2016 Top Markets Report Cold Chain

Overview and Key Findings

Introduction

The development of cold chain systems is a force multiplier that can generate exports and open new markets over multiple sectors over an extended period, rather than a one-off export transaction that can be quantified simply as an export success. U.S. businesses understand the need for viable and efficient cold chain systems; they spend hundreds of millions of dollars each year to build and maintain both cold storage and transportation systems, which allow U.S. businesses to flourish. Export promotion and trade policy agencies should focus on the development of international cold chains through improved regulatory environments, increased skill level of workforce and encouragement of infrastructure investment, thereby promoting the benefits of U.S. services.

Cold chain systems are crucial to the growth of global trade in perishable products and to the worldwide availability of food and health supplies. Each year, billions of tons of fresh food products and millions of dollars' worth of U.S. exports are lost due to poor cold chain systems in developing markets. The World Economic Forum lists food crises as fourth on its top global risks of highest concern for the next 10 years.[1] Globally, billions of dollars are spent on improving agricultural processes to create higher food yields, but the fact that nearly half of all food never makes it to a consumer's plate is largely ignored.[2]

Global losses in the food industry total more than $750 billion annually.[3] These losses primarily result from lack of proper facilities, improper food safety handling procedures and insufficient training for those personnel working in the cold chain. Additionally, over $260 billion of annual biopharma sales are dependent on cold chain logistics to ensure the efficacy of their products.[4]

The concept and technology for controlling the temperature of sensitive products has been well-established for decades. The development of cold chain systems, especially in terms of government policy, however, is a fairly new concept. Cold chain systems can most aptly be viewed as a business function in a global value chain rather than as an industry. As a business function, they encompass activities and processes that span several industries and support the exports and sales of numerous other industries. The United States has a competitive advantage in cold chain systems derived from some of the most advanced technologies and logistics management services in the world.

Key Findings: Top Markets and Methdology

This report assesses the global market for U.S. manufacturers and service providers in refrigerated supply chains (cold chain). The focus is primarily for U.S. government (USG) decision makers to develop sound policy as well as to assist U.S. companies searching for market opportunities.

Figure 1: Projected Cold Chain Export Markets (Bold indicates case studies included in report)

1. Singapore	**5. Japan**	**9. Australia**	**13. Mexico**	**17. Vietnam**
2. United Arab Emirates	6. Germany	**10. China**	**14. Thailand**	18. Colombia
3. United Kingdom	7. Canada	11. Poland	**15. India**	**19. Kenya**
4. Netherlands	**8. Malaysia**	12. South Africa	**16. Indonesia**	**20. Brazil**

The report details the basis for understanding the market and developing industry and export promotion strategies. It is driven by developments in supply chain technology and its many linkages to other industry sectors and potential exports of services and manufactured goods for the cold chain area itself and for other sectors dependent on the systems.

The report assesses market opportunities in 20 countries, drawing from well-known World Economic Forum/World Bank rankings, business criteria for selecting locations for investment and private sector estimates of business potential. The methodology section sets out regional assessments of the markets for these indicators and then examines individual markets in more depth. Case studies were developed for 11 countries chosen based on interest expressed by government or private sector representatives to the ITA's Supply Chain Team.

Ultimately, the report finds that there are significant opportunities for growth of U.S. cold chain services in key markets. These opportunities may not be quick or easy to achieve, but they represent a potentially strong long-term payoff for U.S. business.

U.S. businesses engaged in international cold chain activity assess markets against specific criteria when selecting locations for expansion. The four primary criteria, according to industry sources, include the governmental regulatory environment, whether there is a trainable skilled labor force, the infrastructure environment and the potential demand within the country or region.

Government/Regulatory

The first aspect that U.S. industries consider when looking at a new market is the regulatory environment of the country. In particular, U.S. industry looks for a stable government with transparent policymaking plus technical regulations, standards and procedures for assessment of conformity that are non-discriminatory and based on relevant internationally recognized best practices. Legal frameworks that allow companies to resolve legal disputes and challenge regulations are essential when identifying potential export markets.

Labor Force

Another important aspect for market decision-making is the quality and skill level of the potential work force in the market. Industry must have the capacity to train and develop the talent and the management required to run an efficient supply chain operation.

Infrastructure

The infrastructure within a country is another key aspect in a company's selection of export markets. Electricity and IT infrastructure must be sufficient to support logistics operations. Transportation infrastructure must be capable of supporting the reliable distribution of a product within the country or region without excessive delays. The International Association of Refrigerated Warehouses has noted a strong correlation of cold storage capacity to a country's transportation score in the World Economic Forum's Transport Index.[5]

Demand

Finally, the demand within a country must be considered. The potential size of the market will depend on consumer needs, the number of consumers in the country, products produced and demanded by the market, as well as the level of development within the market.

When determining which global markets policy-makers should target for export promotion and trade policy activities, it is important to account for the primary decision-making criteria of U.S. businesses engaged in the cold chain market. In this report and the case studies that follow, the criteria for evaluating markets was based on the four specific aspects of *Government/Regulations*, *Labor Force*, *Infrastructure* and *Demand*. These are reflected in the report's scorecard and country case studies.

