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Global Logistic Management for Overseas Production Using a Bulk Purchase 4PL Model

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Abstract. In order to improve the quality of the components supplied by key suppliers and delivered to the final assembly sites overseas efficiently and timely, a new logistics business model and assessment analysis are proposed using services provided by fourth-party logistics (4PL) companies. In the research, a Petri Net process modeling approach is adopted to construct the model and identify the current bottlenecks discovered in the as-is (existing) logistic processes. According to the benefits of the proposed e-logistics information system and its to-be process improvement, total operating time and total operating costs can be reduced 41% and 21% respectively. The global logistics information platform is built to enhance the logistics management efficiency of manufacturers with multi-national operations for improving their global competitiveness.

Keywords. e-logistics information system, fourth-party logistics (4PL), logistics service provider (LSP)

1. Introduction

In order to increase and sustain its competiveness in logistics management, Taiwan has begun to link global production and sales distributors. Since China is relatively closer to Taiwan geographically, most production manufacturers of Taiwan have migrated to China yet most high value added components required in final product manufacturing are made in Taiwan. However, the final assembly, the quality of the components, and the delivery dates are not easy to control, effecting production scheduling, product yield and decreasing profits.

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To solve the above problems, many enterprises build collaborative manufacturing networks across multinational regions to reduce production costs and gain access to new and often unfamiliar markets. Developing Special Economic and Trade Zones (SETZ) is one useful approach to provide reciprocal and convenient logistics services for multinational corporations [1]. Optimizing the operative efficacy and supporting the logistics of final product manufacturing is the desired goal. The solution of the cross-strait logistic process between Taiwan and China where components are produced or provided by Taiwan and then delivered to factories in China, and then assembled as final products is the focus of this research. Many companies migrate to developing countries to take advantage of cheaper land, lower labor costs, and favorable tax incentives [2]. This study proposes a feasible logistics operation model for manufacturers and investigates the service niche of domestic logistic practitioners within this operation model to further develop commercial opportunities.

The paper is organized as follows. Section 2 reviews and discusses the background literature. The methodology is described in Section 3. Section 4 presents the case implementation, including as-is and to-be models, the logistic system platform and the comparison of results. Finally, the conclusions are provided in Section 5.

2. Literature Review

This section reviews the fundamental concepts and related research in the definition of logistics and global logistics management.

2.1 Logistics and Evolution of Logistic Services

The Council of Logistics Management (CLM) in 1991 defined logistics as the process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods and related information from point-of-origin to point-of-consumption for the purpose of confirming customer requirements. Therefore, materials, commercial processes, accounts payable, and information flow are included in logistics. Coleman defined logistics as an overall process that starts with ordering, and then involves other processes such as production, inventory, delivery, and the integration of other services [3]. Primarily, the prevailing belief was that the support of the back office management should be focus for satisfying the customers.

Considering the evolution of logistics services, Su categorized logistics management as five types including first party logistics (1PL), second party logistics (2PL), third party logistics (3PL), fourth party logistics (4PL), and fifth party logistics (5PL) [4]. 1PL is the seller in the business transaction that provides the logistic services for producers or suppliers. The differences between 2PL and 1PL are that the second party refers to the buyer in the business transaction who provides clients with traditional storage and transportation management. 3PL provides the most professional logistic services among the supply chain so 3PL is called logistics outsourcing. 4PL offers comprehensive solutions for members on the supply chain, linking one or more 3PL companies with management consultants, technology consultants, and financial service companies (as proposed and registered by the globally noted management consulting company - Accenture in 1996 [5]). 5PL provides e-services and information services for the supply chain and integrates all the members in the supply chain including sellers, buyers, 3PL, and 4PL. According to the research of Morgan Stanley, the concept of supply chain management from 1PL to 5PL indicated the integration level from low to high [6].

Accenture further defined the model of 4PL, proposing four required factors for 4PL including architect and integration, an intelligence control room, a supply-chain intermediary and resource providers [7]. Accenture emphasizes the relationship with customers and a long-term relationship with the supply chain management system to enhance risk-and-rewards sharing with the customers [8]. 4PL as the mediator provides comprehensive logistic services and integrated resource planning between 3PL and customers [9].

