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[Field Research]

Cold Chain Management in Pharmaceutical Industry: Logistics Perspective

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Abstract

Purpose - This paper aims to review cold chain management, especially in the pharmaceutical industry, to explore the cold chain process of delivering temperature-sensitive pharmaceutical products, and to identify areas for further development.

Research design, data, and methodology - The paper, based on literature review and corporate analysis, reviews the development and status of the cold supply chain system, including its important role in the pharmaceutical industry.

Results - Logistics in this field requires more stages than are typically needed. Due to the unique characteristics of the market, few companies can provide the services; currently, only few global companies with large networks and high technologies can afford to do so. Expanding pharmaceutical markets to meet global demand will require cold chain development, especially in "pharmerging" markets.

Conclusions – Cold chain is a highly sensitive market in terms of products being carried within the chain that itself is a complex system. However, at the same time, it is a niche market with new opportunities. Hence, a sound cold chain infrastructure is needed to satisfy companies, governments, and customers for both commercial and public reasons.

Keywords: Cold Supply Chain, Pharmaceutical Supplies, Temperature Sensitive, Refrigerated Packaging.

JEL Classifications: L87, L93, N70, O30.

1. Introduction

Globalization brought the world much smaller than the reality, mostly by allowing sharing information on real-time basis. On the other hand, globalization brought more freight to be delivered worldwide usually travelling great amount of physical distances; it is usually considered that longer the distance is, higher the chances of damages and risks. Hence, one of the main concerns of companies was maintaining products' value from the origin to final destination safely. Under the circumstances, logistics have developed rapidly into various fields of industries and business, specializing its knowledge of moving freights at right time to right places. As each industry has its own characteristics, its logistics also contains differences according to characteristics of products flowing in the system, and this specialization developed a niche logistical expertise in temperature sensitive products: cold chain logistics. The ability to understand local regulations and to estimate various combinations of distribution channels connecting places in given time made logistics role much more important in globalization. Hence this rather new segment of logistics has been actively participating in certain variety of goods in circulation. Meanwhile, IT plays important role in logistics and supply chain management, holding the participants in chains together possibly seamless. And, this becomes more critical when freight is temperature sensitive or perishables - usually pharmaceutical and food industries requiring cold chain technology to maintain its temperature throughout the chain.

Despite the changes in the market for cold supply chain, its importance of role of logistics seems to be downgraded. The previous studies related to cold chain also shows similarities of either focused on technologies of keeping the product at set temperature (Park & Kim, 2010 Singh, Jaggia & Saha, 2012) or on domestic pharmaceutical industry and its development (Bishara, 2006; Chung & Chung, 2006) in relation to other policies and regulations. Hence the study of cold chain management in logistics perspective seems to be much needed. Other studies (Kim et al., 2008; Kwon, Youn & Namkung, 2007; Su & Yun, 2012) explored on distribution system within pharmaceutical market yet focused on domestic market. Therefore, the purpose of this study is to review cold chain management and its characteristics regarding pharmaceutical industries, especially of-bio-pharmaceutical industries; types of services and how they differ from general logistics services, and major issues in the industry as the pharmaceutical industries are expanding, providing some implications.

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2. Cold supply chain management

The typical supply chain management can be defined by CSCMP (Council of Supply Chain Management Professionals) as an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. And although there exist some different views on its scope, they seem to be similar in describing the process of moving goods and services (Kim & Youn, 2012). Following the definition, cold chain can be defined as a temperature controlled supply chain, in general. And this part of the supply chain market has been growing over the years as demographics change, urbanization and diets change. This can be due to increase in income leading people to become more conscious of healthy way of living, which leads to consumption of fresh food and pharmaceutical products. And these products usually require temperature maintenance throughout its movements, and the products' value would depend on how fast within temperature range it arrives to shelves. Temperature deviation from its given range may shorten the shelf life, and sometimes products will lose its value and become wastes. In other words, if the supply chain cannot maintain accurate temperature range seamlessly, it will create costs that cannot be compensated from anywhere or simply wasted. Therefore, cold supply chain is different from traditional supply chain, as the products require infrastructure with high level of technology and care to maintain its value until it reaches to final customers; 1) accurate information needed prior to its movement to secure its condition throughout the chain – logistical planning to protect integrity of the shipments, 2) keeping temperature at certain range regardless of outside temperature –involving thermal and refrigerated packaging methods (Rodrigue, 2013), and 3) reach its destination as fast as possible.

