

Impact of Cultural Behavior on the Bullwhip Effect in the COVID-19 Pandemic

Thais de Castro Moraes

Department of Industrial Systems Engineering and Management
National University of Singapore
Singapore, 117576, Singapore
thais.moraes@u.nus.edu

Xue-Ming Yuan

Singapore Institute of Manufacturing Technology
Agency for Science, Technology and Research - A*STAR
Singapore, 138634, Singapore
xmyuan@simtech.a-star.edu.sg

Abstract

With the broadening of interconnection between national borders, it is paramount to take into account different cultural behavior to enhance the visibility and integration among supply chain partners with the aim to improve organizational performance. There are a few studies exploring the role of culture in supply chain coordination and buyer-supplier relationships that results in the Bullwhip Effect, but they consider simulation environments or real-life scenarios with minor perturbation. Therefore, this study complements the literature by analyzing how the perception of large disruptions in supply chain coordination varies between cultures. More specifically, this paper will investigate the behavioral causes of Bullwhip Effect during the COVID-19 pandemic to illustrate how these disruptions affect the supply chain coordination. The Hofstede's Cultural Dimensions Theory and other three studies were considered when elaborating and applying a multiple-case study approach with semi-structured interviews and podcasts as the main source of data. The results provided a framework of the relation between cultural differences and the Bullwhip Effect in large disruptions, with the confirmation of a few tendencies that were observed from previous studies, and elaboration of propositions and managerial applications.

Keywords

Bullwhip Effect, Cultural Behavior, Supply Chain Coordination, Large Disruptions and COVID-19.

1. Introduction

There are several ways to estimate the performance of a supply chain. According with Bhattacharya and Bandyopadhyay (2011), service level, total supply chain cost, bullwhip effect and average inventory are the main performance measures considered in managerial practices and research studies. This study is going to focus on the bullwhip effect (BWE) given its relevance in the current worldwide scenario and large applicability in supply chain management. The BWE is a phenomenon that corresponds to fluctuations in demand that promotes irregular transactions between the supply chain partners, making more difficult to forecast sales and effectively manage inventory, which causes disruptions along the chain and, consequently, reduces the service level (Zotteri 2013). The majority of the BWE studies focus on the development of simulation and optimization models and other quantitative methods to mitigate its operational causes, such as demand forecasting and replenishment policies.

However, de Almeida et al. (2015) explained that the origin of this phenomenon relies on the lack of communication, collaboration, and trust among members of the supply chain, emphasizing the little amount of behavioral studies in this topic. In addition, Bhattacharya and Bandyopadhyay (2011) highlighted that most of studies rely only on simulation experiments to draw conclusions on the behavioral causes of the BWE, and the differences in settings between controlled laboratory environment and real industry indicates the need for drawing conclusions about the behavioral causes based on empirical studies with real cases. Bruccoleri et al. (2014) complemented this idea by

discussing the two main reasons for the study of the behavioral variables in operational settings. The authors justified it by describing the contribution to the search for more suitable and effective solutions and managerial practices and how the behavioral analysis helps to understand phenomena that cannot be explored more deeply.

As an example of behavioral study about this phenomenon, Ha et al. (2011) examined organizational culture differences and how they affect trust and collaboration between partners in the supply network. The authors conducted a case study to examine the behavioral causes of the BWE in the Korean context. They identified as a research gap the lack of studies regarding cultural behavior differences in international supply chain collaboration. Markus and Kitayama (1991) highlighted the national cultural divergences and stated that many Asian cultures emphasize harmony and community, whereas individuals in American culture seek to maintain their independence from others. Nisbett et al. (2001) complemented by speculating that the origin of cultural differences is traceable to different social systems, with Easterners behaving notably in a holistic manner and Westerners being more analytic.

These differences among behavior and cultures can be expressed in recent examples, such as the adherence of the use of face masks and restriction measures that have been applied in countries all over the world as a consequence of the COVID-19 pandemic plans of contingency. It has been noticed that restrictive measures, such as full lockdown and mandatory use of masks with heavy penalties for the offenders, are more easily implemented in Asian countries. Singapore and Taiwan are role models for other nations in terms of COVID-19 tracking and contingency. On the other hand, it was noticed that in American and European countries the same kind of restrictions encountered more resistance of the population to be implemented. Even in countries with the highest levels of education and wide access to information, the culture of freedom and non-intervention in the individual's privacy was a major obstacle in implementing restrictions. As a result, places that were more relaxed in the interventions are going through a second infection wave.

Compared with small and expected disruptions that occur on a regular basis, events with low probability and high impact have an enormous influence on the supply chain because historical data on these rare episodes is limited or non-existent. September 11th, SARS, hurricane Katrina and the Indian Ocean tsunami are examples of occurrences that severely disrupted production and distribution industries, resulting in price spikes and stock outs of several basic products, which are consequences of the BWE (Rong et al. 2008). The BWE receives exceptional attention after extreme disruption situations. The COVID-19 pandemic has raised the importance of studying the operational and behavioral causes of this phenomenon to find more effective approaches to mitigate it. The frequent stock-outs in the supermarket for basic products and the scarcity of life-saving drugs, ventilators, and protective equipment can be enumerated as one of the consequences of how unexpected fluctuations in demand affect the transactions in the entire supply chain, justifying the increasing interest on this topic.

