for long-term relationships between buyers and suppliers increases after the implementation of Industry 4.0 technologies is accepted.

p4: *Trust between buyers and suppliers is strengthened after the implementation of Industry 4.0 technologies.*

Data from all companies indicate a positive shift in trust due to the transparency provided by Industry 4.0 technologies (Bienhaus & Haddud, 2018). Company A demonstrates how the introduction of Industry 4.0 technologies necessitated improved product quality and reliability, which in turn tested the trust between Company A and its supplier. Nevertheless, these challenges also facilitated a more collaborative relationship, marked by greater communication and interaction, which helped reinforce the trust between the parties. The excerpts below from the Production Engineer support the stated claim:

"Qué puede ser, no me imagino, pero por decirlo, lo que sí es la confianza en el que ellos se comprometen a una fecha y si la cumplen o sea no te pasean."

"Interviewed 1: Y de confianza sí puede ser porque siempre te contestan el teléfono, siempre están disponibles a poderte atender en una emergencia así sea de noche."

In the case of Company B, the experience corroborates the importance of collaboration in building trust. Their journey with MR technology implementation required an initial phase of joint effort and 100% collaboration with suppliers, which gradually decreased as the system became self-sustaining. While this may indicate a shift toward independence, it does not diminish the trust established during the implementation phase. Rather, as exposed by the interviewee, it underlines the company's trust in the supplier's support during critical issues. This trust is further reinforced by the fact that Company B works with global suppliers, which fosters an even greater level of trust in their relationship. These selected passages from the Project Manager confirm the pre-stated notion:

"Entonces ahí es donde el proveedor mete mano y todo eso, cada vez que ya lo implementas y supuestamente ya todo funciona hay una etapa de seguimiento y acompañamiento que tiene que hacer tu proveedor en cualquier implementación es donde te dice ya está

funcionando ¿ok? Pero de eso hasta que tu logres una estabilidad yo te tengo que seguir acompañando ¿por qué? Porque las casuísticas empiezan aparecer, cualquier casuística cualquiera que se te ocurra porque la etiqueta se leyó mal, se despegó algo, le pegó al sensor y ya no funciona lo que tu quieras entonces hay una etapa de acompañamiento en donde se empiezan a producir todas estas casuísticas hasta que tu sistema esté completamente estable y ahí tu proveedor ya pasa a un segundo plano ya pasa a ser tu soporte eventual cuando ya pasas ciertas cosas muy difíciles de solucionar o cosas que tu no puedas solucionar no? Entonces la relación con un proveedor es paulatina estás primero 100% con él mientras implementas, te da un acompañamiento y ya después del soporte ya simplemente dependes muy poco de él no? Uno siempre busca como empresa a tratar de absorber lo más posible y tratar de solucionar lo más posible internamente para que no dependas tanto de tu proveedor por ejemplo en este caso nuestro proveedor está en España entonces la diferencia de horas hace que te cobre más, hace de que no haya eso que te llamo a cualquier hora porque ahorita lo llamo y ellos están durmiendo o cuando nosotros estamos durmiendo ellos están en pleno día entonces hay ese tipo de cosas, entonces tu tratas de que todo lo que puedas absorber tú, lo que puedas solucionar tu para que dependas lo menos posible de tu proveedor…"

"No, no porque trabajamos con proveedores mundiales, este para la nueva automatización estamos hablando del hemos trabajado con el tercer, quinto y sexto proveedor mundial de automatización, entonces son proveedores que no o sea justo es algo interesante que estábamos conversando en el proceso porque claro como peruanos siempre tenemos ese miedo, nos estará diciendo, nos engañará, nos dirá ósea durante todo el proceso nos hemos dicho oye cómo me aseguro de que realmente me estás diciendo lo que me vas a dar…"

"…Entonces eso va a ver siempre, pero en tema de que te quiero sacar la vuelta de que no te quiero pagar que me voy a escapar que no te voy a acompañar eso no, es muy difícil creerlo y si nos cuesta. Para la parte de la licitación nos ha costado mucho porque siempre queríamos no no que lo ponga, que lo diga que lo haga, papelito manda pero es parte de no?. Pero no en esas esferas no existe eso."

The evolution of supplier relationships from mere equipment providers to operational partners, as seen in the case of Company C, is a significant factor in strengthening trust. The adoption of IoT and CC technologies enabled Company C to share previously confidential information with their suppliers, thereby deepening the level of trust. The suppliers' involvement in day-to-day operations, providing services like 24/7 online technical assistance, remote equipment monitoring, and fault detection, further strengthened this trust. These selected passages from the Project Manager confirm the pre-stated notion:

"...y software para que uno pueda compartir información en línea con el fabricante de tal manera que el fabricante puede estar monitoreando nuestro proceso o, en el caso de fallas, que el fabricante pueda acceder al cerebro de la máquina y nos pueda ayudar a detectar las mismas."

"Sí, ahora viene más enfocadas, no solamente al suministro, sino… No es que venga gratis, pero, por ejemplo, una asistencia 24/7 con estas gafas de realidad virtual, eso es un incremental en el costo pero que no significa un gran incremental; pero, si tú por ejemplo tuvieras una falla y tuvieras la necesidad de traer un técnico de Europa que te involucre estar parado 3 o 4 días hasta que llegue y luego repare. Solamente con una intervención de esas ya pagaste el servicio del año. Entonces, no es un costo significativo, pero sí es un seguro que te va a dar la confiabilidad de que tú tengas un problema y a la hora ya estás con el especialista revisándolo a ver qué tienes que reparar."

