UNIVERSIDADE FEDERAL DE SÃO CARLOS

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DEPARTAMENTO DE ENGENHARIA DE PRODUÇÃO

PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA DE PRODUÇÃO

DEVELOPMENT OF SUPPLY CHAIN VISIBILITY: A CONCEPTUAL FRAMEWORK

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June 2020

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Dissertação apresentada ao Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal de São Carlos, como parte dos requisitos para a obtenção do título de Mestre em Engenharia de Produção.

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SÃO CARLOS - SP

June 2020

UNIVERSIDADE FEDERAL DE SÃO CARLOS

Centro de Ciências Exatas e de Tecnologia
Programa de Pós-Graduação em Engenharia de

Folha de Aprovação

Defesa de Dissertação de Mestrado do candidato Igor Sant'Ana Gallo, realizada em 05/06/2020.

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O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil
(CAPES) - Código de Financiamento 001.
O Relatório de Defesa assinado pelos membros da Comissão Julgadora encontra-se arquivado junto ao Programa de Pós-Graduação em Engenharia de Produção.

ACKNOWLEDGMENTS

First, I would like to thank my parents for all the support they gave when I chose this new journey and the patience they had along the way. I would also like to thank my brother for the example and guidance he gave during my master's degree; it would have been much harder without him.

To my advisor, Andrea Lago da Silva, for challenging me with this project but also giving all the support I needed. I would like to thank her for all the patience she had and for everything she thought, especially how to be a good researcher.

To Morgan Swink, for all the assistance and guidance during the project, for showing the way during the critical moments of this research and for all the time and patience dedicated to this project.

To Moacir Godinho Filho, for allowing me to participate in his research group, which gave me several ideas about how to proceed and improve the project, for the guidance during critical moments of this research and all the recommendations to improve it.

To all my professors from UFSCar, that taught me how to be critical, to be a better researcher and a better student.

For all my friends who supported me during this journey and were by my side during the best and worst moments.

I would also like to acknowledge the contributions of Dr. Ravi Srinivasan, Dr. Baofeng Huo, Dr. Haozhe Chen, Dr. Mark Barratt, Dr. Angela Tumino, Dr. Dirk Pieter van Donk, Dr. Adegoke Oke, Dr. José Moyano-Fuentes, Dr. Jie Yang, Dr. Peter Trkman, Dr. Tyler R. Morgan, Dr. Shilu Tong, and the anonymous authors for their contributions to the proposed framework.

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001

ABSTRACT

The increasing dynamism and environment complexity demand more responsive supply chains, but the technology development allowed companies to take full advantage of supply chain visibility to cope with sudden changes. To develop visibility, it is necessary to identify which information the company should exchange and what factors might impact its value. This research proposes the term visibility dimension to refer to the type of information that can be exchanged to improve supply chain visibility and influential characteristics to organization's social and operating characteristics that can influence the value of a certain visibility dimension. Through the lenses of Contingency Theory and Social Capital Theory, this research presents how influential characteristics impact the development of supply chain visibility. The fit between the visibility dimensions and categories of influential characteristics is defined as visibility configurations. To do so, a systematic literature review was performed to identify the main dimensions, categories of characteristics, and links between a type of information and an influential characteristic. The second part of this project followed a Q-sort method to test if the characteristics and types of information were correctly labeled into the categories of characteristics and visibility dimensions, respectively. The results showed that the visibility dimensions had a high agreement between the judges, but the characteristics part did not. Although the second part of the questionnaire presented some problems, the characteristics that had low agreement could be verified through one of the theoretical lenses or past researches on the topic, so the items were theoretically validated. This research presents contributions to both practitioners and researchers. For practitioners, this research provided an actionable framework to develop visibility and provided guidelines on how to determine which visibility dimension should be developed. For the literature, this research provided two contributions. First, a formal definition of visibility dimensions, a synthesis of the approaches to develop visibility available in the literature. Second, a theory grounded analysis on how influential characteristics impact the development of supply chain visibility and propose the first version of the visibility configurations that might explain the conflicting results regarding some influential characteristics. This research was exploratory, so future researches might validate the configurations proposed and consider the impacts the categories of characteristics have on each other. Researchers should also consider the impact of the visibility dimensions on the categories to provide a more accurate picture of how influential characteristics impact the development of visibility.

Keywords: Supply chain management, information exchange, and supply chain visibility.

RESUMO

Devido ao crescente dinamismo e a complexidade do ambiente empresarial é necessário cadeias de suprimentos mais responsivas, porém o desenvolvimento tecnológico permitiu que as empresas desenvolvessem visibilidade pra lidar com as rápidas mudanças. Para desenvolver visibilidade é necessário definir quais informações a empresa deve trocar e quais fatores impactam o ganho que a visibilidade trará. Esta pesquisa propõe o conceito dimensão de visibilidade para se referir aos tipos de informação que podem ser trocadas para aumentar a visibilidade na cadeia de suprimentos e características ambientais que impactam seu valor. Esta pesquisa apresenta como as caraterísticas ambientais impactam o desenvolvimento de visibilidade na cadeia de suprimentos. A relação entre dimensões de visibilidade e características ambientais é definido como configurações de visibilidade. Para atingir tal objetivo, uma revisão sistemática da literatura foi realizada para identificar as principais dimensões de visibilidade, as principais categorias de características e os links entre informações e características ambientais. A segunda parte do projeto aplicou o método Q-sort para testar se as características e os tipos de informação foram classificados corretamente nas categorias e dimensões de visibilidade,respectivamente. Os resultados sugerem que existe uma alta concordância em relação as dimensões de visibilidade, mas não em relação as categorias de características. Apesar dos problemas na segunda parte do questionário, as características puderam ser validadas através de uma das teorias organizacionais ou através de outros trabalhos disponíveis na literatura, agregando validade teórica. Essa pesquisa apresenta contribuições para o mercado e para a academia. Com relação ao mercado, primeiro, esta pesquisa apresenta um framework que orienta o desenvolvimento de visibilidade. Segundo, ajuda a determinar a melhor dimensão a ser desenvolvida. Para a literatura, esta pesquisa apresenta uma definição formal de dimensões de visibilidade, uma síntese das abordagens encontradas na literatura, uma análise pautada em teorias organizacionais sobre como as características ambientais impactam o desenvolvimento de visibilidade e propõe a primeira versão das configurações de visibilidade. Essa pesquisa é de natureza exploratória, portanto pesquisas futuras podem validar os resultados apresentados, verificar os impactos que as categorias têm umas nas outras. Pesquisadores também podem verificar o impacto das dimensões nas categorias, proporcionando um retrato mais preciso de como as características ambientais impactam o desenvolvimento de visibilidade.

Palavras-chave: Gestão da cadeia de suprimentos, troca de informação e visibilidade na cadeia de suprimentos.

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1 INTRODUCTION

This chapter introduces the research's theme, problem and research questions (Section 1.1), objectives (Section 1.2), the expected contributions of this research to both practitioners and academics (Section 1.3), an overview of the research methods (Section 1.4), and the thesis structure (Section 1.5).

1.1 Theme Presentation

The increasing complexity and dynamism of the company's environment demand more responsive supply chains (MALHOTRA; MACKELPRANG, 2012) where supply and demand information play a key role in building such capability (LUMMUS; VOKURKA; DUCLOS, 2005; SINKOVICS et al., 2011). One example of sudden environmental change is the 2020 Coronavirus pandemic impacting consumer's behavior and company' activities. Several customers started to panic buying and turned to online shopping to avoid human contact that generated stockouts in physical stores and demand peaks in online platforms (BANDOIM, 2020a). To minimize the stockouts and demand peaks, Tesco supermarket limited the maximum number of items a person can buy in their stores and asked people who can go to their physical stores to do so, in order to leave online shopping just for the clients who cannot leave their homes (BBC, 2020). Unlike other types of disruptions, pandemics start small and scale to different regions worldwide, which makes it difficult to estimate their impact and the right measures to take to minimize it (IVANOV, 2020).

Although several countries are suffering from job losses, some companies, such as Amazon, Wallmart, Microsoft, and Netflix, are hiring to adapt to the increased demand (BANDOIM, 2020b; KELLY, 2020), which shows that companies from different industries followed different strategies to minimize the disruption. The companies that are expanding their operations rely on information technology to cope with market changes and deal with supply and demand changes during the disruption. The new technology development, such as data analytics, can improve the company's performance by improving its risk management and customer services (LAVALLE et al., 2010; MCAFEE; BRYNJOLFSSON, 2012) and help companies to take advantage of supply chain visibility.

Supply chain visibility is defined as access to accurate, timely, complete, and usefully formatted data that might come from the company's partners or the market (WILLIAMS et al., 2013). Timeliness, accuracy, and completeness are considered the quality aspect of visibility, and they should be developed along with accessibility, the ability to gather information, and usefulness, the ability to use the data to improve performance (SOMAPA; COOLS; DULLAERT, 2018). Due to all the requirements mentioned, increase visibility is difficult and usually demands the support of information systems to make the exchange possible (LI; YE; SHEU, 2014; MITTENDORF; SHIN; YOON, 2013; WANG; YE; TAN, 2014), but the costs of such systems might discourage its adoption (KEMBRO; SELVIARIDIS; NÄSLUND, 2014).

Despite the potential good outcomes, the managers that do not have clear goals might be disappointed by the outcomes compared to the costs involved in investing in new technologies (VANPOUCKE; BOYER; VEREECKE, 2009). If the company decides to invest in information systems, for example, they should be aware of possible incompatibilities with their partner's system that might compromise the information exchange (KEMBRO; SELVIARIDIS; NÄSLUND, 2014). Even if the company decides to invest in a specific system to avoid possible incompatibilities with its partner, such an asset might increase the interdependency between the companies and might also become a potential problem (YIGITBASIOGLU, 2010). Technical issues are not the only concern; companies might be reluctant to share information because it compromises its ability to control information leakage (SHAMIR, 2012), and such leakage can diminish the benefits from information sharing (LEI et al., 2014). Another potential problem was pointed out by Uzzi and Lancaster (2003), who argued that the risk of opportunist behavior is a significant concern for companies. Therefore, the company should be aware of the factors that might have positive and negative impacts on visibility development.

According to Lawrence and Lorsch (1967), a company can be viewed as an open system where its environment impacts the managerial decisions of the organization. Since each company operates in its specific environment and knowing that this environment can have sudden changes (MALHOTRA; MACKELPRANG, 2012), there is not a universal structure that a company must have to outperform its competitors. To survive in its environment and improve its performance, the company should match its structure with its internal and external environments (BUTTERMANN; GERMAIN; IYER, 2008;

DONALDSON, 2001; FLYNN; HUO; ZHAO, 2010; LAWRENCE; LORSCH, 1967; WOODWARD, 1980).

Due to the importance of the environment for the company's operations, this research used Contingency Theory as its theoretical lens to understand the role of the company environment in developing supply chain visibility. For this research, the structure under investigation is supply chain visibility. The internal and external environment will define the best way to develop visibility balancing the costs, risks, and good outcomes. The alignment between the environment and the strategy will help companies to survive its environment and achieve the best outcomes of visibility (LAWRENCE; LORSCH, 1967; WOODWARD, 1980).

To develop supply chain visibility, the company should be aware that multiple types of information should be shared (WILLIAMS et al., 2013). Although information sharing is the starting point of visibility development, some authors also consider the number of agents involved when thinking about visibility (ZHANG; GOH; MENG, 2011). Another important aspect is how this information is shared, where information systems might be used to operationalize the exchange of information (LEE; KIM; KIM, 2014). Based on these examples, it is possible to see that there are multiple interpretations of how companies should develop visibility and which aspects to consider. Although that are different interpretations regarding how to develop visibility, not much is known about how companies develop such capability. The number of different views and the different aspects they consider can make the development of visibility difficult in practice. Therefore, the literature lacks a rigorous definition of the dimensions of visibility that a company should develop to improve its performance. In this research, the term visibility dimension was used to refer to how supply chain visibility might be developed. Considering that visibility can only be achieved by accessing high-quality information (SRINIVASAN; SWINK, 2018; WILLIAMS et al., 2013), visibility dimension is defined as the type of information that can be exchanged to improve supply chain visibility.

Since multiple visibility dimensions might be explored, but that are also costs and risks involved in the process (KEMBRO; SELVIARIDIS; NÄSLUND, 2014; VANPOUCKE; BOYER; VEREECKE, 2009), the company should be aware of the factors that might influence in its decision, such as the level of trust and commitment, and the availability of an information system (BIAN; SHANG; ZHANG, 2016; BIRASNAV;

MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014; JOHNSON; ELLIOTT; DRAKE, 2013; KEMBRO; NÄSLUND; OLHAGER, 2017; WU; CHUANG; HSU, 2014). In this research, the factors that might impact any visibility dimension were referred to as influential characteristics. Influential characteristics are defined as an organization's social and operating characteristics that can influence the value of a certain visibility dimension. Although Contingency Theory could relate some influential characteristics to the company's internal or external environment, social characteristics, such as trust, commitment, and collaboration, that have been extensively studied in the literature (BIRASNAV; MITTAL; LOUGHLIN, 2015; FU; HAN; HUO, 2017; HUNG et al., 2011; JOHNSON; ELLIOTT; DRAKE, 2013; JONSSON; MYRELID, 2016; JRAISAT; GOTSI; BOURLAKIS, 2013; LIAO et al., 2011; MORGAN; RICHEY JR; ELLINGER, 2018; PATNAYAKUNI; RAI; SETH, 2006; SMITH; DUCHESSI; GARCIA, 2012; VAN DER MERWE; KIRSTEN; TRIENEKENS, 2017; VIJAYASARATHY, 2010; WANG; YE; TAN, 2014; WONG; LAI; CHENG, 2011; WU; CHUANG; HSU, 2014; ZAHEER; TRKMAN, 2017), can relate to both environments (DUNCAN, 1972). Due to the importance that has been given to social characteristics, Social Capital Theory was used as a second theoretical to provide a more in-depth evaluation of social characteristics and avoid any possible misinterpretation of where the relationship is taking place, inside or outside of the company.

Despite the central role of influential characteristics, conflicting results called attention, and raised questions about their real impact. The work of Ha, Tian, and Tong (2017) found that in some cases, stable environments might enable information sharing, while demand and supply uncertainty were also linked to improved information sharing (CARIDI et al., 2010; CAVUSOGLU; CAVUSOGLU; RAGHUNATHAN, 2012). Guo, Li, and Zhang (2014) found that with increased competition, retailers should not share too much information with their manufacturers, although the increased competition was already shown to be an enabler of information sharing (BAIHAQI; SOHAL, 2013). Another example is asset specify, which can either act as an enabler (JRAISAT; GOTSI; BOURLAKIS, 2013) or might not have a significant impact (MÜLLER; GAUDIG, 2011).

One possible explanation for the mixed results is that the characteristics mentioned were acting in different visibility dimensions and impacting them in different ways. Thinking about market uncertainty, for example, it was already shown that under high

levels of uncertainty it is recommended to share more demand information with its partners (BARRATT; BARRATT, 2011), although it was also shown that stable environments might have a positive impact on information sharing (HA; TIAN; TONG, 2017). So, it is possible that under stable environments, information sharing will have better results, except for demand information sharing. For this reason, identifying the characteristics that might enable visibility and aligning them with each visibility dimension can make it easier for practitioners to develop visibility and for scholars to understand it better.

Knowing the importance of supply chain visibility and the mixed results regarding the influential characteristics, it is necessary to identify which characteristics align with each visibility dimension to improve supply chain visibility. In this research, the alignment between visibility dimensions and influential characteristics was named visibility configurations. Visibility configurations are defined as the fit between a visibility dimension and a category of influential characteristics that enables its development where fit represents the environmental-strategy, in this case, characteristic-dimension, coalignment that results in higher performance (VENKATRAMAN, 1989). Table 1 summarizes the main concepts of this research

Table 1 – Main concepts

Concept	Definition
View	The interpretation of the concept of visibility or how it might be developed
Visibility dimension	The type of information that can be exchanged to improve supply chain visibility
Influential characteristic	An organization’s social and operating characteristics that can influence the value of a certain visibility dimension
Visibility configuration	The fit between a visibility dimension and a category of influential characteristics that enables its development

Source: Created by author.

Therefore, managers lack an organized way to evaluate and select the visibility dimensions that are more appropriate for his or her specific environment. The lack of (i) a rigorous definition of visibility dimensions, (ii) a synthesis of the main visibility dimensions, and (iii) the understanding of the real impact of influential characteristics on each visibility dimension make the development of supply chain visibility a challenging task. This research addressed this gap in the literature, which might assist both

practitioners and researchers to understand better how visibility can be developed. Therefore, the research question that was addressed is:

How influential characteristics impact the development of supply chain visibility?

1.2 Objectives

The purpose of this research is to understand how influential characteristics impact the development of supply chain visibility. To do so, the following research agenda is proposed:

a) identify the main supply chain visibility dimensions and the types of information that can be exchanged to develop each one;

b) identify the main influential characteristics that enable supply chain visibility and group them into categories of characteristics;

c) define which categories of influential characteristics enable each dimension of supply chain visibility to develop the main configurations of supply chain visibility.

This research presents a theoretically grounded and actionable framework to guide practitioners during the process of developing visibility. The framework contains the main visibility dimensions along with the types of information that might be exchanged to develop each of them, the categories of influential characteristics with its respective characteristics, and the configurations between the dimensions and categories of influential characteristics. There were contributions to both researches and practitioners that are interested in how visibility might be developed and which characteristics might impact it, as demonstrated in the next section.

1.3 Justification and Expected Contributions

The work of Wieland, Handfield, and Durach (2016) evaluated several supply chain themes to propose a research agenda for the field. Their work identified the most promising areas of research to guide academics and advisors to develop the field, and visibility is one of the most under-researched themes after people, ethics, and internal integration. Williams et al. (2013) pointed as a research opportunity, a detailed study of

different types of visibility because of the rapid development of information technology might leverage supply chain visibility development. This research aims to contribute to this matter by providing a better understanding of how influential characteristics impact the development of supply chain visibility.

One misalignment that exists in the theme regards how visibility might be developed. This research contributes to this matter by providing a rigorous definition for visibility dimensions, synthesizing the current body of literature into the main visibility dimensions, and presenting the main types of information that can be shared to develop each dimension. This contribution provides guidelines for practitioners on how to develop visibility and aligned the views provided in the literature for future studies.

In order to decide which visibility dimension the company should develop, managers should be aware of their internal and external environment to adapt to it and improve their performance (KEMBRO; SELVIARIDIS; NÄSLUND, 2014; LAWRENCE; LORSCH, 1967). To evaluate the company's environment, Contingency Theory and Social Capital Theory were used to define the categories of influential characteristics that make visibility desirable. By using two theoretical lenses to analyze the influential characteristics, this research provides a systematic and theoretically grounded approach to select the visibility dimensions that will maximize the cost-benefit of visibility development.

Despite the importance of influential characteristics, the conflicting results related side payments (MISHRA; RAGHUNATHAN; YUE, 2009), bargain power (CHENG, 2011), and complexity (DU et al., 2012), for example, raised questions regarding their real impact. One possible explanation is that influential characteristics impact different visibility dimensions in multiple ways. To solve this misalignment, the categories of characteristics were linked to each visibility dimension to provide a better understanding of how influential characteristics enable the visibility dimensions. The current literature on supply chain visibility does not provide relationships between influential characteristics and types of information beyond the dyadic level, such as information systems and inventory level (BARRATT; OKE, 2007; BOURLAND; POWELL; PYKE, 1996; WELKER; VAN DER VAART; VAN DONK, 2008) or trust and demand forecast (EBRAHIM-KHANJARI; HOPP; IRAVANI, 2012; GHOSH; FEDOROWICZ, 2008; ÖZER; ZHENG; CHEN, 2011). This research provides the first proposal of visibility configurations that presents the relationship between categories of characteristics and

visibility dimensions. This broader relationship provided a framework that can be used to evaluate the company's environment and decide the appropriate investment that the company should make in each visibility dimension to improve its performance.

With the proposed framework at hand, companies can prepare for their daily activities such as inflow of raw materials or extreme situations such as a pandemic. In the first situation, the companies would be able to evaluate their relationship with their partners, especially considering the contributions of Social Capital Theory, and define the visibility dimension they should invest. In the case of inflow of product, the focal company might be interest in the delivery schedule (SOMAPA; COOLS; DULLAERT, 2018; VIET; BEHDANI; BLOEMHOF, 2018; WIEGMANS et al., 2018) and their inventory levels (CROSON; DONOHUE, 2009; LIN; HUANG; LIN, 2002; SALMI; HOLMSTRÖM, 2004), supply dimension. In contrast, the supplier might be interested in the company's demand forecast (MISHRA; RAGHUNATHAN; YUE, 2009; WELKER; VAN DER VAART; VAN DONK, 2008; YUE; LIU, 2006) and point-of-sale data (JONSSON; MATTSSON, 2013; STECKEL; GUPTA; BANERJI, 2004), demand dimension. If both companies trust each other and are committed to the relationship, relational dimension of Social Capital (LEE; HA, 2018), and have compatible information systems, the structural dimension of Social Capital (JOHNSON; ELLIOTT; DRAKE, 2013), developing supply and demand visibility might be easy.

In more extreme cases, such as a pandemic, the companies would be suffering from high uncertainty, a characteristic of their external environment (LAWRENCE; LORSCH, 1967), that might jeopardize its inflow of raw materials or generate a demand peak in their online systems, for example. If the companies have (i) point-of-sale data from its customers (demand dimension) (JONSSON; MATTSSON, 2013; STECKEL; GUPTA; BANERJI, 2004), (ii) stock availability from its suppliers (supply dimension) (CROSON; DONOHUE, 2009; LIN; HUANG; LIN, 2002; SALMI; HOLMSTRÖM, 2004), and (iii) capacity availability from its plants (process dimension) (KIM, 2000; WELKER; VAN DER VAART; VAN DONK, 2008; YEE, 2005), it might be easy to plan its production schedule to better cope with the new demands and lead times.

This research made contributions to practitioners and the literature. For practitioners, this research provided an actionable framework to develop visibility and provided guidelines on how to determine which visibility dimension should be developed. For the

literature, this research provided a formal definition of visibility dimensions, a synthesis of the views to develop visibility available in the literature; a theory grounded analysis on how influential characteristics impact the development of supply chain visibility and propose the first version of the visibility configurations that might explain the conflicting results regarding some influential characteristics.

1.4 Overview of the Research Method

This research used two methods to achieve its goals, a systematic literature review, and a Q-sort. The systematic literature review was used to select the appropriate material among a large body of knowledge, making the process of selecting the materials as transparent as possible and minimizing the author's bias during the process (BADGER et al., 2000; JESSON; MATHESON; LACEY, 2011). The systematic literature review followed the steps proposed by Tranfield, Denyer, and Smart (2003): planning the review, conducting the review, and reporting and dissemination. The research protocol detailing all the phases of each stage, along with the measures to ensure validity and reliability, can be found in Chapter 3.

To analyze all the articles selected in the review, a content analysis of the material was performed. This technique was selected because the content analysis is used to make valid and replicable inferences from texts (KRIPPENDORFF, 2004). The analysis was done through QDA Miner, a software for qualitative data analysis (PROVALIS RESEARCH, 2019) that was already used in similar studies (LIMA et al., 2018; MORAES et al., 2020; PEREIRA et al., 2020; PEREIRA; CHRISTOPHER; SILVA, 2014). The content analysis was used during the second stage of the systematic literature review to improve the validity and reliability of the results. The details of the content analysis can be found along with the systematic review in Chapter 3.

After the review, a list with the main types of information exchanged to improve supply chain visibility, the main influential characteristics that impact its development, and the links between a type of information and an influential characteristic were presented with the potential visibility dimensions and categories of characteristics. This list was used to develop the items for the Q-sort. The Q-sort method can assess the reliability and validity of constructs (NAHM et al., 2002) (in this case, the visibility dimensions and categories of characteristics) using the Hit Ratio (MOORE; BENBASAT,

1991), Cohen's Kappa (COHEN, 1960), proportional agreement (RUST; COOIL, 1994), and Perreault and Leigh's reliability index (PERREAULT; LEIGH, 1989). These indexes measure the level of agreement between judges, in this case, specialists in the field (COHEN, 1960; MOORE; BENBASAT, 1991). The respondents assigned each information into a visibility dimension, and each characteristic into a category of characteristics. The measures of the agreement were used to determine if the categories, dimensions, information, and characteristics were clearly defined. The details of the Q-sort can be found in Chapter 5.

1.5 Document Structure

This section presents the structure of the thesis. In the first chapter, an overview of the thesis was presented. During the overview, it was presented (i) the research theme, (ii) the main concepts and their definitions, (iii) the literature gap that was explored, (iv) the specific goals, (v) the expected contributions, (vi) an overview of the research methods, and (vii) the justification. The second chapter contains the theoretical background of the research. The theoretical background includes the organizational theories used to analyze the influential characteristics, and a literature review of visibility and influential characteristics.

Chapter three presents the steps for the systematic literature review. The chapter includes (i) the research protocol, its main steps, (ii) a description of the content analysis used to extract the information from the articles selected in the review, and (iii) the validity and reliability measures. Chapter four presents the results of the systematic literature review. The chapter presents (i) the information gathered from the literature that might be exchanged to develop visibility, (ii) the influential characteristics that might impact the development of visibility, (iii) the specific links between a type of information and an influential characteristic, and (iv) the potential visibility dimensions and (v) the potential categories of characteristics.

Chapter five presents a method called Q-sort. This method used the results from the systematic literature review to form the visibility dimensions and categories of characteristics. In this chapter, (i) the steps followed were presented, (ii) followed by the statistical analysis that was used to evaluate the agreement between respondents, (iii) the target values of the agreement indexes, and (iv) the validity and reliability measures.

Chapter six presents the visibility dimensions and categories of influential characteristics validated using the Q-sort. Chapter seven presents the final framework and research propositions. The last chapter presents the conclusions of the research, the contributions that were made, and a research agenda for future researches.

Figure 1 presents the thesis structure and the chapters' content.

Figure 1 - Document structure

Source: Created by author.

2 THEORETICAL BACKGROUND

This section presents a more in-depth discussion about the theoretical background of the research. First, visibility and its multiple interpretations are presented (Section 2.1), followed by the Contingency Theory (Section 2.2), and Social Capital Theory (Section 2.3). The last section presents the influential characteristics and their conflicting results regarding enabling visibility (Section 2.4).

2.1 Supply Chain Visibility

Visibility is the access to accurate, timely, complete, and usable formatted data that describes both demand and supply aspects (WILLIAMS et al., 2013). Accuracy is "the degree of conformity of the shared information with its actual value" (CARIDI et al., 2014, p. 4). Timeliness is related to how frequently the information is updated and if this frequency meets the company's demands (VIET; BEHDANI; BLOEMHOF, 2018). Completeness is "the extent to which information is not missing and is of sufficient breadth and depth for the task at hand" (GOSWAMI; ENGEL; KRCMAR, 2013, p. 282). By guaranteeing all the quality aspects necessary to develop visibility, companies will be able to improve decisions making and improve their performance (LI; YE; SHEU, 2014).

Improving visibility and information sharing was linked to different performance improvements such as responsiveness (LI; YE; SHEU, 2014), financial aspects, such as cost and revenue (WU; CHUANG; HSU, 2014), better coordination (GHOSH; FEDOROWICZ, 2008) and increased flexibility (WANG; WEI, 2007). The research of Li, Ye, and Sheu (2014) investigate the whole of information sharing in improving performance. The authors were able to confirm the critical value of information sharing, showing that both content and quality of information are essential to improve effectiveness and responsiveness. Wu, Chuang, and Hsu (2014) also studied the relationship between information sharing and supply chain performance, but considering both financial and non-financial performance measures and were able to associate information sharing with both. Ghosh and Fedorowicz (2008) were also able to link information with performance and collaboration. Their results showed that with the right governance structure, communication would be developed, and performance would be improved. The authors found that the impact of information sharing in both aspects of performance was positive although mediated by the level of collaboration between the

companies. Wang and Wei (2007) investigate how governance mechanisms could impact visibility and flexibility. They were able to establish a relationship between virtual integration and increased flexibility, which was mediated by information sharing. Therefore, the impact of visibility and information sharing can be direct (LI; YE; SHEU, 2014; WU; CHUANG; HSU, 2014) or indirect (GHOSH; FEDOROWICZ, 2008; WANG; WEI, 2007), but multiple researches already demonstrated the importance of them to improve performance.

Information sharing can also prevent risks and avoid potential loses such as stockouts (BARRATT; BARRATT, 2011), environmental risk (JRAISAT; GOTSI; BOURLAKIS, 2013) and demand amplification, also known as bullwhip effect (COSTANTINO et al., 2013; HOFMANN, 2017; MA et al., 2013; OJHA et al., 2019; WANG et al., 2016). The study of Barratt and Barratt (2011) focused on internal and external linkages and their impact on the firm's performance and the development of visibility. In one of the cases, the authors observed that the companies improved visibility not only to enhance responsiveness but improved the awareness of the supplier regarding partners' actions, which helped with the stockouts and delays the company was suffering. Jraisat, Gotsi, and Bourlakis (2013) studied the importance of information sharing in agri-food chains and found that environmental risks, such as weather changes and product volatility, could be foreseen through information sharing and producers could plan their activities to minimize potential impacts. Another potential benefit that information visibility brings is the reduction of the bullwhip effect (COSTANTINO et al., 2013; JIANG; KE, 2019; MA et al., 2013). The work of Hofmann (2017) is one of many examples; the author investigated the use of information to mitigate the bullwhip effect and found that information can help with the problem where the timely aspect of information sharing plays a significant role.

Despite the benefits, there are potential problems that increased visibility has, like possible information leakage (HA; PARK; CHO, 2011), potential penalties for misused information and power loss (KHURANA; MISHRA; SINGH, 2011). Regarding information leakage, firms are resistant to share information such as new product development or new technology adoption because they fear their competitors might gain access to them (HA; PARK; CHO, 2011). When competitors have access to the company's private information, the exchange of information might lose its potential benefit; this phenomenon is known as leakage effect (LEI et al., 2014). Khurana, Mishra

and Singh (2011) investigated barriers for information sharing and found that information misuse is one of the main concerns which might lead to penalties for the ones involved in the exchange. Besides the misuse of information, the authors also evaluated aspects like loss of power and cultural differences showing its impact. They confirmed the potential leakage as a primary concern for information sharing.

Besides the risks, information sharing demands certain investments in infrastructure, like information systems, but by themselves, they might not have the expected returns (FAWCETT et al., 2011). In the work of Wu et al. (2006), the authors investigated the potential impacts of information technology. However, they found that the relationship between these systems and performance was mediated by supply chain capabilities, such as collaboration and information sharing. In order to identify the systems that will assist in the development of supply chain capabilities, the companies must first define which information they are going to share, and the expected benefits of information sharing and then make the appropriate investment (VIET; BEHDANI; BLOEMHOF, 2018).