By noticing how much the cultural aspects of individuals affect their attitude and opinions towards their daily decisions, this multiple-case study aims to investigate how the behavioral causes of the BWE differ between cultures. In addition, following the existing literature and experiments in the behavioral aspects in supply chain management topics, the paper will examine the constructs that have been discussed in previous studies and how they are affected by the national culture. Considering that the current scenario of supply networks is international and easily connected with individuals and companies in several parts of the world, understanding their cultural norms and values may help the partners successfully improve their relationship strategies. This study is going to explore the behavioral causes instead of the operational to fulfill the gap in literature regarding cultural differences and how they affect the intercontinental supply chain coordination, with the novelty of analyzing the perception of problems gravity in large disruptions, such as natural disasters, in the framework of the BWE.

The remainder of the paper is structured as follows. Section 2 provides an overview of the relevant research on the behavioral causes of the BWE and cultural dissimilarities studies in supply chain management, identifying the literature gap that will be further explored in the paper. Section 3 explains the rationale for the methods design, highlighting how they were referred and complement other studies in the topic by illustrating the problem dimensions. Section 4 details the execution of the data collection and analysis. Sections 5 and 6 bring the results analysis to elaborate propositions and managerial implications, with the acknowledgement of study limitations and outlining future research directions.

2. Literature Review

2.1 Causes of the Bullwhip Effect

The causes of the BWE can be divided in operational and behavioral. The first BWE study was conducted by Forrester (1958) and analyzed data of individuals and companies to draw conclusions about the operational causes. The existence of the behavioral aspects has been first demonstrated by Sterman (1989) with a methodology based on a laboratory simulation experiment named Beer Distribution Game (BDG). Until this present study, this simulation method is still the main approach adopted by authors to verify both operational and behavioral causes of the BWE with several adaptations and restrictions. As an example, Nienhaus et al. (2006) utilized an online version of the game, Croson and Donohue (2005) applied a controlled version by varying the amount and location of shared inventory information and Sarkar and Kumar (2015) studied a variation with simulated supply chain disruptions.

Bhattacharya and Bandyopadhyay (2011) identified in their literature review demand forecasting, order batching, price fluctuation, rationing and shortage gaming, lead time, inventory and replenishment policies as the main operational causes that have been studied the most over the past decades. Regarding the behavioral causes, the authors described the lack of learning and training, fear of empty stock and neglecting time delays when making ordering decisions. To complement this list, de Almeida et al. (2015) highlighted the lack of communication, collaboration, and trust among members of the supply chain.

Providing supplemental information to supply chain members has been used as a predominant approach to mitigate the BWE in most studies. However, Haines et al. (2017) stated that since decision making is not a deterministic process, even the most information rich settings lead managers to create the BWE. This idea is originated from Croson and Donohue (2003, 2005, 2006) studies. The authors made substantial contributions to the behavioral literature in BWE with focus in information sharing. Their research has shown that even when removing all the operational causes and making the demand known to the participants of the Beer Distribution Game, the BWE still persists. This happens due to an irrational reaction of the participants to the uncertainty about the actions of other decision makers. Wu and Katok (2006) confirmed this persistence of the BWE and added that neither training nor communication by themselves eliminate the phenomenon. The performance is only improved when both are combined, indicating that the BWE is due to lack of coordination between supply chain members.

With respect to trust as one of the behavioral causes, Ha et al. (2011) developed the concepts of affective trust and competency trust. The first has a significant influence on collaboration in information sharing and risk sharing, whereas the latter affects collaboration in joint decision making and risk sharing. Mouzas et al. (2007) affirmed that it is more productive to apply trust in the inter-personal level rather than in an inter-organizational setting, since it is a feeling about the emotive aspect toward another.

Regarding supply chain collaboration as another behavioral cause, Ha et al. (2011) elaborated that joint decision making and information sharing affect efficiency. However, the decision-making process must be shared with the condition that the supply chain members have enough expertise for contributing to the work performance. In this way, the authors concluded that trust in competency is a significant predictor for joint decision making. Doney and Cannon (1997), Spekman et al. (2002) and Duffy and Fearnly (2004) have derived detailed studies in trust, decision making, information sharing and risk taking in social interactions between partners in the supply chain management. In summary, the main causes of the BWE derived over the past relevant studies are comprised in Table 1.

Table 1. Main causes of the Bullwhip Effect.

Operational Causes	Behavioral Causes
Demand Forecasting	Communication
Order Batching	Collaboration
Price Fluctuation	Trust
Rationing and shortage gaming	Information sharing
Lead time	Learning and training
Inventory policies	Fear of empty stock
Replenishment policies	Risk taking

2.2 Cultural Differences in Supply Chain Management

The rising number of global interactions in operations management is bringing attention to the cultural behavior characteristics differences, but not necessarily is leading to the adoption of similarities among organizations (Naor et al. 2010). In this context, international operations can encounter as the main barrier for integration these cultural dissimilarities among entities Doetzer (2020), which may present challenges to the health of their relationships (Pagell et al. 2005). Furthermore, few studies had simultaneously collected data from more than one culture to empirically verify differences, and several regions of the world remain under-studied (Cannon et al. 2010).

Cannon et al. (2010) supplemented the literature in buyer-supplier international relationships by stating that the individualism and collectivism dimensions are the main cultural elements that affects the trust and performance in supply chains. To evidence that, the authors consulted the Hofstede's country Individualism Index values to divide their countries analysis. Complementing this cross-cultural framework, Naor et al. (2010) investigated the relationship between national and organizational culture and its impact on manufacturing performance in Eastern and Western countries. The authors applied eight culture dimensions of the GLOBE framework to measure the manufacturing performance. Their findings suggest that organizational culture has more impact on manufacturing performance than national culture. Recently, Doetzer (2020) studied how the national culture different behaviors affect the supply chain visibility, which is related with the internal and external process of information sharing by data provision and technology integration (Kaipia and Hartiala 2006). The author also relied on the Hofstede Cultural Dimension Theory to build the rationale of the study and evaluate his results. The findings suggest that, in the context of international supply chain environment and based on the adjustability of cultural features, dissimilar cultural behaviors can be adapted to the opposite entity to increase visibility.