The scorecard for this report is derived from the Global Competitiveness Index 2015-2016 created by the World Economic Forum for their Global Competitiveness Report.[6] By using this competitiveness index, a cross-country analysis based on these market evaluation criteria is possible. Particular aspects of the index were used to represent the primary criteria that industry indicated as a priority in market selection.

The scorecard assigns a numeric value to each of the criteria on a scale of 1 to 7, with 7 being the highest score in a particular category. The scorecard is color-coded using red, yellow and green to indicate

comparative values of countries in the same income level. It is important to note that the colors yellow and red do not necessarily represent a poor environment but rather represent the lower 40 percent of scores in the given income level.

New for 2016, a separate category has been added to assess industry's interest in each of the countries. The Global Cold China Alliance, which represents all major industries engaged in temperature controlled logistics, provided ratings on a scale of 1 to 7, with 7 being the highest score based on their members expressed interest. This industry interest category effectively contributes 20 percent of the total country score.

The case studies in this report analyze selected potential markets and assess important competitiveness factors. These case studies are intended to aid ITA in promoting the development of efficient international cold chains to improve U.S. export opportunities. Inclusion of countries in the case study section does not necessarily indicate that these are higher ranked countries of opportunity but rather that government or private sector representatives have expressed interest in learning more about these markets to ITA's Supply Chain Team.

Industry Overview and Competitiveness

The series of warehousing and distribution activities that comprise a cold chain system are designed to ensure ideal storage and transportation conditions for temperature-sensitive products. Dozens of U.S. export industries depend on the vital links that cold chain systems provide. U.S. businesses invest hundreds of millions of dollars in their cold chain operations to create efficiency and reliability because an end-to-end cold chain is only as efficient and secure as the weakest link in the system. Each link in the cold chain must maintain the same level of integrity for the customer to receive a satisfactory product. A single breakdown in the chain can result in catastrophic losses of product.

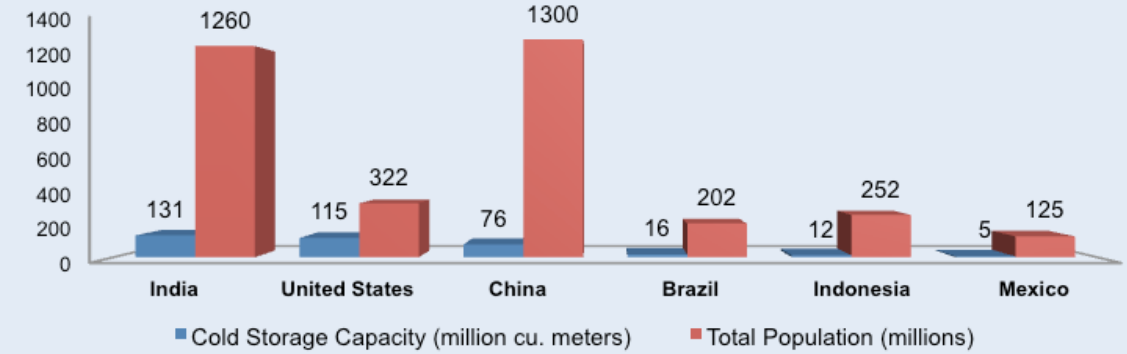
Figure 2: Refrigerated Warehouse Capacity Growth by Country	CAGR 2008-2014 (Percent)
India	43
China	35
Mexico	27
Brazil	26
United States	9

Global Cold Chain Alliance

Cold chain services that support perishable food distribution globally are estimated to be valued at nearly $250 billion.[7] Experts also estimate that cold chain logistics spending in support of biopharma industry is more than $10 billion and is expected to grow to $13 billion by 2019. Asia alone contributes to $1.2 billion in growth.[8] The compound annual growth rate (CAGR) of cold chain markets is anticipated to reach nearly 16 percent into 2019.[9]

The United States is a world leader in developing the technology and processes necessary to develop and manage cold chain systems efficiently; therefore, the U.S. is well positioned to capture a large share of the global market for cold chain development. According to the Global Cold Chain Alliance, an industry association comprised of the many industries that make up cold chain services, global refrigerated warehouse capacity increased by 20 percent from 2012 to 2014, and three of the top five refrigerated warehouse operators by total volume are U.S. companies.[10]

Figure 3: Cold Storage vs Total Population



Operators providing value-adding activities, such as harvesting and food processing, pass off their products to cold chain service providers for storage, transportation and delivery. While the majority of cold chain services are utilized in the fresh food market, cold chain operators typically transport and distribute both processed and fresh foods, especially in the U.S.

Fresh foods, like fruits, vegetables, meat, poultry and dairy, require an uninterrupted cold chain due to their perishable nature. By controlling parameters of temperature, humidity and atmospheric composition, along with utilizing proper handling procedures, cold chain service providers can increase the product life of fresh foods for days, weeks or even months. These services allow fresh products to hold their value longer, increasing their transportability and providing opportunities that expand their market reach.

