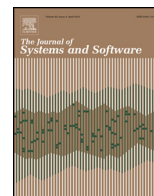




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## SETZ logistics models and system framework for manufacturing and exporting large engineering assets

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### ABSTRACT

Given the dynamic and increasingly competitive nature of international commerce, manufacturing companies must plan global logistics operations for sustainable competitive advantage. Many enterprises build collaborative manufacturing networks across multinational regions to reduce production costs and gain access to new and often unfamiliar markets. Recognizing the strategic importance of globalization, government agencies are developing Special Economic Trade Zones (SETZ). These zones are regulated industrial districts which encourage manufacturing by offering incentives such as new logistic designs linked with the latest information technologies. The objective of this paper is to analyze and design SETZ logistics hub models and system framework for linking manufacturers. By defining the characteristics of the different types of specialized trade zones, and briefly discussing the older types of trade models that are no longer competitive, this research uses the case of a Taiwan power transformer manufacturer to analyze the supply chain logistics processes for manufacturing and exporting large engineering assets within a SETZ. The logistics models and information system framework developed provide a general reference for other governments, companies, and industrial sectors that intend to design export-oriented industrial parks incorporating IT-centric and globally oriented SETZ techniques.

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### 1. Introduction

Global trade increases competition which makes it imperative for companies to improve their logistics and supply chain operations (Vollmann et al., 2000; Jeong et al., 2002; Saad et al., 2002). Taiwan has designed several special export-oriented industrial zones that offer trade incentives to encourage manufacturers to expand the capacity of their existing industry infrastructure to better supply the global market. The main purpose of an Export Processing Zone (EPZ) or a Free Trade Zone (FTZ) is to attract foreign investment and expand a country's export business (Pak and Majd, 2011). A similar model is the export and research-oriented industrial zone, often called a science-based or technology-based industrial park, which promotes the development of exports from high-tech industries. Science parks are somewhat more difficult to establish since the infrastructure investment includes a trade zone, a knowledge-based infrastructure (e.g., participating universities), and government policy makers familiar with global technology trends and investments (Chang and Trappey, 2003).

Changes around the world, especially the outsourcing of manufacturing and the intense protection of intellectual property, have changed the nature of export processing zones. If the old models are employed today, they simply will not be as competitive as they used to be. The important reasons being that global industries are quickly improving their competitiveness by integrating channels, changing the power base of intermediaries, forming global ventures, and seeking sources of capital to try new strategies. Many companies simply migrate to developing countries to take advantage of cheaper land, lower labor costs, and favorable tax incentives (Beamon, 1998). As a result, China and Southeast Asia have become the main sources of supplies for international brand manufacturers and their clusters of original equipment manufacturers. Therefore, new means and methods to provide reciprocal and convenient logistics services for multinational corporations are the critical research issues.

The deregulation of investment rules and the increased capital flow between Taiwan and China has increased the need for more efficient cross strait supply chain manufacturing bases. Taiwan is developing Special Economic and Trade Zones (SETZ) in response to the large migration of manufacturers over the last 10 years and in particular after the establishment of World Trade Organization rules (Trappey, 2007). Taiwan firms can carry out manufacturing,

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logistic, and transportation processes while benefiting from the government provided incentives of the SETZ. The establishment of the SETZ model has a set goal of increasing economic development and upgrading the global competitiveness of Taiwan manufacturers. For economic development, the “zone to zone” operational mode provides an efficient way to link Taiwan to other countries’ special zones and, subsequently, to nearby markets. The framework is designed to make it more convenient for members to manage logistics between domestic and overseas facilities when they are located within a SETZ. Industrial upgrading follows a “zone within the zone” concept meaning that SETZ are established in or near existing special industrial zones (i.e., EPZs, FTZs, science-based industrial parks, offshore shipping centers) to better integrate and modernize the supply chain of existing infrastructure clusters.

Major logistics and manufacturing companies are invited to expand their business by supporting the processing and logistics services used to move manufactured components and finished goods in and out of the zones. The government has provided the SETZ with favorable incentives such as offering one effective administrative window for custom clearances and tax-bonded storage. Furthermore, the operational modes of the EPZ and the SETZ are similar in their characteristics and features. Thus, the management model, logistics model, and supporting information framework for SETZ are modified based on the best practices of the EPZs, which not only decreases the learning curve but increases adaptation of new service and information based on technologies since they are based on platforms that are largely understood and follow accepted operating procedures.

