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In-Store Cold Chain Failures: Food Safety Considerations

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In-store temperature controlled distribution channels (i.e., in-store cold chains) are a retailing critical factor to ensure the safety of food products. Our study seeks to understand the role that access to standardized knowledge, in-store cold chain practices, and the interaction of those two have on the integrity of in-store cold chains. We develop a model to assess the impact of knowledge in preventing in-store cold chain disruptions, introduce the concept of latent failure (i.e., a nonidentified failure that allows for the unexpected deterioration of products ahead of their expiration date), and use a knowledge-based perspective to conceptualize how disruptions in the cold chain affect the safety and quality of food sold at retailers. We analyze a primary dataset generated over two years of field observations in four socioeconomically distinct urban neighborhoods using a partial least squares path model. Implications are discussed.

Keywords: Argentina, cold chain, food safety, food security, in-store logistics, retailing, service failure, urban environment

In-store supply chain management practices are crucial to achieve customer satisfaction (Bouzaabia et al., 2013; Rudolph et al., 2000). They serve to preserve the quality of the products, which in the food retail industry includes maintaining food safety standards and protocols throughout the channels of distribution. Food safety refers to an array of practices such as handling, storage, and preparation of foods that prevent foodborne illness (Osorio et al., 2013). Accordingly, in-store logistics addressing food safety often include the use of in-store cold chain services (e.g., display refrigeration units, stocking procedures of cold preserved products) as part of the protocols to ensure the adequate preservation of perishable food products such as dairy, produce, and meat products (Morelli et al., 2012).

Yet, in-store cold chains are often disrupted. A study assessing the performance of in-store refrigeration units of food retailers found that 70% of the collected temperature profiles were above safety thresholds (Corradini et al., 2011; Morelli et al., 2012). Inadequate practices by food retailers and poor design of the in-store equipment were deemed equally responsible for these observations (Morelli et al., 2012).

Furthermore, a 2013 United States Department of Agriculture risk assessment study also found that even when the temperatures of in-store refrigeration units were kept within the industry standard, the retailers' handling practices resulted in the products having temperatures above the recommended safety thresholds (Akingbade et al., 2013). Handling practices are generically understood as all of the in-store protocols and procedures, including selection and operation of in-store refrigeration units, related to keeping the temperature of all the products of the same type within a narrow and acceptable range.

Disruptions in cold chains in the food industry may arguably be among the most impactful type of disturbances in distribution channels because of their potential outcomes, both negative economic impacts and foodborne disease outbreaks (Stecke & Kumar, 2009). In terms of the overall financial impact of such disruptions, the annual cost of foodborne diseases in the United States (U.S.) alone has been conservatively estimated to be between US$14.1 billion (Hoffmann et al., 2012) and US$16.3 billion (Scharff, 2012). Beyond the economics, the annual reported health impact of foodborne diseases in the U.S. includes about 48 million people sick, 128,000 hospitalized, and 3,000 fatalities (Centers for Disease Control and Prevention, 2010).

Besides the nationwide immediate economic and social costs, in the long term, quality-related disruptions such as those in an in-store supply chain, can also damage the firm's reputation (e.g., Mitra & Golder, 2006), destroy customer-retailer relationships (e.g., Anderson & Sullivan, 1993; Walter et al., 2010), cause a loss of customers, and reduce the firm's market share (e.g., Zhu et al., 2007). Hence, risk assessing and planning for disruptions in supply chains can be considered critical components of the firm's strategy (Neureuther, 2009).

Cold chains are distribution channels that incorporate temperature control mechanisms to preserve the quality of the handled products (Likar & Jevšnik, 2006). These temperature control mechanisms use specialized knowledge to determine the ideal temperature range to best preserve the product's integrity. In the food industry, cold chains use food science and engineering knowledge to determine the temperature range that best preserves the safety of the food, as well as other desirable attributes such as nutritional value and sensorial characteristics (Corradini et al., 2010).

The knowledge on ideal temperature ranges is shared throughout the supply chain and informs the implementation of protocols to monitor and regulate the temperature of the products entrusted to the distribution channel (Farber et al., 2014). Although this shared knowledge informs the ideal temperature required for preservation of food safety and quality, it does not include instructions on how to keep food products within this temperature range, thus leaving the cold chain open to unintended mishandlings, in particular at the retailer level (Akingbade et al., 2013; Gunders, 2012; Morelli et al., 2012), as retailers are seldom included in recent industry guidelines and government regulations (Farber et al., 2014). This knowledge gap on food handling practices within the in-store cold chain might increase the impact of failures in the food industry.

The retail stores serve as the last line of defense between "internal" failures and "external" failures (Koufteros et al., 2014; Lawrence & Lorsch, 1967). This critical issue can be devastating if a failure results in sickness and, possibly, death of consumers.

Despite its critical role regarding food safety, the knowledge regarding proper practices of in-store cold chains is often taken for granted (Akingbade et al., 2013). A major component of this oversight is that in-store cold chain disruptions in the food industry seldom lead to product returns (Bouzaabia et al., 2013; Rudolph et al., 2000) and are not reported unless a safety violation is caught by a direct, often prescheduled, inspection (e.g., Pothukuchi et al., 2008).

In-store cold chain disruptions in the food industry may, unknown to consumers, shorten the product's shelf life (Akingbade et al., 2013). Thus, the product is rendered "good enough" to be eaten immediately (or shortly) after the disruption took place, but not safe (or adequate) to be consumed by the indicated "use by" date on the packaging (Corradini et al., 2010).

This type of incident, where the consequences of the disruption are unknown to the consumer, can be best described as a *latent failure* (i.e., a pre-existing failure not yet manifested such as handling conditions fostering accelerated microbial growth in food). Latent failures are often disregarded by consumers who do not have enough knowledge to assess their emergence or true impact, including the safety of their food.

Cold chain disruptions in the food industry, in particular those resulting in latent failures, can be described as *service failures*. Service failures occur when the expectations of customers are incongruent with the service they receive (Craighead et al., 2004) as, for example, contracting a foodborne disease from eating food that was sold as safe in a factory-sealed package or discovering that unopened food spoiled ahead of its expiration date.

Because of the direct link of service failure to food safety and health, the study of in-store food cold chains has been traditionally limited to the food science discipline and little has made its way into the supply chain realm. This article seeks to address this gap in the supply chain literature by assessing the management of in-store refrigeration units to explore if access, or lack of access, to standardized knowledge (a) may be related to in-store cold chain disruptions and (b) may also affect the in-store cold chain practices. This study also evaluates if in-store cold chain practices may be related to in-store cold chain disruptions.

To conduct this analysis we take into account the operational size of the store and the socioeconomic context of the area where the retailer is located. This approach serves to explore the transferability of knowledge and its value to help prevent the likelihood of an in-store cold chain failure leading to unsafe food products being offered to final consumers.

To this end, first, we discuss the concepts of quality, food safety, and cold chain failures. We introduce a model that allows us to explore the nature of the failure and discuses service failures including latent failures, latent negative impacts, and expedited failures. In particular, we examine the last link of the in-store supply chain: the retailer. We then derive theoretically driven hypotheses surrounding these antecedents, frame the empirical study, and present the results. Finally, we highlight the results and the contributions of this study followed by its limitations and future research directions.

QUALITY, DISRUPTIONS, AND SERVICE FAILURES

The American Society for Quality (n.d.) defines *quality* as "the characteristics of a product or service that bear on its ability to satisfy stated or implied needs." In supply chain management, the quality of a product or service can be viewed as the degree to which, after evaluation, the experienced quality equals or surpass the performance expectations of the consumer or user (Golder et al., 2012).

Well-planned and properly executed distribution channels that preserve product quality are unobtrusive and invisible to consumers, that is, they go unnoticed while ensuring that quality products reach consumers or users regardless of the many intermediaries, including retailers, that are involved. However, the dominant mind-set surrounding quality resides predominantly in manufacturing (Deming, 1986; Powell, 1995). In the food industry, this manufacturing-focused approach has resulted in lack of attention to its last link: the retailers' in-store supply chain practices (Farber et al., 2014).

In-store supply chain practices, such as those involving in-store cold chains, are crucial "safe-keepers" of quality in the food industry. As the last link in the supply chain of the food industry, food retailers have the responsibility to ensure the safety of the food products reaching the consumers and the reputation of manufacturers.