This belief that the frequencies of specific behaviors, values and attitudes is significantly linked with empirically identified cultural dimensions was first derived by Hofstede (1980). The methodology was gradually restated in his further studies (2001, 2010a, 2010b and 2021). The last version of his dimension model states that cultural differences can be described by six elements: power distance, individualism, masculinity, uncertainty avoidance, long term orientation and indulgence. These dimensions have been largely employed in cultural studies as a reliable source to support comparative investigation between countries.

In summary, previous analyzes on the cultural aspects in the context of supply chain and behavioral studies on the causes of the BWE majorly considered supply chains with the absence of significant disruptions. Further, most of the behavioral studies on BWE were conducted in simulation environments, which despite the ease in manipulating and evaluating the variables to reach conclusions, it does not account for many real life elements that might interfere on the overall results. As highlighted by Glaser and Strauss (1967), the development of a valid, testable and relevant theory occurs in studies with intimate relation with empirical reality.

By using the COVID-19 pandemic as an example of large disruption in the supply chain since it is resulting in worldwide consequences and impacting complex international supply chain networks, this research intends to fulfill the gap of how different cultures behave in supply chain decisions under dramatic circumstances. The BWE is an optimal feature to address this perspective, considering that its main causes rely on human reaction to uncertainty. In addition, by applying a multiple-case study for theory building, the study will supplement the behavioral causes of the BWE literature, which is mainly based on the Beer Distribution Game methodology.

3. Methods

Considering that the research question intends to evaluate the nuances of how the cultural dissimilarities affect the behavior, according with Mayring (2000), the hypotheses-testing approach is not suitable, thus it is not going to be adopted in this research. Instead, a qualitative empirical study with the aim to understand how the behavioral causes of the BWE are driven by national cultural differences is going to be executed to account for the subjectivity, generality and wide interpretability of the topic. The early stages of this research make it appropriate for conducting case study research to build theory Eisenhardt (1989) and will build the foundation for future statistical analysis and hypotheses-testing in following studies.

In this way, a multiple case-study in different countries is designed for this research, with the comparison of separate case reports to identify similarities and divergences between cultures. This approach of first executing a within case analysis and then searching for cross-case patterns will follow the strategies presented in Eisenhardt (1989). According

to Miles et al. (2014), another significant reason to conduct a cross-case analysis is to deepen the understanding and explanation of a phenomenon more quickly and easily than with a single case. The data collection was based on semi-structured interviews to extract information about the perceptions of large disruptions in the supply chain, with focus on the BWE during the COVID-19 pandemic. Further details regarding the theoretical sampling and interview protocol are described next. In addition to the interviews, it was observed the occurrence of a spike in podcasts that discuss the consequences of the BWE during COVID-19, bringing rich data that will also be used in the discussion of findings.

3.1 Theoretical Sampling

As highlighted by Gehman et al. (2018), theory building from cases is suitable in situations with difficult to measure constructs and complex processes. To generalize the proposed findings and further develop the existing literature, the theoretical sampling in qualitative research has the aim to select polarizing frameworks and situations that follow certain constraints (Meredith 1998). To increase comparability across the cases, the semi-structured interviews were conducted with supply chain and logistics professionals in a way that the frame of reference about the BWE phenomenon would be similar.

Company size, industry type, and country of origin are some of the elements that must be considered when analyzing the results to avoid drawing conclusions from aspects that cannot be controlled or are not relevant for the study. In addition, it is relevant to consider that companies have their own organizational culture, which might bias the cultural behavior findings, as it was acknowledged in Ha et al. (2011) and Doetzer (2020). With respect to the country selection, Erumban and De Jong (2006) state that when analyzing variables such as national culture dimensions, it is crucial to consider structural features and economic status. In addition, to provide validity related to cross-cultural studies, the Hofstede's Cultural Dimensions Theory is adopted as a guideline for the choice of cultural dimensions in the interview questions formulation, coding process and results analysis.

3.2 Dimensions of the Study

Based on the literature described on Section 2, this paper is going to contemplate three studies that substantially addressed the cultural behavior in supply chains topic with slight variations. Table 2 summarizes these studies.

Table 2. Cultural behavior in supply chain studies that reference this research.

Paper	Focus	Method	Hofstede's Cultural Dimensions Theory	Findings
Cannon et al. (2010)	Buyer-supplier relationships in international markets.	Questionnaire, hypothesis testing.	Yes	Individualism and collectivism are the main cultural elements that affects the trust and performance in supply chains.
Ha et al. (2011)	Trust and collaboration in supply chain partners.	Questionnaire, hypothesis testing.	No	Affective trust has influence on information sharing, whereas trust in competence affects joint decision making.
Doetzer (2020)	Supply chain visibility and cultural differences.	Semi-structured interviews, coding.	Yes	Supply chain visibility differ with long-term orientation and individualism/collectivism cultural characteristics.
Present study	Culture and behavior in supply chain disruptions.	Semi-structured interviews, coding.	Yes	Long-term orientation and supply chain visibility are related with a proactive attitude in large disruptions.

