Measures for the Cold Chain Industry in the Era of the Fourth Industrial Revolution

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Abstract—Modern society is experiencing an era of accelerated life cycles for technological innovations, with technologies spreading at unprecedented speeds. The previous three industrial revolutions irrevocably changed global economic systems and social structures. The Fourth Industrial Revolution (4IR) is incomparable and unprecedented in its impact as it is reshaping the structure of global industries and models of market economies. In response, many countries are establishing and adopting policies so their citizens may reap the benefits of the 4IR. This paper describes the technologies used in the cold chain industry in the era of 4IR and suggests measures for establishing a related ecosystem, as well as governmental policy support measures.

Keywords—Cold Chain, IoT, Block Chain, Smart Container

I. INTRODUCTION

Modern society is experiencing an era of accelerated life cycles for technological innovations, with technologies spreading at unprecedented speeds. The previous three industrial revolutions irrevocably changed global economic systems and social structures. The Fourth Industrial Revolution (4IR) is incomparable and unprecedented in its impact as it is reshaping the structure of global industries and models of market economies. In response, many countries are establishing and adopting policies so that their citizens may reap the benefits of the 4IR. In recent years, industries and governments of various countries have become aware of the importance of the global value chain in terms of policies and investments. They now also recognize the high added value and high growth potential of cold chain logistics. The demand for fresh and safe food and pharmaceuticals is increasing in both developing and developed countries with advanced technologies. The global cold chain logistics market is expected to exceed $233.48 billion by 2019, registering an average annual growth rate of 15.6% during the forecast period. The market’s added value is also gradually expanding. Therefore, this paper describes the technologies of the cold chain industry in the era of the 4IR and suggests measures for establishing a related ecosystem, as well as governmental policy support measures.

II. BACKGROUND

A. The Fourth Industrial Revolution

The first industrial revolution is described as the "mechanical revolution," the second industrial revolution as the "energy revolution," and the third industrial revolution as the "digital revolution," which reshaped the technological, industrial, economic, and social structures of the world in a very short period of time. Brought on by the digital revolution (i.e., the third industrial revolution), the 4IR is defined as an era characterized by a fusion of technologies that is blurring the distinctions between the physical, digital, and biological realms [1].

Based on technologies such as the Internet of Things, Big Data, Block Chain, and Cyber-physical Systems (CPS), and by analyzing big data derived from Online to Offline (O2O) convergence and hyper-connected communications networks connecting people to people, people to things, and things to things, as well as hyper-intelligent hyper-connected networks, pattern identification has enabled everything to become interconnected and spurred the evolution of society into an intelligent society. Figure 1 describes the mechanism driving the 4IR [2].
Cold chain refers to a logistics system that aids temperature or humidity-sensitive products so that they can be safely produced, transported, stored, and consumed. Through the utilization of freezing and refrigeration technologies, a cold chain system preserves and maintains the quality and proper prices of products and regulates supply and demand.

Cold chain is a term used to describe a series of activities, including the production, transportation, storage, and sale of frozen and refrigerated products. Table 1 lists the items commonly handled by cold chain systems.

### TABLE 1. COLD CHAIN ITEMS

<table>
<thead>
<tr>
<th>Fresh products</th>
<th>Processed Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Meat</td>
<td>✓ Processed meat products</td>
</tr>
<tr>
<td>✓ Fishery Products</td>
<td>✓ Frozen food</td>
</tr>
<tr>
<td>✓ Vegetables</td>
<td>✓ Dairy</td>
</tr>
<tr>
<td>✓ Fruits</td>
<td>✓ Ice creams</td>
</tr>
<tr>
<td>✓ Floriculture</td>
<td>✓ Fast food raw materials</td>
</tr>
</tbody>
</table>

The forecast for the global cold chain market predicts an annual average growth of 15.6 percent from $97.84 billion in 2013 to $233.48 billion in 2019. As of 2014, the largest markets, in order, are North America, Europe, Asia-Pacific, and then other regions, though the Asia-Pacific market is expected to overtake the European market after 2019. In Asia, China's market will grow at an annual rate of 25%, leading the growth of the cold chain market. As a result, China's cold chain market is expected to expand to CNY 470 billion in 2017. Despite the worldwide economic recession and port strikes, the volume of sea trade in refrigerated fresh goods has steadily increased over the past decade. In 2014, the figure rose by 4.9% in comparison to the previous year to more than 100 million tons for the first time on record, and in the case of large markets, such as India and China, the types of cold chain systems in use are ever-changing and incorporating the fields of food, bio-medicine, and technology [3,4,5,6].