Cold Chain Failures, Disruptions, and In-Store Supply Chain Practices

Although services are inherently complex and highly individualized activities both in perception and production (Chow & Luk, 2005), their quality can be defined based on the degree to which the recipient of the service is satisfied with its performance or outcome (Walter et al., 2010).

When customers perceive that the service rendered is inconsistent with their personal expectations, then a service failure has occurred (Craighead et al., 2004). Hence, when the consumers' expectation to access safe food is not met, it can be said that a service failure took place (Rudolph et al., 2000). When the failure is related to inadequate temperature control services, then the source of the service failure is often found in the cold chain.

The literature on service failures typically dichotomizes failures into controllable and uncontrollable (Sivakumar et al., 2014). *Controllable service failures* are those that are preventable by the service provider with appropriate in-place procedures, such as standardization of in-store logistics including adequate in-store cold chain management protocols (e.g., refrigeration management) and / or explicit knowledge transfer mechanisms (e.g., mandatory training sessions for employees, availability of adequate written documentation describing procedures available to supply chain partners, and verification protocols as feedback resources).

Uncontrollable service failures are the result of unexpected failures that cannot be avoided or prevented by the service provider as, for example, blackouts or loss of knowledge as when an employee leaves the organization without properly documenting his / her critical knowledge (Dzekashu & McCollum, 2014; Wood & Reynolds, 2013). Regardless, controllable and uncontrollable service failures can equally lead to disruptions when a failure takes place.

Disruptions, in general, are characterized by unplanned events that interrupt the normal operations of distribution channels (Craighead et al., 2007; Habermann, 2009). Given the practical significance of disruptions, much research has studied the antecedents and impacts of traditional distribution channels (Kuwornu et al., 2009; Neureuther & Kenyon, 2009; Stecke & Kumar, 2009). For example, in a foundational work, Blackhurst et al. (2005) highlighted the global nature of modern-day supply chains and the inherent risk for disruptions while advancing issues related to supply chain disruption discovery, recovery, and redesign.

Craighead et al. (2007) studied distribution channels from a network perspective and concluded that although disruptions are unavoidable, proper supply chain design can mitigate the severity of these disruptions. Tomlin (2006) investigated supplier operational configurations as antecedents to supply chain disruptions and found that through holding a safety stock and various sourcing portfolio arrangements disruptions and their severity can be mitigated. Similarly, Sawik (2011) analyzed supplier selection under supply risk and derived an optimal selection model for disruption risk mitigation.

A commonality to all of these works is the premise that although disruptions in the supply chain are unavoidable, their impact and outcomes can be mitigated through knowledge and collaboration. Adequate knowledge can help to mitigate the impact of disruptions by providing the necessary protocols to overcome the disruption in a more efficient and / or expedited manner. Collaborations can reduce the burden or impact of the disruption by dispersing the effects through the different participants within the supply chain, making help more rapidly available or allowing for knowledge sharing / transfer (Easterby-Smith et al., 2008).

Framed by understandings that supply chain disruptions are unavoidable (Craighead et al., 2007) and the need to provide customers with good service (i.e., access to safe food), the food retail industry considers high volumes of perishable food waste as an indicator of adequate quality control within retail practices (Gunders, 2012). This perspective is reinforced by the theoretical interest in cold chain disruptions in the food industry that has traditionally focused on economic outcomes of upstream cold chain disruptions rather than retail-level service failure. This dominant theoretical framework, focused on the economic impact of damaged products after the disruptions (failures) in the supply chain, has directed only limited efforts to explore the nature of the disruption or mechanism to prevent it in the first place.

It has been argued that for a firm dealing with perishable products such as food, the traditional extraction of value of returned products may not be appropriate (i.e., Roth et al., 2008): disruptions (failures) in the cold chain are considered a total economic loss and not a procedual failure that could be improved through collaboration and knowledge. Furthermore, exceptions to this economic view have centered on the temperature range itself (not the handling practices), thus recommending even lower temperatures without assessing the reason why the temperature requirements were not followed before the failure (e.g., Gunders, 2012).

MOTIVATION FOR IN-STORE COLD CHAIN MANAGEMENT

Managing the in-store cold chain is an important extension to the supply chain as it reflects the last stage of product delivery (Gunders, 2012). Failures at the retail store level are costly as they are positioned toward the end of the value chain. By the time products arrive at the retail store, the full cost of production and distribution already has materialized. Yet the food retail industry considers large volumes of in-store food waste an indicator of good in-store operational practices (Gunders, 2012). Retailers' food waste is interpreted as the retailers having the knowledge to develop and implement strong internal quality control protocols to protect consumers (Gunders, 2012).

These in-store controls are focused on products' expiration and sell-by dates, packing integrity, and appearance, thus not considering the impact of inadequate in-store cold chain practices (Gunders, 2012; Morelli et al., 2012). Further masking the in-store cold chain problem is the consumers' confined ability of returning only grossly spoiled food to retailers. Therefore, only if the spoilage is self-evident when opening the packaging (Rudolph et al., 2000) is the food product returned to the retailer. This artificially reduces the number of claims received, giving a false impression of food safety (e.g., Bouzaabia et al., 2013; Rudolph et al., 2000).

Additionally, retailers' practices of addressing spoiled food returns with on-the-spot product replacement (Rudolph et al., 2000) rather than product recalls or changes of in-store cold chain protocols have served to preserve the problem. Furthermore, not all consumers are equally sensitive to food spoilage and its indicators (Corradini et al., 2010), further reducing the number of claims. In all, these elements have helped to create a knowledge gap that has resulted in in-store cold chain management practices not been properly researched and implementation of quality control protocols that are not always effective in ensuring food safety and quality for consumers.

Quality, Food Safety, and Cold Chains

Food quality is associated with many elements. Given its economic and social implications, food safety can be considered the foremost important quality attribute of a food product, along with its nutritional value (Osorio et al., 2013). Food safety includes all the knowledge and food-handling practices necessary to prevent the emergence of foodborne illness (Corradini et al., 2010; Osorio et al., 2013).

To ensure food safety, members of the food industry, mostly when handling perishable products (e.g., dairy, produce, and meat products), include temperature control services as a standard strategy to reduce spoilage rates and extend shelf life (Farber et al., 2014; Morelli et al., 2012). This mechanism relies on specific knowledge (i.e., optimal range of safeguarding temperatures) to preserve the food (Morelli et al., 2012) and ensure its safety (Corradini et al., 2010). Additionally, temperature control also serves to preserve the food's nutritional value, its physicochemical properties such as texture and color, and sensorial characteristics such as smell and flavor (Corradini et al., 2010; Vaclavik & Christian, 2014). The knowledge informing the temperature-controlled mechanisms defines the makeup of the cold chains as the use of the knowledge aims to prevent service failures and ensure the integrity of food products reaching consumers (Farber et al., 2014; Gunders, 2012; Morelli et al., 2012).

Cold chains consist of a series of concatenated procedures focused on controlling the temperature of the products entrusted to the supply chain channel (Likar & Jevšnik, 2006). Properly integrated, well-managed, and well-maintained cold chains should protect products all the way from the manufacturer to the retail establishment, including the last link of the in-store logistics practices: the in-store display refrigeration units (Morelli et al., 2012). Even the most robust cold chains are only as strong as their weakest link, thus many manufacturers and retailers alike take considerable steps to ensure the adequate implementation of procedures to prevent breaks in the cold chain.

Central to these efforts is the adequate use, sharing, and incorporation of knowledge throughout the chain (Grant, 1996; Levin et al., 1987; Teece, 1987). Knowledge is a necessary resource for organizational operations and, if it is unique, a potential source of competitive advantage (Kogut & Zander, 1996). As an intangible resource, knowledge can be shared and transferred to create and support high-performing networks of organizations (Dyer & Nobeoka, 2000). Cold chains rely on flows of shared knowledge traveling along with the product to ensure the preservation of the products' quality.

Figure 1 illustrates these theoretical relationships, including knowledge transfer flows. The model presumes that retailers' omissions of preventative planning in the context of preventable failures is due to a lack of knowledge and not purposeful actions. The right side represents the existence of knowledge while the left side represents the absence of it. Unattended controllable service failures (center) are a subset of failures that take place when there is knowledge but that knowledge is not implemented.