On the other hand, cold supply chain is not just commercial issues, but also closely related to public health issues. As people are more conscious of living healthy life, fresh food and medical supplies have been increasing in global trade. Meanwhile, if the products are not fresh or the temperature range has been deviated during its flow, it will harm people's health and lead to death in some extreme cases if medical supplies have been wrongly injected. Hence, the importance of proper transport and storage are continuously gaining more emphasis, and in the same view, cold supply chain can be more influential to human lives than typical supply chain management.

2.1. Background of cold supply chain

This unique supply chain is known to date back to 1797, British fishermen using ice preserving fish stockpiles while at sea. On the other hand, it can be considered that the major development was based on the two critical causes; food trade from the colonies and pharmaceuticals and medical supplies trade. Food trade, such as frozen meat and bananas, in 1800's and early 1900's from its colonies to European countries was one of the trigger to develop cold supply chain. And the first reefer ship was used for banana trade, which still remains the biggest portion, as a single product, in cold supply chain today(Bananas 20%, Citrus 7%, Deciduous 10%, Exotics 3%, Fish & Seafood 19%, Meat 24%, Dairy 3%, Other 14%; Drewry Shipping Consultants, 2010). Pharmaceutical and medical supplies trade is another critical cause of the development and is rather recent activity. Originally, these products were managed by the manufacturers. However, due to complexity distribution channels and sensitivity of products, companies rely on logistics companies specializing in cold supply chain who can provide services preserving expensive vaccines and medical supplies stably. This reliance created and developed a niche market in logistics industry, and today large portion of pharmaceutical products flow along the cold chain.

According to recent research of KITA (Korea International Trade Association), global cold chain is formed of U.S.A. 49%, Asia 11%, and the market is expected to grow approximately 10% each year. In order to operate competitive cold supply chain under the circumstances, proper technology and equipment would be needed to store and transport temperature sensitive products, as well as the procedures should be secured to reduce time spent at ambient environment. Furthermore, appropriately trained personnel are necessary to manage the whole distribution flow, and possibly deal with risks that may arise. The key elements to cold chain logistics system, therefore, can be personnel, equipment and procedures. Yet, cold chain relies heavily on protective packaging of the products (Higgins et al., 2009).

2.2. Packaging technology

In order to maintain the given temperature, which are usually below ambient temperature, storage and packaging during distribution becomes critical. As transport modes change, it must be designed to maintain the temperature regardless to outside temperature and against its influences. Various materials and technologies are being used today to insure the optimal shelf life of the products dry ice, gel packs, liquid nitrogen, reefer containers, and etc., used according to temperature standards. Common standards would be "banana" (13℃), "chill" (2℃), "frozen" (-18℃) and "deep frozen" (-29℃) (Rodrigue, 2013).Different products will be using different cooling materials and packaging accordingly; usually gel packs for coolings, and liquid nitrogen for frozens, and reefer containers for longer distances.

Usually these cooling materials cannot be stacked up for long period of time in warehouses. Hence, it is critical that information shared throughout the chain, in order to prepare ahead of cooling materials as well as boxes and containers for its seamless movements. After the pre-conditioned settings to adapt its cargo is done, and then the cargo may be set to de-

part to its destinations. One of major issues with cold chain movements is that shipments using cooling materials can keep the temperature cool enough for limited period of time which is usually not so long. And it does not yet contain the controlling ability to maintain its setting temperature range by itself in general, which requires more developments in technology. In other words, it can go below setting temperature as well as above temperature, which both are deviations of temperature range. The other problem could occur during storage; storing cooling packages, in boxes and containers, in cool storage rooms. If the cooling materials are still in function, then the packages should not be kept in cooling storage rooms whereas if it is no longer functioning then should be kept in cooling storage rooms at setting temperature; different procedures required under different circumstances as it cannot adapt to changing conditions. Also, as containers for air transport are rather thin, products can be easily affected by the outside temperature, hence requires careful monitoring regarding cooling materials and replacements whenever needed.