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Lastly, Company D's transition to CC and Big Data brought about increased visibility and transparency in their dealings with suppliers, leading to enhanced trust (Ghadge, Er Kara, et al., 2020). The shift to a consumption-based billing model facilitated a clearer understanding of costs, promoting trust between Company D and its suppliers. The change in supplier dynamics, with more competition and an emphasis on added value, nurtured a cooperative relationship marked by active information sharing, collaboration, and technical support. The excerpts below from the Technology and Engineering Architecture Manager support the stated claim:

"Sí hay más transparencia…"

"...no tenía por qué motivarse a ofrecerte algo nuevo. Ahora son varias con servicios muy similares a nivel de Cloud, y que de alguna manera también tienen que "luchar" para mantener a sus clientes, y que de alguna manera tienen que mantener algún valor adicional, agregado."

"[Talking about Account Managers] Sí. Cada cierto tiempo vienen, nos consultan."

In this regard, it is also important to note that, in all cases, long-term relationships with suppliers are an indication of trust as exposed by J. W. Veile et al. (2020). For example, Company D established five-year contracts for continuous support and consulting, signifying an enduring trust-based relationship. Similarly, Company A's suppliers have been chosen based on their commitment to availability and communication, and these relationships have spanned several years, further evidencing strong trust.

These findings validate the proposition and align with the research conducted by Bienhaus and Haddud (2018); Ghadge, Er Kara, et al. (2020); J. W. Veile et al. (2020), which emphasized that Industry 4.0 technologies can foster trust through increased transparency and collaboration. Hence, Proposition 4 is accepted.

To conclude, the research question initially proposed is addressed, drawing upon the points discussed in the theoretical framework and the methodology applied:

RQ: How does the implementation of Industry 4.0 technologies affect the buyer-supplier relationship in the Peruvian context?

The implementation of Industry 4.0 technologies in the Peruvian context has substantially driven a transformation in buyer-supplier relationships. An evolution towards deeper interdependence and collaboration has been observed, where communication and information exchange, collaboration, relationship durations, and trust play critical roles, fostering a more intense integration among parties.

These technologies have created more complex and interconnected processes, prompting buyers to adopt a long-term perspective. They have understood the importance of maintaining close and timely communication and establishing enduring relationships with critical technology providers.

Moreover, there is an emphasis on consolidating and integrating suppliers, leading to the pursuit of more balanced and strategic relationships. This occurs in an attempt to avoid dependence and achieve greater control over their technologies. In this regard, buyers seek to establish close, collaborative relationships with suppliers who can adapt to their changing needs and accompany them in their process of adopting Industry 4.0 technologies. This has led them to consider suppliers as true partners in most cases.

Another important aspect to highlight about the effect of Industry 4.0 technologies is that, regardless of the sector where they are integrated, the main elements of the BSR have been affected to varying degrees. Trust, in particular, stands out because it lays the foundation for building long-term relationships. The increase in trust results from improvements in communication and information exchange. Likewise, it is evident that the reputation of suppliers,

backed by their global presence, work experience in other parts of the world, the standardization of their processes, the quality of the service offered, and the fulfillment of delivery times, play a significant role in enhancing trust.

Finally, it has been evidenced that Industry 4.0 integrates with pre-existing complementary technologies within companies. From the BSR perspective, this reflects the adaptation and evolution of the relationship based on the demands that arise from the integration of each new Industry 4.0 technology into the processes.

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

- Through the collected information, we have been able to explore how the technologies of Industry 4.0, implemented in Peruvian companies, have affected the BSR. This impact is manifested in key aspects of the BSR, such as trust, cooperation and collaboration, communication, information sharing, and the duration of relationships.

- The literature on Industry 4.0 has been progressively expanding as the concept continues to evolve in tandem with technological advancements and their impact on business and society at large. However, the BSRs have not been thoroughly explored within the context of Industry 4.0, underscoring the need for increased theoretical contributions in this field. By doing so, we can deepen our understanding of the impact that these relationships are experiencing due to the advancements of the Industry 4.0 phenomenon. This aspect becomes particularly relevant when considering the key role that BSRs play as a source for enhanced competitive advantage.

- The literature also reveals that the influence of Industry 4.0 and its associated technologies has been seen in various fields of engineering management. These include production and maintenance management, supply chain management, project management, organizational processes, environmental sustainability, and innovation.

- The qualitative methodology employed in this research has allowed us to delve into the perspectives of the interviewees to explore in detail the impact that Industry 4.0 technologies have on the BSR in the Peruvian context.

- The comparison of the impact of Industry 4.0 technologies on manufacturing, retail, and service companies is interesting, as the effects on supplier relationship characteristics are consistent across the board. This supports the thesis that the Industry 4.0 phenomenon affects not only manufacturing companies but all players in the value chain.

- Implementing Industry 4.0 technologies has transformed operational processes in Peruvian companies, reducing human intervention and improving efficiency in process control, productivity, maintenance, and failure resolution. With regard to the latter, the transformation of processes towards interconnected and automated systems due to IoT and CC creates a high need for immediate fault resolution to avoid process interruptions. Therefore, associations with key suppliers and knowledge transfer are fundamental for companies to face eventualities.

