Outlining benefits and barriers for employing four types of information system in fourth-party logistics

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Abstract

This paper examines the process of employing four kinds of information systems in fourth-party logistics. The paper mainly tries to answer research questions: what is fourth-party logistics and information systems; what are benefits and barriers for using four kinds of information systems (RFID, WMS, EDI, Electronic marketplace) with the help of fourth-party logistics; what are unique benefits and barriers for fourth-party logistics to employ the four kinds of information systems and how to overcome the difficulties. To answer the research question, qualitative case study approach was employed and two case companies were chosen. Information in literature review was collected from secondary data for example scientific paper. Information in findings was collected from interviews of people in charge of the project and internal reports.

Definitions of fourth-party logistics and information system were reviewed in literature review. The differences between fourth-party logistics and third-party logistics were presented as well. In addition, categorization of various kinds of advanced information systems was also listed.

Benefits and barriers organized from literature and case studies were gathered and compared in discussion. Two significant benefits were identified: opportunities to do businesses with leading companies and improved efficiency. Two main barriers are confusion of the concept of fourth-party logistics and terminology of information system and financial justification. There are different opinions between the two case companies, literature review and empirical data, and between different literature. The paper concluded that there are many benefits and barriers for employing the four kinds of information systems in fourth-party logistics, and the future development of it is promising.

Key words: information system, fourth-party logistics, third-party logistics, benefits and barriers.
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1. Introduction

For most of manufacturing and grocery companies, the management of the long-distance supply chain may not be the core competence of them but cost and time consumed for it is troublesome. Therefore, many companies choose to outsource the logistics services and services like outsourcing logistics, communication and human resources have grown to dominate economic activities of the world (Chanman et al., 2003). Christopher (1993) also advocated that logistics management is no longer a passive and costly function but a strategic section of which provides competitive advantage. Fourth-party logistics is one of logistics services providers emerged recent years.

Win (2008) stated that ninety percent of the study said fourth-party logistics aroused as a solution for problems of demand and supply chain, which could be suitable for various kinds of companies. A fourth-party logistics is service provider of which integrates the supply and demand chain for the clients independently without asset Win (2008). Fourth-party logistics service providers have competencies involving advanced information system, knowledge availability, keeping favorable relationship with all participators of supply chain (Coyle et al., 2003).

Information technologies are growing fast and become major driver and competitive weapons for the development of service industrial (Piplani et al., 2004). Information system in this paper refers to all kinds of advanced hardware and software system for which automate operational process for logistics service providers. As mentioned above, advanced information system is one of the competencies for 4PL providers. An integrated advanced information system contribute to a competitive supply chain, and a competitive supply chain gives a company competitive edge in the market (Bowersox and Daugherty, 1995). Since information system is a too general concept to analyze, this paper only focuses on four kinds of it. According to Jonsson (2008) there are four types of information system: Planning and executing system,
communication system, identification system, and electronic marketplace. The paper will discuss four kinds of information systems: Warehouse Management System (WMS) from Planning and executing system, Electronic Data interchange (EDI) from Communication system, Radio Frequency Identification system (RFID) from Identification system, and Electronic marketplace system.

There is little research discussed what fourth-party logistics could do to management information system, though plenty companies are interested to know what is fourth-party logistics and what it is capable of. Many researchers have investigated information systems in supply chain management: Gunasekaran & Ngai (2003) developed a framework for the study of applications of advanced information system in supply chain management; Cooper & Zmud (1990) tried to organize an implementation model of advanced information system for companies. Some researchers have looked advanced information system in third-party logistics: Piplani et al. (2004) did surveys for third-party logistics service providers on the use of advanced information system in Singapore. Because of the lack of research on the four kinds of information systems in fourth-party logistics, outlining the benefits and difficulties brought by applying fourth-party logistics to manage advanced information system is the key purpose of this paper.

2. Purpose

Concluding benefits and difficulties of employing advanced information systems for automating operational processes for logistics service providers in fourth-party logistics is the general research question of this paper. Since fourth-party logistics is a less explored research area, the discussion would emphasis on difficulties and benefits for fourth-party logistics to employ four kinds of information systems (WMS, EDI, RFID, and Electronic marketplace). Some suggestions to overcome the difficulties occurred shall also be given.
The objectives designed for this paper are:

- Identifying the definitions of fourth-party logistics, the competencies that fourth-party logistics could offer, and the differences between fourth-party logistics and third-party logistics. Identifying the contents of advanced information system of supply chain.
- Formulating benefits and difficulties to employ the four kinds of information system in fourth-party logistics from literature reviewed and empirical data collected from the case companies.
- Suggestions to deal with the difficulties appeared.

3. Methodology

Research methodology used for this paper is discussed in this chapter. The paper is a qualitative case study research. The case selection and description, sources of data, analysis of data, validation and reliability are presented below.

3.1 Research strategy

3.1.1 Case study approach

Merriam (2009, pp. 39) introduced qualitative case study as “an in-depth analysis of a bounded system”. Eisenhardt (1989) described case study approach as a research strategy that tries to understand dynamics phenomenon within one fold settings. The two definitions express a same meaning with different words. This paper employs qualitative case study as basic research strategy for many reasons.

First of all, the principal research question of this paper is to find benefits and difficulties of employing information in fourth-party logistics. In another word, the paper answer the question why employing advanced information system using fourth-party logistics. In the light of the study from Yin (2008), research strategy case study is designed to solve why and how question. Furthermore, case study is suitable
for subjects that are not fully understood by researchers and public (Voss et al., 2002),
or subjects that are integrated with practice context (Yin, 2008). The research subjects
of this paper are fourth-party logistics and advanced information system, which
sometimes are confused by researchers, and to analyze their benefits and barriers
requires for much empirical data. Last but not least, according to Eisenhardt (1989)
case study can be used to provide description, test theory, and generate theory. In this
paper case study were used to describe processes of employing advanced information
system in fourth-party logistics and test benefits and barriers identified in theories.
The three points presented above are reasons for using qualitative case study as major
research strategy.

3.1.2 Case selection and description of case companies
Choosing cases is important for figuring out research question as Pettigrew (1990)
stressed. For this paper, case companies need to work as fourth-party logistics service
provider, be in the market for several years, and help their customer to build advanced
information system. Through choosing and contacting with companies, two case
companies were chosen in this paper: Weihai Bonded Logistics Park (BLP) and
Infocomm Development Authority (IDA) of Singapore. The two case companies
fulfilled the criteria mentioned above and were willing to take part in the study.

There are many differences between the two case companies. Table 1 summarizes
basic description of the two case companies from aspects of type, size, ownership,
products, foundation of company, location, customers, market. The differences
between the cases are in favor of comparing and concluding benefits and barriers in
the implementation processes that do and do not depend on one specific advanced
information system.
Table 1: the basic description of the two case companies for the paper

<table>
<thead>
<tr>
<th></th>
<th>Weihai BLP</th>
<th>IDA of Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Logistics services provider B2B</td>
<td>Advanced information system provider B2B</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Medium size company</td>
<td>Large company</td>
</tr>
<tr>
<td><strong>Ownership</strong></td>
<td>State-controlled</td>
<td>State-owned</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td>WMS and RFID</td>
<td>EDI and electronic marketplace</td>
</tr>
<tr>
<td><strong>Foundation of</strong></td>
<td>2008</td>
<td>1999</td>
</tr>
<tr>
<td><strong>company</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>China</td>
<td>Singapore</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>Triangle Group Co., Ltd.</td>
<td>Weihai Port Group Co.</td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td>Mainly in Shandong province</td>
<td>Asia</td>
</tr>
</tbody>
</table>

3.2 Research process

3.2.1 Sources of data

In this paper, data was categorized into two sections: literature review and findings. Several different data collection methods were used. Data collected through different methods and sources enables cross-checking (Eisenhardt, 1989).