When dealing with information sharing, different authors propose their groups of information and then investigate which information should be shared to improve performance (BARRATT; BARRATT, 2011; HUANG; LAU; MAK, 2003; WELKER; VAN DER VAART; VAN DONK, 2008). The work of Barratt and Barratt (2011), for example, identified four main categories in their research named demand information, inventory information, promotional-related information, and production information. Welker, Van Der Vaart, and Van Donk (2008), however, proposed that four main groups of information named sales, order, planning, and inventory. Different from the previous authors, Huang, Lau and Mak (2003) grouped information into product, process, cost, resource, inventory, planning, and order information. Knowing all these possible groups, it is possible to see that are multiple potential visibility dimensions that companies can develop to enhance supply chain visibility.

Not only there are multiple groups of information that can be shared to improve visibility (BARRATT; BARRATT, 2011; HUANG; LAU; MAK, 2003; WELKER; VAN DER VAART; VAN DONK, 2008), but there are also multiple interpretations regarding how visibility can be developed (BARRATT; OKE, 2007; KIM; RYOO; JUNG, 2011; WILLIAMS et al., 2013; ZHANG; GOH; MENG, 2011). In the work of Williams et al. (2013), the authors divided visibility between market-level or partner-level, while

partner-level could either be visibility regarding the customer operations or the supplier operations. Zhang, Goh, and Meng (2011) presented a different view of visibility, where visibility should consider the amount of information shared and the number of companies involved. The authors proposed the notion of atom visibility that represents the ability of an actor accessing specific information, single visibility is two actors exchanging information, and compound visibility is a group of actors exchanging multiple information.

Different from the previous authors, Barratt and Oke (2007) focused on the ability of information sharing to sustain a competitive advantage and propose the term distinct visibility when visibility can provide such results. Not only author focused on the number of agents and the amount of information shared (ZHANG; GOH; MENG, 2011) or the potential source of information (WILLIAMS et al., 2013); but also the technology that might be involved in the process (LEE; KIM; KIM, 2014). Different from previous authors, Kim, Ryoo, and Jung (2011) focused on how the information would be exchanged and proposed the term inter-organizational information system visibility (IOS visibility) as an operational aspect of visibility. Table 2 presents an overview of the views identified in the literature that might help develop supply chain visibility.

Table 2 – Views of supply chain visibility

Views	Source
Advanced shipping notice visibility	Williams et al. (2013)
Atom visibility	Somapa, Cools, and Dullaert (2018); Zhang, Goh, and Meng (2011)
Compound visibility	Somapa, Cools, and Dullaert (2018); Zhang, Goh, and Meng (2011)
Coordinating visibility	Somapa, Cools, and Dullaert (2018)
Demand visibility	Barratt, Choi and Li (2011); Barratt and Oke (2007); Huo, Han, and Prajogo (2016); Kaipia and Hartiala (2006); Lei et al., (2014); Morgan, Richey Jr and Ellinger (2018); Somapa, Cools, and Dullaert (2018); Srinivasan and Swink, (2018); Szymczak et al., (2018); Vigtil (2007); Williams et al., (2013); Zhang, Goh, and Meng (2011)
Dependent visibility	Barratt and Barratt (2011)
Distinctive visibility	Barratt and Oke (2007); Somapa, Cools, and Dullaert (2018)
In-transit visibility	Goel (2010)
Independent visibility	Barratt and Barratt (2011)
Integrating visibility	Somapa, Cools, and Dullaert (2018)
Internal visibility	Barratt and Barratt (2011); Srinivasan and Swink (2018)
Interorganizational systems visibility	Kim, Ryoo, and Jung (2011); Lee, Kim, and Kim (2014)
Inventory visibility	Barratt and Barratt (2011); Somapa, Cools, and Dullaert (2018); Szymczak et al., (2018); Wang and Wei (2007); Zhang, Goh, and Meng (2011)
Learning visibility	Somapa, Cools, and Dullaert (2018)
Logistic visibility	Somapa, Cools, and Dullaert (2018); Zhang, Goh, and Meng (2011)
Market visibility	Somapa, Cools, and Dullaert (2018); Williams et al., (2013)
Node visibility	Somapa, Cools, and Dullaert (2018); Zhang, Goh, and Meng (2011)
Operational visibility	Hall and Saygin (2012); Morgan, Richey Jr, and Ellinger (2018); Srinivasan and Swink (2018)
Process visibility	Barratt and Barratt (2011); Barratt and Oke (2007); Hall et al., (2013); Somapa, Cools, and Dullaert (2018); Szymczak et al., (2018); Zhang, Goh, and Meng (2011)
Product visibility	Hall et al., (2013); Morgan, Richey Jr, and Ellinger (2018)

Source: Created by author.

Table 2 – Views to develop visibility (cont.)

Views	Source
Promotion visibility	Barratt and Barratt (2011); Barratt and Oke (2007); Williams et al., (2013)
Return product visibility	Viet, Behdani and Bloemhof (2018)
Risk visibility	Fu, Han, and Huo (2017)
Sales visibility	Barratt and Barratt (2011)
Sensing visibility	Somapa, Cools, and Dullaert (2018)
Single visibility	Morgan, Richey Jr, and Ellinger (2018); Somapa, Cools, and Dullaert (2018); Zhang, Goh and Meng (2011)
Stakeholder visibility	Morgan, Richey Jr, and Ellinger (2018)
Supply visibility	Barratt and Barratt (2011); Caridi et al., (2010); Huo, Han, and Prajogo (2016); Morgan, Richey Jr and Ellinger (2018); Somapa, Cools, and Dullaert (2018); Srinivasan and Swink (2018); Srivastava, Chaudhuri and Srivastava (2015); Szymczak et al., (2018); Williams et al., (2013)

Source: Created by author.

Therefore, it is possible to see the authors propose multiple ways to develop visibility. In order to better understand visibility and how to improve it, it is necessary a uniform view of the main visibility dimensions and to understand the influential characteristics that influence the company's decision regarding which dimension should be developed. To provide a more in-depth evaluation on the influential characteristics, two organizational theories were used, Contingency Theory and Social Capital Theory. The next sections present both theories and how they link to this research.

2.2 Contingency Theory

According to Lawrence and Lorsch (1967), companies can be viewed as open systems. Since organizations are open systems, the external environment affects the internal structure and managerial decisions of a company (LAWRENCE; LORSCH, 1967). In order to improve the company's performance, the organization should either adapt to its environment (DONALDSON, 2001) or shape it to match its structure (MILES; SNOW, 1978). Therefore, there is no best way to structure a company because its structure should match its internal and external environment (BUTTERMANN; GERMAIN; IYER, 2008; DONALDSON, 2001; FLYNN; HUO; ZHAO, 2010; LAWRENCE; LORSCH, 1967; WOODWARD, 1980). For this research, the structure under investigation is the

development of different dimensions of supply chain visibility where the contingency factors that describe the company's environment are the influential characteristics.

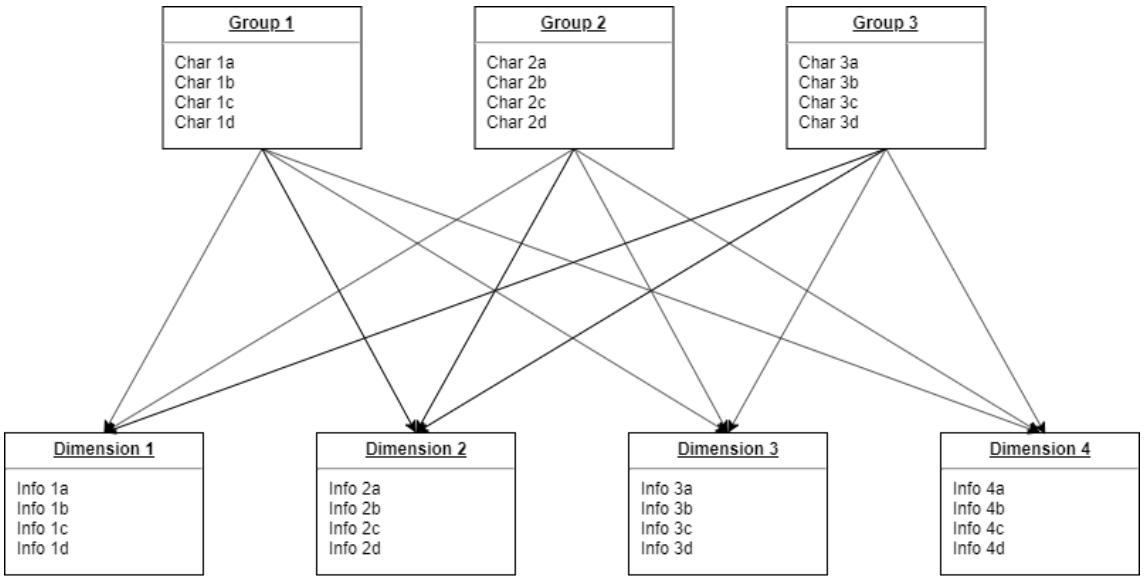
Contingency factors are the characteristics of the company's internal or external environment that impact the relationship between the company's structure and effectiveness (DONALDSON, 2001). Contingencies can be external, such as uncertainty (WONG; LAI; CHENG, 2011) and supply chain structure (SAMADDAR; NARGUNDKAR; DALEY, 2006), or internal, such as the size of the firm (VANPOUCKE; BOYER; VEREECKE, 2009) or product complexity (WONG; LAI; CHENG, 2011). The research of Wong, Lai, and Cheng (2011) provides an example of both internal and external contingencies. The authors investigated the relationship between certain contingencies, such as uncertainty and product complexity, and customer-oriented operational performance and cost performance. They found a positive relationship between stable environments and cost performance and higher product complexity and customer-oriented operational performance.

The research of Samaddar, Nargundkar, and Daley (2006) investigated the supply chain structure considering the number of channels, number of stages, and location in the network. The authors found a relationship between the supply chain structure and the volume (high or low) and scope (operational or strategic) of information sharing. For example, a supply chain with more stages performs better when sharing large volumes of operational information (SAMADDAR; NARGUNDKAR; DALEY, 2006). The work of Vanpoucke, Boyer, and Vereecke (2009) investigated, among other contingencies, the effect of the company's size on investments in information flows. The authors argued that smaller companies have a smaller budget, and in general, are not ready to invest in information systems. The authors found a positive correlation between the company's size and investments in information sharing. As we can see in the examples presented, the internal and external environment of a company can affect the company's structure and strategy. Therefore, in order to improve performance and survive in its environment, a company should fit its structures to its environment (DONALDSON, 2001; LAWRENCE; LORSCH, 1967).

Fit is a central concept in Contingency Theory (DONALDSON, 2001; VENKATRAMAN, 1989). The concept of fit can be understood through six perspectives named moderation, mediation, profile deviation, matching, covariation, and gestalts

(VENKATRAMAN, 1989). In this research, the concept of fit followed the profile deviation perspective. The profile deviation perspective verifies the adherence of the company's strategy to an ideal profile (CHEN; HUANG, 2012; XU; CAVUSGIL; WHITE, 2006; ZAEFARIAN; HENNEBERG; NAUDÉ, 2013). The profile deviation is the best perspective for this case because it considers that influential characteristics can impact each other, and their interaction impacts the ideal strategy to outperform in the environment (CHEN; HUANG, 2012; XU; CAVUSGIL; WHITE, 2006). Therefore, the profile deviation perspective considers the interaction of a large number of characteristics, and can verify their impact on each visibility dimension. By applying this perspective, the influential characteristics suggest which dimensions of visibility could be developed, and on which ones the company should focus. Figure 2 presents the structure of the conceptual model to develop supply chain visibility.

Figure 2 - Conceptual framework

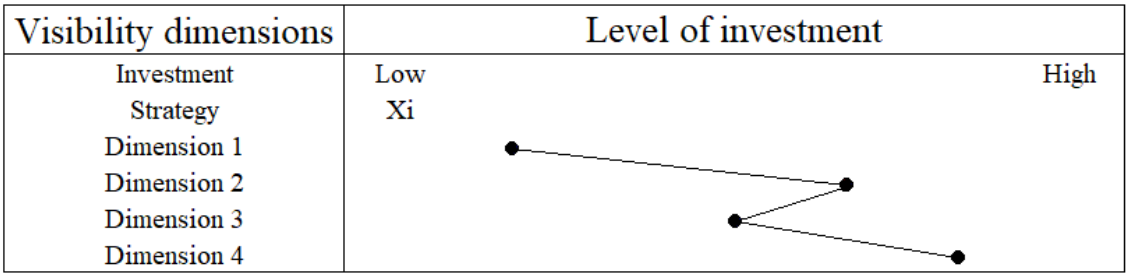


Source: Created by author.

Figure 2 presents the conceptual model to develop supply chain visibility through the theoretical lens of the Contingency Theory. In this model, it was assumed that there are three categories of influential characteristics and four visibility dimensions. Each category of characteristics has its characteristics listed below, and each visibility dimension has the types of information that can be exchanged to develop them listed below. The categories one to three represent the contingencies presented in the environment. The dimensions of supply chain visibility are the structures that form the visibility profile. The arrows represent the visibility configuration, the alignment between

the structures and environment. Since the influential characteristics may impact each dimension differently, the environment might require that a company invest more in one dimension instead of another, forming the ideal profile of visibility. Figure 3 represents a possible visibility profile considering four visibility dimensions and an environment with influential characteristics from different groups.

Figure 3 - Supply chain visibility ideal profile for a specific environment.



Source: Venkatraman (1989) (Adapt.).

After identifying the influential characteristics that form the company's environment, it is possible to determine how suited is a visibility dimension to that particular set of characteristics. After determining how well each dimension might perform in the environment, the company can allocate the appropriate resources to each one to reach the ideal profile of supply chain visibility for its environment. The strategy Xi is the ideal strategy that balances the investment on each visibility dimension, developing the correct amount of each one to reach the best visibility profile for the environment.

2.3 Social Capital Theory

According to Duncan (1972), internal and external environments include all relevant physical and social aspects that impact decision making, but due to the importance of social characteristics, they were evaluated separately. Some social characteristics have been extensively investigated in the literature, such as trust (JOHNSON; ELLIOTT; DRAKE, 2013; PATNAYAKUNI; RAI; SETH, 2006; VIJAYASARATHY, 2010; WANG; YE; TAN, 2014; WU; CHUANG; HSU, 2014), commitment (BIRASNAV; MITTAL; LOUGHLIN, 2015; FU; HAN; HUO, 2017; HUNG et al., 2011; JONSSON; MYRELID, 2016; LIAO et al., 2011; ZAHEER; TRKMAN, 2017), top management support (CHEN; WANG; YEN, 2014; LI; LIN, 2006; VIJAYASARATHY, 2010; WONG; LAI; CHENG, 2011), and collaboration (JRAISAT; GOTSI; BOURLAKIS, 2013; MORGAN; RICHEY JR; ELLINGER, 2018; SMITH; DUCHESSI; GARCIA,

2012; VAN DER MERWE; KIRSTEN; TRIENEKENS, 2017; WONG; LAI; CHENG, 2011). The characteristics presented are developed through social interactions, and the network of connections that are a valuable source of information (NAHAPIET; GHOSHAL, 1998).

Social capital is the actual or potential resources that a person or group can access through a network of connections (BOURDIEU, 1986), and consists of an aspect of a social structure which aims to facilitate the actions of its members (COLEMAN, 1988), for example, a company facilitating the information exchange within its members (NAHAPIET; GHOSHAL, 1998). To better understand the concept of social capital, three elements must have a clear distinction: the agent who possesses the social capital, the one that will request his or her network for resources; the sources of social capital, the other members of the network; and resources exchanged (COLEMAN, 1988). Therefore, the volume of social capital depends on the resources the person and his or her network possess, where the network has a multiplier effect of the resource each induvial has (BOURDIEU, 1986). Some of the benefits of social capital are the development of trust, improved communication, improved coordination, and focus on the collective benefits (PUTNAM, 2000).

Coleman (1988) proposes that there are three forms to express social capital. The first one is obligations, expectations, and trustworthiness of structures. When a person A shares its resources with B, it is expected of B to repay A in the future; therefore, B has an obligation with A. This form of social capital only works because A trusts B, so despite the motives A has to help B, A trust that he or she will have B's help when needed. The second form is through information channels, which means that a person can use his or her social network as a source of information (e.g., LEE; HA, 2018; LI; YE; SHEU, 2014). The last form is through norms and effective sanction. Norms over a specific action exist when an actor does not have control over a particular action, but the group he or she belongs to does (COLEMAN, 1990). Therefore, his or her actions might be punished or rewarded, depending on the action. Norms and sanctions are used to constrain selfish behavior and reward actions that favor the whole group, for example, punishing an employee for misconduct in the working environment.

The factors proposed by Coleman (1988) helped Nahapiet e Ghoshal (1998) identify four factors that might impact the development of social capital named interdependence,

interaction, closure, and time. Regarding interdependency, Coleman (1988) argues that in times of need, such as the World Wars, organizations emerge to aid those who form them. These organizations increase the social capital of its members because each member depends on the group, and being part of the group creates more benefits than each individual acting by itself (COLEMAN, 1987). Regarding interaction, social capital increases with interaction because it is through the exchange of resources that one strengthens its relationship with its network (BOURDIEU, 1986), which makes interaction a factor that enhances social capital. Closure impacts social capital due to its importance in building trust and enforcing norms (COLEMAN, 1987, 1988, 1990). Coleman (1987, 1988) argues that network closure impacts how effective a norm is because, with higher closure, sanctions and rewards are more easily applied. Trust emerges because the members trust that each person on the network will repay its creditor since he or she fears the sanctions that might be imposed by the whole group. To develop social capital, it is necessary to invest time and effort in one's social network not only to form the network but to maintain it (BOURDIEU, 1986). Therefore, time is a necessary factor to build and strengthens social relations, and with continuous interaction, time also enhances the development of the other three factors (NAHAPIET; GHOSHAL, 1998).

Nahapiet e Ghoshal (1998) not only identified factors that might enhance social capital, but they also proposed that social capital can be understood through three clusters named relational dimension, cognitive dimension, and structural dimension. The relational dimension emerges from a series of interactions between two people and can be seen through trust, and commitment, for example (LEE; HA, 2018; NAHAPIET; GHOSHAL, 1998). The cognitive dimension includes the characteristics that provide the base for mutual understanding, for example, shared codes and languages (INKPEN; TSANG, 2005; JOHNSON; ELLIOTT; DRAKE, 2013). The structural dimension represents the network of relations and patterns of connections that a person is involved in, and it includes characteristics such as network configurations, and communication frequency (JOHNSON; ELLIOTT; DRAKE, 2013; LI; YE; SHEU, 2014). It is important to notice that, despite the division proposed by Nahapiet e Ghoshal (1998), the authors acknowledge that the divisions of social capital can be highly interrelated.

Knowing that the social characteristics were extensively investigated (JOHNSON; ELLIOTT; DRAKE, 2013; PATNAYAKUNI; RAI; SETH, 2006; VIJAYASARATHY, 2010; WANG; YE; TAN, 2014; WU; CHUANG; HSU, 2014), this research used Social

Capital Theory to analyze such characteristics. The three dimensions proposed by Nahapiet e Ghoshal (1998) were used to segment the influential characteristics into relational, cognitive, structural factors. The influential characteristics identified in the literature review were sorted into these three categories, and any other deemed necessary to describe factors not related to social aspects of information exchange.

2.4 Influential Characteristics

In order to achieve the positive outcomes of information sharing and visibility, firms must be aware of its environment and identify the possible influential characteristics that enable information sharing (WONG; LAI; CHENG, 2011), such as trust and asset specificity (LEE; KIM; KIM, 2014), for example. If the companies develop information sharing under unfavorable conditions, they might suffer from excessive information, which will not increase visibility and hurt the decision process (KEMBRO; SELVIARIDIS; NÄSLUND, 2014). Companies might also suffer from information leakage, which will diminish the positive outcomes of information sharing (HA; PARK; CHO, 2011) or make huge investments on information systems that might not give the expected returns (FAWCETT et al., 2011). Due the interactions between companies and their environment (MORGAN, 1986) and knowing the possible adverse outcomes of operating in unfavorable conditions (KEMBRO; SELVIARIDIS; NÄSLUND, 2014), it is necessary to identify the influential characteristics that enable information sharing and visibility to better plan their development and focus the investments.

Although the influential characteristics that affect visibility have been researched during the past years, authors found different characteristics and propose different categories for them (JONSSON; MYRELID, 2016; KEMBRO; NÄSLUND; OLHAGER, 2017; LEE et al., 2010). The work of Lee et al. (2010) investigated nine characteristics grouped into three categories: relationship characteristics, organizational characteristics, and information/technology characteristics. Jonsson and Myrelid (2016), on the other hand, found 24 characteristics and proposed four main categories named business context, information, inter-organizational, and intra-organizational. Another example of research regarding influential characteristics is the paper of Kembro, Näslund and Olhager (2017). The authors found through a Delphi study 22 main characteristics and grouped them into six categories named information utilization, technology utilization, power structure, culture, business process, and legal. Even though the previous

researches found different characteristics and possible groups for them, there are widely recognized influential characteristics that enable information sharing, such as trust, commitment, top management support and information systems (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014; VIJAYASARATHY, 2010; WANG; YE; TAN, 2014; WU; CHUANG; HSU, 2014).

Despite some well recognized influential characteristics, by reviewing the literature it is possible to find conflicting results regarding competitor's pressure (GUO; LI; ZHANG, 2014; HA; TIAN; TONG, 2017), uncertainty (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014), premiums and specific investments (MÜLLER; GAUDIG, 2011), for example. Competitor's pressure was found to be an enabler of visibility (BIAN; SHANG; ZHANG, 2016; FUENTES; JURADO, 2016), but the results found by Guo, Li and Zhang (2014) and Ha, Tian and Tong (2017) found that less competition favors information sharing. Uncertainty is another example of conflicting results. While some authors found that in unstable environments companies share more information (BARRATT; BARRATT, 2011; YIGITBASIOGLU, 2010) others found that stable environments are more favorable for information sharing (BIRASNAV; MITTAL; LOUGHLIN, 2015) or that uncertainty does not have a significant impact on information sharing (CHEN; WANG; YEN, 2014). Asset specificity and premiums are other points of divergence, while Müller and Gaudig (2011) found no significant relationship between premiums and asset specificity with information sharing, Jraisat, Gotsi, and Bourlakis (2013) e Patnayakuni, Rai and Seth (2006b) found a positive relationship. Table 3 summarizes the divergences discussed and presents some other conflicting results.

Table 3 – Conflicting results regarding influential characteristics.

Characteristic	Positive impact	Negative impact	No direct impact
Competitor's pressure	Bian, Shang, and Zhang (2016); Moyano-Fuentes and Martínez-Jurado, (2016); Viet, Behdani and Bloemhof (2018)	Guo, Li, and Zhang, (2014); Ha, Tian, and Tong (2017); Zhang, Lee, and Li (2016)	
Uncertainty	Boutarfa et al. (2016); Jraisat, Gotsi, and Bourlakis (2013)	Li and Lin (2006); Wong, Lai, and Cheng (2011)	Chen, Wang, and Yen (2014)
Asset specificity	Jraisat, Gotsi, and Bourlakis (2013); Patnayakuni, Rai, and Seth (2006b)		Müller and Gaudig (2011)
Dependency	Kembro, Näslund, and Olhager (2017); Kembro, Selviaridis, and Näslund (2014); Lee et al. (2010)		Fu, Han, and Huo (2017) (Only presents indirect impact)
Bargain power	Hsiao and Huang (2016); Kembro, Näslund, and Olhager (2017); Zhang and Xiong (2017)	Cheng (2011)	

Source: Created by author.

Knowing the conflicting results regarding some influential characteristics (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014; GUO; LI; ZHANG, 2014; HA; TIAN; TONG, 2017) an alignment between influential characteristics and visibility dimensions might explain the mixed results. The work of Kim, Ryoo, and Jung (2011) is an example of a specific link between influential characteristics and an views to develop visibility. The authors found a positive relationship between IOS visibility and asset specificity due to the necessity of systems compatibility. Vigtil (2007) is another example; the author found that point-of-sales data is more critical if demand uncertainty is high. Another information that was tied to demand uncertainty was cost information, because, by sharing cost information, companies might improve their relationship with their partners (YANG et al., 2018). Although Ha, Tian, and Tong (2017) are divergent from similar researches, the authors specifically linked competitors' actions to demand information; therefore, it is possible that when different types of information are shared, researchers might find different

results. The specific relationships between categories of influential characteristics and visibility dimensions form the visibility configurations, and they might help both practitioners and researches to understand how visibility can be developed.

3 SYSTEMATIC LITERATURE REVIEW

This chapter presents the systematic literature review and its research protocol, as well as the measures that were taken to ensure validity and reliability. The first section introduces the steps of development and research protocol, and the second section, validity and reliability measures. The partial results of the systematic literature review can be found in chapter 4.

The literature review is one of the main parts of a research that aims to identify the current body of knowledge in a particular theme and helps researchers to define better their research question (TRANFIELD; DENYER; SMART, 2003). The literature review can also help researchers to identify contradictions and potential literature gaps that could be explored (JESSON; MATHESON; LACEY, 2011). Reviewing the literature is usually the starting point of every research, but the amount of work available due to the internet and scientific databases forces authors to select the material that will be revised to focus their time and effort (BADGER et al., 2000). To minimize the authors bias in choosing the material that will serve as the base from their research, the selection should be transparent and with clear criteria, so other authors would be able to replicate the study with similar results (DENYER; TRANFIELD, 2009; TRANFIELD; DENYER; SMART, 2003). A systematic literature review was used to provide the theoretical base for this research and minimize the author's bias (DENYER; TRANFIELD, 2009; TRANFIELD; DENYER; SMART, 2003). The next section presents the steps for the systematic literature review following the guidelines of Tranfield, Denyer, and Smart (2003).

3.1 Steps for the Systematic Literature Review

The systematic literature review can be structured in three main stages named planning the review, conducting the review, and reporting and dissemination (TRANFIELD; DENYER; SMART, 2003). The first stage verifies if the review is necessary, prepare the proposal, and elaborates the research protocol. The second stage includes the identification of studies, study selection, quality assessment, data extraction, and data synthesis. The last stage consists of reporting the results.

Following the guidelines proposed by Tranfield, Denyer, and Smart (2003), the first step of the literature review consisted of identifying previous researches that would help to define the research questions. A search in the Scopus database was performed to select

the most relevant articles and the most recent ones. The Scopus database was used because it is one of the most extensive databases for scientific literature, and it is frequently updated (CHADEGANI et al., 2013). After the scoping review, the first version of the research questions was defined.

To better understand how influential characteristics impact the development of visibility, three research questions were defined. The first question was, “What are the main dimensions of supply chain visibility?”. This first question focus on the multiple types of information that can be exchanged to developed supply chain visibility (BARRATT; BARRATT, 2011; HUANG; LAU; MAK, 2003; WELKER; VAN DER VAART; VAN DONK, 2008) that define potential visibility dimensions. The second question was, “What are the main influential characteristics that make visibility desirable?”. The second question focused on the influential characteristics such as trust, commitment, and information systems (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014) that can have a positive impact on visibility. Identifying the influential characteristics would help both practitioners and researchers to evaluate the company’s environment and define if they should develop supply chain visibility. The third question was, “What are the possible visibility configurations?”. The final question searches for specific relationships between visibility dimensions and categories of influential characteristics. Some examples of links that would provide evidence of visibility configurations are uncertainty in demand impacting cost information sharing (YANG et al., 2018) or sharing of POS information been adequate under demand uncertainty (VIGTIL, 2007).

To guarantee that the research questions are well-formulated, the CIMO logic was used to evaluate and refine the questions (DENYER; TRANFIELD, 2009). The CIMO logic verifies if the research questions can identify the context (C), intervention (I), mechanisms (M), and outcomes (O) of the problem that has been investigated (KAIPIA et al., 2017). By applying CIMO logic, we can verify if the research question for the systematic review can identify the main aspects of research. For this research, the context of interest is information sharing between companies or supply chains; the intervention is the development of the visibility dimensions, the mechanisms that make this development possible are the influential characteristics, and the outcome is the alignment between the categories of influential characteristics that act as enablers to individual visibility dimensions. The context can be seen in the first question with the intervention,

the mechanisms in the second question, and the desired outcome in the last one. Therefore, each question has its value to fulfill the requirements of CIMO, so it is safe to assume that the questions are adequately formulated (DENYER; TRANFIELD, 2009; KAIPIA et al., 2017).

After refining the research questions, it is necessary to define the search period and the databases that were used (BADGER et al., 2000). The search period was set between 1990 and January of 2019, and it was considered appropriate because, during the first ten years, just one article was included or extraction. Regarding the databases, Scopus and Web of Science were included because they are two of the most extensive databases for scientific literature and have publications in various fields (CHADEGANI et al., 2013). Besides Scopus and Web of Science, Engineering Village was included due to its relevance to the engineering field and for being considered one of the most relevant databases for scientific literature besides the two bases already included (BUCHINGER; CAVALCANTI; HOUNSELL, 2014). The fourth and last base considered was Scielo, so Brazilian papers that might not have reached international journals and are relevant to understand the country's context were considered.

To guarantee transparency and replicability, the inclusion and exclusion criteria were defined beforehand (DENYER; TRANFIELD, 2009; TRANFIELD; DENYER; SMART, 2003). Five criteria were defined for the review, access, clarity, journal quality, objective alignment, and unit of analysis. Regarding access and clarity, the articles should have been written in English or Portuguese and deal with information sharing or visibility. For objective alignment and unit of analysis, visibility or information sharing should be related to the operational activity of supply chain management; articles dealing with technical aspects, sustainability, public policies, project development, and joint planning were not included.

For the quality criteria, only peer-reviewed journals were included and, following the works of Ghadge, Dani, and Kalawsky (2012), Kamalahmadi and Parast (2016) and Schorsch, Wallenburg and Wieland (2017) different journal indexes were used to access the journal's quality. In order to reduce potential bias from individual indexes, three of them were selected for quality assessment, the Journal Citation Report (JCR) (SCHORSCH; WALLENBURG; WIELAND, 2017), the Academic Journal Guide rating (AJG) (GHADGE; DANI; KALAWSKY, 2012; KAMALAHMADI; PARAST, 2016)

and the Scimago Journal & Country Rank (SJR). The AJG index is published by The Association of Business Schools (ABS), and they are widely applied around the world for journal quality assessment (GHADGE; DANI; KALAWSKY, 2012). The JCR is another widely applied index to evaluate journal quality and was previously used as a quality criterion for systematic literature reviews (SCHORSCH; WALLENBURG; WIELAND, 2017). The JSC was included in case the journal meets only one of the two criteria. JSC was chosen because the index is powered by Scopus, the database that returned the largest number of articles. In this research, the chosen value for AGJ was three or higher (GHADGE; DANI; KALAWSKY, 2012; KAMALAHMADI; PARAST, 2016), for JCR was one or above (SCHORSCH; WALLENBURG; WIELAND, 2017) and JSC was two or higher. Table 4 summarizes all inclusion and exclusion criteria.