In this scenario, Hofstede (2001, 2010a, 2010b and 2021) developed an effective method to evaluate cultures that can be generalized to several scenarios and contribute for the justification of country results and comparison of attributes of the dimensions. For the purposes of this research and following the two mentioned studies that adopted this method, not all the six cultural elements are going to be utilized, only three: individualism, uncertainty avoidance and long-term orientation. Power distance, masculinity and indulgence were neglected since it was not identified in the

empirical data and relevant literature a correlation between these dimensions and the underlying topic. Figure 1 presents the numerical scores of the relevant dimensions in the countries in study. To clarify the design of this study and the perspective that is adopted in the interview protocol and coding process, the flowcharts in Figure 2 and Figure 3 were elaborated to provide a conceptual model of the framework of the relation between the BWE precedents and relation between cultural aspects, behavioral causes, and the reduction of the BWE, respectively.

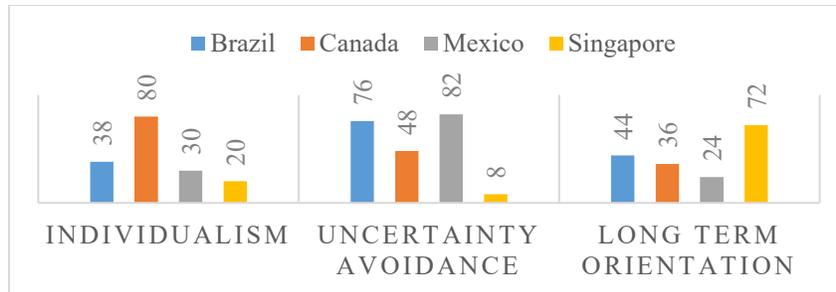


Figure 1. Scores for the countries in study based on the selected Hofstede Cultural Dimensions.

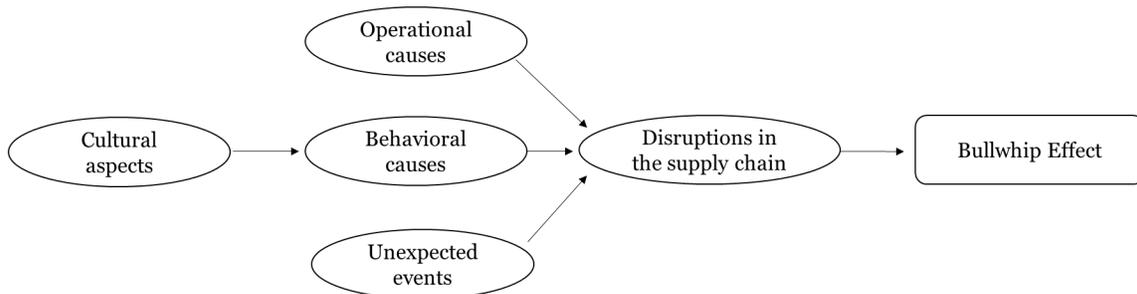


Figure 2. Framework of the relation between the BWE precedents.

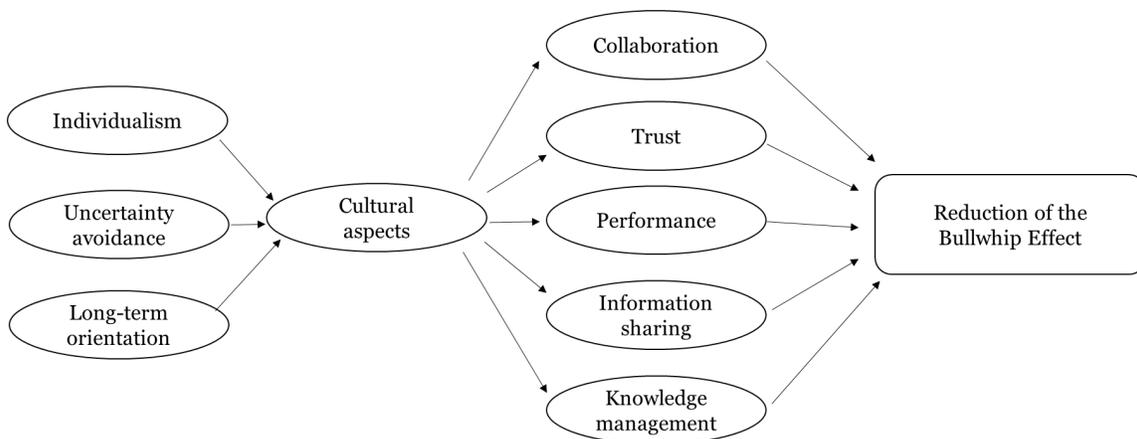


Figure 3. Framework of the relation between cultural aspects and behavioral causes of the BWE.

4. Data Collection and Analysis

Considering the dimensions of the study described on Section 3, a semi-structured interview was elaborated to capture an overview of the behavioral and cultural aspects in the BWE. The interview begins with nine specific questions

regarding decision-making, relationship with partners and strategic planning. The remaining five questions look for a broader perspective of the BWE illustrated by the COVID-19 disruption. To complement the interviews, podcasts that discuss the BWE during the COVID-19 crisis were evaluated as another source of actual and rich data to assist in the information triangulation and reach meaningful results.

4.1 Interviews

The first speaker selected for the interview was Sofia Rivas Herrera, an Industrial Engineer from Mexico that works in the airport industry in Latin America as a Data Analyst, performing benchmarking reports and predictive analysis of future market behavior. She has a Graduate Certificate in Logistics and Supply Chain Management by the Massachusetts Institute of Technology and identifies herself as a Supply Chain Ambassador, by participating in international forums and events. Her international experience and daily involvement with supply chain analysis makes her an appropriate professional to provide insights and share experiences. The second interviewed was Estevam Son Park, a Logistics Manager from Brazil that works in Intergis Co., a multinational logistics company that has its Brazilian central office in the Port of Pecém. To reduce the loss of language features and meaning that might naturally occur is the translation process, the interviews did not consider the interviewee native language and were conducted in English following the protocol.