As Murray & Hughes (2008) stated, for literature review the sources of data could come from books, scientific papers and documents. Literature review shows the connection between the paper and existing body of knowledge. Secondary data, such as books, scientific paper and documents, with the keywords like fourth-party logistics, logistics service provider, and advanced information system or system are used in literature review.

The empirical data presented in findings section was collected from interviews, internal documents from the case companies, reports of the related projects. Owing to
the geographic limitation, direct observation of the case companies is not possible. Four online interviews were held to collect data and the general questions were sent by email before the interviews. The interviews were held with general manager and project leader of the advanced information system project from Weihai BLP, assistant manager of Weihai Port Group Co. Ltd and project leader of the advanced information system team from the IDA of Singapore. The four interviews are about one hour for each. What is more, the interviews are semi-structured interviews, which mean the interviews were structured within a specific list of topic area but not specific questions (Jarratt, 1999). Some major topics were designed before the interviews and during the interviews specific questions were formulated by interviewers. The interviewees were asked approximately 13 questions. The interview questions are presented in the appendix.
3.2.2 Analysis of data

The methodology of analyzing data combined empirical data and secondary data. The flow chart of data analysis process is shown in figure 1.

![Flow chart of data analysis process](image)

Figure 1: flow chart of data analysis process.

Literature review consists of introduction of fourth-party logistics and all kinds of advanced information system as well as drivers and barriers of using fourth-party logistics and advanced information system. In the findings part, descriptions of the two cases and benefits and barriers of the cases were presented. As displayed in figure 1, benefits and barriers from literature review and case studies were compared and conclusions were draw from the comparison.

3.3 Research quality
3.3.1 Validity

Construct validity, internal validity and external validity are three major aspects of validity of a paper (Yin, 2008). The validity of this paper is discussed following this order. According to Yin (2008), construct validity is about identifying right operational steps for the research concept; internal validity for explanatory studies it to build causal relationship that one thing could lead to another thing under certain circumstances; external validity is to regulate in which domain the finding of the study can be generalized.

To increase construct validity multiple sources of evidence were used, such as secondary data from scientific papers, interviews of the case companies and internal reports of the advanced information system projects. According to Yin (2008), other two ways to increase construct validity are building a chain of evidence and have key information presented and discussed in findings and conclusion, which were done in this paper.

Internal validity could be improved by using techniques of doing within-case analysis, cross-case matching, explanation-building, and guaranteeing the internal coherence of findings (Riege, 2003). The two case studies were analyzed independently in finding chapter and then compared in discussion chapter. The description of two cases following the structure of introduction, presentation of project process and content, and benefits and barriers aroused. In discussion chapter, concepts mentioned in literature review were analyzed with empirical data in case studies, which contributes to a systematic structure for the paper.

External validity is about the ability to generalize findings and conclusions to companies beyond the cases. As mentioned in table 1, the two case companies have different settings in locations, products, ownership, and markets. Two case studies have higher external validity compared with single case study. What is more, the case company Weihai BLP could represent many fourth-party logistics companies in China
because in China most of fourth-party logistics companies are the same with the case company, which are not large companies and newly rouse. IDA of Singapore could represent fourth-party logistics companies in developed countries in Asia. Fourth-party logistics companies are service companies of which have some history in developed countries of Asia. The case company IDA of Singapore is from developed country Singapore with over ten years history and plenty of experience in doing this kind of businesses. Hence, the two case companies could represent medium and large fourth-party logistics companies with short and long history in developing and developed countries in Asia.

3.3.2 Reliability

According to Yin (2008) the possibility to do the same study once again and come to the same conclusions is called reliability. As for this paper, if take other two fourth-party logistics companies to analyze the benefits and barriers of implementing advanced information system for their customer, the conclusion will not be exactly the same with this paper but part of the conclusions would be similar. The literature review was made from peer reviewed paper. The conclusion of this paper combined theories collected from literature review and empirical data from case companies, so some of the conclusions are universal for most of cases. While since only there was only two case companies discussed, part of the conclusions may be biased and not able to be reached if more companies are involved.

To enhance reliability of the paper, case study protocol was developed and followed. As Yin (2008) defined four steps should be included in case study protocol: an overview of the case study project, field procedures, case study questions, and a guide for the case study report. In the overview of the case project objective of case study was identified as finding benefits and barriers for employing advanced information system in fourth-party logistics and related readings were written in literature review. For the field procedures, since there is no visit for the case companies but only interviews were made, the dates of the interviews were 24th, 25th of April and 23rd,
25th of May. Interviewees are general manager and project leader of the advanced information system project from Weihai BLP, assistant manager of Weihai Port Group Co. Ltd and project leader of the advanced information system team from the IDA of Singapore. When it comes to case study questions, the specific interview questions were designed according to the objective of the paper and understanding of concerning concepts from literature review and presented in appendix. The guide for the case study report is about the structure for the case study, which is start by introduction of the case companies, and then contents of the related projects, followed by benefits and barriers of the projects, finally analysis of the similarity and differences of the data collected.

4. Literature review

Fourth-party logistics providers and information system are the key words for this paper. The concept of fourth-party logistics provider is closely related to logistics services and easily confused with third-party logistics provider. Hence, the reviewed literature introduces four subjects: logistics services, third-party logistics, fourth-party logistics, and advanced information system.

4.1 Logistics services

Advanced information system as well as fourth-party logistics are functions of logistics services. As Bowersox & Closs (1996) acknowledged that, in recent years the functions of logistics services have expanded from marketing and manufacture to warehousing, transportation activities, purchasing, distribution, inventory management, packaging, and customer services, which summarized the logistics services integrated. Apart from the abundant service functions, the relationship between clients and logistics service providers evolved from tactic solution of cost reduction to strategic alliance (Chapman et al., 2003; Langley et al., 2005).

According to Grönroos (2000), the competition nowadays is focused more on the
basis of services not on the basis of physical products. As the cost and efficiency of logistics services grow to have greater impact on economic activities, outsourcing the services to another independent company becomes a popular choice. Third & fourth-party logistics providers are businesses of which offering that kind of help. Since third-party logistics is a more familiar concept, the review would start by introducing it first.

4.2 Third-party logistics

Third-party logistics providers are companies that offer complete or partial logistics services for their customers (Rajesh et al., 2012). Through years of development, third-party logistics provider is accepted by most of businesses. There are surveys done by Lied & Miller (2002) of which exposed that 77 percent of Fortune 500 manufacturers employ multiple third-party logistics providers for various kinds of services. In addition, among those companies that using third-party logistics, half of them have been using the services for more than 5 years. The figures indicate that outsourcing logistics services has really become a common practice.

The survey also investigated what kinds of services are required (see table 2 for the frequency of the used services). Comparing with the classification of logistics services made by Bowersox & Closs (1996) the division of outsourced logistics services are more detailed about the process.

Table 2: The most frequent used logistics services (Lied & Miller, 2002)

<table>
<thead>
<tr>
<th>Logistics Function</th>
<th>Used Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse management/operation</td>
<td>59 %</td>
</tr>
<tr>
<td>Direct transportation service</td>
<td>49 %</td>
</tr>
<tr>
<td>Freight forwarding</td>
<td>44 %</td>
</tr>
<tr>
<td>Shipment consolidation</td>
<td>43 %</td>
</tr>
<tr>
<td>Freight payment</td>
<td>40 %</td>
</tr>
<tr>
<td>Service</td>
<td>Percentage</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Customs brokerage</td>
<td>38%</td>
</tr>
<tr>
<td>Consulting services</td>
<td>30%</td>
</tr>
<tr>
<td>Tracking/tracing</td>
<td>30%</td>
</tr>
<tr>
<td>Carrier selection</td>
<td>29%</td>
</tr>
<tr>
<td>Relabeling/repacking</td>
<td>27%</td>
</tr>
<tr>
<td>Rate negotiation</td>
<td>29%</td>
</tr>
<tr>
<td>Fleet management/operations</td>
<td>24%</td>
</tr>
</tbody>
</table>

Some of the frequently used logistics services listed above are connected with advanced information system management, such as warehouse management/operation and tracking/tracing. The IT support, like advanced information system management, offering by the logistics services providers is heavily relied by the logistics service user (Lied & Miller, 2002; Bessant & Rush, 2000). The advanced information system management is disused detailed in the fourth section.