INSERT FIGURE 1 ABOUT HERE

Knowledge is crucial to sustain healthy supply chains, however, the development, transfer, and acquisition of knowledge are not simple tasks. Presence of knowledge in the form of instructions about the adequate food storage temperature ranges neither means that all retailers may know how to handle food to attain this goal (Gunders, 2012; Morelli et al., 2012) nor that the existent knowledge on handling practices includes all possible scenarios. This knowledge gap can result in large numbers of retailers keeping food products above the recommended safe temperatures (Akingbade et al., 2013; Morelli et al., 2012), translating into service failures that can make food products unsafe to consume (Tetro, 2014).

Controllable, or preventable, service failures (Sivakumar et al., 2014) rely on available and transferable explicit knowledge to enact pre-emptive action plans to provide the adequate delivery of services (see left side of Figure 1). If this knowledge is not transferred and / or assimilated, the resulting knowledge gap may hinder the prevention efforts altogether (Hurt & Hurt, 2005).

The scenario where a preventable problem may not be avoided because of a situation where the necessary knowledge cannot be transferred and / or assimilated opens a theoretical space to explore unattended controllable service failures (the dark shaded area in the middle of

Figure 1). Hurt and Hurt (2005), in a 10-year study about transferring managerial and operational practices in the food retail industry, described some examples where the knowledge existed but knowledge transfer difficulties prevented successful food retail operations. These problems complicated the development of plans to prevent foreseeable service failures.

Differences in managerial practices and cultural contexts across organizations are also present within organizations across the different operational areas or departments: the lack of standardization and documentation procedures were deemed responsible for these difficulties (Hurt & Hurt, 2005). Furthermore, they also identified substantial difficulties when transferring knowledge across organizations embedded within different socioeconomic contexts (i.e., variations across the neighborhoods where the retailers operate) as they resulted in variations in the customer and employee base that required different local operational protocols. Finally, they noted as one of the biggest problems the existence of knowledge that was taken for granted and was omitted when transferring critical operations. All of these conditions caused preventable problems that were not addressed until they became self-evident.

An indication of the knowledge transfer problem in the in-store cold chains in the food retail industry can be found on the labels of many food products where, by law, the required storage temperature is included, making this knowledge publicly shared information. Despite these efforts, numerous observations of deviations of actual temperatures from safety thresholds have been recorded (Corradini et al., 2011; Farber et al., 2014; Gunders, 2012; Morelli et al., 2012). The gravity of this situation is highlighted by recommendations to keep food products even colder, thus not acknowledging that the problem is the in-store protocols of keeping food cold in the first place (e.g., Morelli et al., 2012).

The third type of failure, an uncontrollable or nonpreventable service failure (Sivakumar et al., 2014), takes place when the necessary knowledge to anticipate their triggers and / or deal with the aftermath of the failure does not exist at all as it has not been developed yet (see right side of Figure 1). Examples of these knowledge gaps may include lacking local ability to anticipate natural disasters (e.g., not anticipating an historically high level of local flooding), lacking of systems to monitor the status of the retailer's utilities and alerting of in-store infrastructure failures (e.g., learning about an in-store refrigeration unit warming up over the weekend), and the inability to anticipated local social failures (e.g., learning about a forthcoming terrorist act in the area preventing regular operations). Communalities to these triggers are their local nature, the element of surprise, and the subsequent lack of operational knowledge to forecast the problem and / or deal with the aftermath.

Thus, a major distinction between unattended controllable (preventable) and uncontrollable (nonpreventable) failures is the existence of available knowledge to help learn about the upcoming failure and / or deal with its consequences afterwards. But, regardless of the type of failure, the outcome is a service disruption (i.e., an in-store cold chain failure). Service disruptions are sudden failures that may interrupt the normal operations of the supply chain resulting in an expedited failure or a latent failure (see the lower left section on Figure 1).

Expedited failures are disruptions leading to self-evident damage to products. These damaged products are often considered waste and accounted for as part of the regular operations of the retailer (Gunders, 2012). Given the immediate impact and notoriety of these disruptions, they may present opportunities for learning (i.e., development, transfer, and appropriation of standardized knowledge). If the disruption takes place because of an unattended controllable failure (preventable), efforts will seek to address issues of knowledge transfer and knowledge appropriation. When the disruption takes place after an uncontrollable failure (nonpreventable), efforts will seek to develop new knowledge capable of preventing or controlling future occurrences of the same nature.

Latent failures are disruptions that damage the product in ways that are not immediately self-evident. They are equally likely to be trigged by a controllable or an uncontrollable failure (see Figure 1). A latent failure only presents itself after a triggering event takes place. This triggering event may be internal (e.g., safety audit, regular quality control inspections, nutritional value inspection), or external (e.g., industry inspection, consumer complaints, government audit).

In the food industry, latent failures often originate from disruptions in the cold chain that occur at the retail level such as in-store display refrigeration unit management (Corradini et al., 2011; Farber et al., 2014; Gunders, 2012; Morelli et al., 2012). As there is a lack of a self-evident direct relationship between the original disruption in the supply chain and the latent failure, the latent failures seldom prompt the development or assimilation of knowledge, as is the case with other types of disruptions as previously discussed.

The latent nature of this type of failure does not alert the consumer, who ultimately may accept the failure as normal. Products may have been in operational condition when delivered or, in the case of the food industry, safe to be eaten upon delivery, yet the service life of the product may have been shortened as a result of the failure. In some cases, customers may even assume this level of service to be normal and that the problem lies with the product itself or with the manufacturer and not with the in-store product handling practices.

A Knowledge-Based View of the Firm with Food Distribution Channels

Food safety requires knowledge that can be easily shared across members and partners of the cold chain (e.g., from manufacturers, distributors, and retailers to consumers including intermediary delivery services) and operationalized (Gunders, 2012). Without adequate knowledge, food might not be properly handled through the distribution channels and become unsuitable for consumption. Prevention of in-store cold chain failures and the mitigation of in-store cold chain disruptions are a knowledge-driven phenomenon whose antecedents are better analyzed from the perspective of the knowledge-based view of the firm (Kogut & Zander, 1996).

The knowledge-based view introduces an approach in which the primary rationale for a venture to exist is the creation, transfer, and application of knowledge (DeCarolis & Deeds, 1999; Demsetz, 1991; Grant, 1996; Nonaka, 1994). In the food safety context it proposes that access to unique knowledge serving to preserve the quality of products is essential to attain repeated customers and to reduce costs (Zhu et al., 2007). Therefore, knowledge that helps to prevent supply chain disruptions, hence preserving the product's quality outside of the manufacturer's control (i.e., in-store logistics), may be understood as a competitive advantage for members of a distribution channel. This competitive advantage at the retail level means less service disruptions and lower volumes of product waste, enhancing firm reputation and reducing operational costs.

Blackhurst et al. (2011) found that intangible assets, such as knowledge, can increase supply chain *resiliency*, that is the supply chain's collective efficacy to mitigate disruptions. Martens et al. (2011) proposed that a firm's collective knowledge, by way of employee training, can increase supply chain security, thus increasing the firm's disruption mitigation capabilities.

Van Landeghem and Vanmaele (2002) advanced an implicitly leveraged knowledge-driven view of supply chain planning, wherein they proposed a new approach that takes into account information for planning purposes. For a channel to be strategic in its quality preservation objectives, it needs to "create a rare, valuable, and inimitable source of knowledge and coordination" (Hult et al., 2004, p. 243). This action by its nature requires "the coordinated efforts of individual specialists who possess many different types of knowledge" (Grant, 1996, p. 112).

Access to Knowledge

Extant research has examined retail-level cold chain handling practices and have found that although most food retailers are familiar with the need to monitor and preserve the in-store cold chain, very few keep the temperature of their refrigeration units (Morelli et al., 2012) and / or their products (e.g., Akingbade et al., 2013; Hurt & Hurt, 2005; Likar & Jevšnik, 2006) within the recommended standards. These findings further suggest that operational understandings in the food retail industry presume that the use of in-store refrigeration units is enough to preserve the in-store cold chain, thus not considering the knowledge requirements to adequately select and operate these refrigeration units as part of the in-store cold chain practices (e.g., Akingbade et al., 2013; Morelli et al., 2012).