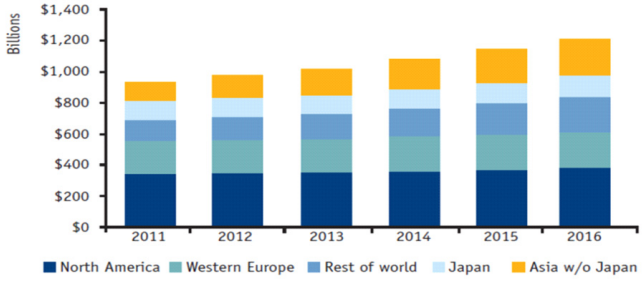
Meanwhile, cold chain requires close monitoring of its temperature change thus it is usually recorded either manually at each stage or automatically by data logger throughout the chain. However, monitoring at this stage is not meaningful, since there is no integrated system covering whole chain. And even if the temperature deviation is found, many of the standard procedures today cannot fix the problem on real-time basis. Moreover, consumers usually cannot detect the interruptions. The key point of cold chain would be maintaining its given temperature, and over the years this filed has been showing lot changes, yet it is still fragile in some ways. More technology developments and relevant trainings to people to establish stable cold chain, especially for high value products such as pharmaceuticals, should be expected in near future.

3. Cold Chain in Pharmaceutical Industry

3.1. Pharmaceutical market analysis

Over the years, pharmaceutical industry has been showing continuous growth. This can be closely related to the aging society and increased interest in ‘well-being’or healthy life style. According to "Global Pharmaceutical Market Report & Forecast: 2012-2017", global pharmaceutical market is expected to grow continuously, 5% CAGR from 2011 to 2017, sales worth of US$ 1.1 trillion by 2017 (Kamlesh et al., 2013). And this trend is to be continuous for more years, not only demand is increasing but also companies and the governments are encouraging the industry’s growth. As the market grows, the competition between companies in the industry is becoming intense, and with FTA and other policies to opening its market to other international companies, it is expected to face far more fierce competition in near future.

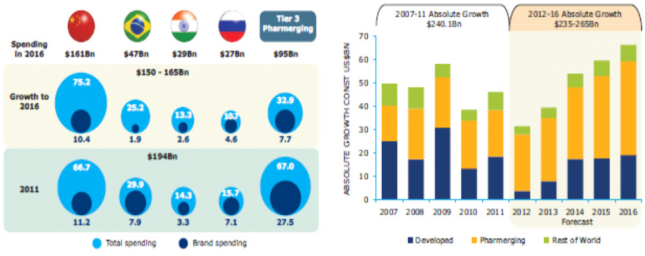
Although some countries’ pharmaceutical industry is looking at slow recovery from global economic crisis, showing growth rate of 2.4% in 2012 compared to previous year (IMS, 2013), BRICs (Brazil, Russia, India and China) are known to be the emerging markets, or "pharmerging" countries, with fast growth rate. According to a study, China, India, Brazil, Russia and Mexico will create 28% of total spending on pharmaceutical products by 2015 (Kumar et al., 2013), and overall Asian market is expected to reach US$ 350 billion in 2016, comprising 30% of the global pharmaceutical market of US$ 1.2 trillion (IMS,2013). It is also expected that China will be the world’s second largest pharmaceutical market by 2015, growing at 22%-24% through 2014.