Sheffi (1990) recognized two main types of Third-party provider, companies that own their own transportation assets and those that do not. However, in recent research the second kind of company that does not have tangible logistics assets is called fourth-party logistics.

**4.3 Fourth-party logistics**

To begin with, as many of the researchers acknowledged that there are similarities between third-party logistics and fourth-party logistics. To interpret fourth-party logistics precisely, it will be discussed by three steps: definition, fourth-party VS third-party logistics, and finally drivers and barriers of employing fourth party logistics.

**4.3.1 Definition for fourth-party logistics**

Fourth-party logistics dose not have a widely accepted and accurately defined
definition. However, some researchers have come up with their opinions. Win (2008) viewed that:

“A fourth-party logistics is an independent, singularly, accountable, non asset based integrator of a clients supply and demand chains. The role is to implement and manage a value creating business solution through control of time and place utilities and influence on form and possession utilities within the client organization.” (Win, 2008, pp. 677)

This definition points out the nature of fourth-party logistics and explained roughly how it works with client. While, it only see fourth-party logistics from the angle of value creation, which makes it lack of integrity. Despite of the short coming, the definition could give the reader a general idea of what is fourth-party logistics.

4.3.2 Fourth party VS Third party logistics
As presented above, most of companies are familiar with third-party logistics and many of them have more than one third-party logistics providers. Lied & Miller (2002) discovered that the user of third-party logistics provider intends to expand service range, continuously cut down cost and have a lead logistics provider. This phenomenon is the reason for fourth-party logistics emerging (Bowersox et al., 2007).

Fourth-party logistics is capable of managing various kinds of third-party logistics for its customer (Coyle et al., 2003). What is more, fourth-party logistics is a “leading edge consulting firm and technology provider” and a “break through supply chain solution” (Cheng et al., 2008). The terminology of fourth-party & third-party logistics is ambiguous for readers. To distinguish those two concepts, the differences of them are organized in table 3.

Table 3: Differences between fourth-party logistics and third-party logistics
<table>
<thead>
<tr>
<th>Factors</th>
<th>Third-party logistics</th>
<th>Fourth-party logistics</th>
<th>Referenced literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset basis</td>
<td>Asset based (assets like warehouse and means of transportation)</td>
<td>Non asset based (apart from e.g. advanced information system)</td>
<td>Win, 2008</td>
</tr>
<tr>
<td>Accountability</td>
<td>Partial accountability (be accountable together with other third-party logistic providers/carriers)</td>
<td>Singular accountability</td>
<td>Win, 2008</td>
</tr>
<tr>
<td>Relationship structure</td>
<td>Tactical</td>
<td>strategic</td>
<td>Gattorna, 1998; Langley et al., 2005; Mukhopadhyay &amp; Setaputra, 2006</td>
</tr>
<tr>
<td>Role</td>
<td>Logistics service provider</td>
<td>Logistics service provider as well as supply chain integrator</td>
<td>Bowersox et al., 2007; Coyle et al., 2003; Craig, 2003; Mukhopadhyay &amp; Setaputra, 2006; Win, 2008</td>
</tr>
<tr>
<td>Neutrality</td>
<td>Not Neutral (e.g. take side with its cooperated carriers)</td>
<td>Neutral</td>
<td>Gattorna, 1998; Mukhopadhyay &amp; Setaputra, 2006; Win, 2008</td>
</tr>
</tbody>
</table>

Table 3 illustrates that fourth-party logistics provide strategic alliances for customer,
which leverage supply chain management skills, strategy and technology that will take years to duplicate without support. While, there is also an interesting fact existing in the world of fourth-party logistics that when a third-party logistics of which possesses core competence of the outsourced function the company often tries to form a fourth-party logistics provider (Gattorna, 1998; Mukhopadhyay & Setaputra, 2006). The survey done by Langley et al. (2005) asked questions: what kind of company is suitable to offer fourth-party logistics services. Existing third-party logistics providers received highest vote over 4 years (2002-2005). New firms with former third-party execs became potential competitor in recent years.

4.3.3 Drivers and barriers for using fourth-party logistics

Exploring benefits and difficulties for employing advanced information system in fourth-party logistics is the main topic of this paper. First, drivers and barriers for using fourth-party logistics discussed in literature are categorized.

Drivers for employing fourth-party logistics are listed:

- A large proportion of manufactory companies use more than one third-party logistics providers at the same time and demand for a leading company to manage the relationships with various logistics providers (Lied & Miller, 2002).
- Fourth-party logistics is supply chain integrator of which offers technology and logistics management experiences for its clients (Bowersox et al., 2007; Coyle et al., 2003; Craig, 2003; Mukhopadhyay & Setaputra, 2006; Win, 2008).
- Suppliers and logistics services providers show willingness to take part in fourth-party logistics, because they could see the opportunities and potential gain (Hingley et al., 2011).
- Green issues drive the choice of customer. Employing fourth-party logistics in supply chain management cut down transportation time and it can help to run reverse logistics (Hingley et al., 2011).
- The use of logistics services will continue to grow, which indicates a booming
market environment for fourth-party logistics to development (Chapman et al., 2003; Lied & Miller, 2002)

- Being associated with such innovations benefits the reputation of a company, contributing better customer cognition (Barratt, 2004).

Barriers for employing fourth-party logistics are listed:

- The survey shows that many of companies still confused by the difference between third-party logistics and fourth-party logistics. The confusion hinders the expansion of fourth-party logistics (Langley et al., 2005).
- Small and medium size companies are not interested in using fourth-party logistics because of the cost and the complex standards it may bring (Hingley et al., 2011).
- Companies worry that using fourth-party logistics may change the current supply chain system and the changes may cause lots of problems, for example harming the relationship with retailers (Kumar, 2005).
- Suppliers are concerned about the flexibility of fourth-party logistics when reacting to local circumstances. Compared with local logistics service provider, fourth-party logistics provider may neglect local influences (Grant, 2005).
- Cost for hiring fourth-party logistics service provider is also one barrier (Hingley et al., 2011).

4.4 Information system

In supply chain management, the accessibility of complete, real time and correct information is crucial for the efficient flow of material (Jonsson, 2008; Helo & Szekely, 2005). To capture and share the right information various kinds of information systems are used in logistics and supply chain management (Copacino, 1998; Gold et al., 1998; Knill, 1998). The definition of logistics information system is:
“People, equipment and procedures used to gather, sort, analyze, evaluate, and distribute needed, timely and accurate information to decision makers.”
(Murphy & Wood, 2004, pp. 66)

4.4.1 Description of different information systems

Information systems can be categorized into different groups by different standards. Jonsson (2008) divided information system into four groups: Planning and execution systems, Communication systems, Identification systems, and Electronic marketplaces. The inter-relationship within the four kinds of information system is shown in figure 2.

Figure 2: inter-relationship within different information technologies (Jonsson, 2008).

Planning and executing systems consist of databases and software that offering information and data for decision making. Jonsson (2008) sorted two types of systems. The first type of planning and execution system is Enterprise Resource Planning System (ERP), which is a business management system that contains computer systems support for all business units (Hsu & Chen, 2004; Jonsson, 2008), such as marketing, finance, human resources, logistics, manufacture, etc. The second type of systems are specialized programs designed to meet specific planning needs, such as
WMS, Advanced Planning Scheduling systems (APS), Transport Management System (TMS).