The paper is organized in the following sections. Section 2 describes the related background and the logistics model of the SETZ. A detailed case study of a large engineering asset manufacturer building electrical power transformers within a SETZ is presented in Section 3. By documenting the case company’s business strategy and demand forecasts, the logistics reference models and the system framework for the SETZ concept as a generalized application guide for other industries are provided in Section 3. The conclusions and future works are described in Section 4.

## 2. The SETZ logistics operation model

Promoting Special Economic Trade Zones (SETZ) is a critical policy issue for developing economies since it facilitates trade liberalization, enhances resource utilization, promotes economic growth, and structural changes (Ge, 1999; Chaudhuri and Yabuuchi, 2010). Several countries including Singapore, Korea, and Japan have established international logistics zones to expand the capacity of their existing infrastructure (Lu and Yang, 2007). Taiwan, with its increasing trade relations with China, has developed five international logistics zones that combine incentives from facilities located at the Keelung seaport, the Taipei seaport, the Taoyuan International Airport, the Taichung seaport, and the Kaohsiung seaport (MOTC, 2010). Applying the “zone within a zone” and the “zone to zone” concepts, Taiwan SETZs are developed near these pre-existing international logistics zones to further boost economic development. These zones are considered to be outside the normal customs territory for purposes of establishing favorable trade duties, tariffs, and allow government regulators to relax banking and workforce regulations. The existing infrastructures for ports are leveraged for lower costs of upgrading transactions and communications and avoiding costly new construction. Thus, SETZs offer special advantages to investors and provide a more comprehensive range of logistics services such as simple or in-depth processing, transportation, and customs-clearance that are within convenient zones close to the international ports.

Fig. 1 shows the logistics operation model for the SETZ environment. The logistics processes start from Taiwan companies providing key components and transporting containers to the final manufacturer in China or Southeast Asia for final assembly and distribution. Furthermore, goods imported from other countries into the Taiwan SETZ for manufacturing processing, assembling, or re-packaging also receive equal incentives for re-exporting. The operational headquarters are responsible for taking orders from clients or from foreign subsidiaries as their own business processes and then deliver the information electronically to the production department in the SETZ. The production department outsources the logistics operations to third-party logistics (3PL) companies that ship the products in and out of SETZ. Carbone and Stone (2005) were among the first researchers to document the advantages of this approach. After completing the customs declaration with administration, the consigned goods are transferred to the SETZ’s affiliated airport or seaport terminal. Using direct point-to-point shipments, the goods are delivered to the overseas SETZ for additional manufacturing of final assembly processes. The end products finished in the SETZ may be shipped overseas or sold directly to local markets. Even though the import and export flows are increased by the SETZ, an absolute requirement is the comprehensive services from third-party logistics firms to support timely final or semi-final order fulfillment (Trappey et al., 2011).

### 2.1. The logistics process between manufacturers and 3PLs in the SETZ

As supply chain management and global outsourcing become globally dispersed, the virtual enterprise environment and the efficient of exchange data become increasingly important (Shin and Leem, 2002). The 3PL service providers in the SETZ manage the connection between the information systems of the manufacturers and the SETZ administration in order to provide complete shipping information such as ocean liner shipping confirmation and customs clearance information. The detailed processes are illustrated in Fig. 2. First, the internal enterprise resource planning system of the manufacturer (Wang et al., 2008) or the business hub (Trappey et al., 2007a, 2007b) notify the 3PL of the delivery request and automatically provide the invoice and packing list. Then, the 3PL collects the goods from the manufacturer, stores the goods in the logistics hub, and then transports the goods to the container yard. Afterwards, the 3PL checks the shipping schedules and reserves a cabin spot with the freight forwarder. When an export permit is received from the SETZ administration, the 3PL forwards the notice electronically to the manufacturer.