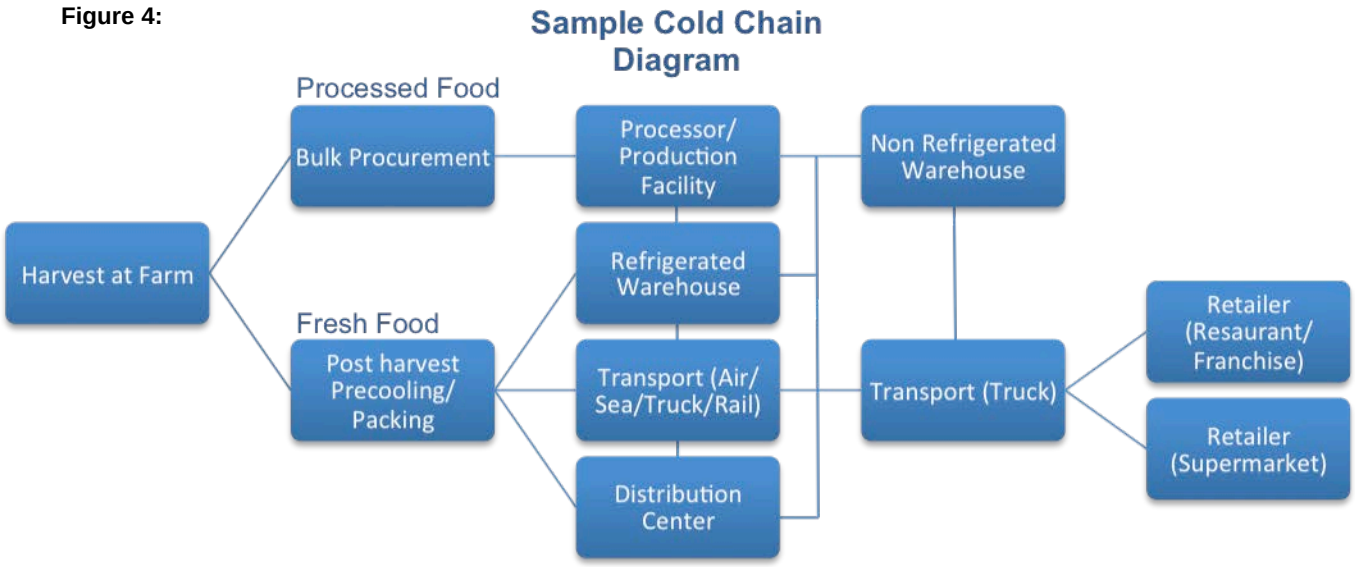
Cold chain systems for processed foods have a slightly different flow. The activities involved in processing are usually transformative in nature and involve adding ingredients or preservatives or altering the natural characteristics of the food product. These alterations can extend the life of the resulting product by months or even years. In some cases, processing may delink the product from the cold chain system if the resulting product is no longer susceptible to temperature shifts.

The nature of processing also allows the use of lower grade food products that are not suitable quality for the fresh food market. Thus, processing can be considered as an option to maximize food harvesting and to optimize the utilization of available cold chains and various grades of harvested food.

The exact structure of each cold chain varies significantly depending on product and customer requirements; however, the goal of a properly designed cold chain system is to safely move temperature-sensitive products in a way that reduces waste, maintains the quality and integrity of the product and limits opportunities for bacterial contamination. A complete cold chain system may include post-harvest pre-cooling or freezing, processing, temperature controlled warehouse or storage, retail or distribution and refrigerated transport between locations.

Requirements for cold chain facilities vary based on the size, type and amount of product, along with the particular requirements of the customer. Fruits and vegetables often require cool facilities and are stored around 55°F. Most dairy products require temperatures just above freezing around 35°F. Meat and poultry products are typically stored just below freezing at approximately 28°F. Ice cream and other frozen products may require deep freezing at temperatures that can range from -10°F to -150°F. The Global Cold Chain Alliance (GCCA), through its core partner, the World Food Logistics Organization (WFLO), maintains information and research on the safe harvesting, storage, handling and transporting of different commodities and temperature-sensitive products. ITA has a strong partnership with GCCA to

Figure 4:



help expand and grow cold chain systems around the world based on international best practices.

Each cold chain varies by region, location and temperature requirements; however, ensuring a cold chain for agricultural products begins at the farm. Produce often goes through precooling at the harvest location and is then loaded onto a truck or other transportation unit designed to keep the produce protected from the sun and held within a desirable temperature range, as it travels to a processor facility or a temperature controlled warehouse. In less-developed locations, transportation may be carried out on covered trucks or smaller carts; in more developed locations, these transportation solutions can include insulated reefer trucks.