Communication systems are different communication methods that enable information exchanges within and between companies. Apart from common communication methods like internet, telephone, letter, fax, email, and radio-frequency, EDI and Electronic data access (EDA) are popular communication systems as well. EDI is defined as business information exchange through computer between organizations and different units within the organization (Arunachalam, 1995; The UN/EDIFACT standards, 1984).

Identification systems are used to capture data automatically and identify goods in the flowing processes. Bar code system is the most common system for goods identification (Jonsson, 2008). RFID readers capture information form the tag via electromagnetic waves (Kärkkäinen, 2003). Comparing with bar code system, RFID does not require manual handling to make the tag and reader to be in line and all goods in a truckload can be read at the same time, which making the process less time consuming (Jones, 1999). Other identification systems are Optical character recognition (OCR) and Global positioning system (GPS).

Internet-based systems that supporting purchasing and selling with various companies are called electronic marketplace (Jonsson, 2008). Buying and selling goods and services via electronic marketplaces could help to form collaboration with different organizations, this process is known as e-commerce or e-business.

4.4.2 Model of the information system implementation process
The implementation of information system is an organizational effort for which needs systematic process control (Cooper and Zmud, 1990). Zmud and Apple (1989) described the implementation process into six parts:
• Initiation is the process that problems in an organization are found and solution about information system is putting forward.
• Adoption is the process that negotiations are made for supporting the implementation of information system.
• Adaptation is the process that the information system program is developed, installed and maintained.
• Acceptance is the process that members of the organization are come to commit to the information system program.
• Routine is the process that the information system program has become a normal activity in the organization.
• Infusion is the process that continuous efforts are made in using the information system.

4.4.3 Drivers and barriers of using information systems

Plenty of information systems have been used for many years, such as EDI, WMS, and RFID etc. the empirical data of implementing these systems exposed drivers and barriers of information systems.

Drivers for employing information systems:

• Compliance with major trading partners may be the first and foremost reason for company to employ information systems (Iacovou et al., 1995; Vijayaraman & Osyk, 2006). The power of the trading partners could be significant factors in pushing information system updating. For example, Wal-Mart, Target and Tesco are interested in RFID and recommended to use it in logistics processes. As a result, many companies have to comply with the powerful retailers and started to use RFID.
• Cost saving is crucial internal needs and perceived benefits of information systems (Iacovou et al., 1995; Janssens & Cuyvers, 1991). Cost saving consists of many aspects: reduced operation cost, reduced labor cost because of less material
handling, reduced lead time, and less identified defects (Aggarwal et al., 1998).

- Better inventory management is also one driver. For example, RFID and WMS are able to keep tracking of the goods through the transportation processes, improve inventory accuracy, and allow collaboration on inventory management, planning, forecasting, and replenishment (Frazelle, 2002; Lee & Moon, 2002).

- Information systems enable tracking of shipments, materials and products (Holmström et al., 2010). Significant information like location, transportation time, and production data will be documented and shared within and among companies.

- Visibility of inventory and logistics process can be achieved through the use of advanced information system (Vijayaraman & Osyk, 2006).

- The service level for customers could be improved (Jun et al., 2000). Customer services will be punctual with less mistakes and more product information.

- Adding up the advantages mentioned above, efficiency will be gain.

- Apart from the benefits information systems brings, the competitive pressure among manufactory and logistics businesses pushes them to be innovate and adopting new technologies (Iacovou et al., 1995).

Reasons for not deploying information systems:

- The biggest challenge for employing various kinds of advanced information system is to control the cost while realizing significant benefits (Vijayaraman & Osyk, 2006). Take RFID as an example, Alvarez (2004) said that the costs of tags and related infrastructure are greater than perceived benefits.

- Some of the information systems are lack of international standard, such as EDI and RFID (Bamfield, 1994; Vijayaraman & Osyk, 2006). No standard results in the situation that companies on one supply chain have different standard information, which made information sharing difficult to operate in the real world. It is hard to meet the administrative requirement of information systems for both upstream and downstream companies in the supply chain, due to the variation of
information systems.

- Lack of systematic understanding for information systems is also an obstacle (Iacovou et al., 1995; Vijayaraman & Osyk, 2006).
- Technology concerns are not easy to deal with. For instants, the difficulty to integrate certain complex information system with existing business processes (Elmuti & Abebe, 2005; Iacovou et al., 1995).
- Privacy and security concerns also emerged, as McGinity (2004) discovered, the information collection may violate consumers privacy. The key issue is the security of the data gathered from identification systems.
- The willingness to share data with trading companies sometimes is weak. In another word, trust issues are knotty for the integration of information system (Iacovou et al., 1995).

4.4.3 Advanced information system in third-party and fourth-party logistics

As discussed in the third-party logistics section, many companies choose to outsource logistics services concerned about advanced information systems management to third-party logistics providers (Lied & Miller, 2002). There are also many scientific papers about the performance of third-party logistics when managing WMS, EDI, ERP, and RFID technologies.

Power et al. (2007) wrote that using third-party logistics have positive effect on customer service performance while third-party logistics providers are employed in managing information systems such as EDI and WMS. As Berglund et al. (1999) concluded in their paper, the most popular outsourced information based logistics service is planning and execution system like the management of transportation and warehousing. Tracking and tracing activities are outsourced to third-party logistics as well. Piplani et al. (2004) did surveys to outline the use of advanced information system in third party logistics service providers for Singapore. The survey revealed top five motivate factors and barriers for advanced information system adoption in third-party logistics providers. The motivate factors and barriers are similar to the
drivers and barriers listed in preceding section. Since fourth-party logistics and third-party logistics are logistics providers, drivers and barriers for adopting advanced information system in fourth-party logistics might be almost the same.

Although Win (2008) advocated that the skills, technology and global impact of fourth-party logistics are hard to duplicated, and many researchers conclude that fourth-party logistics is better than third-party logistics when it comes to strategic thinking. Little literature mentioned about the performance of fourth-party logistics in managing advanced information system. Hence, to discover the benefits and difficulties to managing advanced information systems in fourth-party logistics is the gap the paper try to fill in.

5. Finding

Two cases of employing fourth-party logistics are described in this part. The two fourth-party logistics providers are Weihai Bonded Logistics Park (BLP) and Infocomm Development Authority (IDA) of Singapore. WMS, RFID, EDI, and electronic marketplace are advanced information systems and technologies were used by the case companies. The following descriptions about two advanced information system applying are collected from project report and proposal of the case company and interviews with general manager from Weihai BLP and Weihai Port Group Co. Ltd.

5.1 Weihai BLP

The first case company is Weihai BLP, which is a wholly-owned subsidiary company of Weihai Port Group Co. Ltd. The company locates on the northeast corner of China. The special location leads to a frequent commerce with South, North Korea and Japan. Weihai BLP serves as a forth-party logistics service provider for tire manufacture Triangle Group Co., Ltd. located in Shandong Province in WMS management based on RFID technology.
The strategic alliance between Weihai BLP and Triangle Group Co., Ltd. started in 2009 and continues today. The description of the case is presented in four levels: the situation and problems before the fourth-party logistics provider got involved; the introduction of the advanced information systems brought by the case company; achievements after employing it; finally difficulties emerged during the process.

5.1.1 Before the fourth-party logistics provider got involve

As a tire manufacture, in logistics link Triangle Group Co., Ltd. is supposed to deliver goods to customer with minimal cost and time. While, the reality is that the logistics link of the company became a bottle-neck of further development.

Weihai BLP summarized five major problems faced by its customer in logistics in its report (see figure 3). Based on those problems, the specified WMS management with the help of RFID technology is introduced to Triangle Group Co., Ltd.

![Figure 3: weakness for the logistics link of Triangle Group Co., Ltd.](image)

5.1.2 WMS based on RFID

This advanced information system outsourced project consists of three steps
according to the contract (mentioned in internal operation report, 2013).

