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Construction of Network Infrastructure for Automotive EDI in Asian Countries

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***Abstract*—Car production in the developing countries in Asia is increasing. As a result, OEM and suppliers in Japan, the U.S., and Europe have grown as well. Although EDI between OEM and Tier-one suppliers is routine, there are a lot of enterprises that have not yet used EDI with small-scale Tier-one or Tier-two suppliers. The environment in which EDI is widely used in Asian car production needs to be further developed to suit the auto industry's needs. Communication infrastructure that integrates correspondence procedures of various EDI is now required. In this paper, the infrastructure is defined, and the need for advanced communication infrastructure is confirmed. I discuss EDI as a suitable communication infrastructure within Asia and beyond. I conclude by arguing for the appropriateness of this communication infrastructure, which has been used in Japan, the U.S., and Europe. Especially, I recommend that this communication infrastructure be widely used in Japan.**

Keywords-*component; EDI, Automotive network, ANX, ENX, JNX, Supply Chain Management*

I. Introduction

Constructing and operating the network infrastructure of EDI in the automotive industry has the potential to level the playing field for competition in related enterprises, such as the assembly and Automotive Original Equipment Manufacturers (henceforth OEM), suppliers, material manufacturers, dealers, financial and insurance companies, and so on. The use of EDI in the automotive industry is already quite advanced compared with other industries, with a long history of effective usage, exchange of various types of data, and global scope. Especially, the construction of the network infrastructure of EDI is advanced in the countries and regions where the main automotive production of Europe, the U.S., and Japan takes place. However, development and operation of EDI in developing countries throughout Asia, where car production is rapidly increasing now, is an urgent problem. Fortunately, there is a history of more than ten years of development of network infrastructure of EDI in Europe, the U.S., and Japan. Their respective EDI network infrastructures work well because technical issues have been solved as they have arisen over time. I would like to discuss the model that is most suitable for developing countries of Asia when EDI infrastructure is installed in the future after analyzing the features of several models.

This paper takes a general view of the form of EDI (traditional EDI and Web-EDI) in the first section. My analysis of the frame of EDI is presented in section two. I discuss infrastructure in section three. Finally, in section four, I present the results of Japanese government efforts to construct infrastructure in Asian countries, where numerous problems have arisen. In the end, I propose that Japanese organizations should cooperate to construct the EDI network infrastructure throughout Asia..

II. Forms of EDI

EDI has two forms: traditional EDI and Web-EDI, which has spread rapidly in recent years due to the growth of the Internet. Before proceeding, it is necessary to review the definitions of EDI.

(1) Definitions of EDI

Hill and Ferguson (1989) defined EDI as follows: "Electronic Data Interchange (EDI) is the movement of business data electronically between or within firms (including their agents or intermediaries) in a structured, computer-processable data format that permits data to be transferred without rekeying from a computer-supported business application in one location to a computer-supported business application in another location" (para 8).

Emmelhaninz (1994) defined EDI in similar terms: EDI is "The organization-to-organization, computer-to-computer exchange of business data in a structured, machine-processable format. The purpose of EDI is to eliminate duplicate entry and to improve the speed and accuracy of the information flow by linking computer applications between companies." (p. 737)

(2) Features and restrictions of traditional EDI

These definitions of EDI were developed before the spread of the Internet, so they are used to define traditional EDI, or classic EDI, today. They assume that OEM connects with Tier-one suppliers by fixed telecommunication lines. In many cases, the traditional EDI system is built into an in-house system of the enterprise. Data is automatically sent and received according to the timing deemed appropriate by the application program. People are not involved in the operation, except in special cases. This means that once a traditional EDI system is constructed, it can be used continuously for many

years. An expert is necessary only for high security use of the telecommunication lines and for updating the application program. These are significant burdens for a Tier-two supplier or a Tier-three supplier, though not significant ones for OEM and Tier-one suppliers. As a result, many enterprises continue to exchange orders and deliver data not by EDI but via fax or e-mail.