Table 4 - Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Access	Full content written in English or Portuguese	Full content not written in English or Portuguese
Clarity	Clearly deal with visibility or information sharing within companies or supply chains	Does not clearly address visibility or information sharing within companies or supply chains
Journal quality	Scientific periodic peer-reviewed, AJG 3 or higher, JCR above 1 and JSC 2 or higher	Business magazines, conference proceedings, books and notes
Objective alignment	Visibility or information sharing within the scope of supply chain management	Visibility or information sharing within the scope of other research areas like system engineering, information science, green, sustainable, circular economy, product development, joint planning
SLR unit analysis	Organizations or supply chains	Communities

Source: Created by author.

After defining the inclusion and exclusion criteria, to finish the research protocol and proceed to the next stage, the steps for stages two and three were planned and included in the protocol (TRANFIELD; DENYER; SMART, 2003). Table 4 presents the final version of the research protocol.

Table 5 - Systematic literature review protocol

Stages	Activities	Tasks
1 - Plan SRL	Research questions	1. What are the main dimensions of supply chain visibility?
		2. What are the main environmental characteristics that make visibility desirable?
		3. What are the possible visibility configuration?
	Research Scope	1. Define data bases
		2. Define search period
2 - Conduct SLR	Define research strategy	1. Define constructs
		2. Define keywords
		3. Define research strings
	Articles selection	Filter 1: Title, abstract and keywords assessment*
		Filter 2: Introduction and conclusion assessment*
		Filter 3: Full article assessment*
	Data collection	1. Full reading
		2. Data coding through QDA Miner
		3. Critical analysis
3 - Report results	Data analysis and synthesis	1. Raise relevant information
		2. Answer SLR questions
		3. Raise literature gaps

*Evaluation through inclusion and exclusion criteria

Source: Created by the author.

After finishing the protocol, the research enters stage 2, which consists of identifying and selecting the studies, evaluation of the studies, data extraction, and data synthesis (TRANFIELD; DENYER; SMART, 2003). To start the search, the constructs that describe the research questions were defined, followed by the keywords of each construct. Table 5 summarizes the constructs with their keywords.

Table 6 - Constructs and keywords

Constructs	Keywords
Visibility	Visibility
	Data
	Information
	Intelligence
	Know-how
	Knowledge
Environmental characteristics	Environment* characteristic*
	Environment* variable*
	Environment* context
	Context* variable*
	Context* characteristic*
Supply chain	Net* chain
	Net* value
	Supply chain*
	Supply net*
	Value chain
Exchange	Availab*
	Based link
	Exchang*
	Flow
	Integrat*
	Shar*
Configuration	Configuration*
	Fit
	Cluster
	Align*
	Profile
	Gestalt

* All possible suffixes should be accepted

Source: Created by the author.

Five main constructs were defined to describe the research questions, visibility, environmental characteristics, supply chain, exchange, and configuration. The construct visibility included the term itself, information and its variations, and knowledge and its variations. The synonyms from this construct and the others were identified through Thesaurus, Cambridge dictionary. It was considered information and its variations since information sharing is used to define visibility (BARRATT; OKE, 2007; WILLIAMS et al., 2013). Knowledge and its variations were considered because, at least until 2002, the term knowledge was misused when referring to information (WILSON, 2002), and the search period defined started in 1990.

For the environmental characteristics construct, it was considered variations of both words to make the search more comprehensive. The supply chain construct considered variations such as value chain and network, similar to previous works in the field (LIMA et al., 2018; PEREIRA; CHRISTOPHER; SILVA, 2014). The exchange construct complements the first one. To improve visibility, information must be shared; therefore, the first construct aligned with the last one provides the variations of information sharing. The last construct considered the terms that would indicate an alignment, configuration, or group, forming the idea of visibility configurations defined in chapter 1

After defined the constructs and keywords to each question, a search string was assigned to describe each question. Table 7 presents each research question with its appropriate search string.

Table 7 - Search strings

1. What are the main dimensions of supply chain visibility?
((((data OR information OR intelligence OR knowledge OR "know-how") W/3 (availab* OR flow OR integrat* OR shar* OR "-based linkage" OR exchang*)) OR visibility) AND ("net* chain" OR "net* value" OR "supply chain*" OR "supply net*" OR "value chain"))
2. What are the main environmental characteristics that make visibility desirable?
(((data OR information OR intelligence OR knowledge OR "know-how" OR visibility) AND ("Environment* characteristic*" OR "Environment* variable*" OR "Environment* context" OR "Context* variable*" OR "Context* characteristic*" OR contingent* OR situation*)) AND ("net* chain" OR "net* value" OR "supply chain*" OR "supply net*" OR "value chain"))
3. What are the possible visibility configurations in the supply chain?
((data OR information OR intelligence OR knowledge OR "know-how" OR visibility) AND (configuration* OR fit OR cluster OR align* OR profile OR gestalt) AND ("net* chain" OR "net* value" OR "supply chain*" OR "supply net*" OR "value chain"))

Source: Created by the author.

Defined the search strings, the search was realized in Scopus, Web of Science, Scielo, and Engineering Village due to the reasons presented during the description of phase 1. The software StArt, a free software designed for systematic literature reviews (LAPES, 2019), was used to organize all the articles retrieved and perform the selection of the studies. The selection of the articles was executed in three steps. In the first filter, the title, abstract, and keywords were assessed using the inclusion and exclusion criteria; if all the inclusion criteria were met, the article would pass to the second filter. During the second filter, the introduction and conclusion of the articles were evaluated; if the article met all inclusion criteria, it would pass to the third and final filter. The last filter consisted of a

full reading of the article and preparation for data extraction; if all inclusion criteria were met, the article would pass to the extraction. The number of duplicated articles, the number of articles accepted, and excluded in each filter can be found in chapter 3.

The final activity of phase 2 is the extraction of the data necessary to answer the research questions and identification of possible research gaps for further exploration (TRANFIELD; DENYER; SMART, 2003). The analysis of the articles was done through QDA Miner, a software dedicated to the analysis of qualitative data (PROVALIS RESEARCH, 2019). QDA Miner was already used in similar studies (LIMA et al., 2018; MORAES et al., 2020; PEREIRA et al., 2020; PEREIRA; CHRISTOPHER; SILVA, 2014) in order to improve the content analysis (BRINGER; JOHNSTON; BRACKENRIDGE, 2006; JOHNSTON, 2006), a technique used to make valid and replicable inferences from texts (KRIPPENDORFF, 2004).

Following the guidelines of Krippendorff (2004), Bringer, Johnston, and Brackenridge (2006); and Johnston (2006), the content analysis was performed to extract and synthesize the data. First, it is necessary to define the unit of analysis for the articles selected for extraction. The unit was defined as a sentence because, according to grammatical rules, sentences are independent of each other to construct meaning; therefore, it would not be necessary to consider more than one sentence to decide if it corresponds to a code (KRIPPENDORFF, 2004). Second, the list of codes should be prepared. It was considered three categories, information, influential characteristics, and configurations, aligned with the research questions proposed. The groups of information and influential characteristics, necessary to answer the first two questions, were formed based on the Social Capital Theory, Contingency Theory, and the groups proposed by other authors, identified in the review. The groups need to be comprehensive and mutually exclusive for the next step of the research (COHEN, 1960), therefore, all the information and characteristics gathered should fit in just one of them.

After analyzing the data, the systematic literature review enters the final stage, report the results (TRANFIELD; DENYER; SMART, 2003). Chapter 4 presents the Prisma diagram to point out the number of articles that came from each database, the number of articles excluded in each filter, and the final sample selected to answer the research questions. Chapter 4 also presents the results of the content analysis, the potential

visibility dimensions and categories of characteristics, along with the description of such groups, and the corresponding descriptive analysis.

After analyzing all the articles, the codebook was reevaluated. Since a detailed list of codes was prepared to observe all possible distinctions within the group of information and the group of influential characteristics (GILBERT, 2002), all codes were evaluated to remove any possible ambiguity. If two codes were used with similar meaning, they were merged into a broader concept. If the code was used in a single article, the code was considered specific to the context of the article. Since this research aims to provide the main visibility dimensions and categories of characteristics, those codes were excluded. This process was done in several rounds, eight for the list of information, and six for the list of characteristics. With the final list of codes, all their definitions were reviewed, and the final version of the codebook was defined. It is important to notice that the links identified were a combination of the information and characteristics in the final codebook. Therefore, if two characteristics were merged, for example, “trust” and “reliability”, all the configurations involving reliability became part of “trust”. For example, the code “reliability impacting demand forecast” would become “trust impacting demand forecast”. That is why the configurations list was not evaluated in the same way as the list of information and influential characteristics since they would change along with them.

The results of the systematic literature review were the potential visibility dimensions, the potential categories of influential characteristics, and the configurations between the categories of influential characteristics and specific visibility dimensions. To analyze the results and propose a final theoretical model, a Q-Sort with specialists in the field was used. The second method is detailed in chapter 5.

3.2 Validity and Reliability

Validity and reliability are two of the main criteria for evaluating research, where the first one measures if the conclusions are appropriated based on the evidence gathered, and the second represents if the results found are replicable (BHATTACHERJEE, 2012; BRYMAN, 2012; TROCHIM, 2006). However, the concepts of validity and reliability are widely used in quantitative researches, but when the approach is qualitative, researchers do not accept the assumption that the final result is external of the researchers'

perception (TROCHIM, 2006). Therefore, to proper analyze qualitative research, a different, although equivalent, set of measures are proposed (BRYMAN, 2012). The first criterion is credibility, which consists of assuring the method was carried out according to its best standards (BRYMAN, 2012). The second is transferability, which verifies if the conclusions drawn can be applied in a different context (TROCHIM, 2006). The third is dependability, which verifies if all the choices made along the research are recorded so the decisions could be traced and evaluated by an external party (BRYMAN, 2012). A fourth criteria that can be used to evaluate qualitative research is confirmability. Confirmability refers to the ability of external researchers to arrive in similar results if all the steps proposed by the original research is followed (TROCHIM, 2006). Therefore, these for main quality criteria were observed along the research in order to guarantee standardize procedures and consistent results.

This research considered all four aspects of quality criteria in its design to guarantee its rigor and value. The credibility criterion was assured by following the guidelines of Tranfield, Denyer and Smart (2003) for the systematic literature review and Krippendorff (2004); Bringer, Johnston, and Brackenridge (2006); and Johnston (2006), for the content analysis. Regarding dependability, during the literature review, a research protocol was made as the last step for the first stage of research (TRANFIELD; DENYER; SMART, 2003), which included not only the decisions made during the first stage but all the steps planned for the second and third stage. During the second stage, conducting the review, the software StArt was used to organize and keep track of each article that was excluded in each filter and for what reason. The software also kept a record for all the duplicate articles and the final list containing all the articles accepted; their metadata such as authors, keywords, and abstract; and from which database they were retrieved. For the content analysis, QDA Miner recorded all the codes created, where they were used, which category they belong to, and how many times they were used, making the coding process transparent and able to be verified. In QDA Miner, a research journal was created, as suggested by Johnston (2006) and Bringer, Johnston, and Brackenridge (2006). Notes were taken on all relevant information, like conflicting results and research suggestions, that deserved a separate discussion during the report of the results. The research journal also helps external researchers to follow the review process and verify the information deemed relevant to answer the research questions and point possible research gaps.

During the reevaluation of the codebook, several files were made after each round of the reevaluation to guarantee that the changes were traceable.

Regarding confirmability, during the design of the literature review. First, the research questions were validated through CIMO logic. The research questions was verified through the CIMO logic to guarantee that they could describe all different aspects of the problem (DENYER; TRANFIELD, 2009; KAIPIA et al., 2017). During the content analysis, the codes used were as close as possible to the original terms avoiding potential misinterpretations (KRIPPENDORFF, 2004). In order to used more advanced tools presented in QDA Miner, a detailed list of codes was used to guarantee all possible distinctions of the problem were considered (GILBERT, 2002).

Regarding transferability, although the scope of the review was limited to the supply chain, there was no restriction regarding which type of chain would be evaluated. By not limiting which type of supply chain would be investigated, the influential characteristics, the visibility dimensions proposed, and the possible configurations would apply to different supply chains. A second aspect regarding transferability relates to the supply chain position. Since no specific link in the supply chain was defined, such as manufacturers or retailers, the dimensions, characteristics and configurations would be valid independent of the which link the company is positioned.

4 RESULTS FROM THE SYSTEMATIC REVIEW

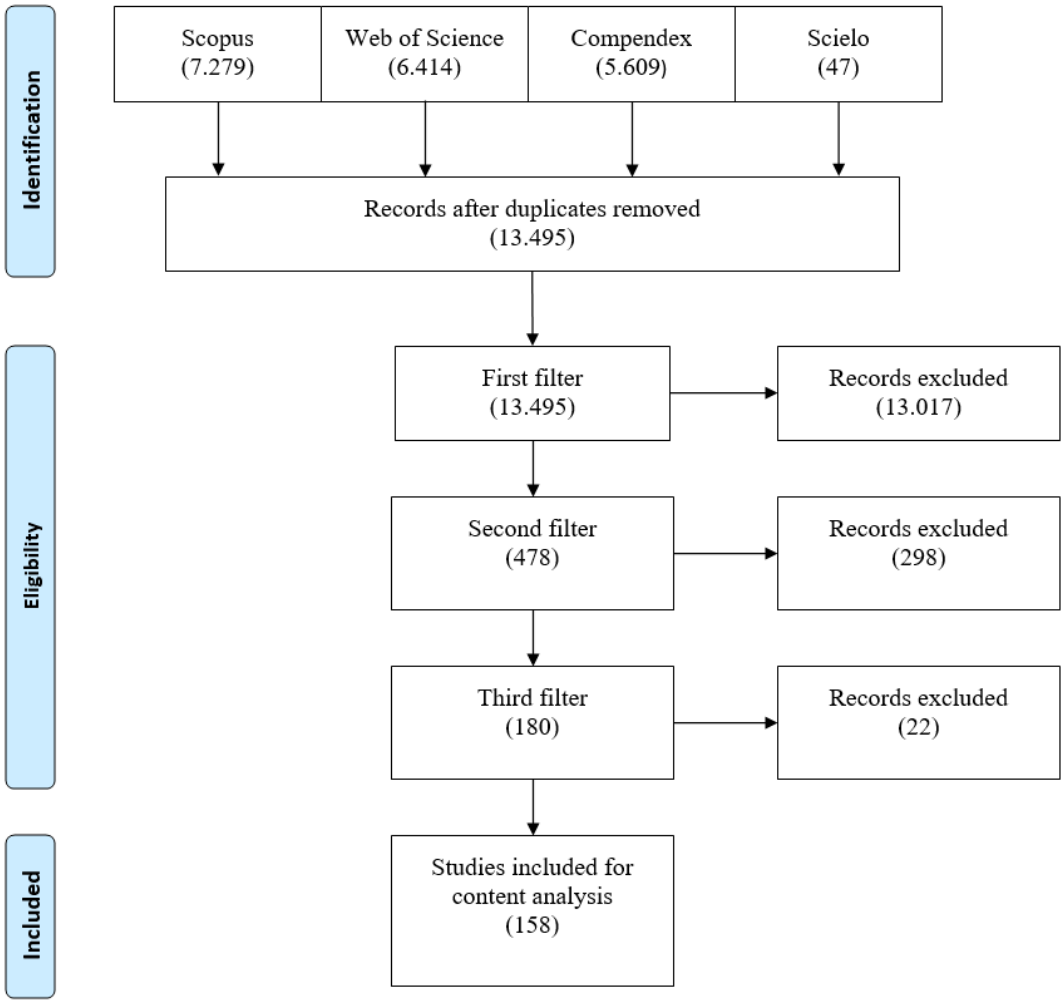
The goal of the systematic literature review was to minimize the author's bias while selecting the articles and provide a way to review a large body of literature to answer the research question presented in the previous section (DENYER; TRANFIELD, 2009; JESSON; MATHESON; LACEY, 2011; TRANFIELD; DENYER; SMART, 2003). The next section presents the PRISMA diagram to provide an overview of the systematic literature with the number of articles assessed in each stage, and the number of articles accepted and rejected in each stage. After the descriptive analysis of the review, the chapter presents the multiple views of supply chain visibility (FAN et al., 2017; KIM; RYOO; JUNG, 2011; LI; YE; SHEU, 2014; SMITH; DUCHESSI; GARCIA, 2012; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; VIET; BEHDANI; BLOEMHOF, 2018; WILLIAMS et al., 2013), multiple types of information that might be shared to develop visibility (BIAN; SHANG; ZHANG, 2016; JRAISAT; GOTSI; BOURLAKIS, 2013; WU; CHUANG; HSU, 2014; YU; TING; CHEN, 2010; ZHANG; XIONG, 2017) and some possible groups of information (BARRATT; BARRATT, 2011; SAMADDAR; NARGUNDKAR; DALEY, 2006; VIGTIL, 2007) (Section 4.2). For the second question, the chapter presents the different influential characteristics identified (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHEN; WANG; YEN, 2014; KEMBRO; NÄSLUND; OLHAGER, 2017; VAN DER MERWE; KIRSTEN; TRIENEKENS, 2017; VIET; BEHDANI; BLOEMHOF, 2018) and some possible categories of characteristics (JONSSON; MYRELID, 2016; KEMBRO; NÄSLUND; OLHAGER, 2017; LEE et al., 2010) (Section 4.3). The final section presents the links found in the literature between information and influential characteristics (KIM; RYOO; JUNG, 2011; MITTENDORF; SHIN; YOON, 2013; WILLIAMS et al., 2013).

During the review, two other systematic literature reviews were found. The first one was from Kembro, Selviaridis, and Näslund (2014), who focused on the theoretical lenses used to understand information sharing. The second one was from Somapa, Cools, and Dullaert (2018), who focused on metrics to measure supply chain visibility accurately, but the authors also presented multiple definitions of visibility and how different authors understand the concept. Therefore, to the best of the author's knowledge, there is not a previous systematic literature review that addresses the questions proposed for this research.

4.1 Descriptive Analysis

In chapter 3, it was presented all the steps for the systematic review and the criteria used to select the papers. This section starts by presenting the number of articles accepted and rejected from each step, and the number of duplicated articles found in the review. To better present such results, the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram was used (MOHER et al., 2009). Figure 4 presents the diagram with the number of articles mentioned.

Figure 4 - PRISMA diagram



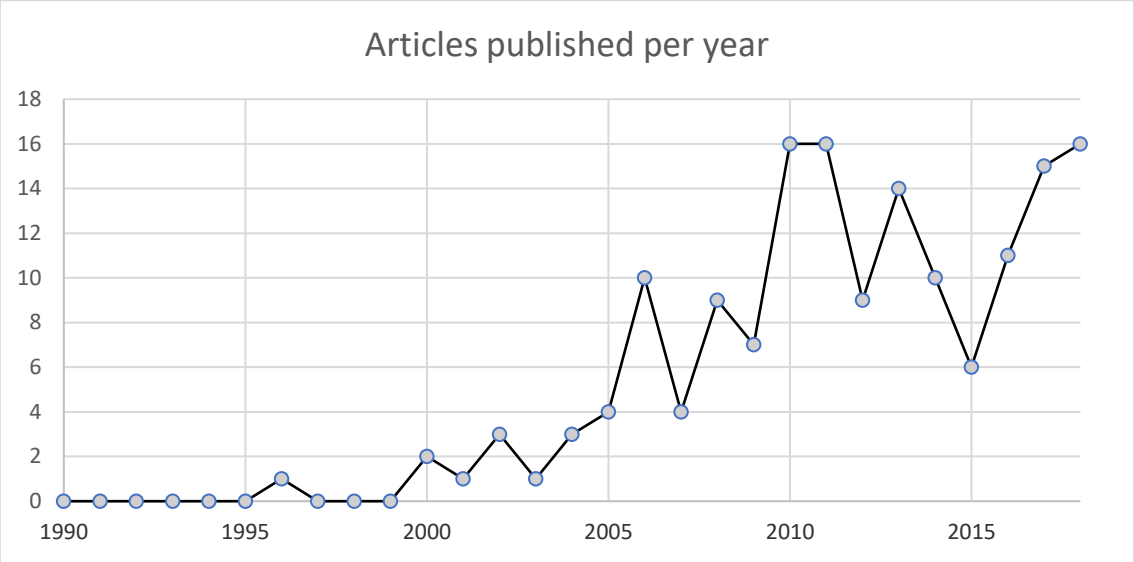
Source: created by the author

In the identification phase, the four bases described in chapter 3 were used, where Compendex corresponds to Engineering Village from Elsevier. The search strings

identified 19.349 articles in total, where 5.854 were duplicated. Therefore, 13.495 articles were included in the first filter. Using the inclusion and exclusion criteria (TRANFIELD; DENYER; SMART, 2003), three filters verified the eligibility of the articles. After the selection, 158 articles were included in the content analysis. Scopus contributed to 60,76% of the articles included in the extraction, Web of Science with 35,44%, and Engineering Village with 3,80%. Scielo was the only database that did not contribute to any article for the extraction. A possible reason is that the articles that met all inclusion criteria developed by Latin American researchers reached international journals and were retrieved through Scopus, Web of Science, and Engineering Village.

The articles included in the extraction were published between 1996 and 2018, reaching the highest levels between 2010 and 2011, followed by another increase in publications between 2015 and 2018. Figure 6 presents the number of articles published per year.

Figure 5 – Articles published per year



Source: created by the author

It is important to notice that none of the articles published between 1990 and 1995 that were retrieved from the databases were included in the extraction, and before 2000 only one article met all inclusion criteria. Therefore, it seems safe to assume that defining the search period between 1990 and January of 2019 was appropriate, considering that just one article published during the 1990s was relevant for the research questions.

The articles selected were distributed across 67 different journals, most of them with just one or two articles. Table 8 presents all the journals that had three or more articles selected with their respective number of articles.

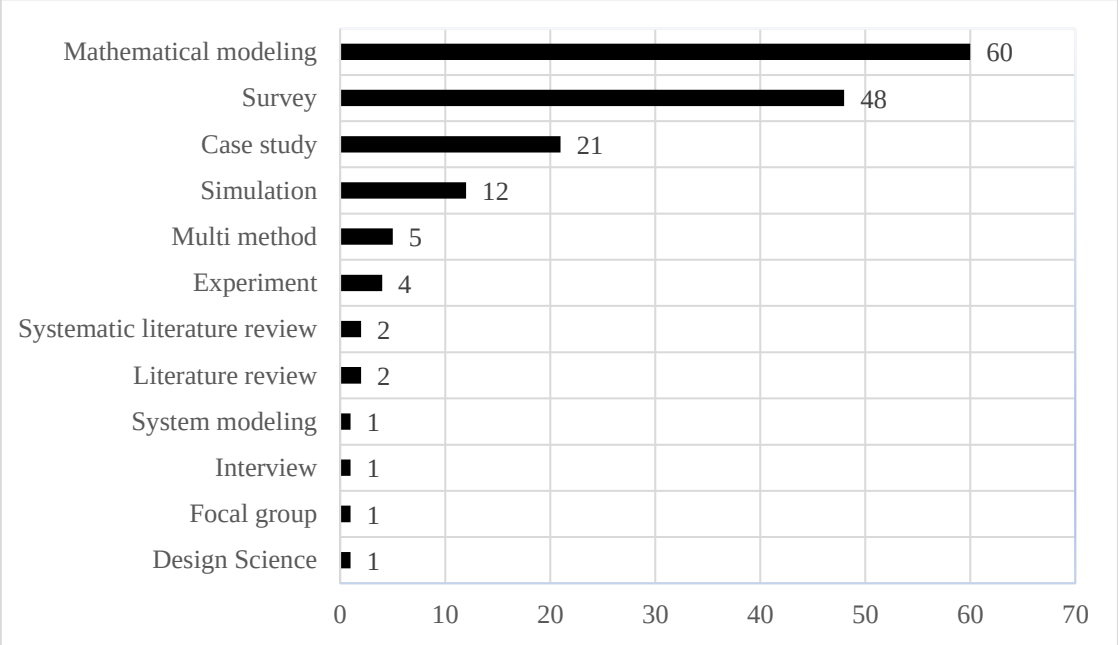
Table 8 - Articles distribution per journal

Journal	Frequency
International Journal of Production Economics	18
Management Science	12
Production and Operations Management	9
International Journal of Production Research	9
European Journal of Operational Research	7
International Journal of Physical Distribution	6
The International Journal of Logistics Management	6
Ômega	5
Supply Chain Management: An International Journal	4
Production Planning & Control	4
Manufacturing & Service Operations Management	3
Journal of Operations Management	3
International Journal of Operations & Production Management	3
Information & Management	3
Computers & Industrial Engineering	3
British Food Journal	3

Source: created by the author

Regarding the research method, four research methods together correspond to 88,60% of the articles published, mathematical modeling, survey, case study, and simulation; all of them appeared in at least ten articles. Seven methods appeared in less than five articles, experiment, systematic literature review, traditional literature reviews, system modeling, interviews, focal group, and design science. Figure 6 presents the number of articles included in the review per research method.

Figure 6 - Number of cases per method



Source: created by the author

The next section presents the data gathered in the systematic literature review to answer each research question. First, the results regarding information sharing and visibility are presented, pointing out the views found in the literature to develop visibility and if they might correspond to a possible visibility dimension or not. Following the discussion about the views, the potential visibility dimensions are presented based on the groups of information found in the literature.

4.2 Information Sharing and Visibility

This section presents the views identified during the systematic literature review, the groups of information used in the literature, the visibility dimensions found through the content analysis, and the information that can be shared in each one. First, the views to develop visibility are presented and evaluated to see if they are in line with the definition of visibility dimension. After discussing the views, the section presents the potential visibility dimensions followed by a discussion on each one of them.

4.2.1 Views on how to develop visibility and groups of information

During the review process, two of the information extracted from the articles was the possible views on how to develop visibility and groups of information. As presented in chapter 1, the views are all the interpretations about how to develop visibility. Visibility

dimensions, on the other hand, are related to the type of information that might be shared to develop supply chain visibility. This section presents the most cited views and analyzes if they are possible candidates for visibility dimensions. Other possible candidates can be found by analyzing possible groups of information since visibility dimensions relate to types of information that might be shared to develop visibility. First, the section presents the views and the possible visibility dimension candidates found among them. Following the views, the section presents the groups of information identified as possible candidates for visibility dimensions.

During the review, it was identified 28 possible views to develop supply chain visibility. Table 8 presents all the views cited in at least two articles during the review.

Table 9 - Views of supply chain visibility

Views	Cases
Demand visibility	12
Supply visibility	9
Process visibility	6
Inventory visibility	5
Operational visibility	3
Promotion visibility	3
Single visibility	3
Atom visibility	2
Compound visibility	2
Distinctive visibility	2
Internal visibility	2
Interorganizational systems (IOS) visibility	2
Logistic visibility	2
Market visibility	2
Product visibility	2

Source: created by the author.

Demand and supply visibility were the most cited views. Demand visibility appeared in 12 different articles (BARRATT; BARRATT, 2011; BARRATT; OKE, 2007; HUO; HAN; PRAJOGO, 2016; KAIPIA; HARTIALA, 2006; LEI et al., 2014; MORGAN; RICHEY JR; ELLINGER, 2018; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; SZYMCZAK et al., 2018; VIGTIL, 2007; WILLIAMS et al., 2013; ZHANG; GOH; MENG, 2011), while supply visibility in 9 (BARRATT; BARRATT, 2011; CARIDI et al., 2010; HUO; HAN; PRAJOGO, 2016; MORGAN;

RICHEY JR; ELLINGER, 2018; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; SZYMCZAK et al., 2018; WILLIAMS et al., 2013). Both views are in line with the definition of visibility dimensions; therefore, they are not only possible views but also potential visibility dimensions. Similarly, the concepts of process, inventory, promotion, market, internal, logistic, and product visibility (BARRATT; BARRATT, 2011; HALL et al., 2013; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; WANG; WEI, 2007; WILLIAMS et al., 2013) are also in line with the concept of visibility dimensions. Process visibility refers to the information regarding the process the company performs to produce its products or services (SOMAPA; COOLS; DULLAERT, 2018), while product refers to information related to the company's product (HALL et al., 2013). Inventory visibility refers to the exchange of information related mostly with inventory levels (BARRATT; BARRATT, 2011; SOMAPA; COOLS; DULLAERT, 2018). Promotion visibility refers to the exchange of information related to promotion plans (BARRATT; BARRATT, 2011). Market visibility refers to information about market conditions (WILLIAMS et al., 2013). Internal visibility refers to the access of information within the organization (BARRATT; BARRATT, 2011), while logistics visibility refers to the information related to the logistic process (SOMAPA; COOLS; DULLAERT, 2018; ZHANG; GOH; MENG, 2011); therefore, they are possible candidates to be visibility dimensions. There were three views cited only once that might be potential visibility dimensions, return product visibility (VIET; BEHDANI; BLOEMHOF, 2018), risk visibility (FU; HAN; HUO, 2017), and sales visibility (BARRATT; BARRATT, 2011).

On the other hand, the concepts of IOS, operational, distinctive, single, atom, and compound visibility do not align with the definition of visibility dimension. Interorganizational System (IOS) Visibility is an operational definition for supply chain visibility, due to the importance of information system to information sharing (KIM; RYOO; JUNG, 2011; LEE; KIM; KIM, 2014). Although its importance, the concept of IOS visibility does not align with the proposed definition of visibility dimensions, because information systems are considered one influential characteristic that might facilitate information sharing. Operational visibility is a broader concept that refers to both demand and supply visibility (SRINIVASAN; SWINK, 2018); therefore, it includes multiple types of information. Distinctive visibility refers to the information sharing that can provide a sustainable competitive advantage (BARRATT; OKE, 2007), not referring

to a particular type of information. Zhang, Goh, and Meng (2011) proposed the last three views where atom visibility represents the ability of an actor accessing specific information, single visibility is two actors exchanging information, and compound visibility is a group of actors exchanging multiple information (SOMAPA; COOLS; DULLAERT, 2018; ZHANG; GOH; MENG, 2011), not specifying any type of information.