As a result of this lack of clarity about the value of operational knowledge, in-store cold chain practices have gone unattended. In separate studies, 70% of the collected temperature profiles of refrigeration units were above safety thresholds (Morelli et al., 2012) and, even when the refrigeration units had an adequate temperature, the unique in-store cold chain handling practices of each retailer have kept the food available to consumers at temperatures above the recommended safe points (Akingbade et al., 2013). These reports also found that food handling practices are internally consistent at the store level, yet different from store to store. Therefore, it can be inferred that standardizing knowledge in the food retail industry that is shared across local stores within a chain and / or from headquarters to its subsidiaries (Hurt & Hurt, 2005) is not universally available throughout the industry (Akingbade et al., 2013; Morelli et al., 2012).

Accordingly, we suggest that access to critical operational knowledge that allows for proper operation of in-store cold chains might be treated by members of the industry as a competitive advantage shared only under constrained conditions. We further suggest that this access to standardized knowledge, when present, might serve to mitigate disruptions in the in-store cold chain.

Thus, we advance the idea that retailers that belong to well-established supermarket chains that have well-documented operations and guidelines are more likely to have access to adequate knowledge in the form of standardized operational knowledge. Subsequently, we propose that access to this standardized knowledge results in better management of the in-store cold chain allowing for fewer disruptions, where these disruptions are understood as smaller temperature discrepancies from industry-recommended safety thresholds. Hence, we advance the following hypothesis:

HYPOTHESIS 1: A firm's access to adequate standardized knowledge, represented by the firm's membership in a supermarket chain, negatively impacts the likelihood of an in-store cold chain disruption.

Handling Practices

Access to standardized knowledge, as previously described, is not enough to prevent a cold chain disruption. Available knowledge needs to be consistently applied to help prevent disruptions in the in-store cold chain. Handling practices, including protocols for product shelving and preservation inside the in-store refrigeration units (as well as selection and maintenance of refrigeration units), are at the core of the knowledge implementation practices of in-store cold chains (Morelli et al., 2012).

Handling practices, as implemented knowledge, can be adequate or inadequate. Adequate handling practices are consistent in their implementation thus providing uniform outcomes. This means that similar products will be kept within the same temperature range with very little variation from package to package. Conversely, inadequate handling practices may result in broad temperature variations across packages of the same products at the same location.

Studies have shown that handling practices outside of the manufacturer's control can negatively affect the quality of products available to consumers (Endrikat et al., 2010; Garrido et al., 2009; Gormley et al., 2010; Hoelzer et al., 2011; Morelli et al., 2012). In a study sponsored by the U.S. Food and Drug Administration, Kendall et al. (2003) found that retailers' mishandling practices may result in a significantly large negative impact on local food safety. Accordingly, in-store cold chain disruptions significantly increase the risk of foodborne illnesses.

Furthermore, Pothukuchi et al. (2008) established that retailers' handling practices are directly responsible for significant violations of food safety protocols. Similarly, Corradini et al. (2010) estimated that inappropriate in-store management practices, including operations of in-store display refrigeration units and inventory management, put consumers at a higher risk of foodborne diseases, as retailers systematically disrupt in-store cold chains while selling products close to or after their expiration dates. In another study, Aiello et al. (2012) modeled the potential deterioration of perishable goods due to temperature fluctuations within a cold chain showing the negative effect of temperature abuse on quality and illustrating the relevance of adequate handling practices to prevent cold chains disruptions.

Overall it can be assumed that adequate in-store cold chain handling practices ensure the reliability of the in-store cold chain services by helping to keep the temperature of all products of the same kind within a narrow temperature range. It should be noted that this measurement does not consider whether the temperature is adequate / proper but rather whether it is consistent across all packages. Thus, we suggest the following:

HYPOTHESIS 2: The better a firm's product handling practices, represented by the temperature variations across samples of the same product at the same retailer, the lower the likelihood of in-store cold chain disruptions.

Combinative Capabilities

When combined, *access to knowledge* (i.e., to know what to do) and *standardized handling practices* (i.e., to have uniform operations) are more effective in reducing disruptions in the in-store cold chain than either one independently. This interaction takes place as access to knowledge enhances the quality of the food retailer' standardized handling practices, although standardized handling practices present the food retailer with the ability to better identify in-store cold chain disruptions, hence opening the possibility of creating new knowledge in the process.

It is worth reiterating that *knowledge* herein does not refer to the awareness of the optimal food storage temperatures. Rather, it refers to the operational practices that each retailer may develop to ensure that products, in general, are kept at the recommended temperatures (Akingbade et al., 2013). Standard practices refer to the replicability of procedures that ensure that each individual unit is treated in a way that guarantees the whole lot is kept at the same temperature.

Having the capability to create new insights from common knowledge and use this newly developed knowledge to improve standardized operations is referred to as "combinative capabilities" (Kogut & Zander, 1992, p. 391). Combinative capabilities can become a sustainable competitive advantage if established as part of the firms' quality maintenance strategy, a critical process of the firm (Naso et al., 2007). Consequently, we argue that the in-store cold chain's ability to deliver quality is rooted in the food retailer's ability to leverage the existing knowledge within its network (i.e., other members of the retailer's chain) and bring it inside its boundaries to improve its own operations.

Essentially, firms operating in temperature-controlled supply chains must exploit the benefits derived from the appropriation of knowledge flowing within their network for the firm to generate a return in direct proportion to the value of the absorbed knowledge (Grant, 1996; Levin et al., 1987; Teece, 1987). In effect, to facilitate the internal transfer of knowledge, routines and procedures that lead to a collective "know-how" should be identified and engaged.

Thus, we propose that the downstream intermediaries in a distribution channel (i.e., retailers) collaborate (Hurmelinna-Laukkanen & Ritala, 2010) with upstream members of the cold chain (i.e., headquarters). The downstream intermediaries will be able to leverage and apply the collective knowledge of the chain and, subsequently, the likelihood of in-store cold chain failures will be reduced. Consequently, we advance the following two hypotheses:

HYPOTHESIS 3: Access to knowledge positively impacts the in-store cold chain handling practices of a food retailer.

HYPOTHESIS 4: Access to knowledge interacts with the in-store cold chain handling practices negatively impacting in-store cold chain disruptions (the stronger the interaction, the less likely the disruption).

Socioeconomic Context

Not all environments are equal. The average income of residents within neighborhoods and their educational level influence retail store availability in the area as well as the quality of the retail services to be found there. Alwitt and Donley (1997) found that poorer zip code areas in the U.S. City of Chicago have fewer and smaller retail outlets than nonpoor areas, including fewer supermarkets, banks, and large drug stores. Corradini et al. (2010) found that in-store cold chain practices were different across neighborhoods, yet were consistent overall inside each neighborhood.

Looking at food retail stores in the U.S. City of Detroit, Pothukuchi et al. (2008) established that food safety code compliance by food stores varies across neighborhoods. Worst practices prevailed in low-income neighborhoods and communities that were predominantly African-American. Consequently, we suggest that analysis of in-store cold chain practices need to account for the socioeconomic status of the neighborhood where the store is located.

Retailer's Operational Size

In general, retailers with large operations are more likely to have implemented protocols and controls to manage their volume of activities. Conversely, small retailers are less likely to rely on institutionalized protocols and so base their monitoring procedures on direct interactions and personal supervision (Osorio, 2014). Furthermore, small retail operations are easier to initiate and operated as an independent organization compared with starting and managing a large retail operation as an independent operator. Therefore, we suggest that the analysis of in-store cold chain practices needs to account for the size of the food retailers included in the research.

EMPIRICAL STUDY AND METHODOLOGY

The data for the empirical portion of this article were gathered on site throughout the City of Buenos Aires, Argentina over a period of two years (November 2009 to November 2011). The selection of the different retailers included in the study was done through a stepwise process that included the following stages.

First, using governmental census data, four distinctive neighborhoods representing low, middle-low, middle, and high socioeconomic status were identified within the city. The four neighborhoods, namely San Cristóbal, Monserrat, Almagro, and Recoleta, respectively, were selected based on the similarity in zoning policies. They share minimum boundaries but are far enough apart to control for the flow of customers.

As census data did not include average household income per resident, property values for each neighborhood were combined with the data in Table 1 to identify the dominant socioeconomic status of each neighborhood. To verify that the neighborhood selection and the socioeconomic categorization of the neighborhoods were adequate, additional ethnographic observations were performed in each one of the four target areas. The selection of neighborhoods served to control for the socioeconomic context of the retailers and account for service variations resulting from the socioeconomic attributes of the residents of the area.