In the current logistic industry, information systems play a crucial role in the success of logistics operations. A coordinating platform for logistic information processing can analyze, program, and coordinate all operations to enhance information sharing among the supply chain. Some researchers suggest that using logistics information systems (LIS) not only enhances information sharing, but helps to better control logistic activities in the supply chain, enhance flexibility, improve efficiency, reduce costs, and shorten delivery times [1, 10, 11].

2.2 Global Logistics Management

Global logistics management (GLM) evolved from logistics management [12]. Since 1980, global brand competition has been increasing and product life cycles are becoming shorter with global logistics playing a critical role in supporting the changes. In order to better allocate the global resources of an enterprise, GLM applies a consumer-oriented approach and is open to flexibly adjusting business operation flows and processes [13]. The development of global logistics requires that the logistic providers build hubs at strategic positions around the world. This globally distributed network provides better access to the customer with rapid service delivery while reducing the stocks and even achieving the goal of zero stock [14].

The two major problems encountered by the transnational logistic service providers are as follows. First, single logistic providers may be unable to provide all the services. Second, the performances of logistic service providers may not meet expectations which impacts on the service delivery image, brand, and reputation. Global logistics is a comprehensive service composed by multiple services provided by different service providers. Any delay or improper handling of the service by any member may cause losses that further affect follow-up service outcomes, and the brand equity of the member firms [15]. Due to the fierce competition among logistic suppliers, Li and Lin proposed several dimensions to measure and increase a GLM's competitiveness including IT infrastructure capacity, cross organizational resource integration, manufacturing flexibility, information sharing, and asset specificity [16]. Improving the relationships among the network of the supply chain members also increases the efficiency of GLM.

3. Methodology

This study applies Petri Net modeling to construct a model to depict the as-is logistic service model [1, 17, 18], search for bottlenecks, and then experiment with changes in processes to derive improved to-be processes. Petri Nets were proposed by the German mathematician, Carl Adam Petri in 1962 and requires two features: (1) the graphic notation to describe and visualize the operations of the system such as sequence, synchronization, and conflict and (2) the support of mathematic theory to seek satisficing (not always optimal but better) solutions. The Petri Net construction rules have a solid mathematic foundation verified by well accepted and widely published algorithms. Therefore, the use of Petri Net is used to model the structure and operation of the system and also to evaluate and adjust the system. Petri Nets are most frequently used for modeling discrete events dynamic systems (DEDS), which emphasize the description of casual relationships among events. Petri Nets are also commonly applied to study flexible manufacturing systems, logistics systems, electric systems, and computer systems. The resulting model construction is used to improve scheduling, control, and conduct performance evaluation of new process configurations.

The model construction tool uses systematic quantification to express the as-is logistics models and processes. Data collected from the case company was used as the reference for the system simulation and the benefits of to-be model was evaluated. The study uses the Process Designer of the INCOME 4 SUITE which provides methods, tools and services for modeling, simulation and implementation of business processes to improve the logistics management process. This software was developed by the German software company, PROMATIS [19].

4. Case Study

This section presents the case study focusing on 3C's (computer, communication and consumer products) of the global supply chain. The preliminary case study and its bulk purchase logistic model were first reported in [20]. The research shows how methodical data collection and current situation diagnosis of the as-is problems are identified for the 3C industry. The goal is to identify the reasons that cause problems, derive a to-be global logistics model solution, build the global logistic system platform, and demonstrate the improvements in the new logistic operations. INCOME 4 SUITE is used to organize, archive, and analyze the collected data, simulate the processes, and benchmark the as-is and to-be models.

4.1 Case Description and Current (As-Is) Model

This research uses data from Company A, a global manufacturer and marketer for digital image processing devices established in 1991. Over 80% of the company's business focuses on the development and production of image components for 3C products, particularly a wide range of scanners. Company A has four strategic global business units accepting orders from Taiwan, the USA, Germany and Shanghai. The company has complete distribution networks in America, Europe and China. All business functions, such as order fulfillment and supply chain management, are conducted through the Taiwan headquarters, excluding the service functions of accepting orders and after-sales maintenance.

Currently, Taiwanese 3C manufacturers control the volume of key components and the frequency of shipments from hubs to manufacturing plants for final assembly. Due to information non-transparency, these manufacturers and their logistics service providers (LSPs) are only able to collect partial shipping status and updates. The bottlenecks of the existing global logistics model are illustrated using INCOME 4 SUITE in Figure 1 [20] and are described as follows:

- Unable to reach economies of scale with individual small order quantities.
- No integrated information system is used.
- Difficult to get real-time shipping status since several LSPs are used and shipments are at different stages of processing.
- Slow customs clearance causes deliveries delays.