- While trust, communication, and cooperation are important for establishing long-term partnerships, seeking a balance that allows the company to maintain a reasonable degree of autonomy and the ability to adapt to future changes and requirements is essential. This might involve looking for suppliers that offer flexible technological solutions, provide adequate training to internal staff, and promote a collaborative relationship in which the purchasing company has an active role in decision-making and system configuration, thus ensuring a balance between dependence and autonomy to ensure their adaptability and flexibility in the future. In this regard, there is a clear trend in all companies to absorb as much knowledge about new technologies as possible to avoid such dependency on suppliers and reduce costs.

- Relationships with key suppliers for companies continue to be contractual but no longer solely to secure a purchase supply or the provision of a specific service. Instead, they also ensure joint work after the implementation of new technologies. Post-sale services are positively valued for helping companies in their process of adopting new technologies, training for knowledge transfer, and technological upgrades or improvements.

- The reputation of suppliers, marked by their global presence and work experience in other parts of the world, the standardization of their processes, the quality of the service, and compliance with delivery times, generate a sense of trust in the buyers.

- The shift from purchasing licenses to consuming cloud-based services has improved reliability in the process and delivery of services. The willingness of suppliers to share knowledge, connect customers with other users, and offer added value contributes to the establishment of strategic partnerships, avoiding exclusive relationships or contracting with suppliers that hinder direct communication.

- Unfortunately, none of the interviewees claimed to have found manufacturers of Industry 4.0 technologies in the Peruvian market; however, the support in installation and maintenance of local suppliers is still valued due to availability. Working with direct representatives of the technological solution suppliers is also valued, avoiding involvement or relationships with intermediaries to guarantee the availability and flexibility of attention to needs.

- The arrival of Industry 4.0 technologies modifies and displaces manual processes to make way for automated processes; however, it is up to the companies to find mechanisms to avoid affecting personnel by providing opportunities for development in other activities that add more value.

- BSR adapts and evolves based on the demands brought about by the integration of each new Industry 4.0 technology into the processes.

- The Industry 4.0 phenomenon should be viewed as a complex problem and not be minimized by associating it solely with certain technologies. It is also crucial to understand how this phenomenon affects BSR, especially in countries where there is a deficiency in technological knowledge and production, as well as in business practices based on values and good business practices.

5.2. Recommendations

- For future research, it is suggested to incorporate a deeper exploration of how companies adapt to technological changes, particularly those derived from Industry 4.0, and how these adaptations may influence their relationships with suppliers. In addition, considering medium-sized enterprises as a subject of study could enrich the analysis, allowing a broader and more diverse comparison of the effect that Industry 4.0 technologies have on the BSR.
- We recommend the use of a quantitative methodology for future studies, which would allow a more robust generalization of the findings obtained in the current research.

- In an effort to improve the accuracy and validity of the results, it would be beneficial to increase the number of interviewees per company to two. This approach would allow for a more effective triangulation of the results obtained in each company. Furthermore, the inclusion of companies from various sectors would add considerable value to the research, as it could reveal unique characteristics of the BSR in the Peruvian context.

- In order for buyers to promptly benefit from Industry 4.0 technologies, it is important to promote knowledge about the advancement of these technologies and ensure suppliers adopt policies and standards that secure the buyers' information.

- To increase cooperation between buyers and local suppliers, it is necessary to enhance local technological production and/or knowledge about new technologies. Or at the very least, direct representatives from the companies of Industry 4.0 technologies should have a presence in Peru, establishing a direct communication channel with buyers to benefit from direct interaction with manufacturers, thereby improving availability for rapid attention and promoting technological knowledge development in Peru.

- To increase autonomy and adaptability to future changes and requirements and thus maintain a balance of dependency between the buyer and its suppliers, it is again

necessary to promote knowledge about Industry 4.0 technologies at all levels in both buyers and local suppliers and local technological production. This grants buyers greater flexibility to switch suppliers according to their needs and interests.

- To increase or maintain long-term relationships, it is necessary for suppliers to transform their processes and/or acquire new knowledge and solutions that keep pace with global trends and their buyers' needs. Especially for local suppliers, this is crucial to ensure relevant permanence among the strategic suppliers of buyers. This applies to both standardized and non-standardized product or service suppliers.

- To improve communication channels and information sharing, the presence of account managers with technological knowledge is recommended, adopting a more proactive stance to offer products or services according to the current needs of the buyers.

- For production managers, this research underscores the importance of adopting a proactive approach to anticipate changes in trends or potential challenges. Active participation and vigilance are crucial to staying ahead in the ever-evolving landscape of Industry 4.0.

- For both general and production managers, in an era of increasing automation, it becomes essential to consider the scalability and prospective growth of the chosen solutions. To strike a balance between dependence and autonomy, contracts should include clauses that provide flexibility for future enhancements.

- For general managers, exploiting the potential of new Industry 4.0 technologies like artificial intelligence and blockchain requires fostering knowledge within their organizations. Heightened monitoring and assessment of emerging technologies and their associated benefits can enhance internal understanding of the pros and cons of adopting certain technologies, thereby increasing the likelihood of early adoption.

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APPENDIX A. INTERVIEW GUIDELINE

Introduction

I would like to hear about your professional background and experience working in this company.

Could you please describe your experience and expertise? What is your position and function in the company? What do you like about working in your current role? What would you want to change or be different?