Source: IMS(2013)

<Figure 1> Projected Contribution of Asia to Global Pharma Value Sales (USD, BN)

On the other hand, global spending on medicines tends to show more clear differences between developed countries of declining 57% and emerging countries of increasing 10 to 30% over the next five years.



Source: IMS(2012)

<Figure 2> Pharmerging Spending and Growth (Left) & Global Growth from 2007 to 2016 (Right)

While overall growth of the industry is expected at emerging countries only, the market in general is still considered to be optimistic as innovative sectors of the industry are actively developing; biopharmaceuticals and newly created medicines. Biopharmaceuticals are based on biotechnology, which is produced from naturally made protein, enzyme, and antibody to cure disease or hereditary problems (KHIDI, 2008). Many of pharmaceutical companies seems to be expanding their busi-

ness into this sector as these products are known to be less harmful to body yet able to cure diseases, and comparatively lesser money and time needed to develop new products but expensive compared to existing pharmaceutical drugs. Biopharmaceutical is one of the major sectors in pharmaceutical industry requiring temperature control, mostly 2℃-8℃. And considering its value being usually expensive, cold chain connection from origin to destination without any temperature deviation becomes comparatively even more critical. According to International Market Analysis Research & Consulting (IMARC), the global market for biopharmaceuticals is expected to grow from US$ 109 billion in 2012 to US$ 166 billion in 2017 (DHL, 2013). Also, according to the Healthcare Distribution Management Association, the cold chain is taking responsible for transporting a near 20 billion dollar investment in pharmaceutical products (Rodrigue, 2013). As pharmaceuticals and relevant products are highly valuable, any unanticipated exposure to variant temperature levels would jeopardize the products commercially as well as ineffective or harmful to public health.

3.2. Cold supply chain in pharmaceutical industry

Unlikely pharmaceutical industry, where rapidly moving into newly emerging markets under the competition, pharmaceutical logistics market yet shows much signs of serious investment or competition, but highly dependent on few numbers of global freight delivery services. Understanding its uniqueness of pharmaceutical industry characteristics, it will require additional attention to its movements of when, where, under which condition and how. Especially, temperature sensitive bio-pharmaceutical products will require to be maintained under certain temperature ranges throughout its flow from the origin to the final destination. Thus, within pharmaceuticals cold chain, many of different components, raw materials and products, have to be stored handled and shipped at different temperature, usually below ambient, and sometimes below freezing temperatures. This definitely will need not only capability of delivering on time but also relevant technology to maintain it high value to the customers. Due to its sensitivity and difficulties with high risk in delivery, logistics companies may not easily make investments and expand their business to this field. However, considering logistics market in an extreme state of high competition and cutting down its cost, pharmaceutical market may be the new niche market with lots of opportunities.

Cold chain logistics in the pharmaceutical industry is concerned mostly about the storage and the transportation; temperature maintenance both in the air and on the ground. Various pharmaceutical products are packed in small batches, and these will be flowing in the chain in small yet frequent deliveries, heading to city areas most of times. Some of these fluctuate according to seasonal demands, and most of the products are originally unable to forecast, considering some of diseases come and go without particular reasons yet to be found. Others may require additional care to maintain its characteristics, such as different temperature, stored or transferred separately, and reverse flow if any. These unique conditions lead to systemized logistics process with high technology and knowledge of the field, including relevant regulations and documentations. Considering these circumstances and characteristics, standard logistic strategy and processes guiding other industries' logistics cannot be simply applied to rather unpredictable and sensitive chain that are creating a web of contingencies, interdependencies and uncertainties (Rossetti & Handfield, 2011). The risks including damages, customs clearance delays, and temperature deviations can not only create major costs but also affect product efficacy. The World Health Organization has stated that due to incorrect shipping, every fourth vaccine reaching its destination is in a degraded state (TNT, 2012). Hence, different yet suitably designed planning, adaptability and contingency plans must be required.