The first step is system design and arrangement planning. Technicians visited customer and got to know about current situation of logistics. Based on the investigation, “Standardized execution plan for warehousing management system” was drawn, which includes blue print of building advanced information system, management system, operation flow, and technological standard. Then, training the customer employees and making supervision on their operation.

In the first step, the fourth-party logistics provider integrates RFID intelligent warehousing system into logistics process of customer. RFID intelligent warehousing is WMS management based on RFID technology. Advanced information system team adjusted the system design according to the manufacture, logistics and sale data of customer. After adjusting, there are totally eight function modules for the special designed RFID intelligent warehousing for customer: system management, inbound management, outbound management, inventory accounting management, intelligent rack, allocating and moving, inspect management, and statement analysis. In the blue print of advanced information system, RFID forklift, RFID reader and tag, smart terminal, and warehouse management system are used.

Management system is the second content in “Standardized execution plan for warehousing management system”. The case company offered customer internal management handbook concerning about equipment, safety and staff management. The third content is operation flow. Rigorous flows are designed for inbound and outbound process (see figure 4 & 5). The fourth content is working standard design for receipt of goods, stocking of goods, packaging of goods, stacking of goods, and delivery of goods.
In the inbound logistics flow chart, critical points are attaching RFID tag and entering information into computer system. When attaching RFID tag, the information about goods is reorganized and seeded into the tag, which is the beginning point of goods information tracking. The information entered in computer is important basic step for information digital process and information sharing.
Through the outbound logistics process, all the information transfer among sale, warehouse and transportation department is carried out via WMS. What is more, RFID readers are equipped on forklifts to make sure the accuracy of picking goods.

Step one spend about six months in total. Then is comes to step two: test run for the designed system. During the test run, the case company monitored and gave instructions for customer, which lasted for approximately nine months. The final step is maintaining of the system of which started right after the test run ended and the system officially begin to run. The case company is responsible for dealing with problems aroused in the maintaining stage for two years duration.

5.1.3 Achievements for employing advanced information systems in fourth-party logistics
Going through five years developing, achievements for implementing the project were collected from data from customer through feedbacks by the case company and summarized in the final report of the project and.

• To start with, reduced error rate, such as data enter error and human error, is one obvious achievements. The error rate is reduced to less than one in million. If a mistake is found, a person who is responsible for that mistake could be found easily through the system.

• Reduced inventory cost is a desirable result of the project. The number of employees working in the warehouse reduced by 27 percent, and cost of inventory for one thousand goods reduced by 28 percent.

• Efficiency improved from many aspects. Working performance per person improved by 245 percent, total number of in and out goods increased by 33 percent as well. The project enables visible tracing for goods, intelligent fork
lifter dispatch, speediness location, automatic inventory check, and generating needs for replenishment automatically.

- Further integration of supply chain activities has been achieved among production, transportation, stocking and forecasting units. The system makes it possible to take in control of the inventory situation and adjusts production and sale plan accordingly.
- Last but not least, order cycle time is reduced through accelerate velocity of goods, quicker capital return, and faster goods exchange.

5.1.4 Difficulties emerged in the project

There are plenty of obstacles aroused in the implementation process, mentioned by the general manager of the fourth-party logistics services provider Weihai BLP in interviews.

- Financial justification is the most intractable problem at the beginning of the project and throughout the whole implementation process. When the case company talked over the cost issues with customer at the very beginning, customer is not willing to pay such a high price for the project, although interested with the topic. During the implementation process the infrastructure and adjusting cost exceeded the plan a little bit, which caused lots of trouble to explain to customer.
- Lack of customer trust is a deadly barrier. It took a long time for the case company to gain trust from customer, since customer is not familiar with the concept of fourth-party logistics and does not believe that the case company can do as they claim. After many meetings and seminars, the trust relationship started to build.
- The major third-party logistics provider of customer is difficult to persuade. The third-party logistics provider for part of warehouse management of customer is not happy with the collaboration at first. The case company made compromise with the third-party logistics provider to gain their support.
• The case company itself is in developing stage and has little success case and experience. Time is needed to overcome these problems.
• As mentioned above, many reasons resulted in a long implementation period for the project.
• The degree of office automation in China is rather low. Vital information is integrated into advanced information system by this project. However, the need for paper is still existing, which force the case company retain some paper exchange and organization process in the logistics flow.
• The customer in this case does not have wide supply chain range. Hence the improve space for supply chain integration is small. For example, the project did not integrate other trade partners in the supply chain, apart from the third-party logistics provider.

5.2 The IDA of Singapore

The second case company is the IDA of Singapore, which is a statutory board of the Singapore Government formed on 1 December 1999, to cope with advanced information system and telephone problems. The case company works as a fourth-party logistics provider for Weihai Port Group Co. Ltd. in project of building intelligent port. The IDA of Singapore is a figure in advanced information system in Asia and has oversea offices in US, China and Indian.

The case company and Weihai Port Group Co. Ltd signed cooperation agreement on building intelligent port in 2013. This project is an ongoing case with grand scale and lots of troubles. First, the content, strategy and concerning advanced information system will be introduced. Then the expected benefits will be listed. At the end, the problems facing by the case company are described.

5.2.1 The content of the project

The content of this project has four primary sections, according to the proposal of action plan written by the case company. Before introducing the advanced information
systems, the overall development strategy & planning of the port and the consulting of the efficiency of port running are planned to be done. The first two sections help to establish a background analysis, overall strategy and direction for customer.

The third section is about setting up advanced information systems, such as EDI and electronic marketplace. How to improve port running efficiency through paperless transaction is the first large project in building intelligent port. The paperless transaction could be achieved by EDI system.

To establish EDI centre, the case company plan to set data exchange standard according to United Nations/Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT). Setting data exchange standard for customer and their trading partners is the first move. Next is to discuss interface design for data exchange, data transformation design, data structure design, and framework for EDI system in depth. After completing EDI system design, the construction of infrastructure plan shall be made. Then how to run to EDI system in practice will be given to customer. Through these actions the logistics process of Weihai Port shall transform from manual handling work with paper to automatic working process.

The second advanced information system the project tries to build is electronic marketplace among the port, consignor, consignee, carrier, charter agent, logistics service provider, marine board, and free zone authority. To integrate working process, reduce approval links, and sharing data with trading partners, government and customers, a synthesis logistics information platform is planned to be established (see figure 6).
The fourth section from the proposal is training program of staff for advanced information system management. An excellent system can not run without proper operation and maintenance. People with the capability of running advanced information system is essential for the success of the project. The case company will make training program based on the practical situation of human resources for customer.

The estimated time for finishing the project is 17 months, while actually there are many delays for this project. The total cost for the project is still not clear, but it can not be cheap.

5.2.2 Expected benefits
The expected benefits are concluded in the proposal for the intelligent port project.

- Weihai port has to deal with various logistics service providers and government departments. The EDI and electronic marketplace systems supported by the case company simplify the working process and build better relationship with various actors in the supply chain.
- Efficient information management for the port can be achieved. Such as offering information for trace and tracking of the goods, in time load and unloading goods, integrated information sharing standard, shorter lead time.
- Building advanced information system based on UN/EDIFACT standard offers opportunities to work with international port and companies in the future.
- Productivities could be released through smother supply chain management and timely information sharing. For example, communication through EDI and electronic marketplace system among consignor, consignee, shipping company, and port contributes to a precise time plan for shipping goods, which reduces lead time for one shipment and release more space for more shipment.
- Improved security of information and safety of navigation. For example, updated advanced information system keeps away confidential information leak and in time weather and ship route information secure safety of navigation.

5.2.3 Difficulties faced by the case company

As an ongoing project, there are plenty of obstacles preventing the project to be success. These obstacles are organized from interviews of assistant manager of Weihai Port Group Co. Ltd.

- It is a large scale project with huge risk. Hence Weihai Port needs time to reach a consensus internally on the approval of the project. The opponents query the financial benefits of the project.
- This project requires coordination from many actors in the supply chain, such as shipping company, authority and logistics providers. The data exchange standard
is hard to unify.