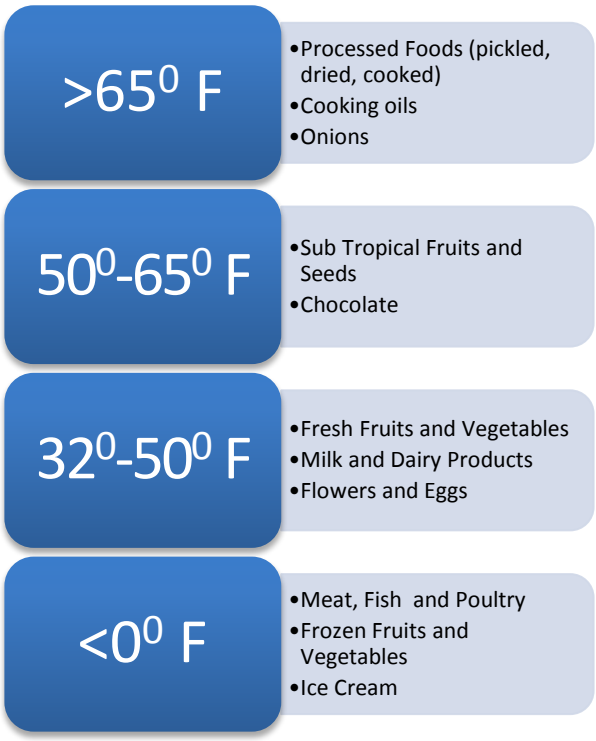
Depending on the type of product and its ultimate destination, a product may proceed to one of several types of facilities. A cool dry storage facility protects the product and keeps it from high temperature fluctuations and humidity. A cold storage facility may be appropriate for products that require a lower temperature to remain fresh. This reduces the chance for bacterial introduction. A super cold facility is designed for products that may need to be kept frozen. Sometimes these temperatures may be 100° or more below zero. At each of these facilities, the product is kept at the ideal temperature until it is loaded onto an appropriate vehicle and shipped to a distribution center or its final destination, such as a retailer or restaurant.

At the retailer or restaurant, a product must be stored at the appropriate temperature in a refrigerator or freezer, as it awaits its final user, typically a home use customer or restaurant customer.

Cold chain systems are critical to the operations of U.S. franchisors and retail service providers. Modern retail sales have been growing at a rate of 10 to 15 percent globally and have reached 50 percent of market share in most large emerging markets.[11] U.S. franchise brands for food concepts are known for quality and safety around the world. In order to maintain their reputations, franchisors must have reliable and safe means to transport products to their retail operations.

Cold chain services typically have a deep vertical co-ordination with the retail and franchise customers that receive their services, allowing those customers to ensure the quality and the safety upon which they

Figure 5: Sample Storage Temperatures



have built their reputations. The level of co-ordination often extends beyond just how products are stored and transported, to the local farmers, and allows for control of how food is grown and harvested.[12]

In some less-developed economies that lack cold chain services, retailers and franchisors have had to invest large sums of money in developing their own cold chain logistics systems. While companies like Wal-Mart, McDonalds and YUM! have the necessary capital to establish cold chain systems for their operations, the lack of cold chain development more broadly in many countries represents a significant limitation for many U.S. companies. This is especially true for small and medium size enterprises (SMEs) attempting to expand into international markets.

Transportation costs are often the most challenging obstacles to suppliers in developing countries.[13] In countries with well-developed cold chains, most retail and franchise service providers outsource their supply chain operations to third party logistics providers (3PLs) and to other cold chain service providers that meet their requirements based on their products and business strategies.

A recent global trend in cold chain is the rise of E-commerce for fresh food and grocery sales, as well as prepared food delivery. In the U.S. and China, there are a growing number of delivery services that offer fast food and dining beyond the traditional pizza delivery experience. A third party, rather than a vertically integrated part of a retail franchise, often provides these services to the restaurant operator or directly to the consumer, much like a 3PL would offer delivery and transportation for products.

Grocery delivery, including fresh and frozen foods, is a rapidly growing service that is being utilized around the world. In the U.K., as much as 27 percent of shoppers utilize e-commerce for their monthly grocery shopping and have their food delivered directly to their home. This industry is expected to reach $23 billion by 2020. U.S. web retailer and supply chain specialist, Amazon, recently struck a deal with a major U.K. grocer to expand same day delivery of groceries in the country.[14] The complexities of warehousing and delivering fresh products directly to consumers are beyond the specialty of most retailers, and these services are mostly contracted to cold chain service providers.

Among Asian economies and developing markets, e-commerce is having an outsized impact on the delivery of retail products, including fresh and prepared foods. ITA anticipates that many of these economies will skip cycles of normal development, bypassing the standard transition from wet market to brick and mortar supermarkets and organized retail. Instead, many large metropolitan markets will see the largest growth in direct to consumer e-commerce and m-commerce (commerce conducted through mobile devices) sales of temperature-sensitive products. Thus, a rapidly advancing model of distribution that will more heavily utilize cold chain services is expected. Smaller cold storage facilities located closer to urban environments are likely to grow quickly.

While food and beverage products are the most commonly associated commodities that utilize cold chains, they are not the only ones. Many pharmaceuticals, vaccines, bioengineered drugs and biologics that are derived from living cells must remain within a limited range of temperatures to maintain their viability. To meet these requirements, U.S. express delivery service providers, such as FedEx and UPS along with foreign companies such as DHL, have made huge investments to develop complete logistics systems throughout the world. These systems maintain the integrity of the vaccines and other healthcare products that they transport for various manufacturers and healthcare providers. Their cold chain systems include warehouses, specialized aviation and ground transportation equipment, advanced software management systems and extensive personnel training.