Some of key issues in this chain would therefore be technology, process and personnel. Currently, level of technology and process are different in countries, while the product needs to be maintained under one seamless chain. As the equipment are expensive than the ones used in standard logistics system (e.g. a regular 40 foot container costs around $5,000, while a reefer is in the range of $30,000; Rodrigue, 2013), not every system and process will contain same level of technology. Not just being old and new, but there are various types of packages and containers to keep the temperature during its transfer and cool storages during its stopovers, and temperature data loggers, either by human or devices, recording temperature changes throughout the chain. These differences may create risk of exposure to unnecessary temperature deviations. Yet the reality is that many of monitored temperature data are often not meaningful because of the lack of integrated system to exchange temperature data throughout the whole chain. Seamless chains would be based on unimpeded pipeline of information and technology, where real-time basis information flow can deliver necessary information to all relevant parties such as seller, buyer, freight forwarder, carrier, and container, who can prepare the process ahead and reduce lead time. Importance of technology and information has been known for long enough time, and lot has been changed over the years, whereas training people often has been less interested. However, poor monitoring or inadequate maintenance and usage of the equipment will create similar results to not having proper technology and infrastructure for the chain. People that are part of the chain will need to understand that the general logistics processes and cold chain logistics are different. In other words, ability to keep the container and maintain temperature can be the least knowledge required. Cold chain can be considered to be the most human needed chain until today. People are needed to connect the gap between the transport and storage, monitor, come up with contingency plans if anything goes wrong, and provide any specific conditions if required, such as immunization. Furthermore, security issues may arise as pharmaceutical products are usually high value as well as under high surveillance of governments

due to counterfeits and regulations matters. Therefore, it requires lots of documentation works which could influence cold chain in some ways.

Not just final products in pharmaceutical industry, but also developing and testing products rely heavily on controlled and uncompromised transfer of shipments. Researches and trials are major part of the industry that costs millions of dollars, which are in the experiment or developmental phase moving along the cold chain, and the National Institutes of Health data shows that about 6,500 new trials per year are started. According to Pharmaceutical Commerce's BioPharma Cold Chain Sourcebook, the clinical trial materials logistics business worth $2.7 billion in 2013 is expected to increase over $3 billion by 2017. Yet it is also known to experience approximately 80% failure rate (Rodrigue, 2013), which could possibly be interpreted that the existing cold chain still has long way to develop and be stabilized. Meanwhile, most of bio-pharmaceutical products move through cold chain. They are highly sensitive to temperature, and it is difficult to detect any interruptions occurred during transfer. These usually fly in thin container boxes with dry ices to keep them cool, yet thin container is easily influential to exterior temperature which changes from any possible weather while waiting at airfield to rather stable flight temperature of 15℃-20℃. On the other hand, growth rate in pharmerging countries show higher numbers than that of developed countries, and many of the global pharmaceutical companies are expanding their markets into the area rapidly. However, their infrastructure to deliver supplies seamlessly and safely has not been firmly established yet; lacking expertise in personnel, equipment and knowledge on procedure, which would delay the whole process as well as increase risks of product being deteriorated and wasted. And this would be one of the negative factors that can influence further expansions and developments in the countries where the consensus on supplies and pharmaceuticals are 'expensive' (IMS, 2013).

These challenges for the pharmaceutical cold chain will have many consequences for logistics within the sector. New technologies and trained expertise may provide positive impact on the chain. Innovative products will influence the process and how to be stored and transported. Regulations and competitions, and the pharmerging countries, with adequate logistics infrastructures not yet fully developed but expected to see fast growth in near future, will affect logistics procedures.

3.3. Cold supply chain services

As mentioned earlier, global logistics networks of pharmaceuticals are usually provided by outsourcing services or logistics service providers, due to its complexity –regulations, processes, and high costs. Unlikely the typical logistics networks, it requires pre-notices of when the products will be released under which condition, so to prepare packaging accordingly set for the temperature. It would usually use truck at one end then air freight delivery then to truck again as last mile of the chain. These processes should be known to producers, transport companies, and receivers, so that all parties may prepare ahead of what is coming; setting temperature controlled containers, warehousing, packaging, and contingency plans if any problems arise. Therefore, logistics service providers will require not just their networks in global market, but also technology and experiences in this field. Major global logistics companies provide special services suited for pharmaceutical products; TNT, DHL, and FedEx.