About cutting-edge technologies

To begin, I would like to ask you about the new technologies that your company has recently invested in and that you have been involved in or have extensive knowledge about.

Could you please describe these technologies and their main characteristics? Additionally, what are the key differences between these technologies and their predecessors?

About BSR before a specific i4.0 technology implementation

Moving on to the relationship between your company and its suppliers, some professionals argue that this relationship can differ depending on the products provided by the company. I'd like to hear your thoughts on this. Do you agree or disagree? Could you please elaborate on why you think this is the case and provide some examples?

If you have worked with the ___ technology supplier before, I would like to know more about the relationship with that supplier before implementing the ___ technology. Could you describe the nature of the relationship? (Purely contractual, communication, cooperation, opportunism, reputation, and trust). Alternatively, if you haven't worked with that supplier before, could you describe the relationship with your previous technology supplier or process suppliers before implementing the ___ technology?

About BSR after i4.0 technology implementation, drivers, and causes

Could you describe the relationship with your suppliers after the ___ technology implementation?

What has changed in your relationship? (Trust increasing, close forms of cooperation, operational integration, incrementation of reliability, long-term partnerships, transparency, and traceability, especially in components with higher complexity) From an operational perspective, have the implemented processes been transformed? What changes have you noticed? (Facilitate the exchange of information and data between actors thanks to standardized and integrated systems

and interfaces) On a strategic level, do you think that personal and manual contact have remained relevant and important after the implementation of the new technology? What do you think? (face-to-face meetings and contacts to cultivate trust and transparency, long-term BSR).

When something new is implemented, some motivators make companies decide to go for it. In this case, what were those motivators? What barriers did you have to overcome? Could you please describe them? How would you have liked events to have worked?

Wrap up

Now that you know what the interview was about, is there anything else you would have the opportunity to share? Is there anything else you would like to talk about?

APPENDIX B. CODEBOOK

Codebook

Project: Thesis

Report created by Juan Carlos Chuquizuta on 8/06/23

Code Report

All (81) codes

- **+_suppliers**

All references to the increase or decrease of providers, whether internal or external. *"mantenimiento con terceros pero se ha incrementado 20 o 30 por ciento más." Case 1*

- **100%_automa**

Fragments where it is mentioned that there is no human presence to carry out the processes. *"ya no hay ninguna persona" Case 1*

- **amr**

Regarding the core technology of Autonomous Mobile Robots (AMR). *"Entonces compramos estos robots que es AMR Autonomous Mobile Robots que básicamente lo que te hace es traer la mercadería hacia ti, hacia una estación de trabajo." Case 2*

- **autonomous**

Any information that demonstrates the robots' autonomy. *"Si ya, a través de la lectura del sensor del código de barra, la faja se autorregula para que éstos polímeros que están así lo manden para acá y es dentro de la misma faja de ese tamaño y hacen que la faja lo muevan a esta dirección." Case 1*

- **barreras**

Fragments that mention the barriers the buyer had to face and overcome to implement the technologies. *"...hay mucha más resistencia, normalmente, a que tus servicios corran en un ente tercero, donde de alguna manera tú no tienes mucha injerencia,..." Case 4*

- **big_company**

Related to large companies. *"es una compañía inmensa" Case 1*

- **bigdata**

Any reference to big data and related technologies. *"Temas como por ejemplo Big Data, también ha sido parte de lo que estamos trabajando." Case 4*

- **bsr**

Any information referring to buyer-supplier relationships. *"pero si ha habido incremento de más proveedores, pero por decir sí con proveedores locales buscando desarrollos a los repuestos." Case 1*

- **buyer_develop**

Information related to the development of the supplier, either by buyer's demand or on their own initiative. *"Y ellos son los que no tenían claro lo que tú me comentas a veces, han tenido que implementar nuevas políticas ahí, nuevos filtros, nuevos procesos.*

Interviewed 1: Si han puesto Checklists." Case 1

- **capacitacion**

Refers to instances where personnel are trained. *"Se les delegó, necesitamos que ustedes chapen esto y ustedes tienen que liderar, entonces ellos han estado en la capacitación, muchos técnicos viajaron." Case 1*

- **cloud_computing**

Referring to the core technology of Cloud Computing. *"el WCS normalmente ósea ahora hasta donde yo sé básicamente todo es en la nube son muy pocos, hay algunas partes digamos del WCS sobre todo que son las partes de los automatismos que, si tienen servidores físicos porque tienen que estar conectados a PLC, tienen que estar conectados a esas cosas, para eso si no, difícil que esté en la nube entonces siempre son servidores físicos ¿no? Hay la parte mecánica, la parte de eso que para esas comunicaciones normalmente necesitan servidores físicos pero el resto está en la nube." Case 2*

- **common_probl_solving**

Working together (buyer and supplier) to solve a challenge. *"en este caso a Proveedor 1 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos, hay que comenzar" Case 1*

- **communication**

Any information referring to communication between buyer and supplier, including changes in the form of communication and increased frequency. *"Si, sí hemos trabajado hay repuestos así, pero básicamente es el área de mantenimiento que trabaja con ellos, en desarrollar, traen, hacen una prueba, un prototipo, lo prueban, no funciona vuelven a hacer modificaciones, cambian de material porque el otro material se gastó, se sacó el gancho rápido, si hay bastante desarrollo en repuestos y el área de mantenimiento con proveedores locales." Case 1*