INSERT TABLE 1 ABOUT HERE

Once the four neighborhoods were selected, all food retailers within each neighborhood were identified, recorded, and coded. This categorization was used to control for the number of food retailers available within each area and for the quality of their operations. This control was included to account for earlier findings in the literature that suggest an uneven spatial distribution of food retailers, that is, lower-income neighborhoods have been identified as underserved areas (Alwitt & Donley, 1997; Osorio et al., 2013).

To address the problem of inadequate governmental records on the presence of food retailers within each neighborhood, a systematic street-by-street canvass process was performed. This survey was done with teams of two persons to increase the accuracy of the information and ensure the safety of the surveyors.

The name, address, type of retailer (i.e., chain affiliation or independently owned), and the retailer's estimated size in square meters were recorded during the canvass. The estimated size of the retailers was cross-referenced with publicly available city property records that include lot dimensions (Buenos Aires City Government, 2013). The final geocoding was summarized in a database where all food retail stores and their characteristics within the four selected neighborhoods were included. Based on the canvassing and cross-referenced city records, a total of 286 stores were recorded and classified.

After the retailers within each neighborhood were identified, a second wave of surveyors was sent to visit each location. A total of four teams, each with two or three members, were involved in this task. The goal of this second inspection was to document in-store supply chain operations including surface temperature of the products. The data were later used to evaluate the food safety practices at each retailer, inform the proposed model, and help interpret the findings.

The observations were conducted using the ethnographic methodology of having the surveyors pose as customers at each location, thereby allowing observations to capture the retailer's habitual business practices. The surface temperature of five chilled products (i.e., two dairy products and three meat products) was taken and recorded. The evaluated food products were selected based on their reported implications in foodborne disease outbreaks, their widespread availability across local retailers within the targeted neighborhoods, the products' prevalent consumption across local residents, and the economic accessibility of the items, that is affordability (Osorio et al., 2013). The final sample resulted in observations of the in-store cold chains of 66.4% (*n* = 190) of the surveyed establishments over the two-year period.[1]

The length of the data recording period served to capture wide temperature changes due to substantial changes in environmental temperatures (i.e., the change of seasons). Table 2 provides a breakdown of the type of food used to assess the in-store cold chains, the acceptable temperature for each product, and the average temperatures captured during this study.

INSERT TABLE 2 ABOUT HERE

The temperature of at least three packages from each type of product was recorded at each store visit. The packages were selected from the same shelving space row and included the back-to-back first, second, and third product from each line. This sampling procedure allowed

[1] Food retailers were removed from the sample when any of these events occurred: there were no refrigeration units in the premises, they were closed when the surveyors visited the premises (when the closing seemed temporal a second visit was scheduled at an alternative time), none of the five target products were present, or when recording the temperatures may have resulted in unnecessary disturbance of the retailer's operations (e.g., reduced accessibility to refrigerators located behind a counter).

determining the effectiveness of the in-store handling practices by assessing (a) if the shelving procedures and managing of the refrigeration units helped to maintain all products within the same temperature range and (b) if the temperature of the products was within the recommended range, despite the environmental temperature.[2]

Before data collection was started, a preliminary pilot study was conducted to determine the thermometers' response times and conditions of use, optimal measuring time, distance to the package, and emissivity of materials and colors. The accuracy of the measurements during the pilot study was verified using adequate thermocouples. The use of infrared thermometers allowed for on-site rapid and noninvasive testing of the surface temperature of the product. The overall testing time per unit was less than 10 seconds, fast enough to obtain the measurement without altering the original temperature of the product or disturbing the operations in the store.

Dependent Variable

The dependent variable in this study is the size of the disruption and it is operationalized as the difference between the recorded surface temperature of the products kept in the display refrigeration unit inside the store and the industry-recommended storage temperature for that product. This was recorded in degrees Celsius (°C).

Because not all the stores carried all five products and, even when doing so, often there were no more than one item of each on the shelves, the final analysis only included franks and ham. This selection was consistent with similar studies assessing the operations and handling practices of in-store refrigeration units at food retailers that have used deli department products, in particular ham and franks, to capture the complexity of the operations (e.g., Akingbade et al.,

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[2] The surface temperatures were measured using handheld infrared thermometers (models Y-IRK and CZ-IR, ThermoWorks, Orem, Utah) previously calibrated and certified following U.S. National Institute of Standards and Technology guidelines.

2013; Morelli et al., 2012).

The choice of products was further informed by these additional considerations: both products have the same temperature requirements (2°C), they belong to the same department (i.e., the deli section), and they are traditionally kept in the same refrigeration unit (all of which were confirmed through on-site observations). These two products were merged in a single variable called *cold chain disruption*.

This procedure resulted in a full data set comprised of 164 records that included samples from all three store sizes (small, medium, and large), from both categories of stores (independent and chain), and across all four socioeconomically different neighborhoods (high, middle, middle-low, and low income). To capture this, we defined the following continuous variable:

$$Cold\ Chain\ Disruption_{j,k,l} = Surface\ Temperature - Industry\ Recommended\ Temperature \qquad (1)$$

where $j = 1, \dots, 164$ represents the recorded temperature, $k = 1, \dots, 3$ corresponds to each of the three store sizes, and $l = 1, \dots, 4$ stands for the four different types of socioeconomic environments where the retailers are located.

Independent Variables

Our first independent variable, access to knowledge, speaks to the access to knowledge available at the retail stores. We classified each retail establishment as belonging to a chain or as an independent affiliation (e.g., single proprietor).

Chain stores typically have standardized practices surrounding employment, materials management, and other operational practices (de Resende Melo et al., 2013). Field observation and open-ended interviews suggested that the formal infrastructure and standardization of operational practices within a chain retailer facilitates the transfer of standardized knowledge across all of the units of the commercial chain. The standardized knowledge in the chains was documented to be present as operational manuals, basic training, and stocking protocols. This shared knowledge implies better product handling practices and procedures to prevent cold chain disruptions (see Figure 2). Accordingly, we operationalized access to knowledge as:

$$Access\ to\ Knowledge_j = \begin{cases} 0 & if\ store\ does\ not\ have\ a\ chain\ affiliation \\ 1 & if\ store\ has\ a\ chain\ affiliation \end{cases} \qquad (2)$$

where $j = 1, \ldots, 164$ represents the recorded temperature.

INSERT FIGURE 2 ABOUT HERE

Handling practices correspond to the overall implementation of the acquired standardized knowledge including the selection and operation of in-store refrigeration units and the shelving procedures. Access to knowledge is a necessary, but not sufficient, condition to prevent disruptions in the cold chain. To be of value, knowledge needs to be appropriated (i.e., implemented) as part of in-store cold chain operations.

Thus, to reflect the adequate appropriation of standardized knowledge, we operationalized handling practices as the temperature differences between the consecutive (back-to-back) packages of the same product within the same in-store refrigeration unit. We argue that larger differences in temperatures between the packages signaled inadequate in-store cold chain handling practices (e.g., wrong choice of refrigeration unit, inadequate shelving, etc.). This approach serves to include, by proxy, events that may not be evident, yet are relevant to the preservation of the in-store cold chain (e.g., customers taking products out of the refrigeration unit, walking throughout the store picking other products, getting to the cashier and leaving them behind for the clerk to put back into the refrigeration unit, with the consequently warming of the product through the process). Accordingly handing practices were operationalized as:

$$Handling\ Practices_j = Deli_{front} - Deli_{back} \tag{3}$$

where $j = 1, \dots, 164$ represents the recorded temperature, $Deli_{front}$ is the surface temperature of the first product on the shelf, and $Deli_{back}$ is the surface temperature of the next product on the same shelf in the same line.

This served to measure the uniformity on operations at the store level where large values of the handling practices variable would suggest inconsistency in the operations within the in-store cold chain of the product, while small values will indicate a uniform operation. This assessment does not presume that any of the products is or is not within the recommended temperature range. Yet, it implies that the quality of the handling practices requires knowledge and documented practices to account for consistency in the operations. In all, we posit that the larger the difference, the more inconsistent the practices appear to be and the higher the likelihood of a failure. Also, a larger difference may also indicate a low level of knowledge.