- The IDA of Singapore is unfamiliar for the Weihai Port, therefore the trust relationship is hard to build, which cause lots of troubles in the payment date and method, culture differences, and different ways of doing business.

- Judging by the working speed now the total time needed for this project will last over two year. The two years time is a little bit long for customer.

- The obsolescence rate of technology is rapid. May be after the completion of this advanced information system the technology used in it will be out of style.

- Every participant in the supply chain has its own advanced information system. To uniform different advanced information system is a complex job.

6. Discussion

Four kinds of descriptions for benefits and difficulties are shown above. To fulfill the research aim of this paper, these benefits and difficulties are going to be reorganized and compared to figure out which is common benefit or difficulty and which is not in discussion section. The discussion combines information from literature review and case study. The following lines will talk over benefits and barriers one by one.

6.1 Benefits for using advanced information system in fourth-party logistics

After organizing all the benefits mentioned, eleven benefits are recognized. Recognized benefits are listed:

1. Better management of various logistics providers and partners. Lied & Miller (2002) suggested that fourth-party logistics provider could manage relationships with various kinds of participants in logistics process.

2. Better management in inventory, trace and tracking (Frazelle, 2002; Lee & Moon, 2002), visibility (Vijayaraman & Osyk, 2006), and customer services (Jun et al., 2000).

3. Offering technology and logistics management experiences as supply chain
integrator (Bowersox et al., 2007; Coyle et al., 2003; Craig, 2003; Mukhopadhyay & Setaputra, 2006; Win, 2008).

4. Creating opportunities to work with companies of which have leading positions (Bowersox et al., 2007; Iacovou et al., 1995; Vijayaraman & Osyk, 2006).

5. Financial benefits (Hingley et al., 2011; Iacovou et al., 1995; Janssens & Cuyvers, 1991).

6. Improved efficiency for logistics processes (Aggarwal et al., 1998; Bowersox et al., 2007).

7. Obtaining competitive advantages in market through the implementation (Iacovou et al., 1995).

8. Being associated with such innovations contributes to good reputation (Barratt, 2004).

9. The future development of fourth-party logistics and advanced information system is promising (Chapman et al., 2003; Lied & Miller, 2002).

10. Efficient logistics processes and reverse logistics, which contributes to greener logistics (Hingley et al., 2011).

11. Improved security level of information management.

In order to compare benefits of literature and case study, table 4 was made. In previous section the benefits were numbered, hence the “Number of listed benefits” stands for various benefits. There are totally four kinds of description of benefits. The star in table means that the particular benefit has been written in that kind of description. Finally, total number of stars summarizes how many kinds of descriptions have mentioned that benefit.

Table 4: Comparing benefits from different sources
<table>
<thead>
<tr>
<th>Number of listed benefits</th>
<th>Literature review of fourth-party logistics</th>
<th>Literature review of advanced information system</th>
<th>WMS in Weihai BLP</th>
<th>RFID in Weihai BLP</th>
<th>EDI in the IDA of Singapore</th>
<th>Electronic marketplace in IDA of Singapore</th>
<th>Total number of stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Management of logistics</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>3</td>
</tr>
<tr>
<td>2. Management of inventory, trace and tracking</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>5</td>
</tr>
<tr>
<td>3. Supply chain integrator</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>5</td>
</tr>
<tr>
<td>4. Work with leading companies</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>6</td>
</tr>
<tr>
<td>5. Financial benefits</td>
<td>☺</td>
<td>☺</td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
<td>2</td>
</tr>
<tr>
<td>6. Efficiency improved</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>6</td>
</tr>
<tr>
<td>7. Competitive advantages</td>
<td>☺</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>1</td>
</tr>
<tr>
<td>8. Reputation</td>
<td>☺</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>1</td>
</tr>
<tr>
<td>9. Future development</td>
<td>☺</td>
<td>☺</td>
<td></td>
<td></td>
<td>☺</td>
<td>☺</td>
<td>4</td>
</tr>
<tr>
<td>10. Greener logistics</td>
<td>☺</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>☺</td>
<td>1</td>
</tr>
<tr>
<td>11. Security level</td>
<td>☺</td>
<td></td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
<td>2</td>
</tr>
</tbody>
</table>
No. 4 benefit “Work with leading companies” is one of the benefits that get all stars, which says that employing advanced information system in four-party logistics creates opportunities of doing business with leading companies. Both fourth-party logistics and advanced information system related literature mentioned this benefit: Bowersox et al. (2007) admitted fourth-party logistics service provider as supply chain integrator attracts leading companies to cooperate with its customer; Iacovou et al. (1995) concluded that in most cases adopting advanced information system is to be in compliance with powerful trading partners. In the case of Weihai BLP, the uniformed advanced information system offers a larger platform for its customer. The IDA of Singapore case also built a systematic information exchange system to work with global companies.

No. 6 benefit “Efficiency improved” gets all stars as well. Efficiency improvement is referred in literature of fourth-party logistics and advanced information system as well as two case studies. As Coyle et al. (2003) claimed, employing fourth-party logistics service provider improves supply chain efficiency from strategic view. Advanced information system improve supply chain performance from many aspects, for example reduced cycle time (Aggarwal et al., 1998; Bowersox et al., 2007). Weihai BLP case reduced error rate, improved performance of worker and so on, which indicates efficiency improvement. IDA of Singapore constructed efficient information management system of which cut down lead time as well.

No. 3 benefit “Supply chain integrator” has five stars. The missing star is from advanced information system related literature. Number three benefit is about fourth-party logistics works as supply chain integrator (Win, 2008). Advanced information system can not work as supply chain integrator, which in why there is no literature about this benefit. While, both case studies show relevant benefit. The case of Weihai BLP showed further integration of different logistics activities, such as production, transportation, and stocking. IDA of Singapore helped customer to build
EDI and electronic market place that integrate various logistics service providers and government in the supply chain.

No. 2 benefit “**Management of inventory, trace and tracking**” gets five stars. One is from literature review of advanced information system and another two are from case studies of IDA of Singapore. Applying fourth-party logistics is a strategic decision (Gattorna, 1998), hence benefit of detailed logistics functions is not written. Employing advanced information system is tactical behavior, therefore benefit of better inventory management, trace and tracking, visibility and customer services are mentioned (Jun et al., 2000; Vijayaraman & Osyk, 2006). Reduced inventory cost and better tracking system are benefits from case study of Weihai BLP. EDI and electronic market place built by IDA of Singapore cut down shipping time and improve veracity of tracking.

No. 9 benefit “**Future development**” gets four stars as well. Case study from Weihai BLP does not support this benefit. Because the advanced information systems built in this case are ordinary and basic systems like WMS and RFID, the promising future of advanced information system is not relevant in this case. While in the case of IDA of Singapore, frontier technologies EDI and electronic market place are employed. Therefore the case mentioned the promising future of advanced information system is one of the benefits. As for the literature, Chapman et al. (2003) mentioned the booming market for fourth-party logistics contributes to the development of it and Iacovou et al. (1995) indicated that many powerful companies push the market to upgrade advanced information system.

No. 1 benefit “**Management of logistics**” has three stars. One is from literature review of fourth-party logistics and others are from case study of Weihai BLP. As Lied & Miller (2002) said, fourth-party logistics provider could manage other logistics service providers. While advanced information system can not manage other participants but only can cooperate with them. The project about WMS and RFID for Weihai BLP is
rather small, so there is not many logistics servicer providers get involved, as a result
the case company did not manage other companies. The scale of the other case is
large. Many logistics providers got involved during the process; therefore a better
management of the relationship among them became a benefit.