3.3.1. TNT

TNT provides "Pharma Safe" service, which uses specially designed containers, the va-Q-tainer, for keeping the temperature of the products within the given range, and transmitting the information on real time basis to the management center. By using its own containers and its own fleets, it seeks to overcome the weakness of temperature control during the journey, in other words, detect any temperature deviations and correct it before its customers'interferences. Considering the fact that typical air shipments involve many different parties and that errors may occur when hands change, TNT acting as a one main control tower from the origin to final destination does seem to have competitive advantage over carrying the product and its value safely. Furthermore, it provides rental service of pre-conditioned va-Q-tainer, which could load and begin the delivery upon registry. The service is available between Europe, the Middle East, Asia and the United States, to more than 70 destinations worldwide, with real time tracking of location and temperature from origin to destination (Moeksis and Gibot, 2012).

<Table 1> TNT Cold Chain Service

Service	Main Characteristics
PharmaSafe	- A specialized temperature-controlled service for the reliable transport of large quantities of pharmaceutical products, such as vaccines and insulin - Designed to tackle the main challenge facing pharmaceutical supply chains: the lack of control and visibility inherent in the involvement of too many parties - Acts as one partner: controls the full supply chain, from packaging procurement to delivery. It uses its own aircraft, handling stations, collection and delivery networks, as well as in-house customs clearance experts - The va-Q-tainer:capable of maintaining the required inside temperature (frozen, refrigerated or controlled room temperature) for more than 120 hours without electrical power supply or dry ice, even in extreme outside temperatures

Source: Moeksis and Gibot (2012).

3.3.2. DHL

DHL operates "Medical Express"service, which manages the transportation of time and temperature sensitive shipments for the Life Science industry. DHL has expanded into various logistics services through mergers and acquisitions; not only express parcel deliveries, but also freight forwarding, ocean shipping, finance, and others, regardless of its success in the market. And recent one can be the beginning the cold supply chain service, focusing on pharmaceutical products. Based on DHL Quality Control Center, where all the necessary information to track the shipment is gathered and monitored, the service provides dedicated transportation for time sensitive medicines and clinical supplies, including priority handling to confirm shipment delivery toa pre-12 promise, ensuring its set temperature of ambient, chilled or frozen, to their delivery. As shipment visibility is crucial for the Life Sciences industry, the service offers dedicated IT infrastructure that links the many stakeholders in a Clinical Trial and provides advanced user reporting capabilities. The service holds a strong position in the Clinical Trials business within the Life Sciences industry, especially within emerging markets like Eastern Europe, Russia, South Africa and India (DHL, 2013; Wiedemann ,2009).

3.3.3. FedEx

FedEx also operates similar services as the two other major logistics companies do; "HealthCare Solutions"for shipping temperature-sensitive healthcare products, especially of deep frozen shipments, connecting life sciences and biopharma industries and its customers around the world. With the pre-conditioned containers, the customers may load their temperature-sensitive product where then FedEx takes the shipment, monitors and intervenes if necessary during transit, and delivers the container to its final destination. Using the innovative dry vapor technology and its main strength of reliable logistics management, FedEx provides high level of integrity and security for high-value frozen shipments worldwide. Unique technology used for this service is the CryoPort Express® Dry Shipper, which is the liquid nitrogen dry vapor that maintains a temperature of below -150℃ for up to 10 days. As this technology is classified as non-hazardous, it eliminates the complexities that can arise when classified as dangerous goods, and together with its recyclable containers, the service is designed to reduce environmental impacts as well. The service is provided in 13 markets across the Asia-Pacific region; Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan, Thailand and Vietnam. (JOC, 2013).