As access to knowledge and handling practices are related, there is also an interaction between the two that needs to be considered. This is a combinative capability understood as the ability of a firm to use and apply the knowledge available to it. To operationalize this measure in our context, we create the following variable:

$$Combinative\ Capabilities_j = Access\ to\ Knowledge_j \times\ Handling\ Practices_j \tag{4}$$

where j = 1, … , 164 represents the recorded temperature.

This interaction integrates the two different dimensions related to access to useful knowledge and the adequate use of this knowledge. Based on this variable, we can then gauge the extent to which the retailer is leveraging, or combining, these practices to facilitate maintaining adequate temperatures in the in-store cold chain.

Control Variables

To properly account for external factors that can also affect the likelihood of an in-store cold chain disruption, we included several control variables in our model. First, we control for the socioeconomic background of each store. Socioeconomic background refers to the socioeconomic status of the neighborhood where retailers are embedded and conduct their operations.

The categorization of neighborhoods was informed by the assessment of multiple variables that gauge the extent of an area's socioeconomic position namely: population density, unsatisfied basic needs (i.e., households that present at least one of these five conditions: (a) lack of access to a permanent residence, (b) poor sanitary conditions in the household including lack of toilets, (c) overcrowded household quarters, (d) presence of at least one school age child not attending to school, (e) households where the head of the household and main income provider has less than a third-grade education), health coverage, literacy, higher education (i.e., having at least a bachelor's degree or equivalent), and households without refrigeration units. The integration of this array of variables into a single element (i.e., low, middle-low, middle, and high economic status) served to determine the overall socioeconomic status of the neighborhoods where the stores were located. This integration into a single variable was done to account for the high correlation among the multiple elements that could have led to significant econometric issues.

Additionally, during temperature data collection, we controlled for the size of the store, measured by the area occupied by the operations of the retailer in square meters. The size reflects the extent of the operations of the retailer interpreted as the number of employees required to run the establishment given the space available. The size categorization was also informed by field observations.

The ethnographic and field work served to determine that the larger the store the more likely that in-store retail practices were in compliance with regulations, thus directly addressing the controllable failures. Conversely, smaller stores were more likely to leave unattended the controllable failures. Then we accounted for the competition in the area of each store location by looking at the proportion of chain stores to nonchain stores. All chains operate as national chains, even when they are international brands.

Empirical Model

The purpose of this study was to identify the elements that may predict the presence of service failures of in-store cold chains. To achieve this goal, we gauged the impact that access to knowledge and consistence of operations may have on in-store cold chain practices. To ascertain these consequences, we have defined a continuous dependent variable that registered the difference between the observed and the recommended temperatures of the products inside the in-store refrigeration units. The final model can be expressed as:

$$Cold\ Chain\ Disruption_j = Handling\ Practices_{j,k,l} + Access\ to\ Knowledge_{j,k,l} + \left(Handling\ Practices_{j,k,l} \times Access\ to\ Knowledge_{j,k,l}\right) \quad (5)$$

where *j* represents the store, *k* indicates the socioeconomic conditions where the store is located, and *l* indicates the size of the operations of the retailer.

Following standard practices (Chin, 1998; Hair et al., 2012), the model only includes items with large loadings as part of the analysis. To aid our estimations, the SmartPLS software was used to run a variance-based structural equation model (SEM) using the partial least squares (PLS) method to test the primary hypotheses. Unlike other methods, the strength of the partial least squares algorithm is that it imposes no distributional assumptions (Temme et al., 2006).

To ensure the robustness of our results, significance levels of path coefficients were bootstrapped with a SmartPLS bootstrap 5000x routine. Resampling methods, including jackknifed statistics with a blindfolding routine, were implemented in this study with the SmartPLS software. As this type of analysis generates results that are generally strong, this approach has become a standard practice (Wong, 2013).

ANALYSIS AND RESULTS

To estimate the likelihood of an in-store cold chain disruption that went unnoticed (latent failure) as specified previously, we use SEM along with a SmartPLS bootstrap 5000x routine. This method uses maximum likelihood estimation to calculate the parameters in the model. Table 3 presents these results.

INSERT TABLE 3 ABOUT HERE

We first hypothesized that access to standardized knowledge would decrease the propensity of in-store cold chain disruption at the retail level. Accordingly, the coefficient for this relationship is positive and not statistically significant ($p < .459$), thus not supporting Hypothesis 1. This suggested that the mere access to standardized knowledge was not enough to prevent a disruption in the in-store cold chain.

We also suggested that access to standardized knowledge was to be influenced by the size of the store and the socioeconomic conditions of the neighborhood. The analysis suggested that the size of the store was related to the access to standardized knowledge ($p < .000$) but not so the socioeconomics of the neighborhood ($p < .386$). A close inspection to the data shows that the number of stores located in the high-income neighborhood was far greater (twice as many) than that of the low-income neighborhood (Table 4). Thus, even when not statistically significant, the type of neighborhood variable was related to store presence.

INSERT TABLE 4 ABOUT HERE

We also advanced in Hypothesis 2 that better firm product handling practices, represented by the temperature variations across samples of the same product at the same retailer, would result in a lower likelihood of in-store cold chain disruptions. Accordingly, we argued that the larger the difference in temperatures for each product (i.e., inadequate handling practices) at each store, the higher the propensity of an in-store cold chain disruption. Turning our attention to this relationship we see that it is negative and statistically significant ($p < .008$). This confirms the idea that the smaller the variation the better the odds of preventing a failure in the in-store cold chain. Thus, Hypothesis 2 is supported.

In Hypothesis 3, we suggested that access to standardized knowledge was positively related to in-store cold chain handling practices. That is, access to standardized knowledge would increase the likelihood of having better in-store handling practices. This relationship posits the idea that food retailers associated with a business chain will have well-documented, standardized practices that will be available to all members of the group. Conversely, independent operators may not have the benefit of the readily available protocols nor the vicarious learning of a collective, thus having a higher likelihood of disruptions as they would have to learn everything on their own.

This hypothesis was strongly supported ($p < .000$) suggesting the benefits of access to standardized knowledge to improve operations. Furthermore, this hypothesis was strongly related to the size of the food retailer indicating that large operations that may have many employees are more likely to have well-documented in-house protocols to aid in their operations.

We also considered that access to knowledge was not only informing adequate handling practices, but that there was also an interaction between the two. This was tested in Hypothesis 4 where we posited that this interaction was negatively correlated to in-store cold chain disruptions, where the stronger the interaction the less likely the disruption. This idea was also strongly supported ($p < .000$) suggesting an internal operational relationship that went beyond the mere accessing and implementing of knowledge. Figure 3 summarizes the tests of the cold chain disruption model.

INSERT FIGURE 3 ABOUT HERE

DISCUSSION AND IMPLICATIONS

We began this study with an overarching question: how does access to knowledge and the integration of knowledge facilitate proper cold chain practices? To respond to this question, we drew from literature surrounding supply chain disruptions, service failures, and cold chain preservation practices. The research literature suggests that although much research has been conducted to examine the antecedents of disruptions from the perspective of supply chain structure, little research has looked at the impact of service failures and their relationship to supply chain disruptions, in particular, in-store cold chain applications.

In the context of distribution channels that rely on temperature control services to preserve quality (i.e., cold chains), we found that the relevance of in-store cold chain logistics has not been properly addressed. Furthermore, we found that even less research has looked at the connection between access to knowledge and knowledge implementation to prevent service failures in temperature-controlled distribution channels at the retailer level.

Theoretical Implications

Because of its focus, our inquiry contributes to the food safety research in several ways. First, by considering the role of the in-store cold chain it highlights the importance of the last link in the supply chain, the retailer. In addition, by assessing the value of access to well-documented knowledge in the context of in-store cold chain disruptions, this inquiry brings forward the importance of implementing and documenting learning as part of the standard procedures of in-store supply chain practices. By including the type of retailers and the socioeconomic status of the neighborhoods, this inquiry also explores the relationship between food safety and the business environment.

The data suggested that low-income neighborhoods had fewer food retailers and a larger number of disruptions. Although not part of the original analysis, we suspect this is due to a lack of competition in the area studied resulting in low expectations of services by local consumers (Alwitt & Donley, 1997). This additional finding can serve to address issues of food security currently pressing our society (Osorio et al., 2013).