Other potential candidates for visibility dimensions can be found through groups of information. While reviewing the articles, it was taken notes of possible groups discussed by the authors. Seven articles reviewed presented possible groups of information. The work of Jraisat, Gotsi, and Bourlakis (2013), for example, comments about the groups proposed by Huang, Lau, and Mak (2003) that divided information into eight groups, product, process, cost, quality, resource, inventory, order, and planning information. Some of these groups are in line with the previously discussed views that might also be a visibility dimension, such as product, process, and inventory. A second potential group of information was found in Caridi et al. (2010), who considered the information groups proposed by Bracchi, Motta, and Francalanci (2001). The authors divided information sharing into four groups: transactions, such as advanced shipping notice; status, such as inventory level; master data, such as commercial information, and operational plans, such as production schedule (BRACCHI; MOTTA; FRANCALANCI, 2001; CARIDI et al., 2010).

Another possible group of information was identified in the paper of Samaddar, Nargundkar, and Daley (2006), who followed the groups proposed by Seidmann and Sundararajan (1998). The author proposed four levels of information sharing. The first one is the transaction level, exchanging orders, and prices. The second one operational information, such as inventory. The third one is strategic information, such as point-of-sales, which has the potential to impact production planning, and the last one is strategic and competitive, which will impact the company’s planning process and give potential competitive benefits (SEIDMANN; SUNDARARAJAN, 1998). Different from the previous groups proposed, Baihaqi and Sohal (2013) followed Chopra and Meindl (2004), who focused on the source of information by proposing five groups: supply, customer, retailer, distributor, and manufacturer.

Besides the four researches mentioned, three other papers proposed their groups of information. Barratt and Barratt (2011), for example, proposed four main groups based on their case study: demand, inventory, promotion, and production. Another example is Vigtil (2007), who reviewed the literature searching for information that must be shared to implement a vendor managed inventory (VMI) and grouped the information found into stock levels, incoming orders, promotions, stock withdrawals, production schedules, point-of-sale (POS), sales forecast, performance metrics, and delivery schedules. The last grouping found was proposed by Welker, Van Der Vaart and Van Donk (2008), who suggested four groups, sales, orders, planning and inventory.

Therefore, it is possible to see that, despite some similarities, such as production and inventory information as possible groups (BARRATT; BARRATT, 2011; HUANG; LAU; MAK, 2003; VIGTIL, 2007), there is not an agreement on how information should be grouped, which makes the review for information necessary to defined the visibility dimensions. Knowing the possible groups of information presented in the literature, and the relevant information gathered through the content analysis, it was possible to align both results and propose the main visibility dimensions. A list of all the articles and the visibility dimensions and influential characteristics they contributed to can be found in Appendix A.

4.2.2 Visibility dimensions

Following the guidelines of Krippendorff (2004), it was used an extensive list of codes to define the main types of information that a company may share in developing visibility. The codebook was reviewed, as described in the previous section, and a list with 31 types of information composed the final codebook. Table 10 presents the final list of information with the number of cases that they appeared.

Table 10 – List of information.

Code	Cases	% Cases
Demand information	97	61.40%
Inventory level	84	53.20%
Demand forecast	61	38.60%
Incoming order	51	32.30%
Cost information	46	29.10%
POS	45	28.50%
Shipping schedule	43	27.20%
Production schedule	39	24.70%
Service indicator	32	20.30%
KPI	30	19.00%
Lead time	30	19.00%
Process capacity	29	18.40%
Traceability	29	18.40%
Track	29	18.40%
Market information	27	17.10%
Product/Service specification	27	17.10%
Product information	24	15.20%
Order status	23	14.60%
Operating cost	18	11.40%
Product condition	16	10.10%
Promotion information	13	8.20%
Quality information	13	8.20%
Customer indicator	12	7.60%
Product structure	12	7.60%
Financial information	9	5.70%
Risk source	9	5.70%
Flexibility rate	7	4.40%
Risk impact	7	4.40%
People indicator	6	3.80%
Risk probability	6	3.80%
Process details	5	3.20%

Source: created by the author.

Following the review of the codebook, each code was allocated in one of the five visibility dimensions proposed in this research named demand, supply, process, product, and risk. The dimensions were kept as few as possible to make the final framework simpler, but at the same time, as many as necessary to make a clear distinction between the groups (LAWRENCE; LORSCH, 1967). Five dimensions were deemed enough to

make a clear distinction between the dimensions, where demand, supply, and process dimensions were the most cited in the review; therefore, they were strong candidates to be included. Product and risk, although not cited as many times, were necessary to describe the information related to the manufactured goods a company produces and the hazards it might face while operating, respectively. These five dimensions were enough to separate the information, so no other dimension was added.

- Demand visibility

All information related to customers' needs and orders belongs in the demand dimension (JACOBS et al., 2011). In the demand dimension was included promotion information, demand forecast, customer indicator, market information, demand information, incoming order, and point-of-sale (POS) information. Table 11 presents all the information that belongs to the demand dimension with their definitions and the number of cases that they appeared.

Table 11 – Demand dimension and its information.

Group items	Cases	Definitions
Demand information	97	Individual customer needs identified by the company (HOPP; SPEARMAN, 2011).
Demand forecast	61	Estimated demand (HOPP; SPEARMAN, 2011).
Incoming orders	51	Specific requests made by clients (HOPP; SPEARMAN, 2011).
Point-of-sale	45	Reports on real-time sales (JONSSON; MATTSSON, 2013).
Market information	27	Overall market demand (WILLIAMS et al., 2013).
Promotion information	13	Expected changes in customer demands (TOKAR et al., 2011).
Customer indicator	12	Estimated customer satisfaction (NAHMIAS; OLSEN, 2015).

Source: created by the author.

The demand dimension was cited in 81% of the articles, being the most cited dimension proposed in the research. Since demand visibility was the most cited dimension, it was expected that the information that belongs to this dimension appeared in several articles. Three of the six most cited information belong in the dimension, demand information, demand forecast, and incoming orders. Therefore, the literature has extensively investigated the importance of the customer's needs and expectations to

improve their planning process and try to estimate their future demand based on historical and real-time data from its directed customers and final customers.

- Supply visibility

The supply dimension was the second most cited dimension appearing in 66,5% of the articles. The supply dimension consists of all information related to procurement, movement, and storage of materials, parts, and finished inventory belongs in this dimension (CHRISTOPHER, 1998). Five types of information were included in the supply dimension, inventory level, lead time, track, traceability, and shipping schedule. Table 12 presents all the information that belongs to the supply dimension with their definitions and the number of cases that they appeared.

Table 12 – Supply dimension and its information.

Group items	Cases	Definitions
Inventory level	84	The amount of raw material or transformed resources (ROWLEY; SLACK, 2004).
Shipping schedule	43	The information related to the products, time, and quantity to be transferred to a specific destination (BRANCH, 2007).
Lead time	30	The anticipated or maximum allowable cycle time for a job (HOPP; SPEARMAN, 2011).
Traceability	29	The ability to follow the upstream path (THAKUR; HURBURGH, 2009).
Track	29	The ability to follow the downstream path (THAKUR; HURBURGH, 2009).

Source: created by the author.

Since supply visibility was the second most cited view, it was expected that the information that belongs to this dimension appeared in several articles. Although supply did not receive as much attention as demand, the inventory level is the second most cited information, and the shipping schedule appears close to POS information as the seventh most cited information. Therefore, inventory management and distribution appear to be two essential activities related to the supply that managers should pay special attention to. Nevertheless, it is important to notice that track and traceability have received more attention in recent literature, so companies should be aware that their partners or clients might require information about the upstream and downstream path of their products, and also how long the distribution might take.

- Process Visibility

The process dimension was the third most cited dimension appearing in 58,2% of the articles. The process dimension consists of all information related to the sequence of activities necessary to produce a product or service that has value to a particular group of clients (AMARAL et al., 2006). The process dimension is the largest one with ten types of information named flexibility rate, operating cost, process details, cost information, service indicator, people indicator, key performance indicator (KPI), production schedule, order status, and process capacity. Table 13 presents all the information that belongs to the supply dimension with their definitions and the number of cases that they appeared.

Table 13 – Process dimension and its information.

Group items	Cases	Definitions
Cost information	46	Related to the resources spent to produce a product or service (KULMALA, 2002).
Production schedule	39	The time and quantity of each product to be produced (JACOBS et al., 2011).
Service indicator	32	Service level (NAHMIAS; OLSEN, 2015; ROWLEY; SLACK, 2004).
KPI	30	The main metrics that support decision making (GOSWAMI; ENGEL; KRCMAR, 2013).
Process capacity	29	The maximum value-added activity possible during a specific time (ROWLEY; SLACK, 2004).
Operating cost	18	The costs related to producing a product or service (KULMALA, 2002).
Flexibility rate	7	The degree to which a process can change over time (ROWLEY; SLACK, 2004).
People indicator	6	Employees' satisfaction, efficiency, and health (NAHMIAS; OLSEN, 2015; ROWLEY; SLACK, 2004).
Process details	5	Details of the workflow (ROWLEY; SLACK, 2004).

Source: created by the author.

Except for cost information, the information about process did not appear in the same number of articles supply and demand had. When talking about the process dimension, the measurement of performance appeared several times measuring different aspects such as employee's satisfaction and health, service level, estimated costs, and flexibility. Besides performance measurement, estimated costs, production schedules, and capacity availability concerns the process dimension. Therefore, the process dimension sheds light

on how well the process performs, its operating cost, and if the company has a clear schedule of its production.

- Product visibility

The product dimension was one of the dimensions that did not receive as much attention as the previous ones in the literature, but it turned out to be a relevant dimension after raising the information list. The product dimension consists of all information related to tangible commodities manufactured to be sold (GOEDKOOP, 1999). The product dimension consists of six types of information, financial information, product information, product structure, quality information, product/service specification, and product condition. Table 14 presents all the information that belongs to the supply dimension with their definitions and the number of cases that they appeared.

Table 14 – Product dimension and its information.

Group items	Cases	Definitions
Product/Service specification	27	The information necessary to ensure that the customer's expectations were met (ROWLEY; SLACK, 2004).
Product information	24	Presents a description of the product (GOEDKOOP, 1999).
Product condition	16	The environmental conditions of a product, heat, humidity, and pressure that might impact its quality (HSIAO; HUANG, 2016).
Quality information	13	The quality characteristics of a product or service (ROWLEY; SLACK, 2004).
Product structure	12	The design and materials of the product (ROWLEY; SLACK, 2004).
Financial information	9	Product valuation and related taxes/tariffs (GOSWAMI; ENGEL; KRCMAR, 2013).

Source: created by the author.

The product dimension appeared in 37,3% of the articles, and it was the fourth most cited dimension. The most important type of information related to product is the quality aspects of the product. Half of the information that belongs to this dimension focused on quality aspects, while the other half focused on the product's design, except for the valuation and taxes of the product. Therefore, to develop product visibility, the companies should be aware of the product's expected quality, its current condition, design, and possible taxes that might impact the product's success in the market.

- Risk visibility

The last visibility dimension, risk visibility, was mentioned in 8,2% of the articles included in the review, and three pieces of information related to risk were included in the final codebook making the risk dimension necessary. The risk dimension includes all information related to possible damage, danger, loss, injury, or any other undesired consequences (MANUJ; MENTZER, 2008). The types of information related to risk were named risk source, risk impact, and risk probability. Table 15 presents all the information that belongs to the supply dimension with their definitions and the number of cases that they appeared.

Table 15 – Risk dimension and its information.

Group items	Cases	Definitions
Risk impact	7	The potential consequences of an unexpected event (MANUJ; MENTZER, 2008).
Risk probability	6	The chance that an undesired event occurs (MANUJ; MENTZER, 2008).
Risk source	9	The potential cause of an undesired consequence (ALAWAMLEH; POPPLEWELL, 2011).

Source: created by the author.

The risk dimension received less attention than the other dimensions proposed, but it is important to notice that the articles that contributed to this dimension are from the past few years, while the supply and demand dimensions received attention during the whole search period. Since the recent articles are paying more attention to the risk dimension, the information related to risk was kept in the codebook, and more researches focusing on this dimension are necessary. The risk dimension considered the potential events that can cause damage or loss, how likely is that such happens, and their expected impact. These three pieces of information were enough to describe the situations presented in the articles review, but since more attention has been given to this dimension, other information might appear in future researches to complement the list.

4.3 Influential Characteristics

This section presents the potential categories of influential characteristics identified through the systematic literature review to complement the groups proposed by the Contingency Theory and Social Capital Theory. After presenting the groups proposed by

the literature, the section presents the list of influential characteristics identified in the review and the potential groups that they belong.

4.3.1 Potential categories of influential characteristics

It was found seven researches that divided the influential characteristics into categories of characteristics, each one of them with different categories and a number of characteristics. The work of Kembro, Näslund, and Olhager (2017), for example, used a Delphi to identify possible influential characteristics and group them into six categories. The first one was "information utilization," which focuses on planning and forecasting. The second was "technology utilization," which focuses on the means to share information. The third was "power structure," which focuses on how much one company can influence the other ones in the supply chain. The fourth is "culture" that includes the aspects of the relationship between companies and the level of collaboration. The fifth is "business process," that refers to all aspect related to integrating business process from multiple firms. The last group was "legal aspects," the possible arrangements between companies to ensure that the information will not be misused or leaked.

Another way to group the influential characteristics was found in the work of Lee et al. (2010), who proposed three main categories, relationship characteristics, organizational characteristics, and information/technology characteristics. The first group is formed by characteristics such as trust and commitment (MENTZER et al., 2001) that must exist between two companies so they will be willing to exchange information. Organizational characteristics refer to top management support and the company's culture, while information/technology characteristics refer to information quality and the technology used to exchange information (LEE et al., 2010).

Different from previous authors, Jonsson and Myrelid (2016) proposed four main categories based on a traditional literature review: business context, information, inter-organizational and intra-organizational characteristics. Jonsson and Myrelid (2016) defined as business context the contextual drivers of information, similar to the definition of influential characteristics. Therefore, such a group does not divide the concept of influential characteristics into smaller concepts; that is why business context cannot be used as a category in this research. Information refers to quality aspects of information and the usability of such information, which are basic principles to develop visibility. Therefore, this category does not represent influential characteristics, but quality criteria

for the information to develop visibility. Inter-organizational aspects refer to the characteristics of the relationship between the companies, while intra-organizational refers to internal aspects of the organization, both potential categories of characteristics.

The last possible groups of characteristics were found in the articles of Li, Ye, and Sheu (2014), Johnson, Elliott, and Drake (2013) and Lee and Ha (2018), who used Social Capital Theory as a base for their research. As presented in the previous sections, Social Capital Theory proposes three groups of influential characteristics structural, relational, and cognitive (NAHAPIET; GHOSHAL, 1998). The structural dimension refers to characteristics of the network that enables the exchange information, such as network structure (JOHNSON; ELLIOTT; DRAKE, 2013), or technological characteristics, such as information systems (LEE; HA, 2018). Cognitive capital relates to the values and believes of the companies that make the exchange possible, such as shared norms and culture (JOHNSON; ELLIOTT; DRAKE, 2013). Relational capital, on the other hand, refers to aspects specific to the relationship between the companies such as trust and commitment (LEE; HA, 2018).

Based on the groups found in the literature and the organizational theories presented in the previous sections, the next section presents the characteristics identified in the literature with their potential categories.

4.3.2 Groups of influential characteristics

Following the guidelines of Krippendorff (2004), it was also used an extensive list of codes to define the main influential characteristics that impact the development of the visibility dimensions. The codebook was reviewed, as described in the previous section, and a list with 34 influential characteristics composed the final codebook. Table 16 presents the final list of information with the number of cases that they appeared.

Table 16 – List of influential characteristics.

Code	Cases	% Cases
Information systems	79	50.00%
Trust	53	33.50%
Governance structure	44	27.80%
Commitment	26	16.50%
Culture	26	16.50%
Demand uncertainty	26	16.50%
Direct contact	26	16.50%
Relationship complexity	24	15.20%
Incentive policy	24	15.20%
Supply chain position	24	15.20%
Competition intensity	22	13.90%
Shared codes and language	20	12.70%
Bargain power	18	11.40%
Collaboration	16	10.10%
Length of relationship	15	9.50%
Integration	14	8.90%
Supply chain structure	14	8.90%
Demand pattern	12	7.60%
Top management support	12	7.60%
Product complexity	11	7.00%
Supply uncertainty	11	7.00%
Capacity availability	10	6.30%
Size of the firm	10	6.30%
Manufacturing environments	9	5.70%
Asset specificity	7	4.40%
Product durability	6	3.80%
Technology uncertainty	6	3.80%
Lead time pressure	5	3.20%
Reciprocity	5	3.20%
Order batch size	4	2.50%
Cultural similarity	3	1.90%
Holding cost	3	1.90%
Market uncertainty	3	1.90%
Reputation	3	1.90%

Source: created by the author.

It is important to notice that the influential characteristics did not receive as much attention in the literature as information and visibility. The first three characteristics were the only ones that appeared in more than 30 articles, and all of them are social characteristics. Therefore, Social Capital Theory can make a valuable contribution to the

analysis of influential characteristics. Although important, Social Capital Theory is not enough to analyze all characteristics; therefore, Contingency Theory contributed to the uncertainty characteristics, one of the external contingencies mentioned by Lawrence and Lorsch (1967). The last group was derived from the work of Jonsson and Myrelid (2016) that presented two groups related to organizational characteristics. In this research, just a single group considering both internal and external characteristics was used. So, five categories of influential characteristics were necessary to group the characteristics named relational factors, cognitive factors, structural factors, organizational characteristics, and uncertainty.

- Structural factors

The first group derived from Social Capital Theory was structural factors. The structural factors include all influential characteristics that affect the incentives, patterns, and technical means supply chain partners use to manage coordination and collaboration (NAHAPIET; GHOSHAL, 1998). Nine influential characteristics belong to the structural factors named asset specificity, bargain power, relationship complexity, direct contact, governance structure, incentive policies, information systems, integration, and supply chain structure. Table 17 presents all the influential characteristics that belong to the structural factors with their definitions and the number of cases that they appeared.

Table 17 – Structural factors category and its influential characteristics.

Influential characteristic	Cases	Definition
Information systems	79	Elements of hardware and software that connects supply chain partners (VALACICH; SCHNEIDER, 2009)
Governance structure	44	The coordination mechanisms used to manage the coordination and information exchange (DENOLF et al., 2015)
Direct contact	26	The interaction between two or more parties through phone-calls, meetings or e-mails (WELKER; VAN DER VAART; VAN DONK, 2008)
Relationship complexity	24	The frequency and variety of transactions (SAMADDAR; NARGUNDKAR; DALEY, 2006)
Incentive policies	24	Actions such as sharing benefits or price discounts that balances the good outcomes of information sharing (HA; PARK; CHO, 2011)
Bargaining power	18	The imbalance of power or dependence that might induce information sharing (KEMBRO; NÄSLUND; OLHAGER, 2017)
Integration	14	The adoption of collaborative structure and process among supply chain partners (VIJAYASARATHY, 2010)
Supply chain structure	14	How business partners are linked (e.g., owned, alliances, etc.) to form a supply chain
Asset specificity	7	The degree to which partners make firm-specific investments to improve information sharing (PATNAYAKUNI; RAI; SETH, 2006)

Source: created by the author.

The structural factors category appears in 75,9% of the articles included in the review, being the category that received the most attention in the literature. Two out the three most cited characteristics are structural, information systems, and governance structure, and all the characteristics, except for asset specificity, are above the median (13 cases). In the structural factors, we can see that the infrastructure received the most attention, but human interaction between company members and the time they dedicate to these encounters are also relevant to develop visibility. The power in the supply chain can also enforce the information exchange, but it is important to balance the benefits each company might have so the exchange might continue. The structure of the supply chain can impact how easily a company might reach another, and the frequency they interact, although not cited as many times it was considered a relevant characteristic. The characteristic that received the least attention is asset specificity, although not cited as

many times; this type of investment might solve problems such as systems incompatibility.

- Relational factors

The second derived from Social Capital Theory was relational factors. The relational factors include all influential characteristics that affect interpersonal relationships among employees of supply chain partners (NAHAPIET; GHOSHAL, 1998). Six influential characteristics belong to the relational factors named collaboration, commitment, reciprocity, top management support, length of the relationship, and trust. Table 18 presents all the influential characteristics that belong to the relational factors with their definitions and the number of cases that they appeared.

Table 18 – Relational factors category and its influential characteristics.

Influential characteristic	Cases	Definition
Trust	53	The extent to which a company believes its partner will fulfill its agreements (LEE et al., 2010)
Commitment	26	The extent to which they will maintain their relationship (LEE et al., 2010)
Collaboration	16	How often employees work jointly on project and activities (BARTLETT; JULIEN; BAINES, 2007)
Length of relationship	15	The period for which supply chain partners have a business relationship (LEE et al., 2010)
Top management support	12	The extent which top managers support the business relations (BARTLETT; JULIEN; BAINES, 2007)
Reciprocity	5	The likelihood that a company will be treated fairly by its partners, based on past interactions (ZAHEER; TRKMAN, 2017)

Source: created by the author.

The relational factors category appears in 37,3% of the articles included in the review, being the second category based on Social Capital Theory that received the most attention in the literature, and third when considering operational characteristics. Although relational factors are the third most cited, it is important to notice that this category appears in half as many articles as structural, showing a tendency on the literature to focus on structural characteristics. Trust is the most cited characteristic in relational factors, and it is central to Social Capital Theory, so it was expected that trust would be widely

investigated in the literature. After trust, commitment and collaboration had also been widely investigated, measuring the contact the companies have and if they are willing to maintain or maybe expand their relationship. Other important aspects of the relational factors are the support of the top management, how long the companies have been working together, and if they think their relationship is fair based on past interactions. All those aspects depend on constant interactions and are enhanced by the continuous effort of keeping the relationship and interacting with each other (BOURDIEU, 1986).

- Cognitive factors

The last group derived from Social Capital Theory was cognitive factors. The cognitive factors include all influential characteristics that affect common values, representations, interpretations, and systems of meaning across supply chain partners (NAHAPIET; GHOSHAL, 1998). Five influential characteristics belong to the cognitive factors named culture similarity, culture, reputation, shared codes and languages, and importance of the relationship. Table 19 presents all the influential characteristics that belong to the relational factors with their definitions and the number of cases that they appeared.

Table 19 – Cognitive factors category and its influential characteristics.

Influential characteristic	Cases	Definition
Culture	26	The attitude and willingness of a company to share its information with its partner (KEMBRO; NÄSLUND; OLHAGER, 2017)
Shared codes and language	20	The mutual rules and values that help to develop a mutual understanding (JOHNSON; ELLIOTT; DRAKE, 2013)
Cultural similarity	3	The extent to which the two companies have similar values (LEE et al., 2010)
Reputation	3	The extent to which the partners market reputation is significant to the information exchange (MÜLLER; GAUDIG, 2011)

Source: created by the author.

The cognitive factors appeared in 23,5% of the articles, the category derived from Social Capital Theory that received the least attention in the literature. Although the category did not receive as much attention in the literature, one characteristic appears as the fourth most cited characteristic along with commitment, direct contact, and demand

uncertainty, named culture. Culture represents how open a company is to share its information with its partner, and without such willingness, it might not be possible to establish the information exchange. Shared codes and languages derive from the definition of cognitive capital and argue that the exchange is easier when companies with similar rules and values. Cultural similarity follows the same logic as shared codes and languages, while reputation might make the partner feel that the information will not be leakage or misused in any way, making the partner more open to sharing its information.

- Organizational characteristics

There was just one category that was not based on an organizational theory named organizational characteristics. This category was based on the work of Jonsson and Myrelid (2016) and included all characteristics related to how an organization creates and delivers services and products (ROWLEY; SLACK, 2004). There were eleven characteristics classified as organizational characteristics named holding cost, order batch size, product complexity, product durability, competition intensity, manufacturing environments, demand pattern, lead time pressure, size of the firm, capacity availability, and supply chain position. Table 20 presents all the influential characteristics that belong to the operational characteristics with their definitions and the number of cases that they appeared in.

Table 20 – Organizational characteristics and its influential characteristics.

Influential characteristic	Cases	Definition
Supply chain position	24	The company's relative position in the supply chain, such as manufacturer or retailer
Competition intensity	22	The number of competitors operating in the industry (FUENTES; JURADO, 2016)
Demand pattern	12	The level and timing of expected changes in demand (TOKAR et al., 2011)
Product complexity	11	The number of parts, process, and inputs necessary to produce the product or service
Capacity availability	10	The amount of excess capacity within a company
Size of the firm	10	Measured by the number of employees
Manufacturing environment	9	The production system orientation, such as make-to-order, or make-to-stock
Product durability	6	The useful lifetime of the product (ROWLEY; SLACK, 2004)
Lead time pressure	5	The amount of pressure a company feels from customers or competitors
Order batch size	4	The number of jobs done before changing to another family of products (HOPP; SPEARMAN, 2011)
Holding cost	3	The cost of holding inventory and safety stocks (HALL; SAYGIN, 2012)

Source: created by the author.

Organizational characteristics category was the second most cited category in the literature, appearing in 43% of the articles. Although the category was highly cited, two characteristics received much more attention than the rest of the category, supply chain position, and competition intensity. The two most cited characteristics relate to the structure of the supply, so there is a tendency of the researches to focus on supply chain aspects when assessing this category. Other external characteristics also appear in this group, such as lead-time pressure and demand pattern. Although they were considered relevant because they appeared in links that might form the visibility configuration, they did not receive as much attention in the literature. All the other characteristics reflect aspects of the company's internal operation. They were included because they were also linked to some visibility dimensions, but the company's internal factors deserve more attention in future studies since most studies related to this category focus on the company's external environment.

- Uncertainty

The last group of influential characteristics was derived from Contingency Theory. Uncertainty is of external contingencies mentioned by Lawrence and Lorsch (1967), and it is defined as unexpected changes in customer's preferences, suppliers deliveries, technology or market conditions (LI; LIN, 2006). Four types of uncertainty were identified in the review named demand uncertainty, supply uncertainty, market uncertainty, and technology uncertainty. Table 21 presents all the influential characteristics that belong to the uncertainty category with their definitions and the number of cases that they appeared.

Table 21 – Uncertainty category and its influential characteristics.

Influential characteristic	Cases	Definition
Demand uncertainty	26	Unexpected changes in customer's needs and tastes (LI; LIN, 2006)
Supply uncertainty	11	Unexpected changes in product quality and delivery performance (LI; LIN, 2006)
Technology uncertainty	6	Unexpected changes in the emergence of next-generation or obsoleting developments (LI; LIN, 2006)
Market uncertainty	3	Unexpected changes in economic conditions

Source: created by the author.

The uncertainty category appeared in 18,3% of the articles, being the least researched category of influential characteristics. Except for demand uncertainty, the uncertainty group did not receive much attention in the literature when compared to the other influential characteristics. Demand uncertainty appeared as the fourth most cited characteristics, along with commitment, culture, and direct contact. Demand uncertainty is especially relevant, considering the potential visibility configurations that are discussed in the next section. So, it might be expected that with more researches related to supply, technology, and market uncertainty, these three characteristics might also strengthen the relationship between the uncertainty category and the visibility dimensions.

4.4 Visibility Configurations

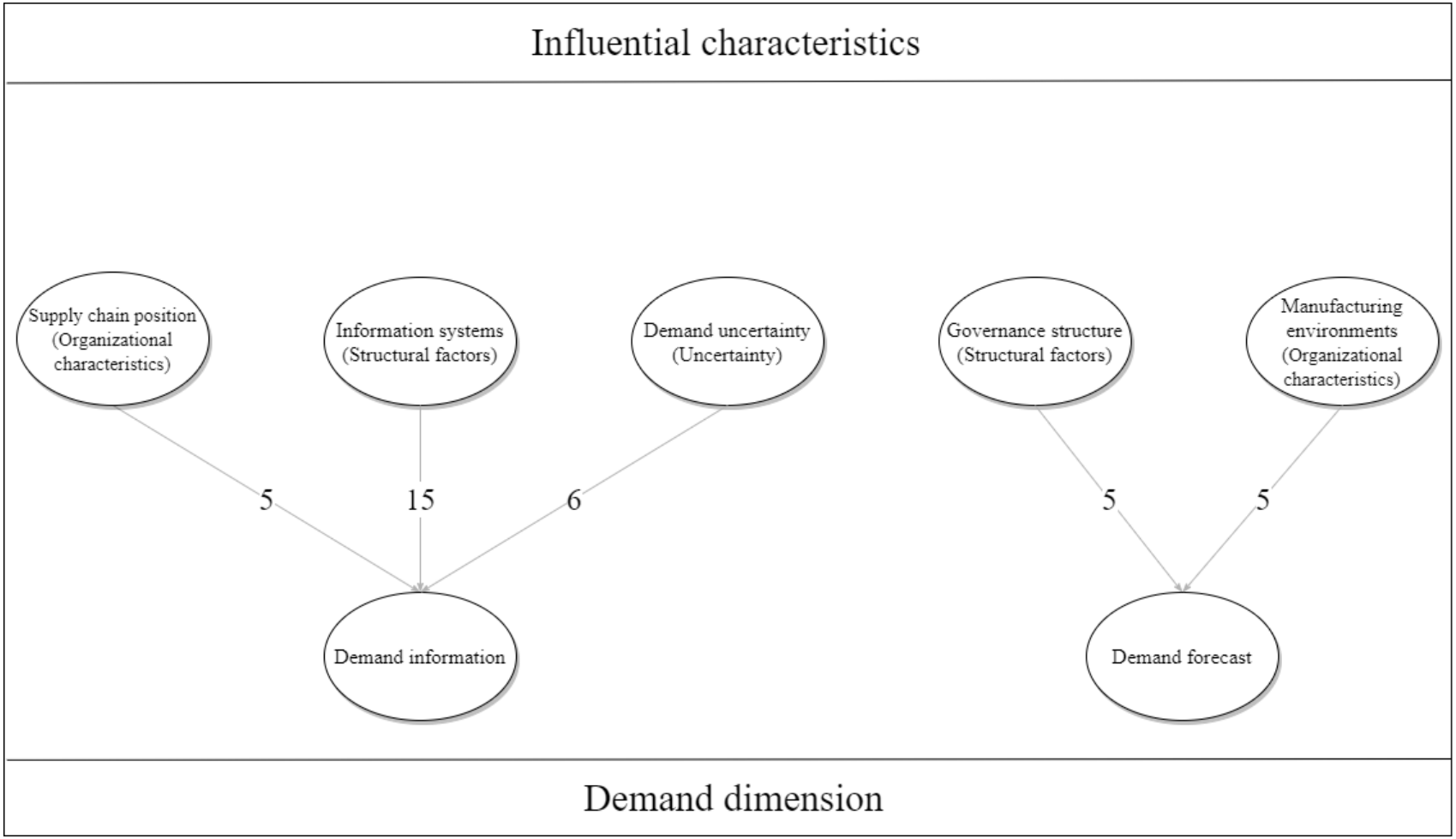
This section presents the links between the information identified in section 4.2 and the influential characteristics presented in section 4.3. First, the section presents the most

frequent links found in the review. Two tables follow the most frequent links, one with the information most frequently linked to any influential characteristic, and another presenting the influential characteristics that were more frequently linked to any information. After presenting these results, the section presents the visibility configurations considering both potential visibility dimensions and potential categories of influential characteristics.