Due to its open-ended nature, some questions were withdrawn, and others were added along the semi-structured interviews to better adequate to the respondents' context. Theory building is an iterative process, therefore each case can be treated as a replication in a way that the interview protocol can be improved after each replication (Eisenhardt 1989), (Miles and Huberman 1994), and (Yin 2014). In this way, we can better evaluate the fit of the interview questions to the purpose of the research in terms of coverage, efficiency and necessity of the samples requirement, identifying issues that can be fixed to refine the process in future studies.

4.2 Podcasts

It has occurred an increase in supply chain podcasts that discuss the BWE given its relationship with the COVID-19 pandemic. The podcasts sampled were from the Spotify streaming platform and most of them debate the operational causes and innovation techniques to mitigate the phenomenon, therefore were discarded for further analysis. The first one chosen for this study depicts the behavioral aspects of the BWE, it's named "COVID-19, the bullwhip effect and inventory bounce" and is presented by Innovobot, a Canadian company that focuses on innovative industry technologies. This episode is part of the series "Founders and Funders – Technology, Innovation and Entrepreneurship" and the interviewee is Richard Markoff, a Canadian supply chain expert that works in L'Oreal and has a PhD in Supply Chain Management. The second podcast analyzed is named "Securing supply chains in an era of turmoil" and is presented by INSEAD Business School. The episode is part of the series "INSEAD Knowledge" and the interviewee is Paddy Padmanabhan, an Indian Professor at the INSEAD Asia campus in Singapore and active researcher in supply chain management. Both episodes were recorded on April and May 2020, respectively, when the COVID-19 pandemic was already spread worldwide, bringing rich data regarding the relations of this crisis and the BWE.

4.3 Data Analysis

With the objective to assess whether the research protocol is effective in surveying the cultural features and how they affect the BWE, the main method used to analyze the interviews was coding. The three coding steps proposed by Strauss and Corbin (1990) were executed: open coding, axial coding, and selective coding. In addition, the podcasts related with the study were also coded to facilitate triangulation of information. Before being combined into cross-case patterns, each transcript was analyzed separately in a within case approach (Eisenhardt 1989). When developing a theory using the coding method, concepts can be grouped to form categories that, with the time, may become related one to another and form a theory (Strauss and Corbin 1990). Figure 4 details the coding process that was executed for both the podcasts and interviews. Contemplating the related literature and the conceptual models that were illustrated in Section 3.2, a list of possible coding themes was elaborated. It is crucial to emphasize the open-ended character of this study. The list presented in Figure 5 was drafted to assist the understanding of the methodology and guide the coding process, but the three rounds of coding were not limited to the concepts described.

Contrasting the coding categories and themes allows to develop a compelling theoretical rationale and aggregate dimensions (Gioia et al. 2013). Both the interviews and the podcasts were transcribed and coded based on the themes and dimensions described below. The open coding process was executed in the qualitative software Atlas-TI and

followed the column of “Subdimensions” presented in Figure 5, but it was not restricted to it. The axial and selective coding processes were executed in Microsoft Excel. To illustrate the comparative framework that this study relies on, the interviews and podcasts were analyzed separately, with the similarities and divergences between them detailed on Section 5.

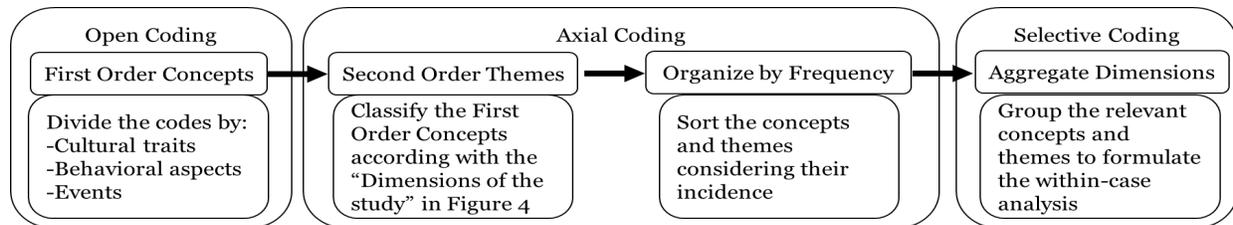


Figure 4. Coding analysis process.

	Dimensions of the study	Subdimensions			Dimensions of the study	Subdimensions
Cultural traits	Individualism and collectivism	Community mindset	That lead to	Behavioral aspects of the BWE	Trust	Affective trust
		Individual mindset				Competence trust
	Long term orientation	Perception of time	➔		Information sharing	Transparency
		Commitment				Open communication
	Uncertainty avoidance	Perception of risk	Knowledge management		Skills training	
		Perception of problems gravity			Strategic flexibility	
		Reactive attitude			Performance	Technical skills
		Proactive attitude				Alternative partners available
	Collaboration		Collaboration		External integration	
					Joint decision making	
		Mutual understanding				

Figure 5. Relevant dimensions of the study.

5. Results and Discussion

5.1 Results

This study intends to establish a relation between the BWE and national culture by evaluating the influence of cultural behavior in supply chain operations and decision making in large disruptions environment. The Hofstede’s Cultural Dimensions Theory (2001, 2010a, 2010b and 2021) and other three studies were referred when conducting multiple-case study to give directions about how culture affects the behavioral causes of the BWE.