(3) Web-EDI

There are now a few hundred Tier-one suppliers for OEM in Japan. It is said that the number of Tier-one suppliers for Toyota Motors is about 250 companies. On the other hand, there are between 2,000 and 3,000 Tier-one suppliers for a single OEM in Europe, and small-scale suppliers continue to communicate data by fax. There are a great many communications of data by fax between Tier-one and Tier-two suppliers. Tier-one suppliers in Germany surveyed by the author in 2010 exchanged about half of their trade data by fax. In these instances, the operator at the Tier-one supplier must input the data described in the fax to process it with its own computer. Because this process is slow and inefficient, one Tier-one supplier started a limited trial of Web-EDI in the latter half of the 1990's. At that time, there was neither concept nor term for what is now known as "cloud-computing." It is now a commonplace aspect of Web-EDI in the German auto sector. *SupplyOn* was established by suppliers (Robert Bosch, Continental Automotive Systems, INA, and ZF) and an IT enterprise (SAP). The first Web-EDI service was launched in Germany in 2000 because the potential of Web-EDI had become significantly larger. Today it is recognized as the best Web-EDI enterprise in the German automotive industry.

III. Framework of Analysis for EDI

I have been investigating EDI and its infrastructure for the automotive sector since the middle of the 1990's. I visited OEMs and suppliers in Europe, the U.S., Japan, Taiwan, Thailand, the Philippines, Singapore, and South Korea to gather information about EDI in those countries and to have discussions with the people in charge of EDI at various firms. I classified the EDI infrastructure into three layers and have developed a model from these experiences as a framework of analysis. The bottom layer relates to protocols of the telecommunication line (X.25, ISDN, TCP/IP, OFTP, and OFTP2 etc.) and connected forms (point-to-point, xNX such as ANX, ENX, and JNX, etc., the Internet, and extranet, etc.). The data format (EDIFACT, VDA, ODETTE, and ANSI X12, etc.) comprises the middle layer. The top layer relates to the application program that sends and receives data. In traditional EDI, two enterprises are connected point-to-point, to send and receive the data processed by the application program of each enterprise. In such cases, it is automatically processed without needing a person's involvement. In contrast, the EDI application program in Web-EDI is a cloud-computing system of the enterprise that provides service. The user confirms data through a browser or downloads and uses the data.

In this paper, the topic of the communication network comprising the bottom layer is the chief point of discussion regarding EDI infrastructure. Web-EDI relating to the application in the top layer and the data format of the middle layer are also very important. However, I want to defer discussion of those points to the future.

ANSI X12 is used in the U.S., and data formats such as EDIFACT, VDA, and ODETTE are standardized in Europe,. Because data conversion is performed by abundant data conversion software and main ERP, data format conversion is not a significant issue for OEM and Tier-one suppliers. However, it is a significant issue for small- and medium-sized suppliers. The reason is the format of smaller companies' data, such as delivery and dispatch by OEM, even if a standard message of EDIFACT is adopted.

IV. Discussion about Infrastructure

(1) Definition of infrastructure

Yoshida (2000) explained that infrastructure is a concept that is best understood synonymously with Hirschman's Social Overhead Capital (SOC). According to Yoshida, Hirschman holds that the public sector chiefly maintains SOC to supplement Direct Productive Capital (DPC). If SOC decreases, DPC shall increase. In such cases, SOC is relatively insufficient, and the indirect production costs of the private sector rise gradually, while the capital of the private organization decreases. In such cases, a request for SOC occurs again, and it expands. For instance, equipment related to harbors, airports, expressways, water for industrial use, communication, and electric power are referred to as "Economic infrastructure." These are considered to be necessary for the production process of private enterprises and generally for economic activity and prosperity. Users can pay a toll to the provider of economic infrastructure directly according to the amount of use. Therefore, there is a worldwide tendency whereby private organizations invest and manage such infrastructure[1] (p. 70).

Yoshida (2000) defined infrastructure as follows:

"The infrastructure is the whole of facilities, service, and the system. It has the aim of contributing to the improvement of productivity, to support the inherent potential of people living under democratic rule, to create the situation in which it functions, to contribute to the improvement of the safety of the citizens and the quality of life directly and indirectly, to offer the function (service) efficiently, and to bring about the best and continued effect on industry (economy) and its citizens"[2] (p. 71). I define the communication network of EDI in the auto industry as a subset of this general network infrastructure of EDI.