4.4.1 Most frequent links

During the review, it was found 127 different links between the 29 influential characteristics selected for analysis and the 27 codes that described the information selected for analysis. Only information related to supply and demand dimensions appeared in more than five articles. Figure 7 presents the links between the information in the demand dimension and the influential characteristics that appeared in more than five articles.

Figure 7 – Demand links



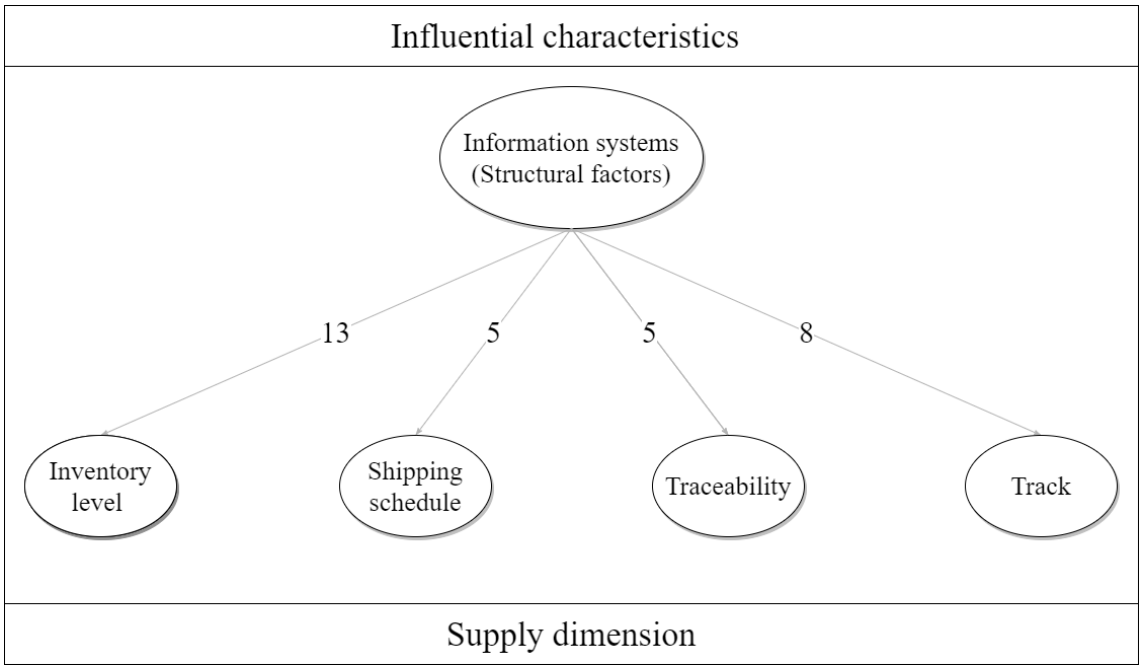
Source: created by the author.

Figure 7 shows that the structural factors and organizational characteristics are the ones that had most of the links with different types of information. Besides them, there was one link involving uncertainty. Therefore, we can see that the literature tends to focus on the structural and operational categories when presenting links between characteristics and information. That tendency was expected in such proportion because the structural factors and organizational characteristics categories were the most cited in the literature.

On the other hand, only two types of information were among the most cited in the demand dimension, demand information, and demand forecast. These two were the most cited information in the demand dimension, but incoming orders and POS were also highly cited and did not appear in the main links.

Among the influential characteristics that had a positive impact on demand, only information systems also appear on supply links. The supply dimension appears to be more balanced because four of the five types of information that belong to supply were identified in the links. Figure 8 presents the main links involving the supply dimension.

Figure 8 – Supply links



Source: created by the author.

Although almost all types of information related to supply appear in the most frequent links, only information systems impacted the supply dimension in more than five cases.

Therefore, there is still a gap related to the supply dimension and the other categories of characteristics.

Regarding the other visibility dimension, it is clear that there is a literature gap that might be explored in future studies due to the low number of cases that cited some links between influential characteristics. Besides the low number of links, the most cited links included mostly structural factors and the demand and supply dimension; therefore, not much is known about the other three categories and three visibility dimensions.

To better understand the role of both information and influential characteristics to form visibility configurations, two tables were prepared. The first one presents only the information involved in the links observed in the articles, regardless of the influential characteristic. Twenty-seven out of thirty-four information types identified in Section 4.2 were observed in specific links. Table 22 presents all the information involved in any link presented in the literature

Table 22 - Information frequency considering all influential characteristics

Information	Dimension	Cases
Demand information	Demand	34
Inventory level	Supply	23
Demand forecast	Demand	21
POS	Demand	11
Track	Supply	10
Cost information	Process	8
Production schedule	Process	7
Incoming order	Demand	6
KPI	Process	5
Shipping schedule	Supply	5
Traceability	Supply	5
Product information	Product	4
Process capacity	Process	3
Product condition	Product	3
Quality information	Product	3
Lead time	Supply	2
Process information	Process	2
Product/Service specification	Product	2
Promotion information	Demand	2
Customer indicator	Demand	1
Financial information	Product	1
Market information	Demand	1
Order status	Process	1
Process details	Process	1
Product structure	Product	1
Service indicator	Process	1

Source: created by the author.

Among the most cited type of information, demand, and supply appear as the most cited dimensions, which was expected based on the main link presented in Figures 7 and 8. Following demand and supply, the process dimension appears with sixth and seventh-most cited information, but those types of information did not reach ten articles. The most cited product information appeared in just four articles, while any risk information did not appear in any specific link.

A similar analysis was also made for the influential characteristics. All the characteristics that were observed in any article are presented in Table 23, along with their potential categories, and frequency.

Table 23 - Influential characteristics' frequency considering all information

Characteristics	Category	Cases
Information systems	Structural factors	34
Governance structure	Structural factors	12
Demand uncertainty	Uncertainty	11
Supply chain position	Operational characteristics	10
Incentive policy	Structural factors	10
Trust	Relational factors	9
Direct contact	Structural factors	8
Manufacturing environments	Operational characteristics	7
Capacity availability	Operational characteristics	6
Competition intensity	Operational characteristics	5
Culture	Cognitive factors	4
Demand pattern	Operational characteristics	4
Size of the firm	Operational characteristics	4
Length of relationship	Relational factors	4
Bargain power	Structural factors	4
Integration	Structural factors	4
Supply chain structure	Structural factors	4
Holding cost	Operational characteristics	3
Product durability	Operational characteristics	3
Shared codes and languages	Cognitive factors	2
Lead time	Operational characteristics	2
Product complexity	Operational characteristics	2
Commitment	Relational factors	2
Order batch size	Operational characteristics	1
Collaboration	Relational factors	1
Top management support	Relational factors	1
Asset specificity investment	Structural factors	1
Market uncertainty	Uncertainty	1

Source: created by the author.

A tendency in the literature towards the structural factors can be seen in Table 22. Three of the five most cited characteristics belong to structural factors, while the other two belong to operational characteristics and uncertainty. Trust, the most cited relational characteristics involved in links, appears as sixth with nine articles, and all the other

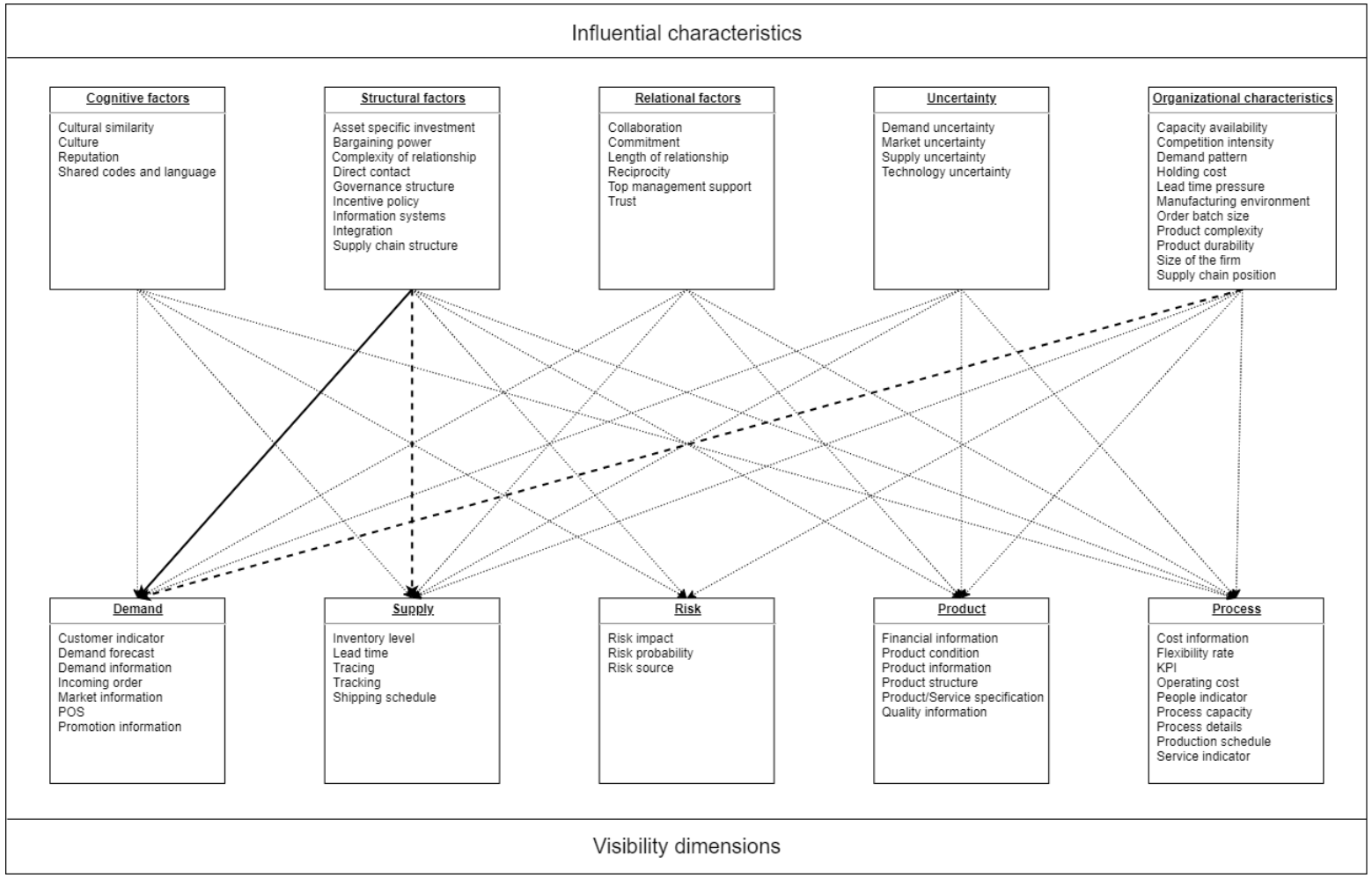
characteristics from this category appeared in two or one articles, despites the relational factors being cited in 59 articles. Therefore, despite the importance of relational factors, its characteristics did not present many links in the literature. Uncertainty had only two characteristics linked with information, but market uncertainty was found only once. The cognitive factors category also appears with two characteristics, but both appeared in four or fewer articles.

Knowing the most relevant information and influential characteristics for the specific links, the next section presents a more in-depth analysis regarding the groups. The next section also proposes possible visibility configurations based on potential visibility dimensions and categories of characteristics.

4.4.2 Visibility configurations

The links between influential characteristics and information presented in the previous section are the base for the supply chain configuration proposed in this section. As defined in chapter 1, visibility configurations are the fit between a visibility dimension and a category of influential characteristics that enables visibility. Therefore, instead of analyzing specific links, this section presents the results based on potential groups and categories. The first version of the framework is presented in Figure 9, considering the categories of characteristics and visibility dimensions presented in the previous chapter. The dotted lines represent associations that appear in less than 10 percent of the articles; dashed lines represent appearance in 10 to 20 percent of articles, and solid lines indicate associations that appear in more than 20 percent of the articles.

Figure 9 – First version of the framework



Source: created by the author.

There was just one configuration that appeared in more than 20% of the articles, the configuration between structural factors and demand dimension. This configuration was expected to be the most cited since it linked the most cited dimension and the most cited category, as presented in the previous section. Two configurations appeared in more than 10% but less than 20% of the articles, the configuration between structural factors and supply, and operational characteristics and demand. The first one was formed by the most cited category, and the second most cited dimension; that is why it was expected that more articles presented this configuration. The second one involved the most cited dimension and a category that presented many characteristics that were linked with different types of information, again a result that can be explained by the importance of the dimension and category involved in the configuration. Three configurations appeared in more than 5% but less than 10%, the configuration between structural and process, operational and supply, and uncertainty and demand. These configurations also involved one of the two main dimensions, supply and demand, or the main category of characteristics, structural factors.

It is important to notice that relational and cognitive factors did not appear in any configuration in more than 5% of the articles. The same happens with product and risk dimensions, where risk and relational, cognitive and process, and risk and uncertainty configurations were not found in the literature. That does not mean that these configurations do not exist or that these dimensions and categories do not have strong relations with one another. Another remark that is needed is the relationship between cognitive factors, structural factors, and organizational characteristics with risk. As mentioned before, none of the types of information related to risk were linked with an influential characteristic. The configurations presented in the framework came from the relationship between the categories and the term risk information. Since risk information defined the risk dimension, it was not included as a type of information, but it indicates that risk is related to the three categories mentioned. Tables 22 and 23 presents what is known in the literature, but the visibility dimensions and categories of characteristics must first be validated because any changes in any of the groups proposed might change the percentages presented.

5 Q-SORT

The Q-sort method is used to assess the reliability and construct validity of items, usually questionnaire items, and it is frequently used as a pre-test phase of survey research (BOON-ITT; WONG; WONG, 2017; LOCKWOOD; PYUN, 2020; NAHM et al., 2002). The Q-sort was chosen as a complement to the systematic literature review because the method can test if the information and influential characteristics identified belong to the dimensions and categories they were classified. It is important to notice that the Q-sort is a first step towards the validation of the visibility dimensions and categories of characteristics, and it refined the definitions and items derived from the literature. Therefore, the nature of this research is exploratory, and the items generated here are the first step for a survey that validated the dimensions, categories, and configuration (BOON-ITT; WONG; WONG, 2017; CAO; ZHANG, 2010; MENOR; ROTH, 2007) but such validation exceeds the scope of this research. Each version of the questionnaire developed based on the literature review can be found in the next chapter and its final version in Appendix B.

The Q-sort is an iterative process that consists of two steps: planning the Q-sort round and reviewing the items. In the first step, before starting the Q-sort, it is necessary to select the judges, define the number of rounds, and the number of participants per round (MENOR; ROTH, 2007; NAHM et al., 2002; OLIVEIRA; ROTH, 2012). Regarding the selection of the judges, they should be experts in the topic being studied (CAO; ZHANG, 2010; ELSHEIKH, 2017; MENOR; ROTH, 2007), in this case, supply chain visibility. The experts were identified through the systematic literature review. All the authors that published at least one article regarding visibility or influential characteristics that were included in the extraction were selected as a potential judge. The e-mails of all the authors selected were checked, and 150 e-mails from the 189 potential judges were retrieved. The list of judges contacted in each round can be found in Appendix C.

Regarding the number of rounds, the Q-sort usually ranges from two to six rounds (BOON-ITT; WONG; WONG, 2017; CAO; ZHANG, 2010; MENOR; ROTH, 2007; NAHM et al., 2002; OLIVEIRA; ROTH, 2012). For this research, three rounds were planned. The judges identified through the review were randomly divided into three groups of 50 judges so that each round would be with a different set of respondents. Regarding the number of respondents per round, this research followed the same structure

as Menor and Roth (2007), and, Oliveira and Roth (2012), where the number of respondents per round ranged from four to seventeen. Fifty authors were contacted in each round, and eight, seven, and six authors responded the first, second, and third round, respectively.

After retrieving the responses from the judges, they were analyzed through measures of agreement. The questionnaire analysis was divided into two parts, visibility dimensions and categories of characteristics, since the potential groups for the visibility dimensions differ from the categories, as shown in the previous chapter. Each round was evaluated through four agreement measures, proportional agreement, Cohen's kappa, Perreault, and Leigh's reliability index, and the hit ratio. The proportional agreement is most likely the simplest indicator to measure agreement (RUST; COOIL, 1994). The proportional agreement, A, is the ratio of the frequency of agreements between the judges, f_0, and the total number of judgments made in the round, TOT. The proportion of agreement is described in equation 1.

$$A = \frac{f_0}{TOT} \tag{2}$$

In this research, the proportional agreement was used to evaluate individual items and verify if the judges labeled each item as its potential group described in the previous chapter. The next chapter presents the questionnaire used in each round with its items, potential groups, and original items, as retrieved from the literature review. Following the works of Ekinci and Riley (2001) and Lockwood and Pyun (2020), the minimum agreement expected in each item should be 60%. If the item did not reach this level, it was modified or excluded for the next round.

To evaluate the judges' agreement regarding the visibility dimensions and categories of characteristics, it is essential to account for the probability of agreement by chance (COHEN, 1960; PERREAULT; LEIGH, 1989; RUST; COOIL, 1994). For this reason, Cohen's kappa was chosen as a second agreement measure. Cohen (1960) argues that it is only necessary to know two proportions to determine if the agreement was by change, the proportion of items the judges agreed (p_0), and the proportion of agreement expected by chance (p_c). The coefficient k considers the difference between the observed

agreement and expected agreement by chance ($p_0 - p_c$) and the maximum nonchance agreement ($1 - p_c$) (BAKEMAN; QUERA, 2011). The formula for the kappa's coefficient is presented in Equation 2.

$$k = \frac{p_0 - p_c}{1 - p_c} \tag{2}$$

An alternative formulation considers the frequencies instead of the proportions, where f_c represents the expected frequency of agreements by chance, the number of items that both judges agreed on the classification, f_0, and *N* is the total number of items classified by the judges. The alternative formulation for the kappa's coefficient is presented in Equation 3.

$$k = \frac{f_0 - f_c}{N - f_c} \tag{3}$$

The second formulation was the one used in this research because it was available through the Python package Scikit-learn (PEDREGOSA et al., 2015). The expected values of *k* ranges from 1, perfect agreement, and zero, agreement by chance. The average kappa from the first part of the questionnaire, visibility dimensions, started as 0,6 and raised to 0,79 in the last analysis, while the second part started as 0,37 and lowered to 0,35. Why the the first part improved while the second did not is explained in the next chapter. As a reference guide, Landis and Koch (1977) propose the following strength of agreement based on the values of kappa.

Table 24 – Strength of agreement

Kappa statistics	Strength of agreement
<0,00	Poor
0,00-0,20	Slight
0,21-0,40	Fair
0,41-0,60	Moderate
0,61-0,80	Substantial
0,80-1,00	Almost perfect

Source: Landis and Koch (1977) (adapt.)

Although some authors argue that a kappa above 0,41 is acceptable (CABRAL; LOCHAN DHAR, 2019; LANDIS; KOCH, 1977), other authors argue that an acceptable value for kappa is above 0,65 (ELSHEIKH, 2017; JARVENPAA, 1989; MENOR; ROTH, 2007; NAHM et al., 2002). Therefore, in this research, the target value for kappa was 0,65. Considering the target value and Table 24, the first part of the questionnaire had a substantial agreement, while the second part had a low agreement.

Cohen's kappa is able to assess the agreement between the judges, but it does not measure if the judges labeled the types of information and influential characteristics as described in the previous chapter. For example, all the judges might have labeled the item that describes inventory level as process dimension, which will raise the kappa values, but in the previous chapter, inventory level was labeled supply, which indicates disagreement with the previous label. Although the proportional agreement was used to evaluate individual items, it did not measure if the items mislabeled belonged to a single group or multiple groups. To measure if the items the judges assigned were correctly labeled, another measurement of the agreement was included, the hit ratio (MOORE; BENBASAT, 1991). The hit ratio is displayed as a matrix where the rows are the theoretical groups, and the columns are the actual groups that were chosen by the judges. A column called "Other" was added in case a judge thinks the item does not belong to any group or belongs to multiple groups. The last two columns are the total number of items in each group, and the hit ratio. Table 25 displays an example of the hit ratio table of the first part of the first round of the Q-sort.

Table 25 – Hit ratio example.

	Demand	**Product**	**Risk**	**Process**	**Supply**	**Other**	**Total**	**Hit ratio**
Demand	51	2	1	0	0	2	56	91,07
Product	0	37	1	6	2	2	48	77,08
Risk	0	0	23	0	0	1	24	95,83
Process	8	2	2	55	1	12	80	68,75
Supply	3	4	0	14	12	7	40	30,00
Total	62	45	27	75	15	24	248	

Source: created by the author.

In Table 25, it is possible to see that the diagonal of the matrix represents the items that were correctly classified. For example, 51 types of information that were classified

as demand in the previous chapter were correctly classified as demand, two were misclassified as product, one as risk, and two were deemed ambiguous, presented in the column “Other.” Since 51 out of 56 items were correctly classified, the hit ratio is 91,07%. The other dimensions follow the same logic, where the column Total represents the number of items that were theoretically classified as a specific dimension times the number of respondents. For example, seven pieces of information were classified as demand in the previous chapter, and there were eight responses in the first round; therefore, the demand dimension had 56 judgments.

The hit ratio is useful to identify potential problems in the groups proposed (MOORE; BENBASAT, 1991). For example, almost all types of information related to risk were correctly classified; therefore, this dimension was properly defined. On the other hand, process and supply appear to have an overlap because their information was mixed when we look to the supply’s row. So the items, or maybe the definition of the dimensions, should be reworded to make the distinction clearer (CAO; ZHANG, 2010; NAHM et al., 2002). As a reference, the minimum value for the hit ratio was 75% (BOON-ITT; WONG; WONG, 2017; MENOR; ROTH, 2007; MOORE; BENBASAT, 1991).

Although Cohen’s kappa measures the agreement of the judges considering all items, and the hit ratio measures if they were correctly placed, none of them consider the size of the theoretical groups. The row “Total” is not part of the original hit ratio table, but it was added to illustrate the necessity of the last agreement index. The row “Total” shows that the judges used more the demand and process dimensions, while risk and supply were not used as much. The proportion in the row “Total” matches the column “Total,” where demand and process dimensions had more judgments, while risk and supply had fewer judgments due to the number of items in each dimension. Therefore, the judges agreed that more items belong to demand and process, and fewer items to risk and supply. Cohen’s kappa cannot capture this agreement, but Perreault and Leigh’s reliability index can. Since the row “Total” does not belong to the original hit ratio matrix (MOORE; BENBASAT, 1991), it was not presented in the results in the next section. The row “Total” was only added in this example to show why the last agreement index was necessary.

Perreault and Leigh (1989) proposed a reliability index, I_r, is based on the frequency of agreement between judges, f_o, the number of items being classified, N, and the number of groups g. The reliability index I_r is calculated through the equations 4 and 5

$$I_r = \left\{\left[\left(\frac{f_o}{N}\right) - \left(\frac{1}{g}\right)\right]\left[\frac{g}{g-1}\right]\right\}^{0,5}, \quad \text{for } \frac{f_o}{N} \geq \frac{1}{g} \qquad (4)$$

$$I_r = 0, \quad \text{for } \frac{f_o}{N} < \frac{1}{g} \qquad (5)$$

Equation 3 only has a real solution if the proportion of agreement (f_o/N) is greater than $1/g$. If the proportion of agreement is smaller than $1/g$, it indicates that the agreement is not beyond chance; therefore, the reliability index is zero (PERREAULT; LEIGH, 1989). The average value for the reliability index for the first part of the questionnaire was 0,79 and raised to 0,90 at the end of Q-sort, while for the second part, it started as 0,61 and lowered to 0,58. The reason why the first part improved while the second did not is explained in the next chapter.

Regarding the reference values, Perreault and Leigh (1989) consider that I_r should be greater than 0,8, but in exploratory cases 0,7 might be enough, while values above 0,9 presents high reliability. Since this study is exploratory and future studies might apply a large-scale survey for further validation, the target value for I_r was 0,7. Considering these reference values, it is possible to see that the first part of the questionnaire reached high reliability, while the second was lower than expected. Although the second part had low reliability, both parts showed an improvement when compared to the kappa values because the reliability index considered the group sizes to estimate the reliability.

The second step of the Q-sort consists of revising the items and definitions of categories of characteristics and visibility dimensions. Based on the target levels proposed, the items, dimensions, and categories that presented problems were revised. After reviewing the questionnaire, we go back to step one with a new set of judges and measure the agreement based on the new responses. This process was followed after the first and second rounds of the Q-sort. After the third round, the items that did not reach

the minimum agreement were either excluded or a particular discussion was presented to justify its label.

All the agreement measures described contribute to different aspects of validity and reliability for the Q-sort. The next section details the types of validity and reliability that were assured while conducting this method and how each of these indexes contributed to them.

5.1 Validity and Reliability

Validity and reliability are two criteria that measure the research quality. Validity measures the quality of the conclusions made from research (TROCHIM, 2006), while reliability measures if the results are consistent (BRYMAN, 2012). All agreement measures described in this chapter relate to reliability, although the hit ratio also improves validity. Regarding validity, Trochim (2006) proposes that are four types of validity named conclusion validity, internal validity, external validity, and construct validity. The goal of the second part of this research is to test the last type of validity, construct validity, in this case, the visibility dimensions and categories of characteristics. By ensuring the construct validity of the dimensions and categories the visibility configurations can be tested in a future study.

Four aspects of construct validity were considered to ensure construct validity named face validity, content validity, convergent validity, and discriminant validity. Table 26 presents their definitions and how they were assured in this research.

Table 26 – Validity measures.

Validity	Definition	Measures to ensure validity
Face validity	Verifies if the indicator seems to be a reasonable measure of the construct (BHATTACHERJEE, 2012)	Implicit in Q-sort
Content validity	Verifies if the definitions of the constructs are clear (TROCHIM, 2006) and if the groups of items proposed are enough to describe the construct (BHATTACHERJEE, 2012)	Derived from the literature and refined by a specialist
Discriminant validity	Verifies if the items that assign to a construct relates to it (BHATTACHERJEE, 2012; TROCHIM, 2006)	Hit ratio
Convergent validity	Verifies if an item describes a single construct, respectively (BHATTACHERJEE, 2012; TROCHIM, 2006)	Hit ratio

Source: created by the author.

The first validity observed in the second part of this research was face validity. One way to ensure face validity is to ask experts in the field if the items used describe the concept that it should describe (BRYMAN, 2012). By asking experts in visibility and influential characteristics which dimension or category of characteristics they would place the items identified in the literature review, it is possible to increase face validity. Since the Q-sort is used to assist in such a process (NAHM et al., 2002), face validity is implicit in the method. Content validity, on the other hand, needs to guarantee that the definitions of the visibility dimensions, categories of characteristics, and their related items were clear. The definitions came from the articles included in the review; therefore, they were previously refined by the authors who published the research. Second, the definitions proposed were refined after each round of the Q-sort to improve their clarity and solve any potential ambiguity, ensuring content validity.

The other two types of validity verify if the items that assign to a construct relates to it and if an item describes a single construct, respectively (BHATTACHERJEE, 2012; TROCHIM, 2006). For example, the items derived from demand forecast, demand information, and promotion information should estimate demand visibility, convergent validity, and they should not measure the other types of visibility, discriminant validity. These types of validity are verified through the hit ratio (MENOR; ROTH, 2007) because

this measure verifies the number of items correctly placed in each group and if there is only one group that the item belongs to.

Regarding reliability, two types of reliability were considered in this research, inter-rater reliability and internal consistency reliability (TROCHIM, 2006). Table 27 presents their definitions and how they were assured in this research.

Table 27 – Reliability measures.

Reliability	Definition	Measures to ensure reliability
Inter-rater reliability	Verifies the consistency of two or more judges' responses (BRYMAN, 2012)	Proportional agreement, Cohen's kappa, and Perrault and Leigh's reliability index
Internal consistency reliability	Verifies the consistency of the item to describe a construct (BHATTACHERJEE, 2012)	Hit ratio

Source: created by the author.

The first type of reliability, inter-rater reliability, verified if the judges interpreted the visibility dimensions, categories of characteristics, and items the same way. In this research, inter-rater reliability was estimated through proportional agreement, Cohen's kappa, and Perrault and Leigh's reliability index, the agreement measures presented in the previous section. The second type of reliability, internal consistency, was measured through the hit ratio since this measure verifies if the items were correctly classified in the visibility dimensions and categories of characteristics. For example, the hit ratio verifies if the items labeled as demand, such as POS and demand forecast, were correctly classified as demand, therefore they correctly describe the construct they should describe.

6 RESULTS FROM Q-SORT

The main goal of the Q-sort was to test if the types of information and influential characteristics were correctly assigned to the visibility dimensions and categories of characteristics, respectively. This chapter presents the results of the agreement indexes presented in the previous chapter. The first section presents the results from the visibility dimensions and their information, while the second section presents the results from the influential characteristics and their categories.

6.1 Results from the First part of the Questionnaire

Each item of the questionnaire was derived from the definitions of the types of information. The first version of the questionnaire was pre-tested with two specialists in supply chain management. After receiving their remarks, the items and the definitions of the potential groups were reviewed to set the questionnaire for the first round. Table 28 presents the information part of the first round of the Q-sort.

Table 28 – First round of Q-sort (information).

Question	Survey item	Potential group	Original item
01	Expected changes in the timing and level of demand	Demand	Promotion information
02	Product valuation and related taxes/tariffs	Product	Financial information
03	Demand forecasts	Demand	Demand forecast
04	Possible causes of undesired consequences	Risk	Risk source
05	Process flexibility	Process	Flexibility rate
06	Customers' satisfaction and loyalty	Demand	Customer indicator
07	Operational costs	Process	Operating cost/Financial indicator
08	Details on the required workflow for a product	Process	Process details
09	Estimated consequences of possible damage, danger, loss or injury	Risk	Risk impact

Source: created by the author.

Table 28 – First round of Q-sort (information)(cont.).