The idea of the in-depth interviews is to source behavior related to the countries and capture features that would be overlooked in questionnaires with close ended questions. After the second round of coding in each case, the open codes were grouped by the category they fell in the axial coding and ranked by the frequency they were identified in the transcription. In this step, it was already noticeable a difference between the perspectives of the speakers. The Canadian and Singaporean cases provided views in a more individualistic and proactive manner, focusing on competence trust aspects, whereas the Mexican and Brazilian had a deeper sense of community and a reactive approach in problems solution, emphasizing affective trust. Table 3 provides an overview of the coding results.

Some of the findings confirm the results derived from the Hofstede cultural dimension scores presented in Figure 1. Canada is the country with the highest Individualism dimension score (80) and, accordingly, the speaker expressed

his opinions emphasizing risk coordination in supply chains in a centralized and individualistic manner. On the other hand, Singapore presents the lowest score in this dimension (20), consequential of its Confucian background with the idea that the individual belongs to a group, which can be families or organizations. However, the speaker brought an interesting contradiction to that by expressing his position similarly to the Canadian case and stating that “supply chain coordination is more efficiently managed if the decision is centralized in a single person, instead of multiple individuals across the chain taking decisions independently.”

Table 3. Within-case results summary.

Country	Cultural traits		Behavioral aspects of the BWE		Disruptions
Brazil	Strong regional and short-term orientation affects the problems gravity perception and leads to a reactive attitude.	Narrow view of the chain is related with a reactive attitude.	Focus in affective trust, open communication and adjustment attitude.	Strategic partnerships to enhance joint decision making and external integration.	Regular awareness of disruptions that affect the supply chain.
Canada	Strong international and long-term orientation affects the problems gravity perception and leads to a proactive attitude.	Individualistic mindset is related with a proactive attitude in uncertainty.	Focus in competence trust, adjustment and flexibility attitude.	Awareness of alternative partners available to enhance external integration.	Strong awareness of disruptions that affect the supply chain.
Mexico	Strong regional and short-term orientation affects the problems gravity perception and leads to reactive attitude.	Community mindset is related with a reactive attitude in uncertainty.	Focus in affective trust, open communication and mutual understanding.	Operations coordination and digitalization to enhance performance.	Regular awareness of disruptions that affect the supply chain.
Singapore	Strong international and long-term orientation affects the problems gravity perception and leads to a proactive attitude.	Broad view of the chain and focus on the customers is related with a proactive attitude.	Focus in open communication and sharing data to enhance visibility.	Technical devices, skills and infrastructure to enhance external integration.	Strong awareness of disruptions that affect the supply chain.

Brazil and Mexico exhibit the highest scores in the Uncertainty Avoidance dimension, 76 and 82 respectively, which demonstrates that these countries possess an intense necessity for legal systems to regulate the life. Yet, the citizens present a weak need to obey to these conventions. Interviewees from both countries provided a narrow view of supply chain coordination and a reactive approach in problems solution. When asked about large disruption events and their relationship with the BWE, the Brazilian interviewee argued “it is more related with people’s psychology.”

The Long-term Orientation dimension is related with how a society prioritizes the traditions or the modernity and economic development. Singapore holds the highest score (72), indicating that the country supports long-term investments with slow results and performs a pragmatic approach in businesses. This outcome relates with the comprehensive and proactive approach in risk coordination and decision-making that could be extracted from the speaker when he mentioned that the BWE is a sequence of “rational actions” with “logical explanations”. He also stated that “the BWE is more pronounced in emergent than in developed markets, because in the latter the retail and distribution levels are much more organized.” Mexico presents the lowest score in this dimension (24), which was illustrated by the short-term and reactive attitude perspectives of the interviewee.

In terms of the behavioral aspects of the BWE, Mexico and Brazil emphasized affective trust features to enhance supply chain coordination, which is characterized by emotions and personality (Ha et al. 2011). In contrast, Canada and Singapore highlighted competency trust features, which refers to dimensions of competency and rationality. To achieve supply chain efficiency through collaboration and joint decision making, both types of trust must be

reinforced. Visibility was a key concept in the information sharing dimension that was heavily mentioned in the four cases, highlighting its relevance to maximize coordination and performance.

5.2 Propositions and Managerial Implications

Based on the constructs and findings detailed on the previous section, the following propositions were formulated:

P1. Cultures that present long-term orientation combined with a comprehensive view of problems gravity perception, tend to behave in a proactive attitude in decision making in large disruptions.

P2. Cultures that present short-term orientation combined with a narrow view of problems gravity perception, tend to behave in a reactive attitude in decision making in large disruptions.

P3. Cultures that present higher individualism levels tend towards competence trust relationships.

P4. Cultures that present mid-range or low individualism levels tend towards affective trust relationships.

One of the main objectives to assess cultural traits and behavioral characteristics is to derive conclusions on how organizations can adjust to differences in culture and behavior to enhance their supply chain coordination in large disruption scenarios. Operational efficiency in collectivist cultures demands for a strategic shift, whereas individualist cultures do not prioritize trust-based relations (Cannon et al. 2010). Considering the findings and propositions elaborated, it can be suggested that supply chain partners from countries with higher individualism levels might adjust their behavior with processes standardization and technology implementation, such as RFID or artificial intelligence systems, to reduce the constraints of in-person or manual collaboration along the chain. Organizations located in cultures that present a short-term orientation must endeavor building long-term involvement with their partners since this is essential to enhance collaboration and information sharing, as it was pointed by Doetzer (2020). Increasing data sharing, and hence the supply chain visibility, among the partners is indispensable for reducing uncertainty and improving the network coordination, which directly minimizes the Bullwhip Effect.