Developing cold chain systems provides export opportunities across the services and manufacturing spectrum. Cold chain-related design and engineering, maintenance, logistics and software, and IT development amount to billions of dollars of U.S. services exports each year. Likewise, manufactured products, such as industrial racking systems, forklifts, trucks and commercial HVAC systems contribute to billions of direct U.S. goods exports. Global expansion of cold chain systems also helps U.S. agricultural producers expand their market opportunities overseas.

The markets opened through efficient internationally developed cold chain systems allow U.S. franchisors and retailers to continue to expand the services trade surplus that the United States has held for more than four decades. Services exports, however, can be notoriously difficult to quantify. The Bureau of Economic Analysis (BEA), the U.S. government entity responsible for recording trade data, defines “cross border trade” as occurring when suppliers in one country provide goods or services to consumers in another country, with people, information or money crossing national borders. Therefore, sales of services provided by U.S. companies physically operating in another country are often recorded not as exports but as U.S. owned foreign affiliate sales.

According to BEA, services exports in 2013 totaled $662 billion. Distribution services accounted for $46.6 billion of these exports, with logistics services functions (including cold chain services) representing 51 percent or $23.9 billion.

By contrast, services supplied by U.S. owned foreign affiliates amount to more than $1.3 trillion, and distribution services accounted for $399 billion in 2012, the latest numbers on record. These foreign affiliates in distribution services had total sales of over $1.8 trillion in 2013.[15]

In the realm of services, there is growing evidence that the focus of exports as a primary indicator of economic

activity is outdated. As more businesses operate on a global level and reallocate their resources on the specific business functions in which they have a comparative advantage, distribution, logistics and cold chain services will continue to facilitate an ever-growing international market of innovation, efficiency and competition. From 2008 to 2012, sales by logistics services affiliates rose on average 21 percent, suggesting that cold chain and logistics service providers are responding to an international demand for value-added services.[16]

Global Industry Landscape

In the United States, cold chain systems are well-developed through many years of investment and provide high quality of life benefits to U.S. consumers. In fact, in 2008, the World Health Organization attributed refrigeration as a major factor in the reduction of stomach cancer by nearly 90 percent in the United States since 1930.[17]

Cold chains in the United States are designed to meet high demands from businesses, consumers and regulators. Businesses require products that meet the level of quality of their business structure; consumers demand the highest quality available based on the price they are willing to pay; and regulators, such as the U.S. Department of Agriculture (USDA) and U.S. Food and Drug Administration (FDA), set requirements and minimum safety standards for the handling of many consumer foods and temperature-sensitive products. These market demands have resulted in a competitive U.S. industry, with standards that lead the world in terms of safety and integrity.

U.S. cold chains have reshaped the consumer market over several decades. Product seasonality issues rarely exist in the United States today, as retailers are able to source from countries with alternate climates. Global trade in perishable products has continued to grow year after year.

Flowers are an example of a product that utilizes and depends on cold chain storage. Cold storage permits flowers of all varieties to be purchased year round, by sourcing them from South America and keeping them fresh through the extensive U.S. cold chain. The United States imports more than 5 billion fresh cut flowers each year. Exports of temperature-sensitive products from the U.S. to many of these same sourcing countries are still limited, however, due to inadequate distribution cold chains outside of the United States.

Figure 6: Fresh Cut Flowers Imports: 2014 Valentines Season By Country of Export (cbp.gov)	Jan 1-Feb 14 2014 (millions)
Colombia	505.9
Ecuador	184.2
Mexico	43.1
Netherlands	21.3
Costa Rica	9.5
Kenya	8.3
Thailand	7.6
Guatemala	7.1
Peru	1.7
India	1.7

Customs and Border Protection

Improving technologies in cold transportation has created a shift in transporat modes; flowers are increasingly being transported to the U.S. via ocean going vessels, rather than the traditional, more expensive air transportation option. In fact, global shipments of all perishable products by ocean carriers has increased rapidly over the last 35 years.[18] Reasons for the shift include greater availability of refrigerated containers, improved facilites at ports and better technology options for monitoring shipments in route.[19]

Air transporation is still a heavily relied on mode of cold transportation for many high value items, such as biologics and bioengineered drugs which can cost as much as $100,000 or more. The amount of biotechnology products that require cold chain has risen drastically around the world. Nearly half of the top 50 global drug products in 2013 required cold chain services. These drug sales amounted to $104 billion, and the overall cold chain biopharma industry is expected to grow to $350 billion by 2019.[20]

Cargo challenges in air transportation have led to some pharmaceuticals shifting to sea modes in recent years. The International Air Transport Association (IATA) found that temperature excursions (a product temperature that has deviated beyond its acceptable range) are one of the primary reasons shippers are shifting away from air transportation. Further, the organization found that more than half of all temperature excursions occur when packages are with airline cargo handlers or in airports. As a result, IATA

created a global pharmaceutical logistics certification program through their Center of Excellence of Independent Validator (CEIV). The certification program trains stakeholders on regulations and standards, compliance and accountability, and audits for adequately equipped facilities. The program allows stakeholders to easily search and identify cold chain service providers that meet certification standards.[21]

IATA has also been heavily engaged in the development of industry best practices and standards for perishable air cargo and has produced the "Perishable Cargo Regulations" manual to improve and standardize the practices among its 280 airline and air cargo handling members.[22]

Due to cold chain service's multiple industrial components, including logistics, transportation, distribution, and equipment and technology industries, it is difficult to describe the industrial nature of the global cold chain sector in general or structural terms. Rather, using a global value chain view of cold chains as a business function is a more effective way to view the various activities and businesses involved in the service. The following is a snapshot of the cold chain service's warehousing, third-party logistics, express delivery, industrial transportation equipment and personal protective equipment activities.