- **contacto**

Any reference to the tendency to establish face-to-face contact to maintain trust and transparency. *"...equipos muy muy tecnológicos sí es mejor que vengan y nos atiendan directamente de fábrica. Eso es uno de los puntos… o equipos muy críticos en el proceso, o equipos donde tenemos que garantizar la disponibilidad, es mejor que sean atendidos por el fabricante porque de eso depende el funcionamiento de la planta, entonces no nos arriesgamos a que lo hagamos de manera local o con un partner que me pueda costar menos pero que recién lo voy a probar." Case 3*

- **contractual**

Merely contractual relationship between buyer and supplier; that is, only the supply of something specific and nothing more. *"No, no, simplemente era el contrato, la licitación, nos llegaba el material y cada vez que necesitábamos llamábamos, pero no es que ellos vengan y nos digan saben que tengo nueva cinta o a lo mejor te interesa, vas a gastar menos." Case 1*

- **co-op & collaboration**

Any information that expresses any form of cooperation and commitment between the buyer and the supplier. Since the difference between the definitions of collaboration and cooperation is subtle, this research considers the concept of collaboration and cooperation as one. *"en este caso a Proveedor 1 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos, hay que comenzar" Case 1*

- **costo_beneficio**

Information that expresses the evaluation of the benefits of an action (monetary, for example) compared to the costs associated with the action. *"y en el tiempo han ido buscando por el tema de los tiempos sobre todo; en traer de Italia que dura como seis semanas en cambio acá lo preparan en una semana para evitar costos y seguramente te dura la tercera parte del tiempo y ellos ya evalúan qué cosas te conviene." Case 1*

- **cumplimiento**

Information that refers to the compliance status of the supplier. *"estos proveedores no los teníamos antes, lo que si no me queda muy claro es que estos patas para repuestos se demoran o mejor dicho tienen tiempos largos, pero sí te cumplen las fechas, te dicen te lo traigo en seis semanas, y en seis semanas lo tienes, no tiene retrasos, son bastante cumplidos." Case 1*

- **dependen**

Referring to the dependency that the buyer has on the supplier for some reason. *"mientras más grande sea la empresa que tú contratas, eh probablemente su WSC esté software su cerebro sea más este, primero más estandarizado no sea tan a la medida tuya, entonces cuando un sistema no es a la medida tuya tienes que hacerle muchos cambios y para hacerle muchos cambios tienes que entrar a la médula que le dicen, a la médula de esto y sólo lo puede hacer el proveedor no? No lo puedes hacer tú." Case 2*

- **disponibilidad**

Referring to the speed and openness with which the supplier responds to the buyer's requirements. *"...porque llamamos al que había disponible, oye necesitamos este diseño ¿lo puedes hacer o no lo puedes hacer? Y con ellos diseñamos y yo le decía oye visualizo más o menos este tipo de estantería" Case 2*

- **drivers**

Any mention of the reasons that motivated the company to adopt new technologies. *"Mira, ¿cuáles son los principales drivers? Primero, productividad y a eso me refiero a disponibilidad de equipos, me refiero a costos, una atención remota o un contrato de atención virtual 24/7 es mucho más barato que traer técnicos cada vez que tengas un problema." Case 3*

- **educ_superior**

The academic degree achieved by the interviewee. *"ingeniero químico" Case 1*

- **faja**

Refers to the conveyors used in an industrial environment. *"han utilizado esa tecnología de la faja de distribución" Case 1*

- **fallas_automa**

Any reference to failures or problems that occur in automated processes. *"lo otro que está ocurriendo en Kuka es que el robot agarra 10 cajas y pan las pone, en algún momento cuando está muy elevado una caja que está mal puesta se va a caer para el costado." Case 1*

- **fallas_manual**

All references to the failures or problems that exist in manual processes or where there is a lot of work done by operators. *"Entonces la caja ya no es cuadrada sino, por un lado la cara sale con una diferencia ya sale un poquito inclinada entonces eso cuando ocurría ya el pata armaba y cuando lo colocamos manual no había problema porque el manual normal se acopla y lo pones." Case 1*

- **force**

Any reference to the fact that the buyer somehow forces the supplier to accept their terms and/or conditions. *"nosotros tenemos una metodología, nosotros estamos implementado el Lean Manufacturing y ellos tienen que hacer su RDP o sea si hay algún problema tienen que darnos cuál ha sido la causa raíz y tienen que darnos las actividades." Case 1*

- **hmi**

Regarding the enabling technology Human-Machine Interface (HMI). *"Todo tiene un PLC o sea dentro de un equipo tiene un HMI por decir falla y ahí sale la alerta, hay un sensor de punto, y yo rápidamente los ubico y lo revisan." Case 1*

- **inhouse_maintenance**

Refers to the maintenance or development carried out by the buyer. *"entonces estos patas ya son la fuerza especializada, si no puede el mecánico pues si es un sensor o una faja que se ha roto, eso lo cambia de mantenimiento, pues si hay un tema más especializado, un tema no sé de programación o que no pueden dar solución la gente de mantenimiento, el de instrumentación viene con su técnico, viene con su laptop, su equipo y comienzan a ver." Case 1*