5.3 Future Research

Cross-cultural research involves a wide spectrum of outcomes and patterns, with several nuances that need to be carefully examined before reaching further conclusions. It is paramount to consider that the divergences identified might be a consequence from organizational culture differences and there is an economic and infrastructural gap between the countries in analysis that might interfere in the perception of problems gravity and solution attitude. A strategy to further elaborate on the current findings and improve the sample size of this study is the adoption of a mixed method approach with the creation of a questionnaire with close ended questions that can be sent to a larger poll of respondents, such as it was executed in Tong et al. (2017), with further hypothesis testing and statistical analysis to add value to the results.

An interesting research direction can be extracted from the Canadian podcast. Richard Markoff mentioned that the Bullwhip Effect is not affecting the supply chains as much as a phenomenon called Inventory Bounce. For future research, it will be relevant to incorporate the investigation about this phenomenon with the objective to study its nuances and relationship with behavior and culture aspects in the BWE.

This study provided indications of the relevance of national culture for improving supply chain coordination which opens doors to further research in the field. Although the Hofstede cultural dimensions theory is widely adopted in operations and supply chain management cultural studies, future research can explore other perspectives in dissimilar cultural behavior, such as the one presented in the GLOBE project (House et al. 2002).

6. Conclusion

The study has shown that it is paramount to understand cultural norms and values when developing supply chain relationship strategies. Business practitioners must be aware that trust, collaboration, information sharing, knowledge management and performance contribute to long-term and successful relationships between supply chain partners in individualist and collectivist cultures in different manners. Unexpected events bring more uncertainty to the relationships and require careful consideration to overcome the disruptions.

This inductive study achieved its objective to provide a framework of the relation between cultural differences and the BWE in large disruptions, fulfilling the gap of how different cultures behave in decision-making under dramatic circumstances. Moreover, the study supplemented the behavioral causes of the BWE literature by conducting a multiple-case study with interviews and podcasts, rather than the usual Beer Distribution Game methodology. The

COVID-19 pandemic is an exceptional case to study large disruptions and has a significant source of data to be explored. To reach more meaningful conclusions, future research will adopt the conceptual models and results from the coding process to conduct a deductive study, where hypotheses will be formulated and tested with a larger poll of respondents to quantify the current findings.

References

- Bhattacharya, R., and Bandyopadhyay, S., A review of the causes of bullwhip effect in a supply chain, *International Journal of Advanced Manufacturing Technology*, vol. 54, pp. 1245–1261, 2011.
- Bruccoleri, M., Cannella, S., and La Porta, G., Inventory record inaccuracy in supply chains: the role of workers' behavior, *International Journal of Physical Distribution & Logistics Management*, vol. 44, no. 10, pp. 796-819, 2014.
- Cannon, J., Doney, P., Mullen, M., and Petersen, K., Building long-term orientation in buyer-supplier relationships: The moderating role of culture, *Journal of Operations Management*, vol. 28, no. 6, pp. 506-521, 2010.
- Croson, R., and Donohue, K., Impact of POS data sharing on supply chain management: An experimental study, *Production and Operations Management*, vol. 12, no. 1, 2003.
- Croson, R., and Donohue, K., Upstream versus downstream information and its Impact on the Bullwhip Effect, *Systems Dynamic Review*, vol. 21, pp. 249–260, 2005.
- Croson, R., and Donohue, K., Behavioral causes of the bullwhip effect and the observed value of inventory information, *Management Science*, vol. 52, no. 3, pp. 323–336, 2006.
- de Almeida, M., Marins, F., Salgado, A., Santos, F., and Silva, S., Mitigation of the bullwhip effect considering trust and collaboration in supply chain management: a literature review, *International Journal of Advanced Manufacturing Technology*, vol. 77, pp. 495–513, 2015.
- Doetzer, M., The role of national culture on supply chain visibility: Lessons from Germany, Japan, and the USA, *International Journal of Production Economics*, vol. 230, 2020.
- Doney, P., and Cannon, J., An examination of the nature of trust in buyer-seller relationship, *Journal of Marketing*, vol. 61, no. 2, pp. 35-51, 1997.
- Duffy, R., and Fearnly, A., The impact of supply chain partnership on supply performance, *International Journal of Logistics Management*, vol. 15, no. 1, pp. 57-72, 2004.
- Eisenhardt, K., Building theories from case study research, *Academy of Management Review*, vol. 14, no. 4, pp. 532–550, 1989.
- Erumban, A., and De Jong, S., Cross-country differences in ICT adoption: a consequence of Culture?, *Journal of World Business*, vol. 41, no. 4, pp. 302–314, 2006.
- Forrester, J., Industrial dynamics—a major breakthrough for decision makers, *Harvard Business Review*, vol. 36, no. 4, pp. 37–66, 1958.
- Gehman, J., Glaser, V., Eisenhardt, K., Gioia, D., Langley, A., and Corley, K., Finding theory–method fit: A comparison of three qualitative approaches to theory building, *Journal of Management Inquiry*, vol. 27, no. 3, pp.284-300, 2018.
- Gioia, D., Corley, K., and Hamilton, A., Seeking qualitative rigor in inductive research: notes on the Gioia methodology, *Organizational Research Methods*, vol. 16, no. 1, pp. 15–31, 2013.
- Ha, B., Park Y., and Cho, S., Suppliers' affective trust and trust in competency in buyers: its effect on collaboration and logistics efficiency, *International Journal of Operations & Production Management*, vol. 31, no. 1, pp. 57–77, 2011.
- Haines, R., Hough, J., and Haines, D., A metacognitive perspective on decision making in supply chains: Revisiting the behavioral causes of the bullwhip effect, *International Journal of Production Economics*, vol. 184, pp. 7-20, 2017.
- Hofstede, G., *Culture's Consequences: International Differences in Work-Related Values*, Sage Publications, 1980.
- Hofstede, G., *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations across Nations*, second edition, Sage Publications, 2001.
- Hofstede, G., and Minkov, M., Long-versus short-term orientation: new perspectives, *Asia Pacific Business Review*, vol. 16, no. 4, pp. 493–504, 2010.
- Hofstede, G., Jan Hofstede, G., and Minkov, M., *Cultures and Organizations: Software of the Mind*, third edition, McGraw-Hill, 2010.
- Hofstede, G., Hofstede insights: compare countries. Available: <https://www.hofstede-insights.com/product/compare-countries/>, Jan 26, 2021.