Question	Survey item	Expected group	Original item
10	Resources consumed in the production	Process	Cost information
11	Service level performance	Process	Service indicator
12	Overall demand market conditions	Demand	Market information
13	Metrics on human resources (e.g., efficiency, satisfaction, health, and safety)	Process	People indicator
14	Amount of inventories arriving at a process	Supply	Inventory level
15	Metrics that support decisions for process improvements	Process	Internal process indicator/KPI
16	Specific needs of customers	Demand	Historical demand/Demand information
17	Anticipated lead time for a job	Supply	Lead time
18	Production schedule	Process	Production schedule
19	Product description	Product	Product information
20	Customer order information (e.g., item, quantity, due date)	Demand	Order information/Incoming order
21	Status of the fulfillment of a customer order	Process	Order status
22	The downstream destination of an item in the supply chain	Supply	Track
23	A list or diagram of the materials and components of a product or service package	Product	Product structure/Material information
24	Quality conformance information	Product	Quality information
25	Point of sales data	Demand	POS
26	The origin and history of items used in a particular product	Supply	Traceability
27	Process capacity	Process	Process capacity/Capacity information/Capacity availability
28	Quality specifications for a service or product	Product	Product/Service specification

Source: created by the author.

Table 28 – First round of Q-sort (information)(cont.).

Question	Survey item	Expected group	Original item
29	Product condition (e.g., temperature, damage)	Product	Product condition
30	Probability of an event that leads to the realization of the risk	Risk	Risk probability
31	Advance shipment notices	Supply	Shipping schedule

Source: created by the author.

Table 28 presents the information part of the Q-sort with the question number, the item derived from the definitions of the original items, the original items, and the expected group. Some items were derived from more than one type of information. In those cases, the original items were merged due to an overlap in their definitions.

The first agreement index calculated was the proportional agreement. The target value of the proportional agreement was 60%, as explained in the previous chapter. Table 29 presents the values of the proportional agreement for the first round.

Table 29 – Proportional agreement – first round (information).

Item	Proportional agreement (%)	Item	Proportional agreement (%)
1	100,00	17	0,00
2	62,50	18	87,50
3	100,00	19	100,00
4	87,50	20	87,50
5	100,00	21	37,50
6	62,50	22	12,50
7	75,00	23	50,00
8	100,00	24	75,00
9	100,00	25	100,00
10	75,00	26	50,00
11	12,50	27	100,00
12	87,50	28	75,00
13	12,50	29	100,00
14	50,00	30	100,00
15	87,50	31	37,50
16	100,00		

Source: created by the author.

Considering the target value, items number 11, 13, 14, 17, 21, 22, 23, 26, and 31 should be reviewed because they are below 60%.

The second agreement index calculated was Cohen's kappa, where the target value was 0,65, as explained in the previous chapter. Table 30 presents Cohen's kappa for each pair of judges.

Table 30 – Cohen's kappa – first round (information).

	1	2	3	4	5	6	7	8
1		0,46	0,44	0,87	0,75	0,67	0,62	0,70
2			0,44	0,55	0,52	0,59	0,47	0,62
3				0,48	0,48	0,52	0,48	0,48
4					0,84	0,79	0,63	0,75
5						0,63	0,55	0,75
6							0,56	0,63
7								0,62
8								

Source: created by the author.

The columns and rows represent the judges ordered by the date of answers, so judge number one was the first to answers, and judge number eight, the last. Only the upper triangle of the matrix needs to be calculated because the agreement between judges 1 and 2 is the same as the agreement between 2 and 1. The main diagonal does not need to be calculated because it represents the agreement of a judge with himself or herself; therefore, the main diagonal is always one. Although we have high agreements between some of the judges, for example, 1 and 4, and 1 and 5, that were above 0,75; we also have low values, for example, 3 and 8, and 3 and 4, that were below 0,5. To evaluate the overall agreement, the average kappa was calculated and was 0,6; Therefore, below our target value.

The third agreement index calculated was Perreault and Leigh's reliability index, where the target value was 0,7, as explained in the previous chapter. Table 31 presents Perreault and Leigh's reliability index for each pair of judges.

Table 31 – Perreault and Leigh's reliability index – first round (information).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1		0,70	0,68	0,94	0,88	0,83	0,81	0,85
2			0,68	0,76	0,73	0,78	0,70	0,81
3				0,70	0,70	0,73	0,70	0,70
4					0,92	0,90	0,81	0,88
5						0,81	0,76	0,88
6							0,76	0,81
7								0,81
8								

Source: created by the author.

Similar to Cohen's kappa, only the upper triangle needs to be calculated due to the same reasons. Perreault and Leigh's reliability index presented higher values than kappa, as expected. As explained in the previous chapter, Cohen's kappa is a more conservative index because it does not account for an agreement regarding the number of items placed in each group (PERREAULT; LEIGH, 1989). Since the groups differ in the number of information assigned to each one, this effect can be seen when we compare both tables. In other words, although the judges did not agree in all the items, they seem to agree that dimensions such as demand and process have more types of information than risk, for example.

Before presenting the hit rate table, it is important to notice that all agreement indexes were above 0,7, the target value, but the ones involving judge number 3. Although judge 3 is an exception, he does not seem to be an outlier because its smaller agreement index is 0,68, which is close to the target value. The average value of Perreault and Leigh's reliability index in the first round is 0,79, above to the expected value for exploratory research, and close to the general recommended value 0,8.

The last agreement index calculated was the hit ratio, where the target value is 75%, as explained in the previous chapter. Table 32 presents the values of the hit ratio for all the visibility dimensions proposed.

Table 32 – Hit ratio – first round (information).

	Demand	**Product**	**Risk**	**Process**	**Supply**	**Other**	**Total**	**Hit ratio**
Demand	51	2	1	0	0	2	56	91,07
Product	0	37	1	6	2	2	48	77,08
Risk	0	0	23	0	0	1	24	95,83
Process	8	2	2	55	1	12	80	68,75
Supply	3	4	0	14	12	7	40	30,00

Source: created by the author.

Considering the values of the hit ratio presented in Table 32, three out of five dimensions reached the minimum value. Regarding the ones that did not, the items related to the process dimension appears to be ambiguous because they were currently labeled as demand or other. The supply items appear to have an overlap with process since more items were labeled as process than supply, and also, there were seven items labeled as other. Due to the overlaps, the definitions of the visibility dimensions were also reviewed for the second round.

After reviewing the items identified through proportional agreement, and the definitions of the visibility dimensions, a new version of the questionnaire was developed. Table 33 presents the questionnaire applied in the second round.

Table 33 – Second round of Q-sort (information).

Item	Survey item	Potential group	Original item
1	Expected changes in the timing and level of demand	Demand	Promotion information
2	Product valuation and related taxes/tariffs	Product	Financial information
3	Demand forecasts	Demand	Demand forecast
4	Possible causes of undesired consequences	Risk	Risk source
5	Process flexibility	Process	Flexibility rate
6	Customers' satisfaction and loyalty	Demand	Customer indicator
7	Operational costs	Process	Operating cost
8	Details on a required workflow for a product	Process	Process details
9	Estimated consequences of possible damage, danger, loss or injury	Risk	Risk impact
10	Resources consumed in house production	Process	Cost information
11	Service level performance	Process	Service indicator
12	Overall demand market conditions	Demand	Market information
13	Metrics on human resources (e.g., efficiency, satisfaction, health, and safety)	Process	People indicator
14	The number of items arriving to a process	Process	Inventory level
15	Metrics that support decisions for process improvements	Process	KPI
16	Specific needs of customers	Demand	Demand information
17	Anticipated lead time for a job	Process	Lead time
18	Production schedule	Process	Production schedule
19	Product description	Product	Product information
20	Customer order information (e.g., item, quantity, due date)	Demand	Incoming order
21	The destination of an inbound procured items	Supply	Track
22	Product's design including the components and materials	Product	Product structure
23	Product's conformance information	Product	Quality information
24	Point of sales data	Demand	POS
25	The origin and history of inbound procured items	Supply	Traceability

Source: created by the author.

Table 33 – Second round of Q-sort (information)(cont.)

Item	Survey item	Potential group	Original item
26	Process capacity	Process	Process capacity
27	Quality specifications for a service or product	Product	Product/Service specification
28	Product condition (e.g., temperature, damage)	Product	Product condition
29	Probability of an event that leads to the realization of the risk	Risk	Risk probability
30	Advance shipment notices of procured items	Supply	Shipping schedule

Source: created by the author.

Like the first round, some pieces of information were merged due to their similarity. The definitions of the visibility dimensions were also reviewed to make their distinction clearer. Table 34 presents the new definitions of the visibility dimensions, where the option “Other” can be used when the item is not adequately defined.

Table 34 – Definitions of the visibility dimensions – second round.

Visibility dimension	Definition
Demand	Information describing projected and actual customers' needs and orders.
Process	Information describing a company's production, delivery, and service activities and performance.
Product	Information describing a tangible commodity manufactured to be sold.
Risk	Information describing possible damage, danger, loss, injury, or any other undesired consequences.
Supply	Information describing the status of purchased items.
Other	Please use this response if you do not think the information belongs to any of the dimensions proposed.

Source: created by the author.

After retrieving the results for the second round, each item was verified through the proportional agreement. Table 35 presents the proportional agreement for the second round.

Table 35 – Proportional agreement – second round (information).

Item	Proportional agreement (%)	Item	Proportional agreement (%)
1	100,00	16	85,71
2	100,00	17	100,00
3	100,00	18	100,00
4	100,00	19	100,00
5	100,00	20	85,71
6	57,14	21	71,43
7	100,00	22	100,00
8	71,43	23	85,71
9	100,00	24	100,00
10	85,71	25	85,71
11	42,86	26	100,00
12	100,00	27	71,43
13	57,14	28	71,43
14	42,86	29	100,00
15	85,71	30	100,00

Source: created by the author.

There was an improvement in the proportional agreement when comparing the first and second rounds. First, the number of items that did not reach the target value of 60%. In the first round, nine items needed to be reviewed while in the second round, just four items needed to be reviewed. Second, the number of items that reached 100% agreement. In the first round, 11 items reached the maximum level of agreement, while in the second round, 16 items reached such level. This difference in items that were not reviewed came from an improvement in the definitions of the visibility dimensions.

The second agreement index calculated was Cohen’s kappa. Table 36 presents the results from the agreement index for the second round.

Table 36 – Cohen's kappa – second round (information).

	1	2	3	4	5	6	7
1		0,67	0,67	0,54	0,67	0,67	0,71
2			0,75	0,67	0,83	0,75	0,83
3				0,62	0,75	0,75	0,74
4					0,70	0,74	0,74
5						0,83	0,96
6							0,83
7							

Source: created by the author.

It is also possible to see an improvement in the kappa values. With one exception, the agreement between judges 1 and 4, all values of kappa reached the target value, 0,65. The average kappa also shows improvement; the average kappa for the second round was 0,73, which shows that there is enough agreement between the judges.

The third agreement index is Perreault and Leigh's reliability index. Table 37 presents the reliability indexes for the second round.

Table 37 – Perreault and Leigh's reliability index – second round (information).

	1	2	3	4	5	6	7
1		0,82	0,82	0,75	0,82	0,82	0,85
2			0,87	0,82	0,92	0,87	0,92
3				0,80	0,87	0,87	0,87
4					0,85	0,87	0,87
5						0,92	0,98
6							0,92
7							

Source: created by the author.

The new table for Perreault and Leigh's reliability index also shows improvement since all indexes are above the minimum value for exploratory researches, 0,7, and the average agreement index is 0,86. An agreement level of 0,86 is above the general recommended value (0,80), which indicates a high agreement between the judges.

The last agreement index is the hit ratio. Table 38 presents the values of the hit ratio for the second round.

Table 38 – Hit ratio – second round (information).

	Demand	Product	Risk	Process	Supply	Other	Total	Hit ratio
Demand	44	0	0	1	1	3	49	89,80
Product	2	37	1	2	0	0	42	88,10
Risk	0	0	21	0	0	0	21	100,00
Process	0	3	0	62	4	8	77	80,52
Supply	0	0	0	0	18	3	21	85,71

Source: created by the author.

There is also a clear improvement in the hit ratio when compared to the first round. In the second round, all indexes reached the minimum level of agreement, 75%. The supply dimension, the dimensions that had the worst performance in the previous round, doubled its value. Another dimension that should be highlighted is the risk dimension, which reached 100% agreement. Therefore, it is clear that the visibility dimensions converged in the second round, so the third round is not needed.

Regarding the four items that did not reach the proportional agreement's minimum value, items 6 and 13 were excluded because they were types of KPI, which was also a recommendation of one of the judges. Since the item KPI had a high agreement, the particular cases were excluded. Item 14 were also excluded because it was derived from "inventory level," and item 30 included the amount of procured items scheduled to arrive; Therefore, item 14 was not necessary. Only item 11 stayed in the questionnaire, and it was reworded to "Service level performance of a delivery process." Since just one item was changed, the third round of Q-sort did not include the information part.

If we calculate Cohen's kappa, Perreault and Leigh's reliability index, and hit ratio, it is possible to see that these indexes improved, and they were already above the minimum value necessary to end the Q-sort. The average kappa would be 0,79, the average Perreault and Leigh's reliability index 0,90, and the hit ratio for demand, supply, product, process, and risk would be 95,24%; 85,71%; 88,10%; 87,30%; and 100%, respectively. All the indexes calculated show high agreement between the judges; therefore, the first part of the questionnaire ended in the second round. The next section presents the results from the second part of the questionnaire, the influential characteristics.

6.2 Results from the Second part of the Questionnaire

The second part of the questionnaire tested the influential characteristics and their categories. The first version of the questionnaire was pretested along with the first part, and the items were refined before the first round. After reviewing the items, the questionnaire for the first round was sent to 50 specialists. Table 39 presents the questionnaire for the first round.

Table 39 – First round of Q-sort (characteristics).

Item	Survey item	Potential group	Original item
1	The extent to which suppliers, partners, and customers working jointly on an activity or project	Relational factors	Collaboration
2	Cost of holding inventory, including work-in-process and safety stock	Operational characteristics	Holding cost
3	The extent to which supply chain partners have similar values, beliefs, and management practices	Cognitive factors	Cultural similarity
4	How business enterprises are linked (e.g., owned, alliance, etc.) to form a supply chain	Structural factors	Supply chain structure
5	The average size of a production batch (or lot size)	Operational characteristics	Order batch size
6	The extent of the unpredictability of customer's demands and tastes	Uncertainty	Demand uncertainty
7	Mechanisms suppliers use to manage coordination	Structural factors	Governance structure
8	Product complexity in terms of the number and diversity of inputs required from suppliers	Operational characteristics	Product complexity
9	The extent to which supply chain partners commit to a business relationship	Relational factors	Commitment
10	The total useful life of the product	Operational characteristics	Product durability
11	Imbalance in the commercial value of transactions between supply chain partners	Structural factors	Bargain power

Source: created by the author.

Table 39 – First round of Q-sort (characteristics)(cont.)

Item	Survey item	Potential group	Original item
12	Rules, values, and goals that facilitate communication and the development of mutual understandings	Cognitive factors	Shared codes and language/Shared vision
13	Number of competitors operating in a company's industry	Operational characteristics	Competition intensity
14	The extent to which fair treatment fosters reciprocal behaviors	Relational factors	Reciprocity
15	Production system orientation: make-to-order, make-to-stock, assemble-to-order, etc.	Operational characteristics	Manufacturing environments
16	The strategic importance of the relationship between the supply chain parties	Cognitive factors	Intensity (Importance) of relationship/ Interdependency
17	The extent of unpredictability in overall demand market conditions	Uncertainty	Market uncertainty
18	The frequency and variety of transactions between supply chain parties	Structural factors	Intensity (Complexity) of relationship
19	The degree to which demand is seasonal	Operational characteristics	Demand pattern
20	The degree to which a firm makes partner-specific investments in resources and technological know-how	Structural factors	Asset specific (investment)
21	The extent to which top managers at supply chain firms understand and support their business relationship	Relational factors	Top management support
22	Hardware, software, and telecommunications networks that connect supply chain partners	Structural factors	Information systems
23	The pressure for short lead times	Operational characteristics	Pressure to reduce lead times
24	The willingness of supply chain partners to collaborate and share information	Cognitive factors	Culture
25	The duration of the relationship between business partners	Relational factors	Length of cooperation (relationship)

Source: created by the author.

Table 39 – First round of Q-sort (characteristics)(cont.)

Item	Survey item	Potential group	Original item
26	The extent to which a business partner's market reputation is significant for an exchange relationship	Cognitive factors	Reputation
27	Interaction between two or more parties through phone calls, meetings or e-mails	Structural factors	Direct contact
28	The extent of the unpredictability of the suppliers' product quality and delivery performance	Uncertainty	Supply uncertainty
29	Number of employees (size) of a company	Operational characteristics	Size of the firm
30	The extent to which employees in supply chain partners trust each other	Relational factors	Trust
31	The amount of excess capacity in the supply chain	Operational characteristics	Capacity (availability)
32	Provision of incentives for information sharing	Structural factors	Benefit-sharing/ Side payment
33	The extent of the unpredictability of technology development in an organization's industry	Uncertainty	Technology uncertainty
34	Use of collaborative and coordinating structures, processes, and practices among supply chain partners	Structural factors	External integration/ Integration/ Internal integration
35	The relative position of the company in its supply chain: manufacturer, retailer, wholesaler, etc.	Operational characteristics	Supply chain position

Source: created by the author.

Like the first part of the questionnaire, some influential characteristics were merged due to their definitions. Three influential characteristics were renamed, capacity, length of cooperation, and asset specificity were renamed to capacity availability, length of relationship, and asset specificity investment, respectively. There was just one characteristic that was split into two items. Intensity of relationship included in its definition the importance of relationship and relationship complexity; therefore, this characteristic was split into two concepts, and one item was derived from each one.

Similar to the first part, some characteristics were also merged do to overlap in their definitions, for example, internal and external integration.

Similar to the previous section, the first index calculated in the first round was the proportional agreement. Table 40 presents the proportional agreement for the first round.

Table 40 – Proportional agreement – first round (characteristics).

Item	Proportional agreement (%)	Item	Proportional agreement (%)
1	62,50	19	12,50
2	100,00	20	37,50
3	75,00	21	62,50
4	62,50	22	75,00
5	75,00	23	50,00
6	100,00	24	25,00
7	62,50	25	62,50
8	37,50	26	25,00
9	62,50	27	37,50
10	62,50	28	87,50
11	50,00	29	25,00
12	50,00	30	87,50
13	37,50	31	75,00
14	75,00	32	37,50
15	87,50	33	100,00
16	12,50	34	87,50
17	87,50	35	25,00
18	75,00		

Source: created by the author.

Considering the target value of 60%, 14 items did not reach the target value. Therefore, these items should either be reworded or excluded for the second round.

The second index calculated was Cohen’s kappa. Table 41 presents the kappa values for the first round of the Q-sort.

Table 41 – Cohen’s kappa – first round (characteristics).

	1	2	3	4	5	6	7	8
1		0,44	0,20	0,26	0,40	0,43	0,32	0,43
2			0,12	0,45	0,54	0,55	0,46	0,57
3				0,20	0,11	0,10	0,17	0,12
4					0,41	0,38	0,32	0,45
5						0,51	0,46	0,57
6							0,44	0,54
7								0,45
8								

Source: created by the author.

The values of kappa show that there is a low agreement between the judges because there was not a pair of judges that reached the target value of 0,65. The average kappa for the first round is 0,37, about half of what is necessary to reach the target value. Therefore, it is clear that the items need to be improved for the second round.

The third agreement index calculated was Perreault and Leigh’s reliability index. Table 42 presents the values of Perreault and Leigh’s reliability index for the first round.

Table 42 – Perreault and Leigh’s reliability index – first round (characteristics).

	1	2	3	4	5	6	7	8
1		0,67	0,46	0,50	0,65	0,67	0,56	0,67
2			0,38	0,67	0,74	0,74	0,70	0,77
3				0,46	0,38	0,33	0,46	0,38
4					0,65	0,62	0,59	0,67
5						0,72	0,70	0,77
6							0,67	0,74
7								0,70
8								

Source: created by the author.

Perreault and Leigh’s reliability index showed an improvement in agreement when compared to Cohen’s kappa due to the difference in the size of the groups, as explained in the previous section. Despite the improvement of the groups' sizes, the values are still below the target value for this index. The average index is 0,61, but the target value is

0,70. Therefore, Perreault and Leigh's reliability index confirms the necessity to adjust the items for the second.

The last agreement index is the hit ratio. Table 43 presents the values of the hit ratio for the first round of the Q-sort.

Table 43 – Hit ratio – first round (characteristics).

	Relational factors	**Operational characteristics**	**Cognitive factors**	**Structural factors**	**Uncertainty**	**Other**	**Total**	**Hit ratio**
Relational factors	33	0	6	5	1	3	48	68,75
Operational characteristics	0	47	3	14	15	9	88	53,41
Cognitive factors	15	1	15	6	0	3	40	37,50
Structural factors	16	4	2	42	3	5	72	58,33
Uncertainty	1	1	0	0	30	0	32	93,75

Source: created by the author.

Table 43 shows that the definitions of the categories of characteristics also present problems. Only the category uncertainty reached the target value of 75%. Since almost all the categories had problems in their definitions, for the second of the Q-sort, all categories were reviewed, and two categories were replaced, but the items remained the same. The operational characteristics category was the largest, and its items were misclassified as structural factors, uncertainty, and Other, which indicates they are ambiguous or do not fit in the categories proposed. To better align with the Contingency Theory, operational characteristics was replaced by internal factors and environmental factors. Therefore, if the item relates to social interactions, it would belong to one of the three categories derived from Social Capital Theory. If the item does not relate to social interactions, it should relate to either the company's internal factors, such as capacity availability, or environmental factors, such as technology uncertainty. Since uncertainty overlapped with environmental factors, uncertainty was merged into environmental factors. After reviewing the groups based on the Contingency Theory, the groups derived from Social Capital had their definitions refined for the second round. The new definitions of the categories of characteristics are displayed in Table 44.

Table 44 – Definitions of the categories of characteristics – second round.

Categories of characteristics	Definitions
Cognitive factors	Issues that affect common values, representations, interpretations, and systems of meaning across supply chain partners.
Relational factors	Issues that affect interpersonal relationships among employees of supply chain partners.
Structural factors	Issues that affect the incentives, patterns, and technical means supply chain partners use to manage coordination and collaboration.
Internal factors	Non-social conditions within the boundaries of the organization or business unit that influence how an organization creates and delivers services and products.
External operations	Non-social conditions outside the boundaries of the organization or business unit that influence how an organization creates and delivers services and products.
Other	Please use this response if you don't think the characteristic belongs to any of the categories proposed.

Source: created by the author.

After reviewing the items, categories, and definitions, the questionnaire was ready for the second round of the Q-sort. Table 45 presents the proportional agreement for the second round.

Table 45 – Proportional agreement – second round (characteristics).

Item	Propotional agreement (%)	Item	Propotional agreement (%)
1	57,14	19	71,43
2	85,71	20	71,43
3	100,00	21	71,43
4	42,86	22	100,00
5	85,71	23	85,71
6	57,14	24	71,43
7	57,14	25	28,57
8	14,29	26	42,86
9	28,57	27	28,57
10	57,14	28	85,71
11	42,86	29	42,86
12	85,71	30	71,43
13	85,71	31	85,71
14	57,14	32	85,71
15	85,71	33	57,14
16	28,57	34	71,43
17	71,43	35	42,86
18	42,86		

Source: created by the author.

There were 16 items in the second round that did not reach the target value of 60% when compared to 14 items in the first round. Although it seems like a drawback, five items were around 57%, which indicates that an extra judge might have a significant impact on such items. Although the small number of judges is a limitation, this study is exploratory, and it uses a similar amount of judges as other studies in the literature (MENOR; ROTH, 2007; OLIVEIRA; ROTH, 2012). All the items below the target level were reviewed for the third round.

To verify the overall agreement between the judges, Cohen’s kappa was calculated after the proportional agreement. Table 46 presents the values for Cohen’s kappa for the second round.

Table 46 – Cohen's kappa – second round (characteristics).

	1	2	3	4	5	6	7
1		0,38	0,55	0,19	0,32	0,54	0,54
2			0,61	0,29	0,50	0,55	0,26
3				0,30	0,50	0,68	0,35
4					0,13	0,18	0,21
5						0,53	0,28
6							0,47
7							

Source: created by the author.

Similar to the first round, the kappa values show a low agreement between the judges. A possible outlier is judge 4 because the kappa values between him or her and the other judges are equal or below 0,30. Despite the negative impact of judge 4, the agreement between the other judges did not reach 0,65; therefore, the questionnaire must be improved for the third round. The average kappa for the second round is 0,40, confirming the necessity of adjustments.

Following Cohen's kappa, Perreault and Leigh's reliability index was calculated to verify the overall agreement between the judges. Table 47 presents the values of Perreault and Leigh's reliability index for the second round.

Table 47 – Perreault and Leigh's reliability index – first round (characteristics).

	1	2	3	4	5	6	7
1		0,62	0,74	0,42	0,59	0,74	0,74
2			0,79	0,53	0,72	0,74	0,50
3				0,53	0,72	0,83	0,59
4					0,27	0,38	0,46
5						0,74	0,53
6							0,70
7							

Source: created by the author.

As expected, Perreault and Leigh's reliability index showed better results due to the difference in the size of the categories. Judge 4 appears again as an outlier because he or she is the only that did not reach 0,70 agreement with any other judge. If we consider judge 4 when calculating the average value for the reliability index, the average is 0,61.

If judge 4 is excluded, the average value is 0,69, close to the target value of 0,70. Excluding judge 4 shows the impact of a single judge in the analysis; that is why this study is considered exploratory and needs a second stage of validation.

The last agreement index verifies if the new categories and definitions improved the understanding of the constructs proposed. Table 48 presents the values of the hit ratio for the second round.

Table 48 – Hit ratio – second round (characteristics).

	Relational factors	**Internal factors**	**Cognitive factors**	**Structural factors**	**External operations**	**Other**	**Total**	**Hit ratio**
Relational factors	24	0	12	2	10	1	49	48.98
Internal factors	0	32	0	1	3	13	49	65.31
Cognitive factors	0	0	21	3	2	2	28	75.00
Structural factors	7	0	4	38	10	4	63	60.32
Environmental factors	0	2	0	2	39	13	56	69.64

Source: created by the author.

By comparing the hit ratio from the first and second rounds, there was a significant improvement in the cognitive factors; the index doubled, the structural factors remained almost the same, a 2% decrease, and relational factors decreased 16,8%. Therefore, there is still a problem with the categories derived from the Social Capital Theory, especially the difference between relational and cognitive factors. Internal factors and environmental factors cannot be compared to the results from the first round because they were defined in the second. Although both categories cannot be compared, they did not reach the target value, only cognitive factors did. Apparently, internal factors and environmental factors are either poorly defined or the items classified as internal and external are ambiguous since they were currently labeled as Other.

For the third and final round, the definitions of the categories and the items identified through the proportional agreement were reviewed. The third version of the questionnaires is presented in Table 49.

Table 49 – Third round of Q-sort (characteristics).

Question	Survey item	Potential group	Original item
01	The extent to which suppliers, partners, and customers working jointly on an activity or project	Relational factors	Collaboration
02	Cost of holding inventory, including work-in-process and safety stock	Internal factors	Holding cost
03	The extent to which supply chain partners have similar values, beliefs, and management practices	Cognitive factors	Cultural similarity
04	How business enterprises are linked (e.g., owned, alliance, etc.) to form a supply chain	Structural factors	Supply chain structure
05	The average size of a production batch (or lot size)	Internal factors	Order batch size
06	The unpredictability of customers' demands	Environmental factors	Demand uncertainty
07	Mechanisms suppliers use to manage coordination	Structural factors	Governance structure
08	The complexity of products an organization produces	Internal factors	Product complexity
09	The extent to which supply chain partners commit to a business relationship	Relational factors	Commitment
10	The total useful life of the product an organization produces	Internal factors	Product durability
11	Imbalance in power between supply chain partners	Structural factors	Bargain power
12	Rules, values, and goals that facilitate communication and the development of mutual understandings	Cognitive factors	Shared codes and language
13	Number of competitors operating in an industry	Environmental factors	Competition intensity
14	The extent to which the relationship fosters reciprocal behaviors between supply chain partners	Relational factors	Reciprocity
15	Production system orientation: make-to-order, make-to-stock, assemble-to-order, etc.	Internal factors	Manufacturing environments
16	The importance of the relationship between the supply chain partners	Relational factors	Importance of relationship
17	The extent of unpredictability in overall demand market conditions	Environmental factors	Market uncertainty

Source: created by the author.

Table 49 – Third round of Q-sort (characteristics)(cont.)

Question	Survey item	Potential group	Original item
18	The frequency and variety in the pattern of transactions between supply chain partners	Structural factors	Relationship complexity
19	The degree to which demand is seasonal	Environmental factors	Demand pattern
20	The degree to which a firm makes partner-specific investments in resources and technological know-how	Structural factors	Asset specific investment
21	The extent to which top managers at supply chain firms understand and support their business relationship	Relational factors	Top management support
22	Hardware, software, and telecommunications networks that connect supply chain partners	Structural factors	Information systems
23	The competitive pressure for short lead times	Environmental factors	Lead time
24	The willingness of supply chain partners to collaborate and share information	Cognitive factors	Culture
25	The duration of the relationship between business partners	Relational factors	Length of relationship
26	The significance of a supply chain partner's reputation	Cognitive factors	Reputation
27	Use of phone calls, meetings or e-mails as means of interaction	Structural factors	Direct contact
28	The extent of the unpredictability of the suppliers' product quality and delivery performance	Environmental factors	Supply uncertainty
29	Number of employees (size) of an organization	Internal factors	Size of the firm
30	The extent to which employees in supply chain partners trust each other	Relational factors	Trust
31	The amount of excess capacity in the organization's operations	Internal factors	Capacity availability
32	Provision of incentives for information sharing	Structural factors	Incentive policy
33	The extent of the unpredictability of technology development in an organization's industry	Environmental factors	Technology uncertainty

Source: created by the author.

Table 49 – Third round of Q-sort (characteristics)(cont.)

Question	Survey item	Potential group	Original item
34	Use of collaborative and coordinating structures, processes, and practices among supply chain partners	Structural factors	Integration
35	The relative position of the company in its supply chain: manufacturer, retailer, wholesaler, etc.	Environmental factors	Supply chain position

Source: created by the author.

After reviewing the items, some adjustments were made in the definitions of the categories of characteristics. Table 50 presents the new definitions.

Table 50 – Definitions of the categories of characteristics – second round.