The process design of the as-is model is depicted in Figure 2. The as-is model shows that the buyers of the company should contact suppliers if the central factories of the 3C and peripheral industry have placed excessive demands on the component manufacturers of products. Multiple buyers will communicate with different suppliers through FAX or via e-mail and provide purchase lists or request price quotation from the suppliers. The buyers will select the suppliers based on their quotations and then fax or e-mail the orders. The supplier evaluates the content of the orders and relays the relevant information to the central factory. The central factory then commissions the 3PL to deliver, post custom declarations, and ship the components or semi-finished products to the customers.

4.2 To-Be Global Logistics Models for the 3C Supply Chain

Improving and eliminating problems that Taiwanese 3C and peripheral companies face requires reengineering of the global logistic business processes. Thus, bulk purchase, fourth party logistic services (4PLs), and the use of authorized economic operator (AEO) certifications are identified as the three key strategies for improvement. Bulk purchase requires aggregating 3C manufacturers with the same key component demands to place bulk orders with suppliers for better unit price and delivery schedules. 4PL service providers are authorized to integrate order information, negotiate ordering price and delivery schedules with suppliers and self-manage shipping processes, including trunk and container loading, customs brokerage services, and air/ocean/land freight, until the shipments arrives at the overseas manufacturing plants. Furthermore, Taiwan Customs gives preferential treatment to enterprises with AEO certification, and security accredited AEOs receive speedy customs clearance for trans-customs boundary transportation of cargo.

Bulk purchase made by 4PL service providers are emphasized for the to-be models. The target customers are 3C companies with the same key component demands. With the same key components demands, 3C manufacturers are able to reach economies of scale and bulk purchase can be used to resolve small order quantity issues. Collective 3C enterprises, suppliers, and LSPs can log into the global information platform built by 4PL service providers and share real-time delivery information to avoid information inconsistency and non-transparency. Government assistance is essential for successful to-be models. Well-designed logistic centers combine ocean freight, air freight and tax preference will attract oversea investors and encourage Taiwanese LSPs to provide value-added services. Training programs developed by the government strengthen 4PL services involvement which supports the alliance formation between Taiwanese LSPs and oversea LSPs for agile global logistics. AEO certification is promoted by the Taiwan government for speedy customs processing and supply chain security. The to-be models and the steps taken for implementation are shown in Figure 3.

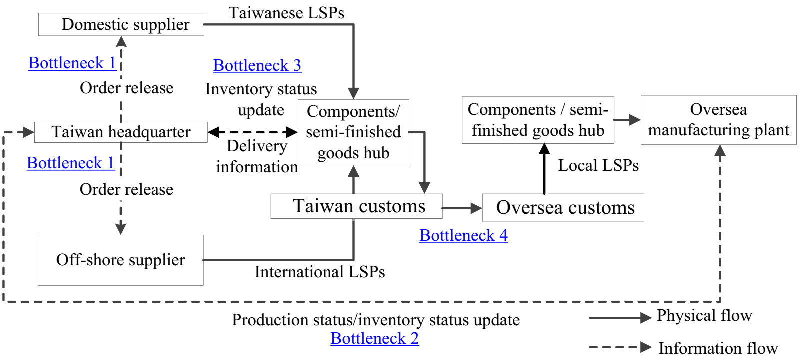

Figure 1. The existing as-is global logistics model [20]