## III. THE FOURTH INDUSTRIAL REVOLUTION AND COLD CHAIN

### A. Internet of Things

Nowadays, various forms of IoT technologies are being applied in cold chain refrigerated and frozen containers as well as general cargo containers to track the location and status of goods and increase management transparency. When containers full of fresh (perishable) items and general cargo arrive at ports, warehouses, and loading sites, information can be automatically sent to the platform via IoT devices to provide the exact location and status of the fresh cargo, playing a major role in improving the stability of logistics costs of the pertaining cargo.

### B. Smart Container

Almost all major global shipping carriers use containers; however, the development of technologies for safer and more secure transportation of container shipments remains at a low level. As of 2016, there are approximately 43 million dry containers and 1.2 million frozen and refrigerated containers being used worldwide, and there is a constant increase in the number of containers annually.

However, under the existing logistics tracking systems, because current dry containers do not support real-time location tracking or monitoring of door opening and closing, it is impossible to respond to changes, unauthorized removal, or smuggling during cargo transport. Regarding containers without security equipment, the U.S. Customs Service will conduct a full inspection that stipulates additional costs for security reasons (the Security and Accountability for Every (SAFE) Port Act). As a result, problems such as rising logistics costs for Korean exports to the U.S. and for the shippers (owners of goods) are expected.
Such issues can be resolved through the utilization of smart containers, which can be roughly classified into two types: removable types, in which IoT devices can be attached to the existing containers, and embedded types embedded with an IoT center.

C. Block Chain

With the rapid growth of the cold chain market ensuring the safe shipment of temperature-sensitive goods that require temperature control during the distribution process, it is vital to implement block chain-based monitoring and tracking systems.

Block chain-based systems are ideal for cold chain applications because they guarantee transparency of information that is vital for food safety, such as product production date and expiration date. Because the database is distributed and replicated and then passed through the payment process to consumers via apps, it is difficult to falsify information in processes that involve producers and intermediate distributors. In addition, during the shipping process, real-time shipment information such as time, temperature, humidity, shocks, and locations of the goods are collected by integrated IoT sensors based on a block chain system and reported to and shared by the producers, distributors, and end-consumers, thus enhancing the trustworthiness of the information being shared.

IV. COLD CHAIN INDUSTRY AND THE FOURTH INDUSTRIAL REVOLUTION, A COPING METHOD

Government-wide programs are needed to provide support for and foster R&D projects to develop technologies applicable to the cold chain industry. Providing support for R&D technology development projects and the training necessary for highly skilled professionals can help establish a cold chain industry ecosystem and begin a virtuous cycle. In addition, through information sharing and cooperation across all industries, it is possible to establish a governance system that can devise inter-connective and cooperative measures. This system can then manage and actively apply such measures, thus securing the growth and competitive edge of all parties involved, including shipping companies, logistics companies, and new venture capital firms. It is also essential for mid- and long-term governmental policies to promote investment in ICT by private enterprises for the discovery of novel business models based on IoT, smart containers, and block chain technologies.

V. CONCLUSION

The cold chain industry shows high growth potential for its logistic activities with high added value. Cold chain logistics is vital for the fresh and safe transportation of food and pharmaceuticals. Because cold chain shipment items include such temperature-sensitive goods, protections against adverse environmental factors including humidity, sudden shocks, and unfavorable locations are vital. Thus, to monitor and maintain the condition of container goods in real-time, it is necessary to enhance the effectiveness and efficiency of cold chain logistics by fully utilizing the main technologies of the 4IR, i.e., IoT, smart containers, and block chain-based systems. In addition, this paper suggested measures for establishing a related ecosystem and governmental policy to support such measures to vitalize the cold chain industry.

REFERENCES