- **innovacion_tech_facilita**

Refers to innovations made with facilitating technologies. *"Tecnologías que no tienen nada de sorprendente que las empresas igual las ha recogido y las han captado bien para esta necesidad" Case 1*

- **insumo_baja_exig**

Inputs that are easy to find in the market, so finding suppliers is not a problem. There is high competition. *"En un momento comenzaron a fallar Proveedor 3, su cinta venía con poco pegamento y se abría, había muchos reclamos y había dos tres reclamos y no mejoraban así que ya decidimos cortar con ellos" Case 1*

- **insumo_cero_falla**

When the buyer demands higher-quality inputs with fewer defects. *"la caja tiene que ser perfecta" Case 1*

- **integration**

Information that refers to the buyer integrating or taking the initiative to integrate the supplier into their processes to collaborate on research and development, solving problems, or creating

new business opportunities. *"en este caso a Proveedor 1 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos, hay que comenzar" Case 1*

- **inversion**

Refers to investments of money in automation projects. *"Sí, sí todo perfecto, son inversiones grandes con retorno a varios años, no es que en Empresa A tú haces proyectos con retornos a 2-3 años, pero acá cuando tú implementas varios millones de dólares seguramente su retorno es a mucho más largo plazo, estamos hablando de 8 o 9 años." Case 1*

- **iot**

Any reference to the interconnection of physical devices, objects, and systems through the Internet, allowing them to collect and share data and perform intelligent actions. *"Entonces puedes tener un robot que embala o que abren sacos o que mueven cajas y eso va de la mano con todo el resto de equipos de la línea. Puedes tener muchos equipos grandes de proceso que ya vienen incorporados sensores de vibración, sensor de temperatura… que esa información se va a la nube y que te genera reportes y te dice "Programa mantenimiento en 15 días". O sea, ya esa obtención de la información, ese manejo de la información es lo que como tecnología están llegando ya con los equipos." Case 3*

- **lector_etiqueta**

Refers to an enabling technology that reads product labels. *"O sea, hay diferentes tipos de estas tecnologías, te lee la etiqueta y probablemente más adelante tu tengas que elegir entre 2 caminos ir de frente o ir a la derecha." Case 2*

- **long-term bsr**

Any mention of long-term relationships between buyer and supplier. *"...son buenos y vienen trabajando con nosotros muchos años y la operación se la saben de memoria, entonces o sea es exactamente un equipo en particular que se sabe mucho la operación porque ha implementado las automatizaciones, eh las automatizaciones existentes, entonces ellos saben exactamente qué es lo que tenemos que ver lo que necesitamos nosotros." Case 2*

- **lvl_know**

Refers to levels of knowledge. Not all buyer personnel have knowledge of how to solve the company's problems. There are different levels of knowledge, and depending on the severity of the problem there is trained personnel to solve it to a certain extent. The highest level would be the supplier's knowledge. *"cada equipo como te digo tiene siempre, las cosas se repiten pero si hay cosas, ajustes de parámetros, cosas que si igual, cada que hay un equipo se le hace su capacitación a la gente de mantenimiento y sobre todo los operadores también, hay capacitación al operador, hay capacitación a niveles, hay capacitación ya más específicas, más técnicas por decir a los supervisores y también tienen niveles de acceso a los equipos. Al operador siempre se capacita en operaciones, algunos parámetros pero hay un nivel de equipo, de acceso que todo tiene clave a nivel de operador pero puede regular velocidades, cosas; y a los mecánicos también hay un nivel que se les enseña el tema de los circuitos, la parte eléctrica, le enseña los airpols o sea hay por niveles no." Case 1*

- **manufact_indust**

Related to the manufacturing industry. *"soy ingeniero de producción" Case 1*

- **marca_reconocida**

Related to renowned brands and therefore recognized for their standards. *"marcas conocidas" Case 1*

- **modif_planta**

Related to plant modification or layout changes. *"trajeron la planta de Breña la que se llamaba Negrita ahora se llama Umsha" Case 1*

- **neumatica**

Refers to the enabling technology of pneumatic systems and components used in an industrial environment. *"unos tubos de venteo que nosotros le decimos que son los que succionan que estos se van rompiendo." Case 1*

- **no_100%_autom**

When referring to a process that is not fully automated. *"no todas las líneas están automatizadas" Case 1*

- **oportunismo**

Any sign of opportunism shown by the buyer and/or the supplier. *"...muchas veces el tema económico prima sobre lo otro, entonces, ¿qué pasa? Que la naturaleza de un servicio tercerizado es "Oye, yo siempre voy a buscar marginar con lo que tú necesitas. Entonces, si yo te firmé un contrato, y hay cosas medio raras o no muy claras, básicamente, lo no claro implica que yo te genere una adenda al contrato, y por detrás tienes que pagar más"" Case 4*

- **plc**

Refers to the enabling technology called Programmable Logic Controller. *"Entonces de acuerdo a lo que se lee en la etiqueta hay diferentes PLC…" Case 2*

- **proce_autom**

When referring to a process that is automated but not necessarily entirely. *"pero ahora todo está automatizado y es un robot que tiene cadenas, es como una parte circular que da vueltas y baja" Case 1*

- **proce_manual**

When referring to a process that is predominantly performed by operators. *"Y antes cuando todo era manual no había eso porque todo era de una persona, la persona validaba, no había estos temas." Case 1*

- **product_complex**

When referring to complex and non-standardized products or services, it can also refer to the process itself, whose complexity is determined by the equipment. *"control supongo que tiene ahí me imagino. Interviewee 1: Los equipos no. J: O sea los sensores, lo que van contando eso. Interviewee 1: Todo tiene un PLC o sea dentro de un equipo tiene un HMI por decir falla y ahí sale la alerta, hay un sensor de punto, y yo rápidamente los ubico y lo revisan.*

J: Bacán.