No. 5 benefit “Financial benefits” gets two stars. The two stars are both from literature
review. Hingley et al. (2011) concluded that fourth-party logistics brings financial
benefits. Iacovou et al. (1995) and Janssens & Cuyvers (1991) claimed cost saving is
crucial benefits for using advanced information system. While two case study do not
have responding benefit considering financial. The case study show little financial
benefit for employing advanced information system in fourth-party logistics in reality.

No. 11 benefit “Security level” gets two stars, which is concluded from case study of
IDA of Singapore. There is no literature mentioned about improved information
security as benefit. While in the case of IDA of Singapore, updated advanced
information system could prevent leaking of confidential information, which
obviously improves security level.

No. 7 benefit “Competitive advantages” has one star. The only one star is from
literature review of advanced information system. Iacovou et al. (1995) considered
competitive pressure as driver of update advanced information system. In another
word, employing advanced information system could create competitive advantage.
While there is no empirical data support this benefit. After employing new advanced
information system, the customer does feel dominant in its businesses. The time for
running this advanced information system may not be long enough to gain
competitive advantage. Another case is under construction, so there is no competitive
advantage gained at this stage.

No. 8 benefit “Reputation” gets one star only. It is from literature review of
fourth-party logistics. Barratt (2004) said being associated with innovation like
employing advanced information system in four-party logistics contributes to good reputation. However, reputation is hard to measure in reality. One can not confirm that the good reputation is because of using that system. That is why in case study no concerning benefit was mentioned.

No. 10 benefit “Greener logistics” has one star from literature review of fourth-party logistics. Hingley et al. (2011) discovered that using fourth-party logistics in reverse logistics contributes to greener logistics. The two case studies are not about reverse logistics, so there is no empirical data supports this benefit.

Since the focus of this paper is on fourth-party logistics, the benefits received from using fourth-party logistics shall be discussed individually. There are two benefits confirmed both by literature and case studies: number one “management of logistics” and number three “supply chain integrator” (see table 4). Lied & Miller (2002) came up with the idea that better management of different logistics providers and partners is one of the unique benefits for fourth-party logistics provider to employ advanced information system. This benefit is supported by the case of IDA of Singapore in the program of EDI and Electronic marketplace. Building EDI system under the help of fourth-party logistics make the customer become the centre of the information sharing system and supply chain system. The management of logistics providers is improved by EDI as well. Another information system build in the case of IDA of Singapore is Electronic marketplace. The Electronic marketplace enlarges the logistics management range for the customer: from logistics providers to all participants of the supply chain. The second unique benefit for fourth-party logistics is offering technology and logistics management experiences as supply chain integrator. Both case studies confirmed this benefit. WMS, RFID, EDI, and Electronic marketplace have integrated the supply chain for the customer. The fourth-party logistics providers offered management experiences for customer to run these information systems and work as integrator through the four kinds of information systems.
6.2 Difficulties for using advanced information system in fourth-party logistics

Difficulties presented in literature review and case studies were reorganized and concluded into eleven terms. Reorganized barriers are listed:

1. Majority of people lack of understanding of fourth-party logistics (Langley et al., 2005) and some advanced information system (Iacovou et al., 1995; Vijayaraman & Osyk, 2006).
2. Using fourth-party logistics may change the current supply chain system and causes troubles (Kumar, 2005).
3. Small and medium size companies are not interested in using fourth-party logistics as Hingley et al. (2011) indicated.
4. Fourth-party logistics may lack of flexibility when it comes to local problems (Grant, 2005).
5. It is difficult to control cost while realizing benefits (Hingley et al., 2011; Vijayaraman & Osyk, 2006).
6. International standard is absence for some advanced information systems, such as EDI and RFID (Bamfield, 1994; Vijayaraman & Osyk, 2006).
7. Technology difficulties like integrating various kinds of advanced information systems (Elmuti & Abebe, 2005; Iacovou et al., 1995).
9. The willingness of sharing data with trading partners is weak. In another word, trust between partners is absence (Iacovou et al., 1995).
10. Long implementation time is barrier.
11. Low office automation degree of China hinders the implementation process.

Table 5 illustrates where barriers are referred from. Eleven barriers are listed in the table. The rules of table 5 are same with table 4.

Table 5: Comparing barriers from different sources
<table>
<thead>
<tr>
<th>Number of listed barriers</th>
<th>Literature review of fourth-party logistics</th>
<th>Literature review of advanced information system</th>
<th>WMS in Weihai BLP</th>
<th>RFID in Weihai BLP</th>
<th>EDI in the IDA of Singapore</th>
<th>Electronic market place in IDA of Singapore</th>
<th>Total number of stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lack of understanding</td>
<td>✿ ✿ ✿ ✿ ✿ ✿</td>
<td>✿ ✿ ✿ ✿ ✿ ✿</td>
<td>✿ ✿ ✿ ✿ ✿</td>
<td>✿ ✿ ✿ ✿ ✿</td>
<td>✿ ✿ ✿ ✿ ✿</td>
<td>✿ ✿ ✿ ✿ ✿</td>
<td>6</td>
</tr>
<tr>
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<td>11. Low office automation rate</td>
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No. 1 barrier “Lack of understanding” has all stars. Langley et al. (2005) found in surveys that many managers are confused by the difference between third-party and fourth-party logistics. Vijayaraman & Osyk (2006) declared systematic understanding of advanced information systems is insufficient. The two case studies both show difficulties to make their customers understand what they are doing.

No. 5 barrier “Cost” gets all stars as well. Hingley et al. (2011) mentioned cost for using fourth-party logistics as barrier. Vijayaraman & Osyk (2006) acknowledged controlling cost is challenging for employing advanced information system. The two case companies considered cost as major obstacle for their projects as well.

No. 2 barrier “Troubles caused by changes” has five stars. Kumar (2005) concluded that there are worries concerning about difficulties caused by supply chain changes brought by using fourth-party logistics. Since this barrier is specific about fourth-party logistics, no related barrier was mentioned in literature review of advanced information system. In order to keep a friendly relationship among supply chain participants, both case companies spent much effort dealing with external relationship, which prolong the duration of their projects.

No. 9 barrier “Lack of trust” gets five stars. Literature review of fourth-party logistics does not cover weakness in the wish of sharing data. The reason might be that fourth-party logistics is technology consulting company, the trust issue between customer and its own partner is not major problem. However, for building advanced information system in supply chain, the willingness of sharing information is a key question (Iacovou et al., 1995). Without trust and information sharing, advanced information system can not be built. The two case companies came across the trust issue and spent time and money to overcome it.

No. 7 barrier “technology difficulties” has three stars. One star is from literature review of advanced information system and other two are from case study of IDA of
Singapore. This barrier is technology difficulties of integrating different advanced information systems from different companies (Elmuti & Abebe, 2005). Therefore, it has nothing to do with fourth-party logistics. Weihai BLP case is to create internal advanced information system of RFID and WMS. There is no need to access other companies’ advanced information system. The case of IDA is different. That case focused on EDI and E-market. Consequently, barrier of uniform advanced information systems arouse.

No. 10 barrier “Long employing time” gets four stars. The four stars are from case studies. Due to many reasons the duration of the two cases is rather long, which was hard to control. No literature has written about this barrier. It seems to be a practical problem that is neglected by literature.

No. 3 barrier “Lack of interesting” only has one star from literature review of fourth-party logistics. Hingley et al. (2011) claimed that fourth-party logistics is not attractive to small and medium companies. The customers of the two cases are both large companies. This paper did not find empirical data to support or overturn this opinion.

No. 4 barrier “Lack of flexibility” gets one star from literature of fourth-party logistics too. Grant (2005) came up with the barrier that the flexibility of fourth-party logistics is questionable. However, neither case has referred to this barrier. It is possible that the two cases in this paper are local cases and do not have large influence area.

No. 6 barrier “Lack of international standard” has one star from literature review of advanced information system. Bamfield (1994) pointed out that international standard is absence for some advanced information systems. The two case companies have found standard for their advanced information systems. The standards used in the cases are widely accepted but not approved as international standard for now.
No. 8 barrier “Privacy and security concerns” gets one star from literature review of advanced information system as well. McGinity (2004) put forward privacy and security problems of advanced information system. The two cases do not have information to support and overturn this barrier.