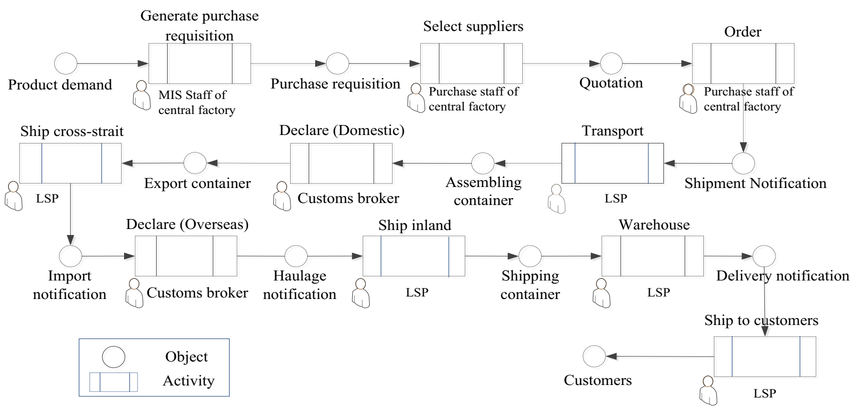

Figure 2. The process design of the as-is logistics model

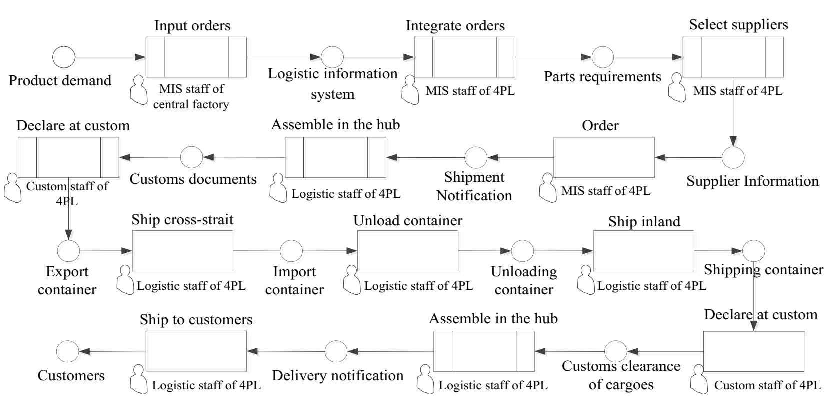

Figure 3. The process design of the to-be logistics model

4.3 Global Logistic System Platform

According to the process design of the to-be logistics model, the essential modules and functions are proposed in this sub-section. The major users include suppliers, the central factory, 4PL's, and overseas customers. Therefore, the corresponding forms for each entity must be established to record respective information and contacts. For security and efficiency of the system operation, a users' information chart is also managed by the browse and download authority of users is controlled to avoid over transparency of competitive business information. On the other hand, the main function and module of the system is designed to speed up the process of customs declaration. Hence, required documents for custom declaration must be entered into the database. The detailed information of shipping must also be included, such as the container number, flight number, time and distance of the shipping (for the system tracking function). Figure 4 depicts the function and modules of the proposed logistic information system. The system includes purchase management, inventory management, customs management, tracking, sales management and financial management. The integrated information system is a web-based supply chain that can be used to improve management efficiency for the corporation. Critical contributions are implementing an information sharing mechanism in the supply chain and speeding up problem feedback, resolution, and overall processing time.

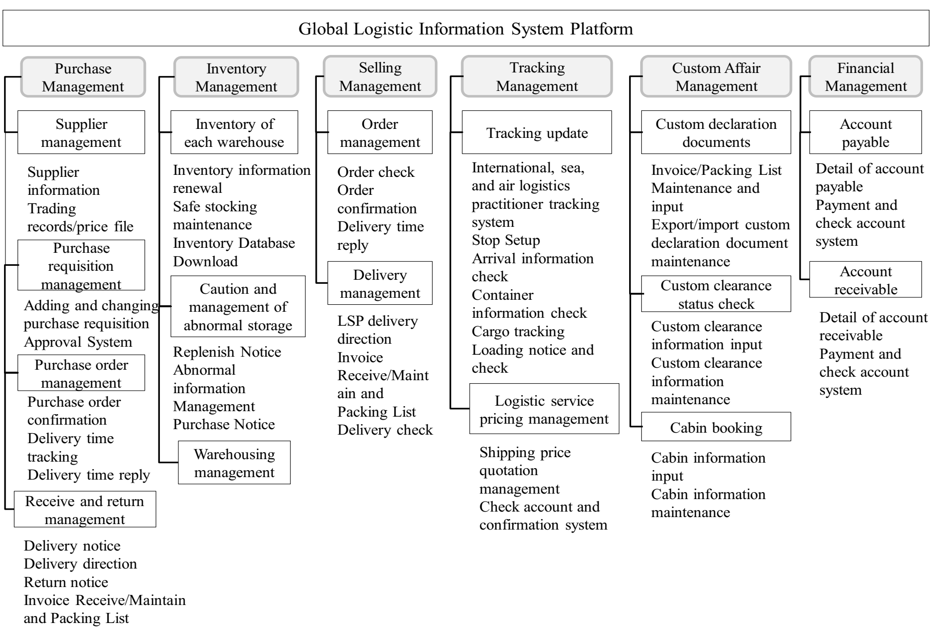

Figure 4. Modules and functions of the logistic information system platform

4.4 Comparison of As-Is and To-Be Model

The model has been verified using the INCOME 4 SUITE. The data were provided by the LSP's [21], information industry companies [22, 23] and the Industrial Technology Research Institute. The evaluation range, limitation, and data are demonstrated as follows:

- Evaluation range: Use a cross-strait express model to deliver parts and semi-finished products to the manufacturing factories in Mainland China.
- Hypothesis and limitation: Fixed cost is not discussed and the stock of components in Taiwan and China are assumed to be sufficient.