Warehousing

Americold Logistics, based in Atlanta, GA, is by far the largest firm in the cold storage and 3PL logistics sector. The company operates 1.1 billion cubic ft. of refrigerated storage, with more than 230 facilities, and has almost $2.5 billion in annual sales. Outside the United States, the company has operations in Argentina, Australia, China and New Zealand. Americold supplies more than 3,000 customers, including Tysons, Heinz, Con-Agra and General Mills, with more than 90,000 freight shipments each year.[23]

Other major refrigerated warehousing providers include Lineage Logistics, Swire Cold Chain Logistics, Preferred Freezer, Nichirei Logistics and Burris Logistics. Lineage, based in California, primarily operates in the U.S. with 600 million cubic feet of storage. Lineage had earnings of $206.4 million in 2014. Swire Group is held by holding company John Swire & Sons and includes numerous cold chain service companies, including Swire, Finlay and U.S. Cold Storage. The collective companies operate in Australia, China, Sri Lanka, the United States and Vietnam; they have 335 million cubic ft. of storage. Preferred Freezer, based in New Jersey, has 260 million cubic ft. of cold storage, mostly near freight hubs in the United States, China and Vietnam where it also provides cross docking and transshipping services. Nichirei Logistics, with 152 million cu ft., is the logistics subsidiary of Nichirei Corporation in Japan, a food processor with nearly $5 billion in annual sales. Burris Logistics, based in Delaware, has 15 facilities with 72 million cubic feet and has estimated sales of $2.63 billion.

Figure 7: Cold Storage By Volume	Storage (mil. ft^3)	Sales Revenue (millions)
Americold (U.S.)	992	$2,430
Lineage Logistics (U.S.)	600	$206
Swire Group (U.K.)	335	N/A
Preferred Freezer (U.S)	258	$441
Nichirei Logistics (Japan)	152	$188
Kloosterboer (NLD)	124	N/A
VersaCold Logistics (Can)	119	$419
Partner Logistics (U.S.)	101	N/A
Interstate Warehousing (U.S.)	83	N/A
AGRO Merchants (U.S.)	80	$76
Nordic Logistics (U.S.)	70	$100
Cloverleaf Cold Storage (U.S)	65	$39
Burris Logistics (U.S.)	72	$2,630

Global Cold Chain Alliance and Hoovers.com

Third Party Logistics

Third party logistics operators (3PLs) provide integrated warehousing and transportation services to businesses on an outsourced basis. The availability of 3PL services allows businesses to focus on their core competencies while having 3PL's specialized systems handle most or all of their logistics requirements. These services can often be customized for individual clients based on the client's specific needs and can include air, rail, maritime and truck freight; brokerage and customs services; warehousing; and distribution and in-bound and out-bound freight consolidation.

Figure 8: Top 10 Global 3PL's	Sales Revenue (millions)
DHL Logistics (GER)	$37.5
Kuehne + Nagel (SZ)	$23.4
DB Schenker Logistics (GER)	$19.0
C.H. Robinson (US)	$11.9
DSV (DEN)	$8.7
CEVA Logistics (NE)	$7.9
Panalpina (SZ)	$7.3
Dachser (GER)	$7.1
Expeditors International (US)	$6.6
SNCF Geodis (FRA)	$5.8

Journal of Commerce

Shipments via 3PLs rose 7.2 percent in the second quarter of 2014, according to the Transportation Intermediaries Association.[24] The role of 3PLs to manage fulfillment in the cold chain sector is likely to continue to grow for the foreseeable future due to the increasing role of omnichannel retailing, especially in the fast growing ASEAN region.

According to the Journal of Commerce, revenue from the top 50 logistics companies was $248 billion in 2014, an increase of almost 5 percent.[25] C.H. Robinson Worldwide led U.S. logistics companies with $11.9 billion of sales revenue. With few physical assets of its own, C.H. Robinson contracts with more than 66,000 carriers around the world to manage 14.3 million shipments to more than 46,000 customers.[26] C.H Robinson buys, sells and transports food and agriculture products around the world.

Express Delivery Services

United Parcel Services' (UPS) subsidiary, UPS Supply Chain Solutions, is one of the top 3PL service providers, though UPS' primary focus is as an express delivery service provider that transports more than 17 million packages per day to over 220 countries. The company operates more than 106,000 vehicles, over 600 aircraft and exceeded $58 billion in sales in 2014.[27] UPS has developed Temperature True, a packaging and transportation system that provides services to more than 500 healthcare companies. UPS has developed 49 facilities dedicated to the temperature-sensitive healthcare industry with cryogenic freezing to -150°F.