Interviewee 1: Es un tema más complejo, como te decía ya viene automatización, ya viene otro nivel de técnico que viene con su laptop a lo mejor tienen que descargar un software que les permite conectarse y hacer otro nivel de monitoreo no." Case 1

- **product_standard**

When referring to non-complex and standardized products or services. "ponías la caja y ya con una encintadora, la cinta había un equipito que te pones en un bracito que pasas la caja en cinta y corta, entonces antes se encintaban como el enfilmado, como tres le compraba con el volumen, ellos daban los equipos, osea la encintadora era de ellos solo que nos lo prestaban para asegurar que nosotros le compremos su producto y como era prestada también le dábamos servicios de mantenimiento por decir si se dañaba su encintadora lo llamábamos, un favor la cortadora ya se gastó la cuchilla y ya tienes una faja de tracción que ya tienes que cambiarla y lo llamábamos y como si había una competencia entre Proveedor 2 y Proveedor 3 ninguno quería quedarse y siempre venían rápido no." Case 1

- **ptl**

Regarding the pick-to-light enabling technology. *"para hacer ese picking de una manera más rápida y eficiente lo que hemos utilizado ahorita en los almacenes tenemos, creo que la tecnología es el pick-to-light." Case 2*

- **reducc_personal**

Regarding the reduction of operational personnel in a process. *"esto desapareció o sea desaparecieron estas y se convirtieron, lo que era manual ya pasaron solo quedaron operadores. Entonces acá tenemos de 16 pasó a 9." Case 1*

- **reliability**

Regarding process reliability or delivery reliability. *"No. Esas cosas… La disponibilidad de una planta tan grande, la hora parada de una planta muy grande es un montón de plata, entonces sí justifica que puedas caer en esos sobrecostos, pero por el bien de garantizar la disponibilidad de los equipos." Case 1*

- **repetitivo**

Referring to processes that are repetitive, usually manual processes where the operator repeats the same activities over and over again. *"operador agarraba con la mano, le daba una vuelta y luego la base comenzaba a girar." Case 1*

- **rf**

Referring to the radio frequency enabling technology. *"El RF es un equipo de radio frecuencia" Case 2*

- **ri**

All reference to core technology Industrial Robots. *"Lo que sí me sorprendió fueron los robots Kukas." Case 1*

- **rpa**

Referring to the Robotic Process Automation enabling technology. *"...o lo que viene a ser los RPAs o los robots, y todo este tema que te permite hacer este tipo de automatizaciones" Case 4*

- **secreto**

Related to trade secrets. Confidential information. *"O sea con el tema de productos, yo creo que sí, están ahí, no permiten." Case 1*

- **seguridad**

Referring to the set of practices and measures that include the involvement of suppliers to protect systems and data from potential cyber threats. *"Sí, de hecho, en el banco, como te decía, tenemos nuestra unidad de Cyber Security, de ciberseguridad, que ha sido repotenciada durante todo este tiempo y, de alguna manera, nos permite llegar a ese mi nivel de interacción con estos proveedores, pero tampoco no abriendo totalmente las cosas." Case 4*

- **sensor**

Referring to the enabling technology, sensors (in all their variations) are used in an industrial environment. *"hay un sensor que lee el código de barras" Case 1*

- **sol_fallas_autom**

Any reference to solutions given or to be given for failures in automated processes. *"entonces se tuvo que trabajar y se consiguió un Stretch film que es pre estirado que es una capa más resistente pero curiosamente más liviano osea es más delgado, es más económico y lo que nos permite también es la cantidad porque antes el operador lo metía hasta que esté bien seguro" Case 1*

- **sol_fallas_manual**

Any reference to solutions given or to be given for failures in manual processes. *"Le haces alguna jugada y luego ya eso se podía encajar y empaletizar sin ningún problema." Case 1*

- **sorter**

Referring to an enabling technology that performs product sorting. *"Y de ahí se va a un pequeño sorter que tiene unas 10 caídas…" Case 2*

- **supplier_competi**

Any reference to competition among suppliers. *"había una licitación a los proveedores y el otro siempre quería dar un buen servicio porque sabía que a lo mejor a la siguiente lo cambiamos." Case 1*

- **supplier_develop**

The buyer encourages the supplier to improve their technology and/or innovate. *"el proveedor, tuvo que mejorar su tecnología, tuvo que comprar otros equipos para que no haya problema o sino íbamos a dejar de comprar a ellos." Case 1*

- **supplier_inspec**

Referring to inspections carried out by the buyer to control the supplier's processes. *"No desde antes, a todos los proveedores en realidad, insumos, van y visitan su planta." Case 1*

- **supplier_local**

Any reference to Peruvian suppliers. *"nosotros damos soporte es la parte eléctrica, la parte mecánica," Case 1*

- **supplier_local_proble**

Any reference to problems the buyer has with Peruvian suppliers. *"hay piezas, nos damos cuenta, que sí no duran y trabajan mal y que ya las mandan a comprar de manera original a Kama" Case 1*

- **supplier_no_strategic**

It refers to non-strategic suppliers for the buyer and any indication of limited engagement with them, focusing solely on factors such as price, cost, volume, and efficiency. "...y como si había una competencia entre Proveedor 2 y Proveedor 3 ninguno quería quedarse y siempre venían rápido no.