No. 11 barrier “Low office automation rate” has two stars from case study of Weihai BLP. The case study exposed that the office automation rate in China is low, and the low office automation rate has negative impact on pushing advanced information systems of WMS and RFID. IDA of Singapore did not mention this problem, but this situation is true in China. No literature has discovered this barrier.

Unique and crucial barriers for fourth-party logistics is only one, which means barrier that is unique for fourth-party logistics and recognized both by literature and case studies is only one. The barrier is about troubles caused by changes of supply chain system. Using fourth-party logistics providers will change the current supply chain power relationship and troubles caused by the changes occurred in the implementation process for both cases for Weihai BLP and IDA of Singapore. For the WMS in case Weihai BLP, since some of the warehouse management was outsourced to another third-party logistics provider, building a new WMS needed cooperation from that company for which caused many troubles. The situation is the same with the use of RFID in Weihai BLP case. The establishment of EDI in the IDA of Singapore case required for integration of various kinds of information systems for many other trading companies. This change caused plenty of time for customer to adopt. The employment of Electronic marketplace is a bigger change compared to EDI; more companies should change their own information systems in order to be in the new systems. To build the four information systems in the hand of fourth-party logistics induced many changes, which need plenty of time and human resourced to make them right and functional.
6.3 Actions that the case companies made to overcome the difficulties

The two case companies implemented the information systems followed by the six steps organized by Zmud and Apple (1989) in their model. Most of the significant barriers happened in the Adoption step, also affected Adaptation step. The lack of understanding of the information system concept (such as EDI and Electronic marketplace) and the problems to control logistics service provider added up the difficulties in the negotiation process.

The two case companies did not foresee these problems. While the problems occurred they have to spend extra time and money on dealing with the participants and introduce the information system program and fourth-party logistics over and over again. Learning from the experiences, before the program started, the relationship between customer and its logistics service supplier shall be considered, and is the customer familiar with the information system that is about to be run shall also be investigated. According to the answer of the two questions, the time and resource spent on Adoption and Adaptation could be estimated and planned carefully.

7. Conclusion

Fourth-party logistics and four kinds of information systems are two key words of this paper. In light of the literature review, fourth-party logistics is an independent and non asset based supply chain integrator (Win, 2008). Although fourth-party logistics is easily confused with third-party logistics, there are many differences between them. The differences composed of factors: asset basis, (Win, 2008) accountability (Win, 2008), relationship structure (Gattorna, 1998; Langley et al., 2005; Mukhopadhyay & Setaputra, 2006, role (Bowersox et al., 2007; Coyle et al., 2003; Craig, 2003; Mukhopadhyay & Setaputra, 2006; Win, 2008), and neutrality (Gattorna, 1998; Mukhopadhyay & Setaputra, 2006; Win, 2008). Information system or system is defined as tools to deal with timely and accurate information for managers (Murphy & Wood, 2004). Jonsson (2008) categorized advanced information system into four
groups: Planning and Execution systems, Communication systems, Identification systems, and Electronic marketplaces.

To answer the question what are the benefits and barriers for using the four kinds of information systems in fourth-party logistics, both literature and case studies were reviewed. Comparisons were held between literature and case studies, literature of fourth-party logistics and advanced information system, case study of Weihai BLP and IDA of Singapore.

There are two benefits mentioned in all four sources, which should be identified as significant benefits. The first one is the opportunities to do business with leading companies created by employing information system in fourth-party logistics. WMS and RFID are essential information system to keep tracking the logistics and product information, building them is basic requirement to get into the supply chain dominant by leading companies. EDI could build and maintain the supply chain for it user and making it easy to integrate with the information system of a leading company. Electronic marketplace creates an attractable supply chain for which may attract leading company to get into the chain. The second benefit is efficiency gained during the process. WMS and FRID improve the efficiency by tractable product information and less time consuming. EDI and Electronic marketplace add up efficiency by creating a valuable chain. Three benefits get recognition by three sources, which could be common benefits. They are further supply chain integration, strategic thinking of supply chain, and the promising future of it.

As for barriers, there are also two barriers recognized by four sources and identified by this paper as important barriers. They are the confusion of the concept for fourth-party logistics and some advanced information system and financial justification. The confusion and financial justification for RFID is about if it is feasible compared with Bar Code system. The confusion for WMS is about the differences among various philosophy (such as Lean and Kanban system), and cost issue is also curial. For EDI and Electronic marketplace, the confusion is about the
definition and function of them, and both of them may cost plenty of money to build. Two other barriers mentioned in three sources and regard as common barriers. They are difficulties caused by changes in supply chain management and lack of willingness to share data with trading partners.

Comparing literature review and empirical data, discrepancy shows. In some cases, benefits and barriers are mentioned in literature review but not mentioned by case study, for example Barratt (2004) claimed that being associated with innovation like using fourth-party logistics provider contributes to good reputation and Hingley et al. (2011) indicated small medium size companies are not interested in using fourth-party logistics providers. These viewpoints are difficult for case study to discover. On the other hand, one barrier is mentioned by case companies but misses by literature review, for example the low office automation rate of China. This barrier is real in practice while not covered by any literature.

As for the focal question: what are unique barriers and benefits for fourth-party logistics to employ the four kinds of information systems, two vital benefits and one barrier were identified. The two benefits achieved by using fourth-party logistics are better management of different logistics providers and partners (apply for EDI and Electronic marketplace), and harvesting a supply chain integrator that offering technology and logistics management experience (apply for all four kinds of information systems). The major barrier for fourth-party logistics providers is the changes for the power relationships within the supply chain (apply for all four kinds of information systems).

Managerial implication

The paper reviewed concerning literature of fourth-party logistics and advanced information system and provides introduction of them for the managers who are confused by the concepts.

Benefits and barriers of employing advanced information system in fourth-party
logistics are listed. Companies that are considering about related project could consider these issues before getting start. In addition, for fourth-party logistics providers, barriers analyzed in this paper should be their future targets, which can lead their way to success.

There is one unique barrier for fourth-party logistics providers to employ advanced information system for their customer identified by this paper. Two case companies have come across the barriers and here are some suggestions for it. The involvement of fourth-party logistics provider will make the other logistics provider become worried. Hence, the fourth-party logistics provider shall take time to develop good relationship with third-party logistics and other actors in the supply chain and introduce the advanced information system program to them to get their support at the beginning of the project.

**Further study questions**

First of all, since barriers are listed, how to overcome these difficulties shall become a further research question.

Then, this paper is merely a qualitative case study with only two cases. Therefore, future study may exam the conclusions of this paper with a quantitative research for multiple case companies.

The paper mentioned about fourth-party logistics, while researches about fourth-party are limited. Is there a promising future for fourth-party logistics is an interesting question. What is more, the development of fourth-party logistics companies in developed and developing countries is also a question worthy to research.
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Appendix

Interview questions

The pre-prepared interview questions for both case companies are almost the same. The following questions are only questions designed by authors before the interviews and in the actual interviews some related discussions were added.

1. Is your company a fourth-party logistics provider?
2. Do you have project concerning about building advanced information system or system?
3. Who is your customer in that project?
4. What kinds of information technologies you have used for your customers?
5. Could you explain the detail procedures for the project?
6. Were there difficulties at the beginning of the project?
7. Do your customer thought cost and long project time as major barriers?
8. What are the benefits your customer received during the process and after the project was finished?
9. Were there misunderstandings between your team and customer? How you solved it?
10. Did you get feedbacks from your customer after the project is done?
11. Do you have some regrets about the project and suggestions for next project?
12. Is it profitable to run a fourth-party logistics company?
13. What is your opinion on the current situation and future development of advanced information system and fourth-party logistics?