Figure 9: Express Delivery Services	Sales Revenue
Deutsche Post (Ger)	$68.83B
UPS (U.S.)	$58.23B
FedEx (U.S.)	$47.43B
LA POSTE (FRA)	$14.56B

Hoovers.com

Another major U.S. service provider is FedEx, which delivers more than 3.5 million packages per day to more than 220 countries. With more than 56,000 vehicles and over 650 aircraft, FedEx generated more than $47 billion in sales in 2015.[28] FedEx has also rapidly developed logistics hubs throughout the world catering to temperature-sensitive transportation and uses a system called SenseAware that can monitor product vitals of humidity, barometric pressure, location, light exposure, at temperatures as low as -238°F.

Within the United States, both companies have established customs clearing processes and host U.S. Customs and Border Protection (CBP) offices within their facilities to allow international deliveries to proceed smoothly, without delays that could potentially expose sensitive products to risk.

Figure 10: Refrigerated Transportation Manufacturers	Sales Revenue (millions)
Wabash National	$1,860
Utility Trailer Manufacturing	$1,020
J.B. Poindexter	$708
Thermo King	$548
Great Dane	$466

Hoovers.com

Industrial Transportation Equipment

One of the largest U.S. manufacturers of reefers, or refrigerated trailers, is Utility Trailer Manufacturing based in California. The family-owned company has more than 140 brands, and has estimated annual sales of over $1 billion and also builds specialized refrigerated vans and delivery trucks.[29] Other manufacturers of refrigerated trailers and commercial trucks and vans include: Wabash National with a variety of manufactured products; J.B. Poindexter which focuses on specialized trucks and vans; and Great Dane Trailers with a variety of dry bed, flatbed and refrigerated sales. Companies like Thermo King, a division of Ingersoll Rand, provide temperature control systems for trucks, trailers, rail cars and shipping containers. Thermo King has annual sales estimated at $548 million.

Cold chain spending in the biopharma industry on insulated boxes, blankets, phase change materials, temperature controlled shipping containers, sensors and recorders, and other tertiary packing and instrumentation is estimated at $3.1 billion.[30]

Personal Protective Equipment

There are also a number of SMEs in the U.S. cold chain sector. For example, Georgia based Refrigiwear provides Personal Protective Equipment for workers operating in the cold environments of warehouses. The 55-year old company employs 142 workers and earns $38 million in sales revenue from their 150,000 square foot facility.

Challenges and Barriers

While it can be challenging to operate a business in any international environment, one of the greatest challenges to cold chain expansion in a developing market is the lack of infrastructure necessary to sustain cold chains. Transportation systems in many of these economies can make reliably transporting refrigerated products in a timely manner difficult to near impossible. In addition, lack of reliable power for cold warehouses, power hookups for reefer trailers at ports and transportation hubs, and adequate facilities at the final customer locations add further costs and complications.

Over many years numerous aid agencies and organizations, both government and private, have been driven by the humanitarian benefits of cold chain to address many of these infrastructure issues in markets that suffer from massive food wastage and malnutrition, with varying degrees of success. Ultimately however, many of these groups fail to reach their goals of widespread cold chain development, largely because they view cold chain as an industry of its own rather than a business function of a global value chain. Thus, they fail to address the second and perhaps most pertinent challenge to the growth of cold chain: finding ways to make a reasonable return on investment.

Cold chain service providers operate as a business function in the distribution services market and meet the needs of retailers and franchises. Due to the enormous investment costs, cold chain operators need a significant amount of volume to become profitable within an ideal time frame of 2-3 years. These volumes typically are met predominantly through large, organized retailers and franchises. For these reasons, the growth of cold chain services often coincides with the growth of the international retail and franchise markets. It is ultimately the retailers and the branded marketers that control the production and flow of products through cold chains to the consumers.

By their nature, most services, like retailers, provide sales to foreign countries that require a physical presence in that country. Service providers therefore establish branches or foreign affiliates to provide these international services. It is critical that, in order for services in a country to grow, there must be in place business friendly government policies that are open to foreign direct investment (FDI). Protectionist measures by foreign governments, often seen in lower and middle-income economies, tend to restrict foreign services activities, especially in the area of distribution services like retail. In doing so, these economies inadvertently restrict the opportunities to expand and grow the business function of cold chain services.

While the prime markets for cold chain are often consumer driven, developed economies and, in some cases, emerging economies can pose opportunities for cold chain operators to service exports that are primarily headed to foreign consumer markets. These prime developing markets need to have policies that are open to FDI and facilitate ease of trade to allow businesses to see clear paths to a return on the investments they will need to make.

In developing, lower income markets, the most likely initial opportunities include design and engineering of warehouses, the operation of third party logistics and technologies that can efficiently overcome shortfalls in infrastructure development, for example: developing economies with unreliable electricity may require unique solutions or alternative energy sources to properly maintain warehouse temperature; a lack of adequate roads may also mean new transportation options or versatile refrigerated containers need to be developed.

As these solutions are developed and introduced, they provide new access to international markets and opportunities for small businesses and farmers where previously there were none. The highest quality products from these small farms are mostly exported to other regions since consumers are often unable or unwilling to pay for the higher quality products locally,

and without economies of scale, local retailers are unable to support the investments necessary to maintain the quality of products.