### 2.2. The logistics process between 3PLs and administrators in the SETZ

The goal of linking the 3PLs and SETZ administration is to speed up the import and export operations. The 3PLs contracted with the SETZ provide integrated logistics services including transporting to designated locations, packaging, and shipping to the container yard. Some 3PLs are even reporting the addition of new value-added services such as sourcing and contract negotiation. Fig. 3 depicts the logistics processes between the 3PLs and the SETZ administrators. When the materials or components are imported from foreign vendors, an approval message from SETZ administrators is required for the goods to enter the SETZ. Afterwards, the 3PL is entrusted to transport the goods to the manufacturer’s SETZ plant for processing. The 3PL is also responsible for the subsequent exporting of the finished or semi-finished goods to the manufacturer’s foreign trade counterparts. The 3PL manages the packaging of products, checking flight and shipping schedules, and transmitting the custom

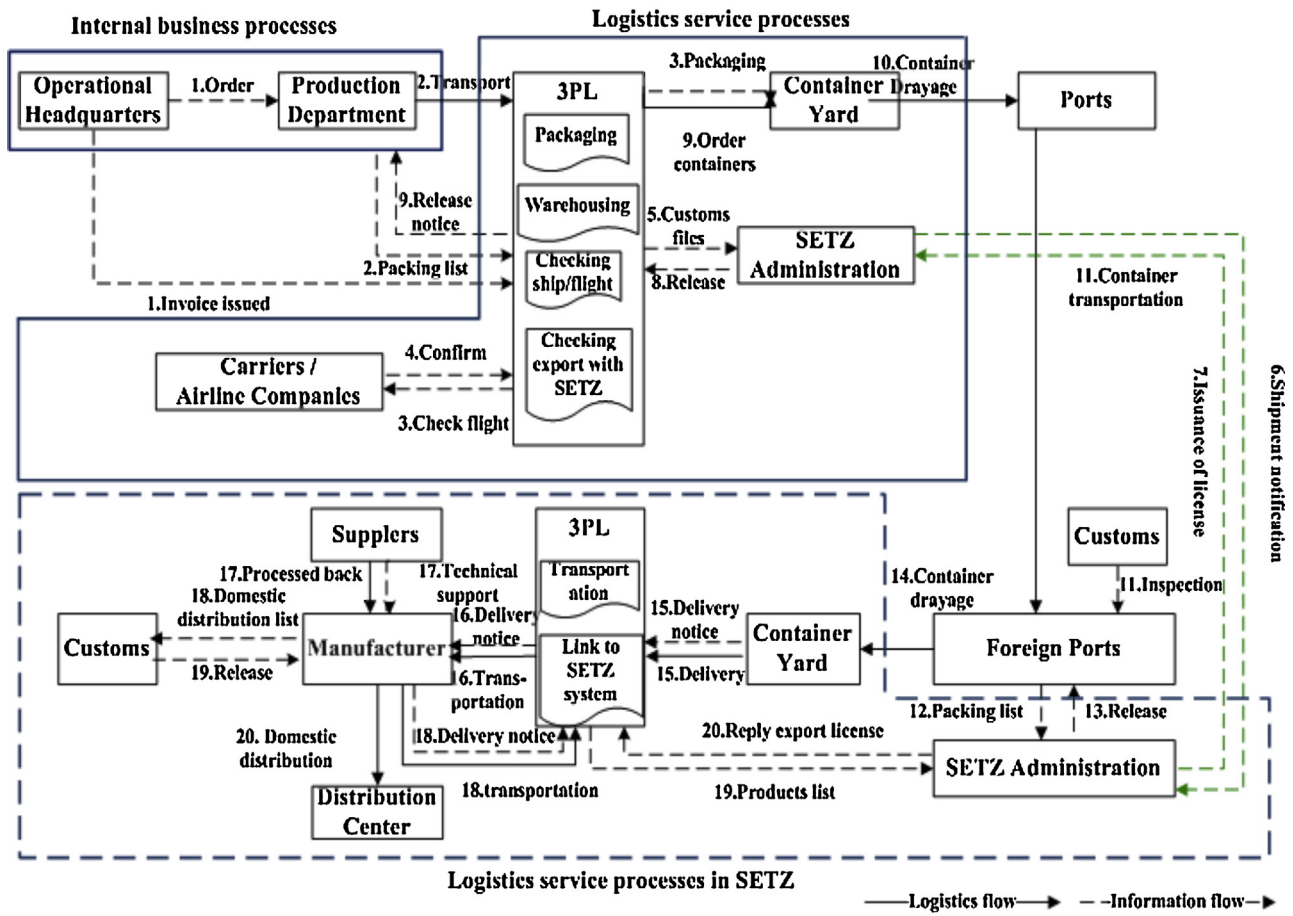


Fig. 1. The SETZ operations model integrated with internal business and 3PL service processes.

clearance information to SETZ administrators in order to receive final export permission.