- House, R., Javidan, M., Hanges, P., and Dorfman, P., Understanding cultures and implicit leadership theories across the globe: an introduction to project GLOBE, *Journal of World Business*, vol. 37, no. 1, pp. 3–10, 2002.
- Kaipia, R., and Hartiala, H., Information-sharing in supply chains: five proposals on how to proceed, *International Journal of Logistics Management*, vol.17, no. 3, pp. 377–393, 2006.
- Markus, H., and Kitayama, S., Culture and the self: Implication for cognition, emotion, and motivation, *Psychological Review*, vol. 98, no. 2, pp. 223-253, 1991.
- Mayring, P., Qualitative content analysis, *Forum Qualitative Social Research*, vol. 1, no. 2, pp. 1–28, 2000.
- Meredith, J., Building operations management theory through case and field research, *Journal of Operations Management*, vol. 16., no. 4, pp. 441–454, 1998.
- Miles, M., Huberman, A., and Saldana, J., *Qualitative Data Analysis: A Methods Sourcebook*, Sage Publications, 2013.
- Mouzas, S., Henneberg, S., and Naude, P., Trust and reliance in business relationships, *European Journal of Marketing*, vol. 49, no. 9-10, pp. 1016-32, 2007.
- Naor, M., Linderman, K., and Schroeder, R., The globalization of operations in Eastern and Western countries: unpacking the relationship between national and organizational culture and its impact on manufacturing performance, *Journal of Operations Management*, vol. 28, no. 3, pp. 194–205, 2010.
- Nienhaus, J., Ziegenbein, A., and Schoensleben, P., How human behavior amplifies the bullwhip effect. A study based on the beer distribution game online, *Production Planning & Control*, vol. 17, no. 6, pp. 547-557, 2006.
- Nisbett, R., Peng, K., Choi, I., and Norenzayan, A., Culture and systems of thought: Holistic versus analytic cognition, *Psychological Review*, vol. 108, no. 2, pp. 291-310, 2001.
- Pagell, M., Katz, J., and Sheu, C., The importance of national culture in operations management research, *International Journal of Operations & Production Management*, vol. 25, no. 4, pp. 371–394, 2005.
- Rong, Y., Shen, Z., and Snyder, L., The impact of ordering behavior on order-quantity variability: a study of forward and reverse bullwhip effects, *Flexible Services and Manufacturing Journal*, vol. 20, no. 1-2, pp. 95-124, 2008.
- Sarkar, S., and Kumar, S., A behavioral experiment on inventory management with supply chain disruption, *International Journal of Production Economics*, vol. 169, pp. 169-178, 2015.
- Spekman, R., Spear, J., and Kamuaff, J., Supply chain competency: learning as a key component, *Supply Chain Management*, vol. 41, no. 15, pp. 41-55, 2002.
- Sterman, J., Modeling managerial behavior: misperceptions of feedback in a dynamic decision-making experiment, *Management Science*, vol. 35, no. 3, pp. 321–339, 1989.
- Strauss, A., and Corbin, J., *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, Sage Publications, 1990.
- Tong, Y., Tan, C., and Teo, H., Direct and indirect information system use: a multimethod exploration of social power antecedents in healthcare, *Information Systems Research*, vol. 28, no. 4, pp. 690-710, 2017.
- Wu, D., and Katok, E., Learning, communication, and the bullwhip effect, *Journal of Operations Management*, vol. 24, no. 6, pp. 839–850, 2006.
- Yin, R., *Case Study Research: Design and Methods*, fifth edition, Sage Publications, 2014.
- Zotteri, G., An empirical investigation on causes and effects of the bullwhip-effect: evidence from the personal care sector, *International Journal of Production Economics*, vol. 143, no. 2, pp. 489–498, 2013.

Biography

Thais de Castro Moraes is a Ph.D. Candidate in the Department of Industrial Systems Engineering and Management at the National University of Singapore. Ms. Moraes holds a Bachelor of Science degree with *magna cum laude* in Mechanical Production Engineering from the Federal University of Ceará, Brazil. She has published in the International Journal of Productivity and Performance Management and national conferences. Her research interests include supply chain management, inventory policies, systems modeling, optimization and simulation.

Dr. Xue-Ming Yuan is an A*STAR SIMTech’s Research Scientist, Chairman of Mathematics Programme Advisory Committee, Singapore University of Social Sciences (SUSS), and adjunct Associate Professor at the National University of Singapore (NUS). He has published Journal of Applied Probability, Statistics Communications: Stochastic Models, Operations Research, European Journal of Operational Research, IIE Transactions, IEEE Transactions, etc. His research interests include supply chain analytics, intelligent forecasting system, data driven inventory optimization, stochastic models, and algorithms.