(2) Japanese cooperation for the establishment and maintenance of infrastructure

The Japanese government has been involved in infrastructure building in Asian nations through ODA for

some time. Unfortunately, even if facilities and equipment are completed, there have been many cases in which they ceased operating when the Japanese engineer left, or when original parts wore out completely. Reflecting on such failures, the Japanese Government assumed that "package type infrastructure overseas deployment" should be a policy with overriding priority as part of a "new growth strategy" for Asian economies. This policy was adopted by the Cabinet Council in June, 2010. Under the new policy, the Japanese government not only provides equipment and new technology but also maintains and manages the infrastructure after the business rights are acquired. This is a significant departure from past policy. It is called the infrastructure of the PPP (Public Private Partnership). Typical examples include an electric power business, a high-speed road construction business, and a water service business. In most cases, when the Japanese government is involved, the contract is concluded between both parties' governments and government agencies, and the responsibility for various conditions to be carried out by each party is determined beforehand. In this scheme, granting the infrastructure service is the responsibility of the government, so the space for participation and intervention of the government is large. Therefore, the possibility of a conflict between the government and the private sector is quite high (Japan Economic Foundation (2011, pp. 1-8). The government is currently doing this voluntarily or in cooperation with private organizations to construct and maintain infrastructure.

(3) Communication network in Asian nations

Regarding the infrastructure of communication networks, including telegraphic communication, the telephone, and data communication, Japan maintained and managed them in many countries, except the U.S., out of necessity for the security of communication. In advanced countries, privatization has advanced in the infrastructure of communication networks as a result of technical improvements and strong global competitiveness. The government itself still manages and maintains the communication infrastructure in many developing countries, or government influence continues to be strong even after privatization. However, this is chiefly the story of fixed telecommunication lines. Privatization has advanced to the mobile telephone network because technical improvement has been fast, and the cost of the installation of base stations and antennae is cheap. In this paper, I will take a general view of the fixed telecommunication line enterprises that comprise the communication infrastructure of EDI.

1) Case in Thailand[3]

Managed by the Government Telephone Organization of Thailand (TOT) and the Communication Authority of Thailand (CAT), the government has been monopolizing the infrastructure of the telephone and data communications fixed telecommunication line enterprises in Thailand for many years. The Ministry of Finance holds 100% of the stock, though these entities were privatized by the Cabinet Council and became free-standing companies in September, 2000. Currently there is a main carrier, True Corporation (TRUE), in addition to the above-mentioned TOT and CAT.

2) Case in Malaysia[4]

The city communication was liberalized for fixed telecommunication lines of Malaysia in May, 1994. Present fixed telecommunication line enterprises are Telekom Malaysia (TM), Maxis Communication, Time dotCOM, and Digi Telecom. However, TM, which succeeded an old national enterprise, is in a dominant position even today.

3) Case in Vietnam[5]

The fixed telecommunication line enterprise in Vietnam is The Viet Nam Post and Telecommunications Corporation (VNPT). It is the biggest business in the country, and it owns the existing infrastructure, so it is dominant. There is also the governmental Viettel, managed by Vietnam Military Telecom Company and EVN Telecom, managed by the Vietnamese electric power public corporation behind VNPT. Viettel took over the management of EVN Telecom in May, 2012. In addition, there are Saigon Postel and Hanoi Telecom, which are governmental collaborative ventures, and FPT Telecom Company, which entered the market for the first time as a private company in December, 2006.

(2) Infrastructure of communication network

For EDI network infrastructure in developing countries in Asia, especially at the communication layer, point-to-point communication and the Internet are the main uses, and there are many uses of fax, too. The connection of point-to-point should prepare the telecommunication line as well as the terminal unit for each customer at the initial stage of the EDI installation in the automotive industry in Japan, the U.S., and Europe. In many cases, the Tier-one supplier will bear this load because it has a lot of customers (OEMs) and suppliers. It has already been proven that the installation of JNX in Japan, ENX in Europe, and ANX in the U.S. resulted in these solutions for enterprises consolidating the telecommunication lines (Ichida, 2006, 2007, & 2010). If a similar frame is installed, a reduction of expert labor related to communication can be expected, and a reduction of communication costs can be expected in countries throughout Asia.

v. EDI infrastructure construction cooperation in Asia

The number of cars produced in Japan has been maintained at the status quo, or it has shown a downward tendency. On the other hand, because consumers' desire for low prices for cars is strong in the developing countries of Asia, automakers are spurring production in regions close to the consumers. Not only OEM but also Tier-one and Tier-two suppliers are doing so; they stake their survival on it as they confront strong competition there.