<Table 2> DHL Cold Chain Service

Service	Main Characteristics
Medical express	- Manages the transportation of time and temperature sensitive shipments for the Life Science industry; it comprises the outbound shipping of investigational medicines and clinical supplies to clinics and hospitals, through to the inbound return shipping of patient specimens to laboratories and research organizations - Simplifies the complexity by offering a sustainable and scalable solution that maintains compliance with local life science regulations, customs legislation and environmental recommendations - Three main temperature settings: room temperature, chilled and frozen - Delivery of: 1) Investigational Medicinal Products: medicines tested during clinical trials, 2) Clinical Supplies: supplies used by Investigators to conduct clinical trials, 3) Patient Specimens: samples taken from patients sent back to laboratories for analysis, and 4) Biological substances Category B (UN3373)

Source: DHL (2013).

<Table 3> FedEx Cold Chain Service

Service	Main Characteristics
HealthCare Solutions	- An innovative end-to-end service for the shipping of temperature-sensitive healthcare products around the world, for customers in the life sciences and biopharma industries - Provides: 1) Up to 10 days of holding time (<-150C) to support complex international moves, 2) Elimination of dry ice, removing the need to re-ice shipments or purchase, inventory or manage insulated boxes, 3) No need to train personnel on handling hazardous materials, 4) Reduced environmental impact since the non-dangerous goods container is recycled and liquid nitrogen evaporates harmlessly, 5) Proactive monitoring and intervention from origin to destination, providing visibility to the shipments via the FedEx Priority Alert(SM) service - Classified under the International Air Transport Association (IATA) as a non-hazardous dry shipper and meets the requirements to handle both infectious substances (UN3373) and non-infectious clinical samples

Source: JOC (2013).

DHL Global Forwarding, which is one other branch of DHL, also provides services of temperature sensitive shipments for Life Science industry, together with LifeConEx, recently fully owned by DGF. DGF and LifeConEx, as a one partner, provide services from warehousing to transportation, a full supply chain solution; some of such as hospital logistics, clinical trials logistics, and supply chain analysis and design.

4. Conclusion

Pharmaceutical industry can be very personalized industry. And these variety of products bundle with different conditions

and highly sensitive to exposures, require different logistics system that can deliver safely within the time. This complex industry is expected to show one of the highest growth rates among other industries, especially in emerging markets, such as Brazil, Russia, India, China and others. While traditional logistics system, comparatively standardized and stable, is under fierce competition, cold chain logistics show different environment, of less density and competition, as not many companies can provide cold supply chain which requires special techniques and people, especially in emerging countries. It is highly sensitive market, in terms of products being carries within the chain that may be considered as much more complex system, yet at the same time, it is a niche market with new opportunities. Not only the number of networks, expertise and ability to make delivery on time are important, like the usual conventional logistics system, but maintaining the ability to adapt is one other key factor that cold chain requires. It is crucial to understand the market characteristics and customer needs. And, most of all, maintaining cold chain remains one of the big challenges in the market, as colder does not necessarily mean better. Yet, it is also true that current systems show lack of understanding its characteristics and uniqueness of the industry and market. In the case of emerging countries, these issues needs to be reviewed in more serious view, since it is the market with high potential of growth rate and lack of understanding the market and infrastructure at the same time. In sum, good and sound infrastructure for cold chain is needed for both commercial and public reasons, especially in emerging markets, that could satisfy companies, governments and customers.

Through this study, it analyzed characteristics of cold supply chain in pharmaceutical industry, and its importance connecting the producers to consumers. As the market is changing rapidly looking at further developments, its emphasis on cold chain will surely increase. Thus, as basis to this study, it will require further studies such as how logistics companies can provide better services, how to manage seamless services throughout the chain, and the necessity of high technology infrastructures and management skills suited to emerging markets. Logistics become a differentiator and key success factor, for strategic reasons. Hence supply chains and companies in the industry need to be well prepared for coming challenges. There are many more expected changes in life science industry in the next decades, then so does the life science's logistics.

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