We contribute to the literature as follows. First, we suggest that higher levels of access to knowledge would increase the efficacy of the in-store cold chain operations, expressed by improved handling practices (Hypothesis 3: $\beta = 0.565$, $p < .000$) and subsequently would decrease the likelihood of a cold chain service failure (Hypothesis 2: $\beta = -0.347$, $p < .008$). We also suggest that these two conditions are not independent of each other but rather interact with each other, decreasing the likelihood of a disruption (Hypothesis 4: $\beta = -0.618$, $p < .000$). In so doing, we contribute to the literature on supply chain disruptions (Blackhurst et al., 2005), service failures in distribution channels (Craighead et al., 2004), and knowledge-driven cold chain management (Likar & Jevšnik, 2006).

We also suggested that access to knowledge *alone* would decrease the likelihood of a disruption, but we found that this was not the case (Hypothesis 1: $\beta = 0.081$, $p < .459$). This last finding, in the context of the other three hypotheses, suggests that access to knowledge is a necessary but insufficient condition to improve operations. Thus, by bringing forward the relevance of retailer in-store handling practices to preserving quality, we contribute to the literature on cold chain handling practices (Garrido et al., 2009; Morelli et al., 2012), retail-level risk mitigation strategies (Tomlin, 2006), and knowledge-driven approaches to cold chain disruptions (Likar & Jevšnik, 2006).

Managerial Implications

These results have several managerial implications. First, firms should establish strong knowledge standardization practices, including the identification and codification of knowledge, paired with mechanisms to properly and regularly implement this standardized knowledge to account for the ephemeral nature of knowledge and the frequent rotation of employees in the food retail industry. These efforts can lead to a substantial reduction in the likelihood of an in-store cold chain disruption.

Practices, such as temperature monitoring procedures and inventory rotation policies, should be implemented (e.g., Akingbade et al., 2013; Morelli et al., 2012). Next, and related to the previous point, firms should pay careful attention to the volatility of their temperature control practices. Not doing so can render the firm more likely to experience a cold chain disruption.

Finally, it is noteworthy that the higher incidence of in-store cold chain disruptions in lower-income neighborhoods can be attributed to a disproportionate presence of individually owned retailers with inadequate facilities and control practices. We suggest that the high number of independent business owners in these neighborhoods may be due to lower economic costs to start operations (e.g., cheaper, dated facilities, lower-quality equipment), less enforcement of regulatory controls (e.g., less frequent on-site inspections, fewer customer complains), and increased local demand for food products (e.g., high population growth rates of cities).

We also suggest that inadequate in-store cold chain practices and / or protocols may be in part due to inclinations to hire lower wage employees without adequate knowledge regarding the preservation of cold chains, magnified by a lack of correct operational understandings by the entrepreneurs themselves. This is often exacerbated by the inability to internalize knowledge. Thus, manufacturers may want to consider developing and encouraging training programs to help independent business owners in low-income neighborhoods implement adequate in-store cold chain practices to preserve the quality of their products.

Limitations and Future Research

Although we have made inroads into furthering the understanding of knowledge-driven antecedents of in-store cold chain failures, there is future work to be done. First, more specific knowledge practices should be studied, including adequate mechanisms for sharing the knowledge needed to preserve the quality of products as they travel along the cold chain.

Variables such as inventory management policies, expiration date ranges, and refrigeration protocols should also be further examined. Additionally, interactive effects between knowledge and other handling practice-related information should be examined. Finally, the external validity of these results should be tested in other industries in which perishable products are popular, such as the pharmaceutical industry.

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TABLE 1
Socioeconomic Factors Taken Into Account in Selected Neighborhoods in Argentina

Socioeconomic factors	Recoleta	Almagro	San Cristóbal	Monserrat
Size (kilometer^2)	5.9	4.1	2.1	2.2
Population density (inhabitants per kilometer^2)	160,000	130,000	46,000	40,000
Unsatisfied basic needs (%)	4	7.7	13.3	24.7
Health coverage (%)	86	78	72	67
Literacy (%)	93	91	90	90
Higher education (%)	37	22	15	18
Households without refrigeration units (%)	1.7	3.1	5.2	11
Socioeconomic status typology	high	middle	low	middle-low

Sources: Instituto Nacional de Estadística y Censos de la República Argentina (2001).

TABLE 2
Products Observed and Their Acceptable and Recorded Temperatures

Product	Acceptable temperature (°C)	Average recorded temperature (°C)	*SD* (°C)
Custard	5	8.07	3.49
Franks	5	7.61	3.89
Ground meat	2	4.76	2.66
Ham	5	9.15	3.88
Yogurt	8	8.49	4.00

Note: °C indicates temperature in degrees Celsius.

TABLE 3
Model Values

Hypotheses	β	Sample mean	*SD*	*t*-value	*p*-value
1. Access to knowledge → Cold chain disruption	0.081	0.085	0.110	0.737	.459
2. Handling practices → Cold chain disruption	–0.347	–0.353	0.130	2.670	.008**
3. Access to knowledge → Handling practices	0.565	0.559	0.092	6.113	.000***
4. Interaction: Access × Handling → Cold chain disruption	–0.618	–0.629	0.129	4.806	.000***
Control					
Environment → Access to knowledge	0.569	0.573	0.058	9.829	.000***
Environment → Handling practices	0.075	0.083	0.094	0.797	.426

** $p < .01$; *** $p < .001$.

TABLE 4
Summary of the Presence of Retailers Across Neighborhoods

Neighborhood income / store size	Number of chain stores	Number of independent stores	Store number subtotals
High income subtotals	**32**	**63**	**95**
large store	18	0	18
medium store	14	46	60
small store	0	17	17
Middle income subtotals	**11**	**15**	**26**
large store	3	0	3
medium store	8	15	23
small store	0	0	0
Middle-low income subtotals	**9**	**41**	**50**
large store	5	2	7
medium store	4	38	42
small store	0	1	1
Low income subtotals	**12**	**30**	**42**
large store	4	2	6
medium store	8	27	35
small store	0	1	1
Grand totals	**64**	**149**	**213**