(1) Communication network of automotive industry

In the automotive industry, the following communication networks are used in EDI:

1) Point-to-point connection

2) Network of OEM or network of provider that OEM specifies

3) Intranet

4) Extranet

5) Use of provider of global scale

6) The Internet

7) Automotive VPN such as ANX, ENX, JNX, etc.

Which among these qualifies as a communication infrastructure of EDI? When analyzing each against the definition of infrastructure discussed in section three, it is facilities, service, and a system of the communication network that support the development of the enterprise and the organization while contributing to the improvement of safety and quality and providing efficient services and sustainable effects. The network of 1), 2), 3), and 4) above are between specific enterprises or belong to a single OEM or group company of OEM. Therefore, these networks do not contribute to the entire automotive industry. Though the network of 5) is global in scale, too many customers are usually included, and no network has been limited to the automotive sector. The general Internet of 6) does not guarantee the security of data. Therefore, it is natural that xNX, which has developed as a network intended for the automotive sector, is most suitable as the communication infrastructure of EDI.

One of the features of communication infrastructure of EDI is that the trade partner (TP) of xNX can select the carrier from two or more telecommunications providers which xNX has certified. That is, neither the communication tower nor the cables are set up as part of the general infrastructure, even if they can be said to be part of the communication infrastructure. Because the overseer of xNX contracts with an existing communications carrier and constructs VPN for the auto sector, the initial cost is suppressed. The overseer of xNX manages the entire network for the entire VPN. When TP needs support, the overseer of xNX does it. It makes an adjustment when trouble arises with the TP. VPN, which can be accessed by the TP, is highly secure,

(2) A suitable model for EDI communication infrastructure in Asian countries

There are a lot of TPs of ANX, ENX, and JNX in xNX. The organization, service, and system, are different because of subsequent development by ENX and JNX based on the frame of ANX. I will discuss which type of ANX, ENX, and JNX is appropriate as the EDI network infrastructure for the automotive industry in Asia.

When we turn to subject of the management of the organization, we see that ANX was initially established by The Automotive Industry Action Group (AIAG). Later, its management was shifted to Science Application International Corp (SAIC). ANX eBusiness Corp., under One Equity Partners (OEP), is managing ANX now. There is a chance that it may be sold off to other enterprises if management deteriorates in the future because ANX eBusiness Corp. is a private company. That is, it is excluded as a candidate because the continuity required of an appropriate infrastructure cannot be guaranteed.

On the other hand, ENX and JNX are organizations of public interest. The JNX center, which managed JNX, was established in the lower organization of Japan Automotive Research Institute (JARI) in 2000. It was a foundation under the Ministry of Land, Infrastructure and Transport jurisdiction before that, though JARI became a general foundation on April 1, 2012. JARI is an organization that contributes to further progress of the automotive society by maintaining neutrality and pursuing the public interest. The OEMs, suppliers, Japan Automobile Manufacturers Association (JAMA), Japan Auto Parts Industries Association (JAPIA), the government, and people related to a former government, are among the directors of JARI.

ENX Association was founded in 2000. It manages ENX network and is a legally independent union of the following enterprises and national associations: Audi, BMW, Bosch, Continental, Daimler, DGA, Ford, PSA Peugeot Citroën, Renault, Volkswagen, ANFAC (Spain), GALIA (France), OSD (Turkey), SMMT (UK) and VDA (Germany). It supervises the performance of the certified service providers, operates central services of the ENX network, and supports its providers whenever they have to solve problems efficiently.

I name nNX type the EDI communication infrastructure based on the frame of xNX (organization, technology, service, and system, etc.) The reason I recommend not the ENX type but the JNX type for Asian countries is that ENX type does not provide the service and depth of relation to which the automotive sector of Japan is related, such as the following:

1) The chance of a small-scale supplier receiving the favor of the communication infrastructure of EDI was small up to now. A small-scale supplier wants to achieve a low-priced, safe data exchange by an easy operation by the use of the communication infrastructure of EDI. When a service named JNX-LA started up quickly because it offered a low price and availability, even a small-scale supplier increased TA as for JNX. SSL-VPN was adopted as encryption on the Internet side, and authentication was performed by the assigned terminal on the terminal side. Thus, security has been strengthened, even though it accesses JNX via the ordinary Internet.