Based on the evaluation range and the cross-strait logistics model mentioned above, the study categorized the logistic business process into four types – order, inventory, custom declaration/clearance, and shipping. From the view of the improved method, order and inventory belong to e-system whereas custom declaration, clearance, and shipping belong to process improvement. The simulation analysis of the cost and time is shown Table 1.

According to the analytical results, the operation time and cost demonstrate a satisficing decrease. The total operation time was dropped from 338 hours to 198 hours with an approximate 41% decrease. The total operation cost was dropped from TWD $19,445 to TWD $15,173 with a 22% decrease.

Table 1. Quantified benefit results

Category	Quantified index	As-Is	To-Be	Benefits
Benefit of e-system	Order process time[a]	69.68	52.16	25.14%
	Order process cost[b]	$ 2,214	$ 1,950	12.00%
	Inventory process time	34.7	21.97	36.69%
	Inventory process cost	$ 2,961	$ 2,348	20.70%
Benefit of process improvement	Custom declaration/clearance process time	108.01	25.2	76.67%
	Custom declaration/clearance process cost	$ 4,920	$ 2,525	48.68%
	Shipping process time	125.5	98.5	21.51%
	Shipping process cost	$ 9,350	$ 8,350	10.70%
Total benefits	Total operating time	337.89	197.83	41.45%
	Total operating costs	$ 19,445	$ 15,173	21.97%

a. Unit of time: Hour; b. Unit of cost: TWD

The proposed to-be model improves production lead-time, increases inventory turnover rate, better controls purchase and transportation costs, maintains consistent quality – critical means to improving the sustainable competitive advantages of 3C manufacturers. The comparisons of business processes between as-is and the to-be models are shown in Table 2 and the four benefits of the to-be models are explained as follows:

- Shorten the lead time and increase inventory turnover rate using the improved global logistic service model.
- Reduce procurement and transportation costs by using bulk purchase.
- Maintain consistent quality of final products by providing high quality components.
- Maintain competitive advantages by manufacturing critical components domestically and assembling final products overseas.

Table 2. Comparisons of operating processes between as-is and to-be models

Operating Process	As-Is Model	To-Be Model
Material Purchase	Individual 3C manufacturer places orders with suppliers regardless of economies of scale.	4PL service provides integrated order and places bulk orders with suppliers to reach economies of scale.
Shipping	Individual 3C manufacturer centralizes key parts in Taiwan and makes oversea shipments according to order demand.	4PL service providers centralize key parts in Taiwan and arrange scheduled oversea freight shipments.
Information Integration	3C manufacturers, suppliers, and LSPs communicate with each other via email, phone or fax and update order status manually.	All parties involved gain access to a global information platform which provides real-time information.
The Role of LSPs	LSPs are only responsible for logistic services.	4PL service providers are authorized to negotiate price, procure key parts, and manage shipping processes.

5. Conclusion

In order to maintain consistent quality of 3C finial assemblies and competitive advantages of 3C manufacturers, global logistics management reengineering is conducted to ensure critical component production remaining in Taiwan and final assembly overseas. The improved global logistics model is constructed to reduce transportation lead times, increase the inventory turnover rate, and solve delivery problems of small quantity freight. The benefits of bulk purchase for 3C components and semi-finished products are devised to accelerate global logistics management reengineering for domestic component supplies of overseas 3C product final assemblies. Bulk purchase generates economies of scale that contributes to production cost control as well. In addition, 3C companies are better enabled to maintain consistent quality of final assemblies by executing global logistic business and operation models. Taiwanese 3C companies are encouraged to manufacture critical components domestically since there is greater efficiency in the supply chain. In summary, bulk purchase contributes to purchase and transportation cost control, and implementing to-be models not only improves production lead-time and inventory turnover rate but expedites global collaborative manufacturing.

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