Categories of characteristics	Definitions
Cognitive factors	Issues that describe values, representations, interpretations, and systems of meaning shared by supply chain partners.
Relational factors	Issues that describe interpersonal relationships among employees of supply chain partners.
Structural factors	Issues that describe the incentives, patterns, and technical means supply chain partners use to manage coordination and collaboration.
Internal factors factors	Non-social internal factors and characteristics that influence how an organization operates.
Environmental factors	Non-social characteristics that define the environment in which an organization and its supply chain partners conduct business.
Other	Please use this response if you don’t think the characteristic belongs to any of the categories proposed.

Source: created by the author.

With the new adjusted items and definitions, the questionnaire was ready for the third and final round. Table 51 presents the proportional agreement for the third round.

Table 51 – Proportional agreement – third round (characteristics).

Item	Propotional agreement (%)	Item	Propotional agreement (%)
1	50,00	19	83,33
2	66,67	20	83,33
3	100,00	21	66,67
4	66,67	22	83,33
5	83,33	23	66,67
6	100,00	24	33,33
7	50,00	25	83,33
8	50,00	26	66,67
9	50,00	27	33,33
10	33,33	28	50,00
11	33,33	29	50,00
12	100,00	30	50,00
13	83,33	31	66,67
14	83,33	32	50,00
15	66,67	33	66,67
16	50,00	34	33,33
17	83,33	35	50,00
18	33,33		

Source: created by the author.

The third round of the Q-sort had 15 items below 60%, but 10 of them are 50%, which means that an extra judge might have raised its percentage to the target level. Before analyzing the individual items, the kappa index and Perreault and Leigh's reliability index were calculated to verify the overall agreement between the judges. Table 52 presents the values of kappa.

Table 52 – Cohen's kappa – third round (characteristics).

	1	2	3	4	5	6
1		0,28	0,47	0,49	0,47	0,30
2			0,39	0,23	0,23	0,21
3				0,27	0,58	0,40
4					0,40	0,29
5						0,18
6						

Source: created by the author.

Table 52 shows that the questionnaire needs more adjustments since no values of kappa were above the target level. The average kappa for the second round is 0,35, and it does not seem to be a single judge that is lowering the average result. To confirm the level of agreement, Perreault and Leigh's reliability index was calculated, and it is displayed in Table 53.

Table 53 – Perreault and Leigh's reliability index – third round (characteristics).

	1	**2**	**3**	**4**	**5**	**6**
1		0,53	0,70	0,70	0,70	0,56
2			0,62	0,46	0,46	0,46
3				0,53	0,77	0,65
4					0,65	0,53
5						0,42
6						

Source: created by the author.

Although the agreement indexes displayed in Table 53 are better when compared to Table 52, it is clear that the overall agreement is below the target value. Only four pairs of judges reached the target value, and the average result for Perreault and Leigh's reliability index is 0,58.

The last index that needs to be verified is the hit ratio. Table 54 presents the values of the hit ratio for the final round.

Table 54 – Hit ratio – third round (characteristics).

	Relational factors	**Internal operational factors**	**Cognitive factors**	**Structural factors**	**Environmental factors**	**Other**	**Total**	**Hit ratio**
Relational factors	26	1	10	3	0	2	42	61.90
Internal operational factors	0	25	1	3	6	7	42	59.52
Cognitive factors	4	1	18	1	0	0	24	75.00
Structural factors	11	5	4	28	3	3	54	51.85
Environmental factors	0	5	1	3	35	4	48	72.92

Source: created by the author.

It is possible to see that the hit ratio improved for some categories, but it did not reach the target value of 75%. Cognitive factors maintained the same level as the second round, and the environmental factors raised close to the target value, although it is 2% lower than expected. The other categories, especially structural factors, still need to be improved. The distinction between internal and environmental does not seem to be clear since these categories were mixed, and some judges chose the option Other, probably due to this overlap. Although the truly cognitive items seem to be clear, some relational items were mislabeled as cognitive. The worst case is the structural factors because its items were mislabeled as all the other categories; therefore, its items or its definition are not clear.

Considering the target values for the agreement indexes discussed in the previous chapter, the second part of the questionnaire did not reach the minimum agreement to provide construct validity. One problem that was identified is the impact of a single judge in the agreement indexes. To minimize this problem, a secondary analysis was carried to see which items were consistent throughout the rounds. The items derived from to Social Capital Theory were evaluated through all three rounds, but the items related to internal factors and environmental factors were evaluated considering the last two because their categories changed in the second round.

First, considering the categories related to Social Capital Theory and the items presented in the previous chapters, Table 55 presents the item numbers, if they were changed or not, the target category, the categories that the authors could choose, and the proportional agreement considering all rounds. Since the categories related to internal factors and environmental factors changed in the second round, they were merged in the column “Operations.”

Table 55 – Joint analysis of the categories derived from Social Capital.

Item	Adapted	Target category	Cognitive factors	Relational factors	Structural factors	Operations	Other	Proportional agreement
3	Not adapted	Cognitive factors	19	1	1	0	0	90.48%
12	Not adapted	Cognitive factors	16	2	3	0	0	76.19%
24	Not adapted	Cognitive factors	9	7	3	1	1	42.86%
26	3	Cognitive factors	9	3	3	2	4	42.86%
1	Not adapted	Relational factors	2	12	2	4	1	57.14%
9	Not adapted	Relational factors	8	10	1	1	1	47.62%
14	3	Relational factors	3	15	3	0	0	71.43%
16	3	Relational factors	3	11	1	5	1	52.38%
21	Not adapted	Relational factors	6	14	0	0	1	66.67%
25	Not adapted	Relational factors	4	12	2	3	0	57.14%
30	Not adapted	Relational factors	3	15	1	0	2	71.43%
4	Not adapted	Structural factors	0	4	12	3	2	57.14%
7	Not adapted	Structural factors	0	6	12	2	1	57.14%
11	3	Structural factors	2	5	9	4	1	42.86%
18	3	Structural factors	1	0	11	7	2	52.38%
20	Not adapted	Structural factors	1	2	13	3	2	61.90%
22	Not adapted	Structural factors	0	0	18	2	1	85.71%
27	3	Structural factors	0	12	7	0	2	33.33%
32	Not adapted	Structural factors	3	2	12	3	1	57.14%
34	Not adapted	Structural factors	3	3	14	1	0	66.67%

Source: created by the author.

By analyzing Table 55, it is possible to see that only six out of 20 items were reworded, all of them in for the third round. The first four items were labeled as cognitive factors, but the last two did not reach the target value of 60%. Cognitive factors appear to have an overlap mainly with relational factors, although some authors also labeled those items as structural. Item 24 represents the company's culture or how open the company is to share information. Culture was labeled as cognitive because in the research of Zhang, Lettice, and Zhao (2015) about the impact of Social Capital on mass customization, the items derived from cognitive capital included shared goals, values and culture, and shared codes and languages. Shared goals, codes, language, and values were related to cognitive capital in other researches (JOHNSON; ELLIOTT; DRAKE, 2013; LEE; HA, 2018; LI; YE; SHEU, 2014). Since values and culture generated an item with a high loading factor with shared goals, codes, and vision (0,823) (ZHANG; LETTICE; ZHAO, 2015), this shows that culture is part of cognitive factors. Item 26 relates to the company's reputation, and it was the second item related to cognitive factors that had a low proportional agreement. Since cognitive capital include shared codes, representations, and vision (JOHNSON; ELLIOTT; DRAKE, 2013; LEE; HA, 2018; NAHAPIET; GHOSHAL, 1998), and the company's reputation is the shared vision of the company, reputation is part of cognitive factors (AULA, 2011). Therefore, although the items did not reach the target level for the agreement indexes, they are cognitive factors.

Relational factors included all characteristics that described interpersonal relations between employees in a supply chain and had four items that did not reach the target level. The first item was derived from collaboration, and according to Capello and Faggian (2005), relational capital includes market and power relationships and cooperation with its partners and suppliers. Despite the difference in terms, both collaboration and cooperation were used to represent supply chain partners working jointly and assisting each other (CAPELLO; FAGGIAN, 2005; LI; YE; SHEU, 2014); therefore, collaboration belongs to relational factors. The second item of relational factors that did reach the target level was commitment. Commitment relates to obligations to some activities, and it is used continuously to explain relational dimensions (LEE; HA, 2018; NAHAPIET; GHOSHAL, 1998), so it is clear that commitment belongs to relational factors. Regarding the last two characteristics that were label as relational factors, the importance of the relationship, and length of the relationship, both were used as proxies to relational capital in past studies (ZHAO et al., 2018). Since both

characteristics were considered good proxies for relational capital, those characteristics belong to relational factors.

The last category derived from Social Capital Theory was structural factors. From the last category, six out of its nine items did not reach the minimum level of agreement. Structural capital relates to the pattern of connections, technologies, and incentives that make the information exchange possible (JOHNSON; ELLIOTT; DRAKE, 2013; LEE; HA, 2018; LI; YE; SHEU, 2014; NAHAPIET; GHOSHAL, 1998). Supply chain structure, relationship complexity, and governance structure reflect the pattern of connection aspect of structural factors. Supply chain structure was defined as how companies are linked; in other words, how are they connected in the supply chain. The complexity of the relationship includes the frequency and variety of transactions, two aspects that describe the pattern of connection between the two companies. Direct contact reflects the technology aspect of structural factors if we consider the use of telephones or e-mails that were separated from information systems since the information would be available to a single person or a small group. Direct contact also includes meetings and site visits that can enable information sharing, which is also part of structural capital (FAN; STEVENSON, 2018; KRAUSE; HANDFIELD; TYLER, 2007; KRAUSE; SCANNELL; CALANTONE, 2000). Governance mechanisms should create incentives for the companies to interact and protect them from opportunist behavior from the other party (DENOLF et al., 2015). According to Coleman (1988), dense networks, which relate to the patterns of connection between partners, help partners to monitor, reward, and punish network members when needed. Since strong ties can provide rewards, and protect companies by pushing deviant behavior, strong ties serve as a governance mechanism (ROWLEY; BEHRENS; KRACKHARDT, 2000); therefore, governance structure belongs to structural factors.

The incentive aspect is the mean used to create new connections that will make the exchange of information possible, and it includes bargain power and incentive policies. Incentive policies can be price discounts or better credit terms (HA; PARK; CHO, 2011) that will make both parties interested in sharing information. With both parties interested in sharing information, they would increase their relationship strength, which is linked to increased structural capital (LI; YE; SHEU, 2014). The research of Lee and Ha (2018) provides evidence that incentive policies belong to structural factors. The authors used

joint risk and benefits management as a survey item to describe structural capital, and it had a high loading factor (0,838) with items related to IT infrastructure and frequency of communication, which indicates that incentive policy is part of structural capital. Regarding bargain power, Inkpen and Tsang (2005) argue that bargain power is related to network stability, and if the bargain power shift from one partner to another, that might jeopardize the relationship. Since bargain power can help partners to maintain their relationship (INKPEN; TSANG, 2005), bargain power belongs to structural factors.

Although the items discussed did not reach the minimum level of agreement even in a joint analysis of all rounds, previous researches and the literature on Social Capital Theory provide evidence that they were correctly labeled. A possible explanation for the low agreement between the judges is that not all of them were familiarized with Social Capital Theory before answering the questionnaire. Although the questionnaire provided a quick definition of the three categories derived from Social Capital Theory, they might not have been enough to give the judges everything they should know before responding. A longer explanation might have been provided, but it would have made the questionnaire longer and more tiring to respond to, and that might have impacted the number of respondents per round. Since each judge had a high impact on the agreement indexes, as shown early in this section, a quicker introduction was preferred to avoid losing respondents.

The second part of the joint analysis relates to the items labeled based on Contingency Theory. The second part of the joint analysis only considers the second and third rounds because the categories derived from Contingency Theory changed in the second round, so they could not be compared to the categories of the first one. Table 56 presents the second part of the joint analysis.

Table 56 – Joint analysis of the categories derived from Contingency Theory.

Item	Adapted	Target category	Cognitive factors	Relational factors	Structural factors	Internal factors	Environmental factors	Other	Total
6	3	Environmental factors	0	0	1	1	10	1	76.92%
13	Not adapted	Environmental factors	0	0	0	0	11	2	84.62%
17	Not adapted	Environmental factors	1	0	0	1	10	1	76.92%
19	Not adapted	Environmental factors	0	0	0	0	10	3	76.92%
23	3	Environmental factors	0	0	0	2	10	1	76.92%
28	Not adapted	Environmental factors	0	0	0	2	9	2	69.23%
33	Not adapted	Environmental factors	0	0	2	0	8	3	61.54%
35	Not adapted	Environmental factors	0	0	2	1	6	4	46.15%
2	Not adapted	Internal factors	0	0	2	10	0	1	76.92%
5	Not adapted	Internal factors	0	0	0	11	0	2	84.62%
8	3	Internal factors	1	0	1	4	3	4	30.77%
10	3	Internal factors	0	0	0	6	3	4	46.15%
15	Not adapted	Internal factors	0	0	0	10	2	1	76.92%
29	Not adapted	Internal factors	0	0	0	6	0	7	46.15%
31	3	Internal factors	0	0	1	10	1	1	76.92%

Source: created by the author.

First, it is important to notice that both categories presented in Table 56 did not have much overlap with the categories derived from Social Capital Theory, which indicates that these items were identified as non-social characteristics. Second, it appears that there is an overlap between internal factors and environmental characteristics since almost all items have been mislabeled as the other category at least once. Third, the column Other was used in all items at least once, which also indicates a possible overlap between categories. So, the absence of social relation appears to be clear in the item from Table 56, but the distinction of which is internal or external of the company did not.

Regarding internal factors, three characteristics did not reach the minimum agreement, product complexity, product durability, and size of the firm. The internal operation was derived from the concept of internal environment and included all characteristics that influence how an organization operates. Product complexity and is related to the product's development involving the number of process needed during the manufacturing, the diversity in inputs, among other things (WONG; LAI; CHENG, 2011). Since the focus is on the internal processes necessary to manufacture the product, product complexity belongs to internal factors. Product durability refers to the product's lifetime (SLACK; ALISTAIR; JOHNSON, 2013). The authors were divided between internal factors and environmental factors, while several authors chose the option "Other" that might reflect the item's ambiguity. At first, product durability was labeled internal factors because the company's internal process and the raw material used in its production have a significant impact on the product's durability. However, after reviewing the item, the consumer's attitude toward the product, how it was stored and transported, and its potential to be repaired also appeared as critical factors to determine its durability. Therefore, although at first product durability seemed to be internal factors, if we focus on the manufacturing process and its raw material, product durability should belong to both internal factors and external factors. Since one item cannot be in two groups at the same time, this item was dropped. The third internal operation characteristic is firm size. Since expanding its operations and sometimes closing a business unit is a decision made by the company, the firm size is part of internal factors. It is important to notice that the firm might expand or reduce its operations based on an increase or decrease in demand, for example, which is external, but the decision to expand or reduce its size is still internal. One possible strategy to cope with market changes, which is external, is to maintain the size of its operations, which is internal since it is controlled by the company, and deal with the consequences.

Regarding the environmental factors, only one item did not reach the minimum level of agreement, supply chain position. At first, supply chain position was labeled environmental factors, but in fact, it is internal factors. Although most authors also labeled supply chain position as environmental factors, the decision to be a manufacturer or a retailer, for example, lies in the hand of the company's owner. Even if the owner sees that he or she will suffer from low demands and high competition, it is still up to him or her to open his or her company, and in which link in which position in the supply chain he or she will work. Therefore, this item was relabeled as internal factors, although the agreement with the judges decreased.

Considering the results of both parts of the questionnaire and the joint analysis presented, it is possible to see that the questionnaire is consistent with the literature. Although the agreement indexes were not high in the second part, it is ready for a large scale validation. The first part of the questionnaire had its groups derived from potential visibility dimensions and groups of information, as presented during the results of the systematic review. After the second round of the Q-sort, the items presented high convergent and discriminant validity, which indicates that they were correctly labeled and that they measure only one visibility dimension. Therefore, the first part of the questionnaire reached the expected level of construct validity to be applied to a large-scale survey. The second part did not reach the minimum agreement, but as shown in the joint analysis, the item that did not reach the minimum agreement were investigated in previous studies and labeled as presented in this chapter. Since the respondents did not suggest that any category added, it seems that Social Capital Theory and Contingency Theory were enough to label all influential characteristics. The low agreement indexes are most likely due to no previous knowledge about Social Capital and its components, relational, cognitive, and structural capital. So, the Q-sort, along with the previous research described in this chapter, provide a first validation of the items, categories of characteristics, and visibility dimensions proposed in this research.

7 THE FIRST PROPOSAL OF VISIBILITY CONFIGURATIONS

In order to provide the first version of the visibility configurations, it is necessary to determine the main visibility dimensions and category of characteristics. The literature provides several views that are candidates to visibility dimensions (BARRATT; BARRATT, 2011; WANG; WEI, 2007; WILLIAMS et al., 2013), but lacks a precise definition of the dimensions of visibility and how companies could develop them. This research proposes the definition of visibility dimensions considering that visibility can only be developed through the exchange of high-quality information (WILLIAMS et al., 2013). This definition was appropriate because the five most cited views to developed visibility found in the literature, demand visibility (BARRATT; BARRATT, 2011; BARRATT; OKE, 2007; HUO; HAN; PRAJOGO, 2016; KAIPIA; HARTIALA, 2006; LEI et al., 2014; MORGAN; RICHEY JR; ELLINGER, 2018; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; SZYMCZAK et al., 2018; VIGTIL, 2007; WILLIAMS et al., 2013; ZHANG; GOH; MENG, 2011), supply visibility (BARRATT; BARRATT, 2011; CARIDI et al., 2010; HUO; HAN; PRAJOGO, 2016; MORGAN; RICHEY JR; ELLINGER, 2018; SOMAPA; COOLS; DULLAERT, 2018; SRINIVASAN; SWINK, 2018; SZYMCZAK et al., 2018; WILLIAMS et al., 2013), process visibility (BARRATT; BARRATT, 2011; BARRATT; OKE, 2007; HALL et al., 2013; SOMAPA; COOLS; DULLAERT, 2018; SZYMCZAK et al., 2018; ZHANG; GOH; MENG, 2011), operational visibility (HALL; SAYGIN, 2012; MORGAN; RICHEY JR; ELLINGER, 2018; SRINIVASAN; SWINK, 2018), and inventory visibility (BARRATT; BARRATT, 2011; SOMAPA; COOLS; DULLAERT, 2018; SZYMCZAK et al., 2018; ZHANG; GOH; MENG, 2011) were in line with the definition.

To determine which visibility dimension a company develop, this research used the theoretical lenses of Contingency Theory and Social Capital Theory to evaluate the company's environment and propose the categories of influential characteristics. Although there were other categories of characteristics found in the literature, none of them were theoretically grounded. Contingency Theory was used to group all non-social characteristics related to the company's internal and external environments (DUNCAN, 1972), while Social Capital Theory was used for all social characteristics.

This research used a systematic literature review to identify the main types of information the companies exchange to develop visibility, the main influential

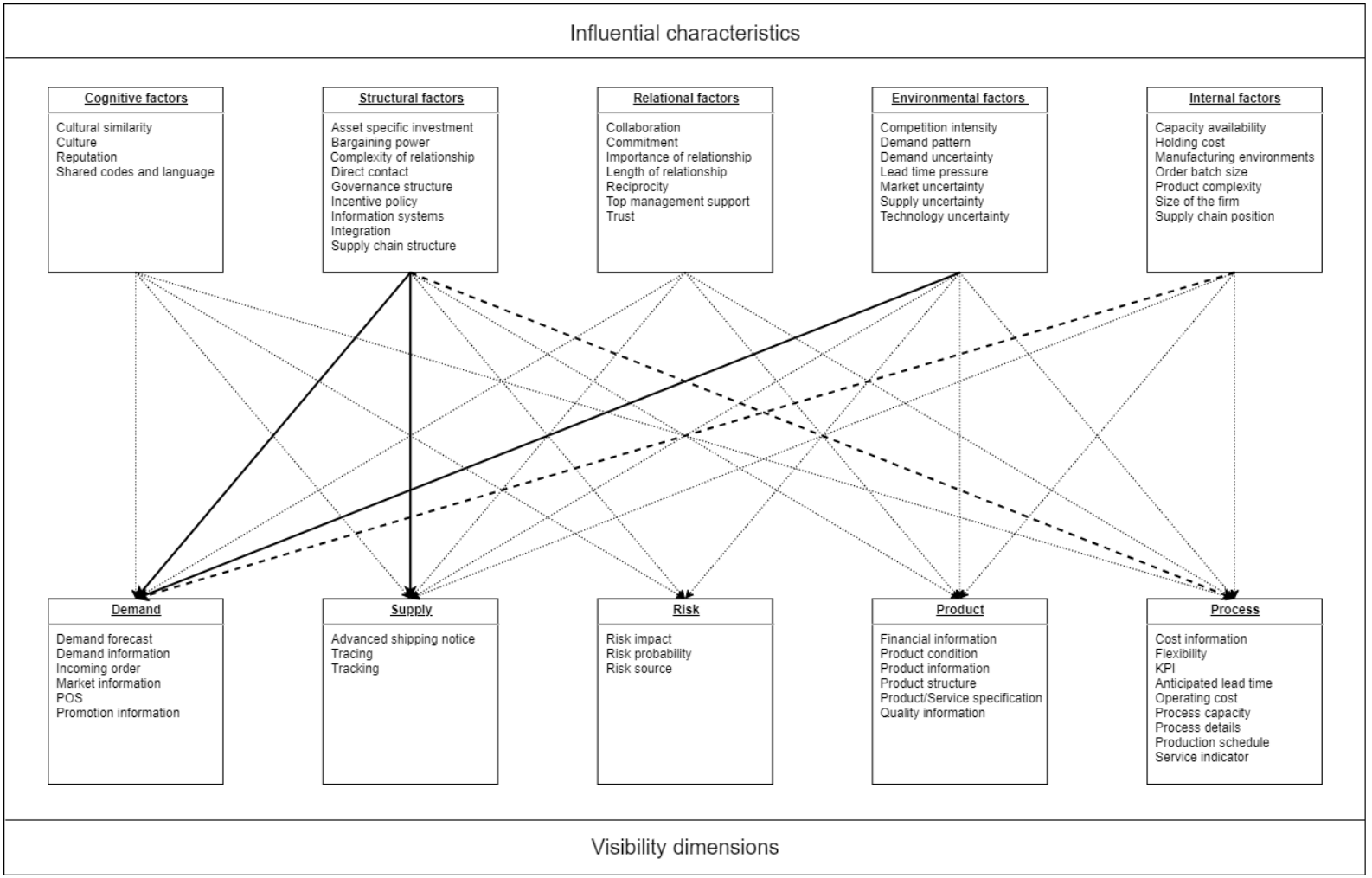
characteristics, and possible visibility configurations. Based on the review, it was possible to identify 28 types of information that were grouped into five visibility dimensions named demand, process, product, risk, and supply. The visibility dimensions derived from views presented in the literature and groups of information used in previous researches. All views that were in line with the definition of visibility dimension were listed along with the groups of information, and based on the types of information retrieved, the five dimensions presented were deemed enough to group all types of information. The review also provided 34 influential characteristics that were grouped into five categories of characteristics named internal factors, environmental factors, relational factors, cognitive factors, structural factors, the first two derived from Contingency Theory, while the other three from Social Capital Theory.

Finally, the review also provided some specific links between an influential factor and a visibility dimension and some potential visibility configurations. The proposed framework considers the visibility dimensions, categories of characteristics, and visibility configurations to present how influential characteristics impact the development of supply chain visibility. The next section presents the proposed framework with some propositions derived from the results of this study.

7.1 Development of Propositions

The potential visibility dimensions and categories of characteristics were validated through a Q-sort, and the results compiled in a proposed framework with the dimensions, categories of characteristics, and visibility configurations. Figure 10 presents the proposed framework. The dotted lines represent associations that appear in less than 10 percent of the articles; dashed lines represent appearance in 10 to 20 percent of articles, and solid lines indicate associations that appear in more 20 to 30 percent of the articles. None of the configurations appeared in more than 30 percent of the articles.

Figure 10 – Proposed framework.



Source: created by the author.

Three configurations appeared in more than 20% of the articles, structural factors and demand, structural factors and supply, and environmental factors and demand. If we compare to the first version of the framework, the first configuration also appeared in more than 20% of the articles, but the others raised their appearance because the Q-sort changed their items. Two configurations appeared between 10% and 20% internal operations and demand, and structural factors and process. The second configuration raised its appearance because track and trace were initially labeled as supply, and internal factors is a new category; therefore, it cannot be compared. It is possible to see that the most common configurations remain between supply and demand, the groups that received most of the attention in the literature. Process appears with one frequent configuration because it is the dimension that has more types of information. On the categories side, structural factors was the category that received the most attention in the literature, and the frequent connection that operational factors had in the first version of the framework was split between internal factors and environmental factors. All the other configurations appeared in less than 10% of the articles.

With the framework at hand, companies that have strong connections with their partner (structural factors) and operate in uncertain environments (environmental factors) should probably develop demand and supply visibility. The company can prioritize its investments on one of these two dimensions based on their internal factors since internal factors seems to have a stronger relationship with demand than with supply. This is one example of how the framework can be used to guide managers in deciding which visibility dimension they should invest. It is important to notice that demand and supply dimensions or the structural category are not more important than the other dimensions and categories or should be developed first, although they received more attention in the literature. One of the reasons that they received more attention is because they have been studied for a longer period than the other categories and dimensions. Companies should evaluate their specific environment to decide which dimension they should invest in.

Also, the percentages do not necessarily represent the strength of the configuration, but it might indicate that some configurations are stronger than others. For example, it seems unlikely that the company would feel comfortable exchanging demand information with a partner that it has never worked before, relation factors impacting demand visibility. However, if the environmental uncertainty is high, for example, during the

Coronavirus pandemic, the company might be willing to exchange its demand forecast and POS information to cope with the sudden changes in customer behavior. In that case, the configuration between environmental factors and demand visibility outweighed the configuration between relational factors and demand.

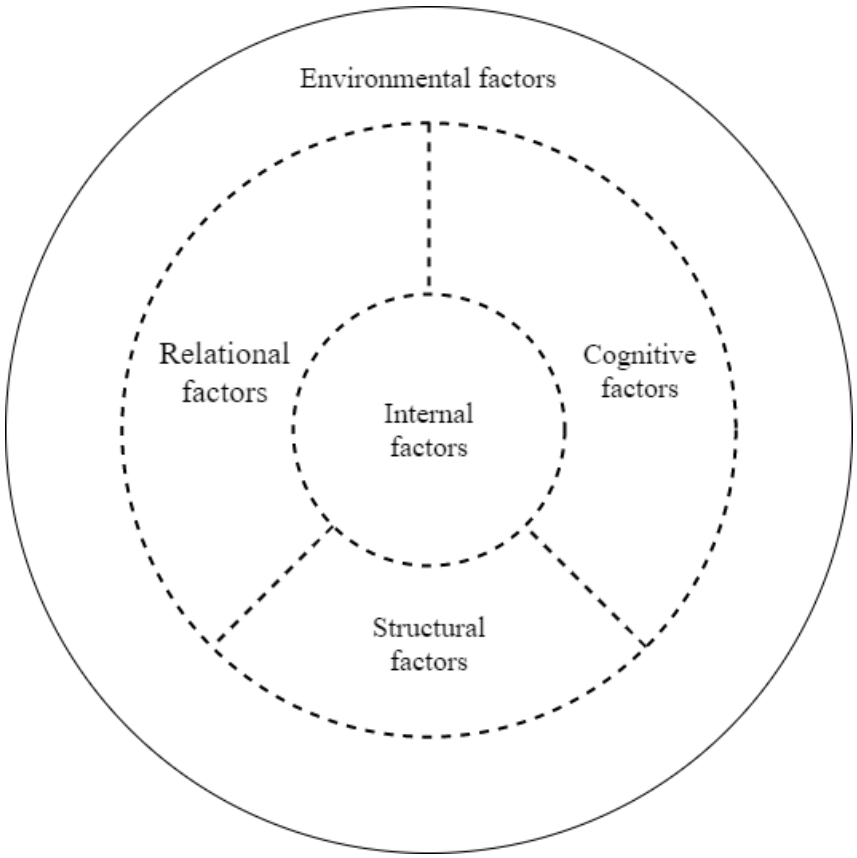
P1. The categories of characteristics have different impacts on each visibility dimension.

Two other remarks need to be made to provide a more accurate picture of how influential characteristics impact the development of supply chain visibility: the impact the categories of characteristics have on each other, and the impact of the visibility dimensions on the categories. If we look at Figure 10, the visibility configurations might give the impression that each category has a clear boundary. However, the boundary might not be so clear in practice. First, the literature review provided evidence that influential characteristics can impact each other (BIRASNAV; MITTAL; LOUGHLIN, 2015; CHIANG; FENG, 2007; CHU; SHAMIR; SHIN, 2017; GHOSH; FEDOROWICZ, 2008; JONSSON; MATTSSON, 2013; KIM; RYOO; JUNG, 2011; PATNAYAKUNI; RAI; SETH, 2006). The work of Birasnav, Mittal, and Loughlin (2015) presents that the leadership style can influence if environmental uncertainty will be beneficial for information sharing or not, and the use of contracts also impacts that relationship. In this case, were have top management support interacting with uncertainty and a governance mechanism, so we have external, structural, and relational factors interacting. A second example was presented by Ghosh and Fedorowicz (2008), who investigated the impact of contracts and power asymmetry on trust; therefore, the impact of two structural characteristics on a relational characteristic.

The interaction of different categories of characteristics is reinforced by the two theoretical lenses used in this research. Nahapiet and Ghoshal (1998) proposed the dimensions of social capital used in this research, relational, cognitive, and structural dimensions. Although the authors proposed these dimensions, they acknowledge that, in practice, they are highly interrelated. Contingency Theory, on the other hand, sees the company as open systems (LAWRENCE; LORSCH, 1967), so in order to survive, they should either adapt to its environment (DONALDSON, 2001) or shape it to match its structure (MILES; SNOW, 1978). Then, the company should balance its internal and external environments, in this research, environmental factors and internal factors. Since

the definition of environment proposed by Duncan (1972) includes social interaction, the company should also consider the interaction between environmental factors and internal factors with the three social categories. A more accurate picture of how the influential characteristics can be presented is displayed in Figure 11.

Figure 11 – Categories of characteristics.



Source: created by the author.