The economic activity sparked by these international transactions increases the income of engaged locals and spurs investment by international retailers and franchisors. As the economy develops into a higher income consumer market and the retail industry becomes more organized, cold chain services will shift more product from exports to the retail and franchises that begin to operate locally.

In many of these developing economies, smaller "mom and pop" retail establishments can often be the greatest recipients of benefits from this situation, since these local establishments are often able to utilize economies of scale from the same supply chains as the large companies without the large footprint.

It cannot be overstressed that this model of the development of an economy through cold chain only works in those economies with business friendly trade policies. In fact, according to the World Bank, gravity model studies have shown that important drivers for FDI include the growth potential for a market, the labor environment and the distance and ease of reaching important markets, which includes the openness of an economy to trade. Further, the World Bank has highlighted that a 1-percentage point difference in the regulatory indicator portion on the *Ease of Doing Business* report correlates to FDI inflows of $250 to $500 million annually.[31]

In developed, higher income economies, competition from numerous cold chain service providers can pose a challenge. The most likely opportunities for U.S. cold chain providers, therefore, will be in the consolidation of existing fragmented systems into higher efficiency systems that provide increased reliability and higher quality options that allow retailers to cater to particular consumer tastes. New technologies that address particular aspects of each market, such as cultural preferences and omnichannel retail shopping, In a cold warehouse, forklifts and trucks are needed to move and store pallets of products. These trucks vary significantly based on the type and design of a cold chain facility. Additionally, refrigerated transportation equipment, such as refrigerated trucks, will be required to transport products to retailers, franchisors or end users.

may also be a significant long-term growth opportunity.

Opportunities

Cold chain systems require industrial designers and engineers to develop efficient warehousing and storage systems, as well as refrigeration units for transportation vehicles and networks. Engineers and industrial design teams take into account what type of product will be stored in a warehouse facility, how much processing will be done within the facility, the quantity of items to be stored and the product's specific handling requirements. Many facilities hold varying types of product sizes and handling requirements, and the design of these warehouses will often take into account the need for flexibility in cooling and handling conditions. A cold warehouse and storage system may cost several million dollars to design and build. These sales and services help contribute to the $4 billion in U.S. industrial engineering exports and $12.3 billion in architecture and engineering services in 2014[32] and $184 billion dollars in industrial equipment exports in 2012.[33]

Once these systems are in place, cold chain warehouses require maintenance and repair services. Freon-based systems are an affordable option for small-scale chiller systems; however, ammonia-based refrigeration systems have long been the industry standard for large industrial refrigeration. U.S. companies have also developed new technologies for small charge ammonia systems that use up to 98 percent less ammonia and can replace older, inefficient systems.[34] All of these systems will require regular maintenance performed by skilled professionals. Due to ammonia's hazardous qualities, safety and administrative controls must be implemented for equipment maintenance and service. The United States exported $22.3 billion worth of maintenance and repair services in 2014[35] – a number that ITA expects to increase, as additional cold chain development takes place in emerging markets.

Modern refrigerated trucks, known as reefers, are designed to be very versatile and can be configured in minutes to carry a wide variety of cold products. Many trucks can carry products of varying refrigerated temperatures by adjusting internal compartments to meet specific product temperature needs. Often modern trucks are fitted with GPS monitoring systems that can provide data on location and can help

operators maintain the temperature in individual compartments. Individual trucks can cost between $30,000 to well over $150,000. Warehousing vehicles and reefer trucks helped contribute to $4.5 billion worth of trucks, buses and special purpose vehicles exported by the United States. in 2014,[36] and U.S. owned foreign affiliates in transportation equipment sold more than $3 billion in 2013.[37]

Managing cold warehousing and delivering products is often contracted out to third party logistics operators (3PLs), which provide important service export opportunities. 3PLs offer outsourced logistics services scaled and customized based on the needs of the customers they serve. Their expertise in management and transportation logistics and economies of scale often provide services at a lower cost than customers can provide for themselves. In 2013, U.S.-owned foreign affiliates in transportation and warehousing had sales of more than $63 billion.[38]

In addition, express delivery service providers also have cold chain logistics services that are expanding internationally. Express delivery service providers can deliver high-value temperature-sensitive products, primarily vaccines, medical and biotech products, by air to facilities around the world. These transportation services contribute to the $90 billion of U.S. exports seen in transport services in 2014.[39]

Managing and coordinating the warehouse and transportation services that are necessary to maintain proper product temperatures is aided through advanced logistics and warehouse IT and managing software. While some logistics service providers develop their own proprietary software, many rely on IT and software service provided by technology companies. U.S. exports of computer software, telecommunications and information services totaled $75.3 billion in 2014,[40] and services from U.S. foreign affiliates sold more than $6 billion in 2013.[41]

Once in place, cold chain systems make it possible for U.S. exporters to reliably ship meat, poultry, fruit and vegetables. Various forms of frozen and fresh food, wine and other beverages can also be exported through these advanced systems. In 2014, nearly $145 billion worth of food products were exported.[42] U.S. foreign affiliates in agriculture sold $547 million, and food services sales amounted to nearly $39 billion in 2013.[43]

Cold chain systems also allow U.S. pharmaceuticals, biotech materials and some sensitive electronic equipment to be exported safely.

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