2) When installing and managing infrastructure, experience and knowledge can be put to use because Japanese OEM and Tier-one suppliers have extensive experience with JNX in Japan. Especially, Tier-one suppliers will achieve the effect of consolidating the line, for they have many suppliers and some OEMs.

3) When JNX was established, the Ministry of International Trade and Industry took part. When the frame of JNX is exported to the developing countries in Asia, its experience is expected to be instrumental in terms of the adjustment with local governments. Moreover, as seen in "(1) the infrastructure maintenance cooperation of Japan" in section three, the Japanese government has recently been making efforts to export infrastructure. If this case becomes

the model for the export of power among OEM and suppliers and management skills, it sounds great. Although it differs from the model in terms of hardware of assumed electric power business, expressway business, and water service business, etc., there is a possibility that all parties concerned will enjoy a win-win outcome in this case.

4) The supplier will be able to enjoy the economy of scale because there are many TP in JNX.

5) JNX worked on the Business Continuity Plan (BCP) before the East Japan earthquake. Backup data center construction (fiscal year 2005), virtualization of the main data center server (fiscal year 2007), and the Certified Exchange Point Operator (CEPO) switch are concretely automated (fiscal year 2010), as is the making of a backup data center server visualization (fiscal year 2011). There was no damage to any key service of the Certified Service Provider (CSP), CEPO, and Common Application Infrastructure (CA) due to the East Japan earthquake. Moreover, the switch to the backup data center was not generated either (JNX 2011). That is, the system was confirmed to be earthquake-proof and very effective in respect to the power supply necessary to secure the data center of JNX. Even if a flood occurs again in the car-producing region of Thailand, the EDI communication infrastructure of this JNX type will not become dysfunctional.

The network infrastructure of EDI of the automotive industry is constructed in each country, such as Thailand, Malaysia, and Vietnam, for TNX, MNX, and VNX based on the JNX type. If it is possible to connect with the line somewhere, TA can use OEM in the neighboring country for business with suppliers via the connected line if the line is made for mutual cooperation afterwards. Japan has the experience of cooperating in the construction of BBC and AICO, which are schemes of automotive parts mutual supplementation circulation exceeding the ASEAN countries in the past. When experienced players construct the communication infrastructure of EDI across each country, it is expected to be most effective.

However, the following solutions to the problem should also be considered:

1) Because current JNX is an infrastructure of domestic-oriented Japan, it is necessary to adjust it to overseas specifications on the management and technological sides. Securing talented people who can communicate in English is indispensable.

2) It is necessary to contract with multiple local telecommunications providers so that TP can select from among two or more telecommunications providers.

3) It is necessary to make the infrastructure correspond with OFTP or OFTP2, which is one of the standard file transfer protocols for OEM and suppliers of Europe and is promoted in developing countries.

Japan should positively take part in the EDI infrastructure building of the automotive sector in the developing countries of Asia, even though there are still problems to overcome. The amount of the investment is small, to the extent that there are fortunately neither physical facilities nor equipment, and the risk is small. If Japan takes part in the infrastructure building of EDI and plays an influential part in controlling it, the influence on the automotive sector in the country and the region is not small either.

VI. Conclusions

I have discussed the possibility of cooperation for the construction of the network infrastructure of the automotive industry in Asian countries where car production has increased rapidly. In addition, I pointed out that the JNX type is suitable and sustainable as a communication infrastructure of EDI in the car producing countries of Asia. If this EDI network infrastructure can be achieved, the possibility to use the JNX type for American OEM and suppliers that use ANX, and European OEM and suppliers that use ENX will expand. I expect that the organizations related to the auto sector of Japan to endeavor to achieve this infrastructure. If it succeeds, it is expected to become a success story for the construction of infrastructures of service and systems without the construction hardware.

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Note

1. The original language of the reference to Yoshida (2000) is Japanese. The author translated this paragraph into English. If there is a mistranslation, it is author's responsibility.
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