Figure 11 presents the five categories of characteristics as part of circles. Internal factors category is the inner circle since its characteristics relate to how a firm operates, and this category was derived from the concept of internal environment. The middle circle represents the social categories formed by relational, cognitive, and structural factors. They were placed in the middle since, according to Duncan (1972), there are social aspects in both internal and external environments. The outer circle represents the environmental factors, and this category was derived from the concept of external environment. The inner and middle circle have dashed borders because they can influence each other, and the outer circle. The fact that the social dimensions were placed in the middle does not mean that internal factors cannot influence the environmental factors or

the other way around. It only means that the social dimensions are part of both internal and external environments (DUNCAN, 1972). Since the categories can impact each other, developing one category of characteristics can be used as an instrument to influence other categories. For example, investing in the company's relationship with its supplier might reduce its environmental uncertainty, improving at the same time the relational and environmental factors.

P2(a). The categories of characteristics interact with each other to form the company's environment and determine the appropriate visibility profile.

P2(b). Improving one category of characteristics can be used as an instrument to improve other categories indirectly, reshaping the company's environment.

The second finding in the review that impacts visibility development is the impact of visibility dimensions in the categories of characteristics. There was evidence in the literature that quality and availability of information, both important aspects in the concept of visibility (WILLIAMS et al., 2013), impact an organization's trust and commitment (CHEN; WANG; YEN, 2014; HUNG et al., 2011). This result was also expected, considering both theoretical lenses used in the research. Since the company might shape its environment to meet its structure (MILES; SNOW, 1978), the good results that came after the development of a visibility dimension might serve as an instrument to improve its relationship with its partner, for example. Since the categories of characteristics can impact each other, an improvement in the relational aspects might impact the other categories, and with a different environment, the visibility profile will also change. The new environment might demand improvements in the dimensions the company already developed, or might be necessary to invest in different visibility dimensions.

P3(a). The visibility configurations have a reverse effect, from the dimensions to the categories of characteristics.

P3(b). The development of visibility dimensions can be used to shape the company's environment.

8 CONCLUDING REMARKS

Information sharing is known to prevent problems in the supply chain, such as the stockouts (BARRATT; BARRATT, 2011) and help companies to prepare for environmental risks such as weather changes (JRAISAT; GOTSI; BOURLAKIS, 2013) and bullwhip effect (JEONG; HONG, 2019). Information sharing was also linked to improved responsiveness (LI; YE; SHEU, 2014), customer waiting time, order mismatch, and product stock age (YEE, 2005). These performance improvements happened due to better decision making and more informed decisions, increasing the supply chain visibility (HUO; HAN; PRAJOGO, 2016).

The literature presents different views to develop supply chain visibility, considering the sources of information, the number of agents involved, and the means to exchange information, for example (LEE; KIM; KIM, 2014; WILLIAMS et al., 2013; ZHANG; GOH; MENG, 2011). In order to provide a common base for practitioners to develop visibility, this research proposed the concept of visibility dimension as an operational view of visibility. To help practitioners decide which visibility dimension they should develop, this research also proposes the concept of influential characteristics that might enable the development of visibility dimensions.

Despite the importance of the influential characteristics, there are some conflicting results in the literature regarding their true impact (CARIDI et al., 2010; CAVUSOGLU; CAVUSOGLU; RAGHUNATHAN, 2012; HA; TIAN; TONG, 2017; JRAISAT; GOTSI; BOURLAKIS, 2013; MÜLLER; GAUDIG, 2011). One possible explanation is that the influential characteristics were acting in different visibility dimensions; that is why they had opposite effects. Knowing that there are multiple views to develop supply chain visibility and that are conflicting results regarding the impact of influential characteristics, this research investigated how the influential characteristics impact the development of supply chain visibility.

Through a systematic literature review and a Q-sort, this research identified and grouped 28 types of information into five visibility dimensions, demand, supply, process, product and risk, and 34 influential characteristics into five categories, relational factors, cognitive factors, structural factors, internal factors, and environmental factors. The categories and dimensions were displayed in a conceptual framework with the

relationship between the groups, the visibility configurations. Some propositions were derived from the framework regarding the strength of the visibility configurations, the impact of categories of characteristics on each other, and the reverse impact of the visibility configurations. This research made contributions to practitioners and researchers and left some research opportunities, as presented in the next sections.

8.1 Theoretical and Managerial Implications

This research has implications for both practitioners and researchers. For practitioners, we presented an operational view of visibility through the visibility dimensions and their types of information. Knowing the visibility dimensions and their components, the companies have a guideline of the information they might share or request from their partners to develop each dimension. In order to decide which dimension they should develop, this research also investigated the influential characteristics that make each dimension desirable. With the framework in hand, companies know the main characteristics of their environment that play a row in developing visibility so that they can evaluate their environment and decide the appropriate level of investment in each visibility dimension. By following the ideal visibility profile for their environment, they will reduce the chances of potential bad outcomes, and improve potential good ones.

For researchers, this project explores the opportunity proposed by Williams et al. (2013), focusing not only on the types of visibility but the role of the company's environment. This research proposed the concept of visibility dimensions to align the divergent view of how visibility should be developed, presented the role of the company's environment in developing visibility, and presented the first proposal of visibility configurations that might explain conflicting results regarding influential characteristics. By using the theoretical lenses of Contingency Theory and Social Capital Theory, the results provided evidence not only to the impact of the categories of characteristics in the visibility dimension, but the impact of the visibility dimensions on the categories, and the impact of the categories on each other. These results showed that the development of supply chain visibility is not straightforward, and that should be considered in future studies.

8.2 Limitations and Research Opportunities

Despite the efforts to perform rigorous research, this project has its limitations. First, although the review was extensive, articles that did not have any of the keywords used in the search string were not retrieved, and therefore not reviewed. Second, the Q-sort method that was used to test the construct validity of the categories of characteristics and visibility dimensions showed a low agreement regarding the characteristics, even though the labels were consistent with the organizational theories and previous researches. Therefore, researches that follow this work should consider selecting the item that reached a high agreement between the judges and complement them with items previous developed in the literature. Third, the nature of this study is exploratory, so a future validation of the dimensions, categories, and configurations is a needed next step.

Regarding the research opportunities: first, a large scale survey can be used to test and validate the dimensions, categories, and configurations proposed in the framework. Second, investigate the interaction between the categories of characteristics that might provide insights into which category plays a major role in influencing the others, and this information might be used to reshape the company's environment. Third, the reverse of the visibility configurations, dimensions impacting categories of characteristics, seems to be a promising way to shape the company's environment that might be further investigated and complemented with different views.

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APPENDIX A

Articles included in the extraction and their contributions

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
A. Y. Ha, Tong, & Zhang, 2011	X						X			X
Agndal & Nilsson, 2008				X		X		X		
Akcay, Ergan, & Arditi, 2017	X	X	X	X						
Alenius, Lind, & Strömsten, 2015			X	X						
Ali & Boylan, 2011	X									X
Azevedo, Carvalho, & Cruz-Machado, 2013	X	X	X	X						
B. Ha et al., 2011		X		X		X				
Baihaqi & Sohal, 2013	X	X	X			X	X	X		X
Barratt & Barratt, 2011	X	X	X	X		X	X	X		X

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Barratt & Oke, 2007	X	X	X	X		X	X	X	X	X
Bendre & Nielsen, 2013				X			X			
Bian et al., 2016	X						X			X
Birasnav et al., 2015						X	X	X		
Bourland, Powell, & Pyke, 1996	X	X		X			X		X	X
Bouzembrak, Camenzuli, Janssen, & van der Fels-Klerx, 2018	X	X	X							
Bradley, 2014	X	X	X	X	X					
Cagliano, De Marco, Grimaldi, & Rafele, 2012		X		X	X					
Cachon & Fisher, 2000	X	X					X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Caridi, Crippa, Perego, Sianesi, & Tumino, 2010	X	X	X	X			X		X	X
Cavusoglu, Cavusoglu, & Raghunathan, 2012	X						X		X	X
Chen et al., 2014	X		X			X	X	X		X
Chen, 2011	X			X			X			
Cheng, 2011						X	X			X
Chiang & Feng, 2007	X	X		X						X
Chu, Shamir, & Shin, 2017	X					X	X		X	X
Creane, 2007	X		X	X			X			X
Croson & Donohue, 2009	X						X			
Cui & Shin, 2018	X	X					X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Dossi & Patelli, 2010	X			X		X	X	X	X	
Du, Lai, Cheung, & Cui, 2012	X					X	X	X	X	
Dwaikat, Money, Behashti, & Salehi-Sangari, 2018	X	X	X	X			X			
Ebrahim-Khanjari, Hopp, & Iravani, 2012	X					X				
Ergen & Akinci, 2008	X	X	X	X			X			
Fafchamps, Hill, & Minten, 2008	X		X	X						
Fan, Cheng, Li, & Lee, 2016	X	X	X		X		X			
Fan, Li, Sun, & Cheng, 2017	X	X	X				X	X		
Folinas, Manikas, & Manos, 2006	X	X	X	X	X		X		X	

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Fransson & Molander, 2013	X	X	X	X	X					
Fu, Han, & Huo, 2017		X				X	X	X	X	
Fuentes & Jurado, 2016							X			X
Lin, Huang, & Lin, 2002	X	X		X			X			
Ghosh & Fedorowicz, 2008	X	X	X	X		X	X	X	X	
Goel, 2010		X					X			
Goswami et al., 2013	X	X	X	X			X			
Govindan, Mangla, & Luthra, 2017	X	X		X		X		X		
Guo et al., 2014	X									X
Ha et al., 2017	X	X		X		X	X	X		X
Hall & Saygin, 2012	X	X		X		X	X		X	X
Hall et al., 2013	X	X		X			X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Hinks et al., 2009	X		X		X		X			
Hodgkins et al., 2010			X							
Holmström, Främling, & Ala-Risku, 2010	X	X					X			
Hosoda, Naim, Disney, & Potter, 2008	X						X			
Hsiao & Huang, 2016		X	X			X	X			
Huang, Jiang, & Tang, 2009	X	X		X						
Hung, Ho, Jou, & Tai, 2011	X	X	X	X		X	X			
Huo et al., 2016						X	X	X		
Huo, Liu, Chen, & Zhao, 2017		X				X	X			
Iida & Zipkin, 2010	X	X					X			X
Jain & Moinzadeh, 2005	X	X	X	X						

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Johnson et al., 2013		X		X		X	X	X		
Jonsson & Mattsson, 2013	X	X		X	X		X		X	X
Jonsson & Myrelid, 2016	X	X		X		X	X	X		
Jraisat, Gotsi, & Bourlakis, 2013	X	X	X	X		X	X	X		X
Kaipia & Hartiala, 2006	X	X		X						X
Kembro et al., 2014	X		X	X		X	X	X	X	X
Kembro et al., 2017	X		X			X	X	X	X	
Ketzenberg & Ferguson, 2008	X	X							X	X
Ketzenberg, 2009	X	X		X			X		X	X
Kim et al., 2011	X	X	X	X		X	X			X
Lee & Ha, 2018	X	X	X	X		X	X	X		
Lee & Ha, 2018						X	X	X		

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Lee et al., 2010	X	X	X	X		X	X	X		X
Lee et al., 2014	X	X		X		X	X	X		
Lee, So, & Tang, 2000	X						X			X
Lei et al., 2014	X						X		X	X
Li & Lin, 2006	X					X	X		X	X
Li et al., 2014	X	X		X		X	X	X		X
Li, 2002	X			X		X	X			
Liao & Hsiao, 2013	X	X		X	X					
Liao, Ma, Jiung-Yee Lee, & Ke, 2011		X	X	X		X	X	X		X
Liu, Li, Steele, & Fang, 2018	X	X	X	X			X			
Liu, Srinivasan, & Vepkhvadze, 2009	X	X		X			X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Lockamy III, 2014		X	X	X	X					
Lumsden & Mirzabeiki, 2008	X	X	X	X			X			
Mishra, Raghunathan, & Yue, 2009	X	X		X		X	X		X	X
Mitra & Chatterjee, 2004	X						X		X	X
Mittendorf et al., 2013	X			X		X	X			
Morgan, Richey Jr, & Ellinger, 2018	X	X	X	X		X	X	X		X
Müller & Gaudig, 2011	X		X	X		X	X	X		
Nakade & Yokozawa, 2016	X			X						
Ouédraogo et al., 2018			X							
Özer & Wei, 2006	X			X			X		X	
Özer, Zheng, & Chen, 2011	X					X	X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Patnayakuni et al., 2006	X	X	X	X		X	X	X	X	
Rached, Bahroun, & Campagne, 2015	X	X		X			X			
Raghunathan, 2001	X	X								
Ramanathan, 2013	X	X	X			X	X			X
Rediers, Claes, Peeters, & Willems, 2009			X							
Ren, Cohen, Ho, & Terwiesch, 2010	X						X			
Resende-Filho & Hurley, 2012		X	X							
Rief & van Dinther, 2010	X	X		X			X			
Roba, Lelea, Hensel, & Kaufmann, 2018		X	X	X						

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Salmi & Holmström, 2004	X									
Samaddar et al., 2006	X	X		X		X	X	X		X
Sarkar & Kumar, 2015	X	X			X		X			X
Shamir & Shin, 2012	X						X			X
Shamir, 2012	X			X			X			
Smith et al., 2012	X	X		X		X	X	X		
Somapa et al., 2018	X	X	X	X		X	X			X
Sošić, 2010	X						X			X
Srinivasan & Swink, 2018	X	X		X			X		X	X
Srivastava, Chaudhuri, & Srivastava, 2015	X	X	X	X						
Srivathsan & Kamath, 2017	X	X				X	X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Srivathsan & Kamath, 2018	X	X		X		X	X		X	X
Steckel, Gupta, & Banerji, 2004	X									
Stranieri, Cavaliere, & Banterle, 2016		X					X	X		
Szymczak et al., 2018	X	X	X	X			X			
Tang & Girotra, 2017	X	X		X			X			
Terwiesch, Ren, Ho, & Cohen, 2005	X									
Thakur & Donnelly, 2010	X	X	X	X						
Thomas, Krishnamoorthy, Singh, & Venkateswaran, 2015	X	X		X						X
Thonemann, 2002	X	X		X			X		X	X
Tokar et al., 2011	X	X					X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Trienekens, Wognum, Beulens, & van der Vorst, 2012		X	X	X		X	X	X		X
van der Merwe et al., 2017		X	X	X		X	X	X		
Viet et al., 2018	X	X	X	X	X		X		X	X
Vigtil, 2007	X	X	X	X			X		X	X
Vijayasarathy, 2010						X	X		X	
Wang & Wei, 2007	X					X				
Wang et al., 2014		X	X	X		X	X			
Watson & Zheng, 2005	X						X			
Welker et al., 2008	X	X	X	X		X	X		X	X
Wiegmans, Menger, Behdani, & van Arem, 2018		X	X	X						
Williams & Waller, 2011	X						X		X	

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Williams et al., 2013	X	X	X	X			X			X
Wong et al., 2011	X					X	X		X	X
Wu et al., 2014	X	X	X	X		X	X	X		
Wu, Zhai, & Huang, 2008	X	X		X					X	X
Wudhikarn, Chakpitak, & Neubert, 2018	X	X		X						
Yan & Cao, 2017	X	X	X	X			X			X
Yan & Pei, 2012	X	X					X			X
Yan & Wang, 2012	X		X				X			X
Yang, Yu, Liu, Xie, & Liu, 2018				X	X	X	X		X	X
Yao, Yue, & Liu, 2008	X	X		X			X			
Yee, 2005	X	X		X			X			

Source: created by the author.

Articles included in the extraction and their contributions (cont.)

	Visibility Dimensions					Influential characteristics				
Articles	Demand	Supply	Product	Process	Risk	Relational factors	Structural factors	Cognitive factors	Internal factors	Environmental factors
Yigitbasioglu, 2010	X	X		X		X	X	X		X
Yin, Li, Xu, Chen, & Wang, 2017		X		X						
Yu, Ting, & Chen, 2010	X	X		X	X		X		X	X
Yue & Liu, 2006	X	X					X		X	X
Zaheer & Trkman, 2017						X	X	X		
Zhang & Cheung, 2011	X	X								
Zhang & Xiong, 2017	X						X		X	
Zhang et al., 2011b		X					X		X	
Zhang, 2006	X	X					X			
Zhang, Lee, & Li, 2016	X	X								X
Zhang, Tan, Robb, & Zheng, 2006	X	X		X			X			X
Zhao & Li, 2018	X	X		X			X			X

Source: created by the author.

APPENDIX B

The final version of the questionnaire.

Question	Survey item	Potential group	Original item
Q2_01	Expected changes in the timing and level of demand	Demand	Promotion information
Q2_02	Product valuation and related taxes/tariffs	Product	Financial information
Q2_03	Demand forecasts	Demand	Demand forecast
Q2_04	Possible causes of undesired consequences	Risk	Risk source
Q2_05	Process flexibility	Process	Flexibility rate
Q2_06	Operational costs	Process	Operating cost
Q2_07	Details on the required workflow for a product	Process	Process details
Q2_08	Estimated consequences of possible damage, danger, loss or injury	Risk	Risk impact
Q2_09	Resources consumed in house production	Process	Cost information
Q2_10	Service level performance of a delivery process	Process	Service indicator
Q2_11	Overall demand market conditions	Demand	Market information
Q2_12	Metrics that support decisions for process improvements	Process	KPI
Q2_13	Specific needs of customers	Demand	Demand information
Q2_14	Anticipated lead time for a job	Process	Lead time
Q2_15	Production schedule	Process	Production schedule
Q2_16	Product description	Product	Product information
Q2_17	Customer order information (e.g., item, quantity, due date)	Demand	Incoming order
Q2_18	The destination of an inbound procured items	Supply	Track
Q2_19	Product's design including the components and materials	Product	Product structure
Q2_20	Product's conformance information	Product	Quality information

Source: created by the author.

The final version of the questionnaire (cont.)

Question	Survey item	Potential group	Original item
Q2_21	Point of sales data	Demand	POS
Q2_22	The origin and history of inbound procured items	Supply	Traceability
Q2_23	Process capacity	Process	Process capacity
Q2_24	Quality specifications for a service or product	Product	Product/Service specification
Q2_25	Product condition (e.g., temperature, damage)	Product	Product condition
Q2_26	Probability of an event that leads to the realization of the risk	Risk	Risk probability
Q2_27	Advance shipment notices of procured items	Supply	Shipping schedule
Q4_01	The extent to which suppliers, partners, and customers working jointly on an activity or project	Relational factors	Collaboration
Q4_02	Cost of holding inventory, including work-in-process and safety stock	Internal factors	Holding cost
Q4_03	The extent to which supply chain partners have similar values, beliefs, and management practices	Cognitive factors	Cultural similarity
Q4_04	How business enterprises are linked (e.g., owned, alliance, etc.) to form a supply chain	Structural factors	Supply chain structure
Q4_05	The average size of a production batch (or lot size)	Internal factors	Order batch size
Q4_06	The unpredictability of customers' demands	Environmental factors	Demand uncertainty
Q4_07	Mechanisms suppliers use to manage coordination	Structural factors	Governance structure
Q4_08	The complexity of products an organization produces	Internal factors	Product complexity

Source: created by the author.

The final version of the questionnaire (cont.)

Question	Survey item	Potential group	Original item
Q4_09	The extent to which supply chain partners commit to a business relationship	Relational factors	Commitment
Q4_10	Imbalance in power between supply chain partners	Structural factors	Bargain power
Q4_11	Rules, values, and goals that facilitate communication and the development of mutual understandings	Cognitive factors	Shared codes and language
Q4_12	Number of competitors operating in an industry	Environmental factors	Competition intensity
Q4_13	The extent to which the relationship fosters reciprocal behaviors between supply chain partners	Relational factors	Reciprocity
Q4_14	Production system orientation: make-to-order, make-to-stock, assemble-to-order, etc.	Internal factors	Manufacturing environments
Q4_15	The importance of the relationship between the supply chain partners	Relational factors	Importance of relationship
Q4_16	The extent of unpredictability in overall demand market conditions	Environmental factors	Market uncertainty
Q4_17	The frequency and variety in the pattern of transactions between supply chain partners	Structural factors	Relationship complexity
Q4_18	The degree to which demand is seasonal	Environmental factors	Demand pattern
Q4_19	The degree to which a firm makes partner-specific investments in resources and technological know-how	Structural factors	Asset specific investment
Q4_20	The extent to which top managers at supply chain firms understand and support their business relationship	Relational factors	Top management support

Source: created by the author.

The final version of the questionnaire (cont.)

Question	Survey item	Potential group	Original item
Q4_21	Hardware, software, and telecommunications networks that connect supply chain partners	Structural factors	Information systems
Q4_22	The competitive pressure for short lead times	Environmental factors	Pressure to reduce lead times
Q4_23	The willingness of supply chain partners to collaborate and share information	Cognitive factors	Culture
Q4_24	The duration of the relationship between business partners	Relational factors	Length of relationship
Q4_25	The significance of a supply chain partner's reputation	Cognitive factors	Reputation
Q4_26	Use of phone calls, meetings or e-mails as means of interaction	Structural factors	Direct contact
Q4_27	The extent of the unpredictability of the suppliers' product quality and delivery performance	Environmental factors	Supply uncertainty
Q4_28	Number of employees (size) of an organization	Internal factors	Size of the firm
Q4_29	The extent to which employees in supply chain partners trust each other	Relational factors	Trust
Q4_30	The amount of excess capacity in the organization's operations	Internal factors	Capacity availability
Q4_31	Provision of incentives for information sharing	Structural factors	Incentive policy
Q4_32	The extent of the unpredictability of technology development in an organization's industry	Environmental factors	Technology uncertainty

Source: created by the author.

The final version of the questionnaire (cont.)

Question	Survey item	Potential group	Original item
Q4_33	Use of collaborative and coordinating structures, processes, and practices among supply chain partners	Structural factors	Integration
Q4_34	The relative position of the company in its supply chain: manufacturer, retailer, wholesaler, etc.	Internal factors	Supply chain position

APPENDIX C

List of authors in each round of the Q-sort

Name	University	Number of articles	Round
Baofeng Huo	Zhejiang University	3	1
Gang Li	Xian Jiaotong University	3	1
Huan Fan	City University of Hong Kong/Xian Jiaotong University	3	1
Byoung-Chun Ha	Sogang University	2	1
J.H. Trienekens	Wageningen University	2	1
Mark Barratt	Arizona State University	2	1
Özalp Özer	The University of Texas	2	1
Alessandro Perego	Politecnico diMilano	1	1
Allan N.Zhang	Singapore Institute of Manufacturing Technology	1	1
Amrik S. Sohal	Monash University	1	1
Andrea Sianesi	Politecnico diMilano	1	1
Asvin Goel	University of Leipzig	1	1
Binshan Lin	Louisiana State University	1	1
Birendra K. Mishra	The University of California	1	1
Brent D. Williams	University of Arkansas	1	1
Dae-Hee Yoon	Yonsei University	1	1
Dorota Leończuk	Bialystok University of Technology	1	1
Eric T. G. Wang	National Central University	1	1
Guangsheng Yu	Fudan University	1	1

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Haozhe Chen	Iowa State University	1	1
Hongming Xie	Zhejiang University of Technology	1	1
Indu Shobha Chengalur-Smith	State University of New York	1	1
Ing-Long Wu	NationalChung Cheng University	1	1
J. Ramon Gil-Garcia	Centro de Investigacio´n y Docencia Econo´micas	1	1
Jao-Hong Cheng	National Yunlin University of Science and Technology	1	1
Jengchung V. Chen	National Cheng Kung University	1	1
Jianghua Wu	Renmin University of China	1	1
Jiwoong Shin	Yale University	1	1
Joseph R. Huscroft	Air Force Institute of Technology	1	1
Joseph Roh	Texas Christian University	1	1
Karan Girotra	Technology and Operations Management Area	1	1
Kay-Yut Chen	Hewlett-Packard Laboratories	1	1
Kostas Selviaridis	Lund University	1	1
Kun Liao	Central Washington University	1	1
M. Birasnav	New York Institute of Technology	1	1
Melissa van der Merwe	University of Pretoria	1	1
Mingyu Liu	Fudan University	1	1
Nainika Seth	University of Alabama	1	1
Paulina Myrelid	Chalmers University of Technology	1	1

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Peter Duchessi	State University of New York	1	1
Quan Tian	Guangzhou University	1	1
Ravi Srinivasan	Loyola University Maryland	1	1
Robert Glenn Richey Jr	Auburn University	1	1
Sirirat Somapa	Thammasat University	1	1
Stefanella Stranieri	Università degli Studi di Milano	1	1
Taco van der Vaart	University of Groningen	1	1
Wei-Hsi Hung	National Chung Cheng University	1	1
Wout Dullaert	Vrije Universiteit Amsterdam	1	1
Xiande Zhao	China-Europe International Business School	1	1
Xin Zhai	Peking University	1	1
Zixia Cao	University of Colorado	1	1
T.C.E. Cheng	Hong Kong Polytechnic University	4	2
Albert Y. Ha	Hong Kong University of Science and Technology	2	2
Dag Naslund	Lund University/University of North Florida	2	2
Hongtao Zhang	The Hong Kong University of Science and Technology	2	2
Joakim Kembro	Lund University	2	2
Kyung Kyu Kim	Yonsei University	2	2
A.J.M. Beulens	Wageningen University	1	2
Adegoke Oke	Arizona State University	1	2
Alessandro Banterle	Università degli Studi di Milano	1	2

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Alessia Cavaliere	Università degli Studi di Milano	1	2
Alexander E. Ellinger	University of Alabama	1	2
Angela Tumino	Politecnico diMilano	1	2
ARUN RAI	Georgia State University	1	2
Astrid Vigtil	Norwegian University of Science and Technology	1	2
Atanu Chaudhuri	Aalborg University	1	2
Benjamin T. Hazen	Seymour Johnson Air Force Base	1	2
Christina W.Y. Wong	Hong Kong Polytechnic University	1	2
Chwen Sheu	Kansas State University	1	2
Daniel Prajogo	Monash University	1	2
Dianne J. Hall	Auburn University	1	2
Dirk Pieter van Donk	University of Groningen	1	2
Dong-Qing Yao	Towson University	1	2
G. Keong Leong	California State University	1	2
Gera A. Welker	University of Groningen	1	2
Helena Hartiala	Helsinki University of Technology	1	2
Helmut Krcmar	Technische Universita¨t Mu¨nchen	1	2
Honghui Deng	University of Nevada	1	2
Hsiao-Lan Wei	National Taiwan University of Science and Technology	1	2
Hsin-I Hsiao	National Taiwan Ocean University	1	2
Imam Baihaqi	Sepuluh Nopember Institute of Technology Surabaya	1	2

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
In Lee	Western Illinois University	1	2
J.G.A.J. van der Vorst	Wageningen University	1	2
Jan Olhager	Lund University	1	2
Jane Fedorowicz	Bentley College	1	2
Joanicjusz Nazarko	Bialystok University of Technology	1	2
Joanna Jakuszewicz	Bialystok University of Technology	1	2
Joe B. Hanna	Auburn University	1	2
Johann F. Kirsten	Stellenbosch University	1	2
John Liu	Hong Kong Polytechnic University	1	2
José Moyano-Fuentes	University of Jaén	1	2
Ke Ke	Central Washington University	1	2
Kim Hua Tan	Nottingham University	1	2
Krzysztof Witkowski	University of Zielona	1	2
Leo R.Vijayasarathy	Colorado StateUniversity	1	2
Mark Goh	National University of Singapore / University of South Australia	1	2
Paul Drake	University of Liverpool	1	2
Tao Huang	Peking University	1	2
Xiling Cui	Hong Kong Shue Yan University	1	2
Yina Li	South China University of Technology	1	2
Zhimin Huang	Adelphi University	1	2
Fei Ye	South China University of Technology	2	3

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Patrik Jonsson	Chalmers University of Technology	2	3
Peter K. C. Lee	The Hong Kong Polytechnic University	2	3
Shilu Tong	CUHK Business School	2	3
Xiaohang Yue	University of Wisconsin-Milwaukee	2	3
Brian Mittendorf	Ohio State University	1	3
Daozhi Zhao	Tianjin University	1	3
David C. Yen	Miami University	1	3
Haiwei Liu	Shanghai Maritime University	1	3
Hongyi Sun	City University of Hong Kong	1	3
Huihui Liu	Peking University	1	3
Jennifer Shang	University of Pittsburgh	1	3
Jie Yang	University of Houston-Victoria	1	3
Juliang Zhang	Beijing Jiaotong University	1	3
Kee-hung Lai	Hong Kong Polytechnic University	1	3
Liang Guo	The Hong Kong University of Science and Technology	1	3
Lode Li	Yale School of Management	1	3
Luai Jraisat	American University of Madaba	1	3
Luca Crippa	Politecnico diMilano	1	3
Maciej Szymczak	Poznan University of Economics and Business	1	3
Manto Gotsi	Cardiff University	1	3
Maria Caridi	Politecnico diMilano	1	3

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Martin Müller	University of ULM	1	3
Martine Cools	Leuven Campus Antwerpen	1	3
Michael Bourlakis	Cranfield school of Management	1	3
Neda Ebrahim-Khanjari	Northwestern University	1	3
Noel Johnson	University of Liverpool	1	3
Ogan M. Yigitbasioglu	Hanken School of Economics	1	3
P.M. Wognum	Wageningen University	1	3
Pedro-José Martínez-Jurado	University of Zaragoza	1	3
Peter Trkman	University of Ljubljana	1	3
Rajiv K. Srivastava	Indian Institute of Management Lucknow	1	3
Rakesh Mittal	New York Institute of Technology	1	3
Ravi Patnayakuni	University of Alabama	1	3
Riikka Kaipia	Aalto university	1	3
Ruiliang Yan	Texas AM university	1	3
Ruth Barratt	Arizona State University	1	3
Samir K Srivastava	Indian Institute of Management Lucknow	1	3
Selene Loughlin	University of New Haven	1	3
Seyed M. R. Iravani	Northwestern University	1	3
Srinivasan Raghunathan	The University of Texas	1	3
Suhong Li	Bryant University	1	3
Sungbin Cho	Sogang University	1	3

Source: created by the author.

List of authors in each round of the Q-sort (cont.)

Name	University	Number of articles	Round
Tian Li	East China University of Science and Technology	1	3
Timon C. Du	Chinese University of Hong Kong	1	3
Tyler R. Morgan	Auburn University	1	3
Vincent S. Lai	Chinese University of Hong Kong	1	3
Waiman Cheung	Chinese University of Hong Kong	1	3
Wenjie Tang	NUS Business School and Institute of Operations Research and Analytics	1	3
Wenliang Bian	Beijing Jiaotong University	1	3
Yanchong Zheng	Stanford University	1	3
Zhongming Ma	California State Polytechnic University	1	3

Source: created by the author.