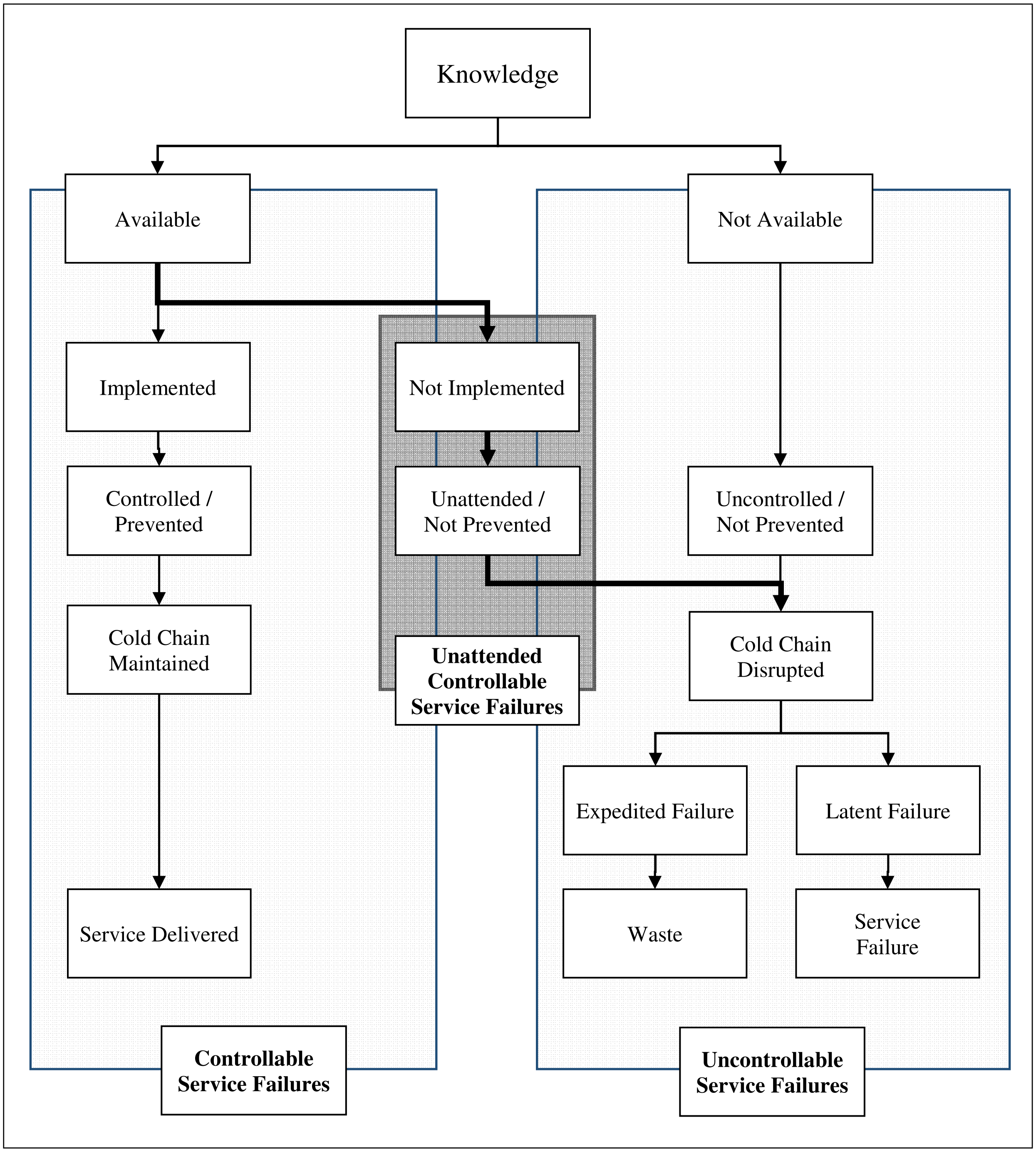

FIGURE 1 Service paths to customer satisfaction.

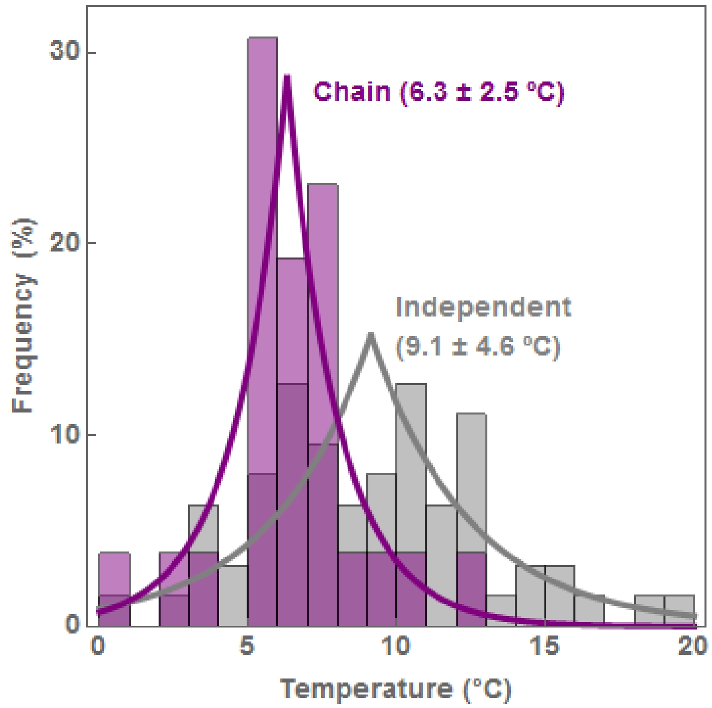

FIGURE 2 Effects of higher quality food handling practices by the chains. *Note:* This graph illustrates the higher quality of food handling practices by the chains (*SD* 6.3 ± 2.5ºC) compared to those of the independent retailers (*SD* 9.1 ± 4.6ºC) in our sample. Chains present colder temperatures in degrees Celsius (ºC) and lower standard deviations (*SD*) thus keeping products safer, even when not in full compliance with industry standards (cf. Corradini et al., 2010). In contrast, independent retailers are more likely to have higher temperatures and larger standard deviations within their operations, thus subjecting food to more extreme thermal abuse that renders products unsafe for consumption at higher rates.

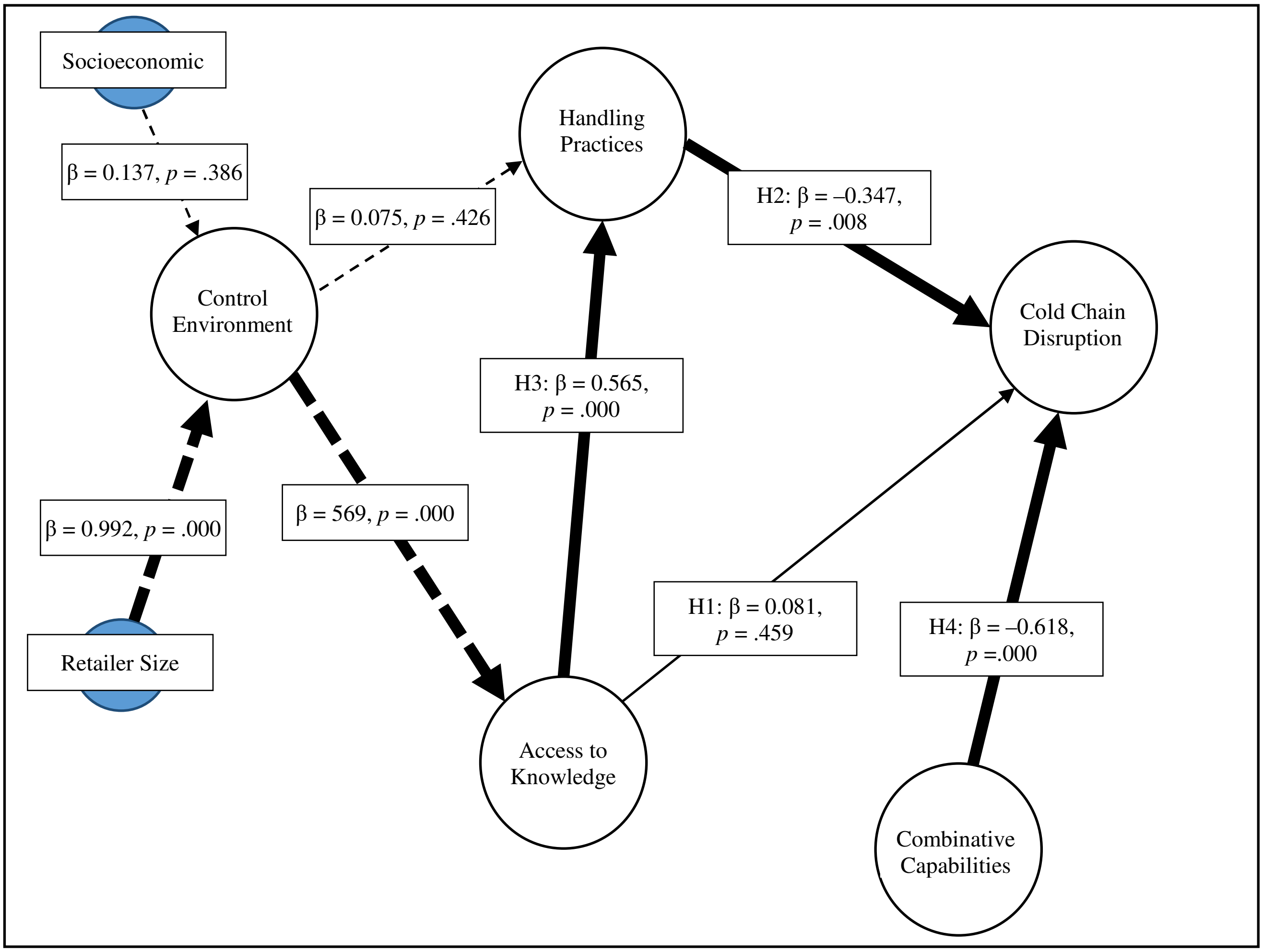

FIGURE 3 Cold chain disruption model. *Note:* Solid lines indicate hypotheses. Thick solid connecting lines indicate accepted hypotheses. Thin solid lines indicate rejected hypotheses. Dotted lines indicate the path of control variables. Thick dotted lines indicate statistically significant paths. Thin dotted lines indicate paths not statistically significant. Boxes on the top of dotted lines are test values of control variables.