J: ¿Tenían dos proveedores?

Interviewee 1: Sí, había una licitación a los proveedores y el otro siempre quería dar un buen servicio porque sabía que a lo mejor a la siguiente lo cambiamos.

J: Si no eran ellos dos, ¿Había otros proveedores que podrían hacerlo también?

Interviewee 1: No sé, osea eso sí había otros, pero sí andábamos con ellos dos, que eran los más grandes y tenían los mejores precios." Case 1

- **supplier_servicio**

Refers to the services provided by the supplier(s). *"De estos equipos quien nos da, corría por cuenta de ellos, y no nos cobraban ni un sol, salvo haya daño de algún equipo," Case 1*

- **supplier_strategic**

It refers to strategic suppliers for the buyer, either during the operation or during the product or solution design stage. *"...en este caso a Proveedor 1 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos, hay que comenzar, hay que hacer mantenimiento para todo y así en realidad si uno se pone a revisar el nivel de fallas es mínimo pero una caja fallada significa 3 minutos de parada, es decir yo mando*

50,000 cajas al dia pero no tengo ni el 1% de falla, sí pero nosotros el 1% es demasiado, no podemos aguantar ese nivel porque el 1% es 500 y si te digo que por uno se para, multiplicar por tres, no podríamos aguantar, entonces ellos a pesar que decían nosotros tenemos un nivel bajísimo con respecto a otro y antes lo mandabamos con un mayor nivel, la caja tiene que ser perfecta" Case 1

- **supplier_support**

Support or assistance from the provider in adopting Industry 4.0 technologies. *"...si hay una empresa que da un servicio y acá en el Perú hay un representante de Kuka que es una empresa que seguramente tiene la representación y ya con ellos van y se van escalando de acuerdo a la dificultad de la resolución del problema" Case 1*

- **tech_core**

Any reference to new and innovative technologies (developed in recent years) that are mature enough to be commercially available in the last decade. *"Kuka son robots alemanes que se encargan del paletizado y me sorprendieron bastante por la rapidez con la que se mueven, son brazos, son robots" Case 1*

- **tech_facilitator**

Any reference to mature technologies that enable new and innovative technologies to integrate, operate, and function properly. *"la tecnología sí no me pareció muy o sea han implementado bien, pero son sensores, son equipos de succión que yo los veo como equipos antiguos" Case 1*

- **tech_foreign**

Refers to technologies that were acquired or produced outside of Peru. *"marca alemana" Case 1*

- **tiempo_reposicion**

Refers to the time it takes to replenish a product or service. *"y en el tiempo han ido buscando por el tema de los tiempos sobre todo; en traer de Italia que dura como seis semanas en cambio acá lo preparan en una semana para evitar costos y seguramente te dura la tercera parte del tiempo y ellos ya evalúan qué cosas te conviene." Case 1*

- **traceability**

Any mention of tracing a product, process, or activity along the supply chain. Also refers to the ability to track and record activities and records related to asset maintenance, equipment, or assets. *"una asistencia 24/7 con estas gafas de realidad virtual, eso es un incremental en el costo pero que no significa un gran incremental; pero, si tú por ejemplo tuvieras una falla y tuvieras la necesidad de traer un técnico de Europa que te involucre estar parado 3 o 4 días hasta que llegue y luego repare. Solamente con una intervención de esas ya pagaste el servicio del año. Entonces, no es un costo significativo, pero sí es un seguro que te va a dar la confiabilidad de que tú tengas un problema y a la hora ya estás con el especialista revisándolo a ver qué tienes que reparar." Case 3*

- **transparency**

Refers to transparency in communication, information disclosure, reaching agreements, resolving problems, or differences. *"en este caso a Proveedor 11 sabes que vamos a cambiar, vamos a pasar más tecnología y necesitamos que las cajas no tengan defectos, hay que comenzar" Case 1*

- **trust**

Any reference to a trusting (or lack of trust) relationship that may be encountered. *"lo que sí es la confianza en el que ellos se comprometen a una fecha y si la cumplen o sea no te pasean." Case 1*

- **univ_reconocida**

When referring to a nationally and/or globally recognized university. *"UNI" Case 1*

- **unknwn_new_tech**

Refers to a technology that the interviewee is unfamiliar with or was unaware of initially, which could turn out to be a core technology. *"nunca había visto y la velocidad que tiene sobre todo me sorprende, sus movimientos coordinados" Case 1*

- **wcs**

Refers to the Warehouse Control System, a facilitating technology. *"A ver las automatizaciones se gestionan tienen su software que se le denomina el WCS ¿ya? Cualquier automatización tiene su cerebro es el WCS que es el que donde están todas estas configuraciones..." Case 2*

- **wms**

Refers to the facilitating technology Warehouse Management System. *"O sea en el almacén es todo a base de código de barras, el WMS lo que te hace es generar tareas entonces estas tareas viajan al RF al equipo de radio frecuencia y le dice a ver tienes esta tarea, cada tarea digamos es una bandeja" Case 2*