**3. Case example: large scale engineering assets production and logistics in SETZ**

The case discussion describes how a power transformer manufacturing and exporting company produces very large and very costly electronic products within the SETZ framework. Industrial transformers are unique products since they are very large and heavy and quite different from the traditional consumer-based products manufactured in the past. These transformers are very high value engineering assets for the stakeholders. The transformer company was determined to establish a logistics and processing factory within the SETZ to better control and manage its export business to overseas markets. On-time delivery, secure and damage free transportation, and continuous and transparent tracking of the entire process provides a sustainable competitive advantage for the manufacturer. As depicted in Section 2, the SETZ is constructed to promote linkages with other special processing zones under the “zone to zone” concept. SETZ provides several functional activities for the manufacturing companies, including transshipment, reassembly, consolidation of components, simple processing, in-depth processing, and coordinated shipping port access. Therefore, the transformer manufacturer used the SETZ to import low-cost parts and components for final assembling and export. Fig. 4 shows the proposed virtual organizational structure of the transformer manufacturing company within the SETZ. The SETZ operations include the manufacturer, suppliers, administrators, customs agents, and the 3PLs. The manufacturer outsources

the logistics operation to 3PLs in order to focus on core manufacturing tasks. Fig. 5 depicts the import logistics model for demand replenishment using a Petri Net process modeling approach (Lee and Park, 1993; Ahmad et al., 2010).

**3.1. Product delivery**

The SETZ export logistics model can be divided into three modes including whole product delivery, completely knocked down (CKD) delivery, and after-sales services. For smaller electric transformers, the machine is delivered directly to the designated locations without disassembling, (whole product delivery). After assembly and testing, the transformer is packaged and responsibility is shifted to the 3PL to manage the export operations. After arranging the shipping schedule and receiving customs clearance from SETZ administration, the transformer is transported by a freight forwarder to the designated location. At the same time, the SETZ administration contacts foreign customs and transfers the required customs clearance information. When the shipment arrives at the destination port, the transformer is delivered to the client after clearing customs. Fig. 6 depicts the SETZ product delivery logistic model.

The transportation and customs services information flows are shown in Fig. 7. The 3PL transmits messages to the forwarder to book space and begin the custom’s clearance processes after receiving the delivery date. Afterwards, the 3PL creates the e-documents and sends them electronically to the SETZ administrators for customs clearance. During the delivery process, the 3PL is required to coordinate the shipment and update the logistics information from the aligned members. The status of transportation, such

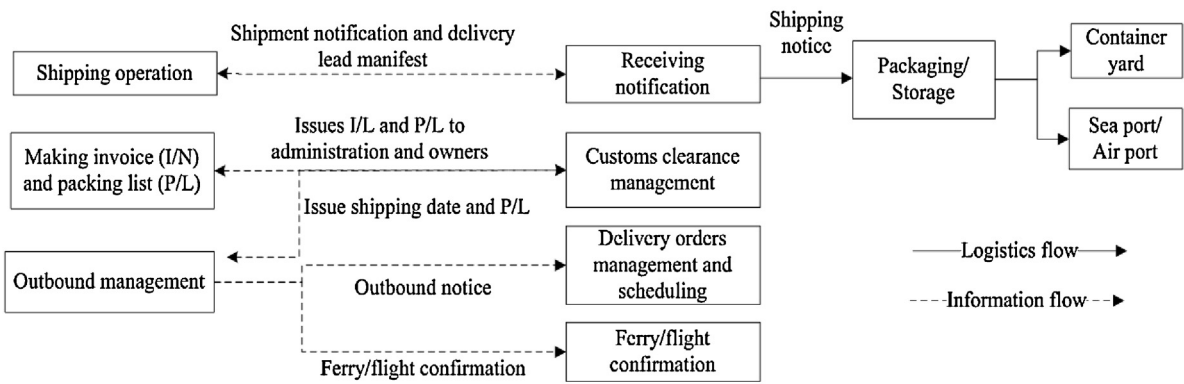
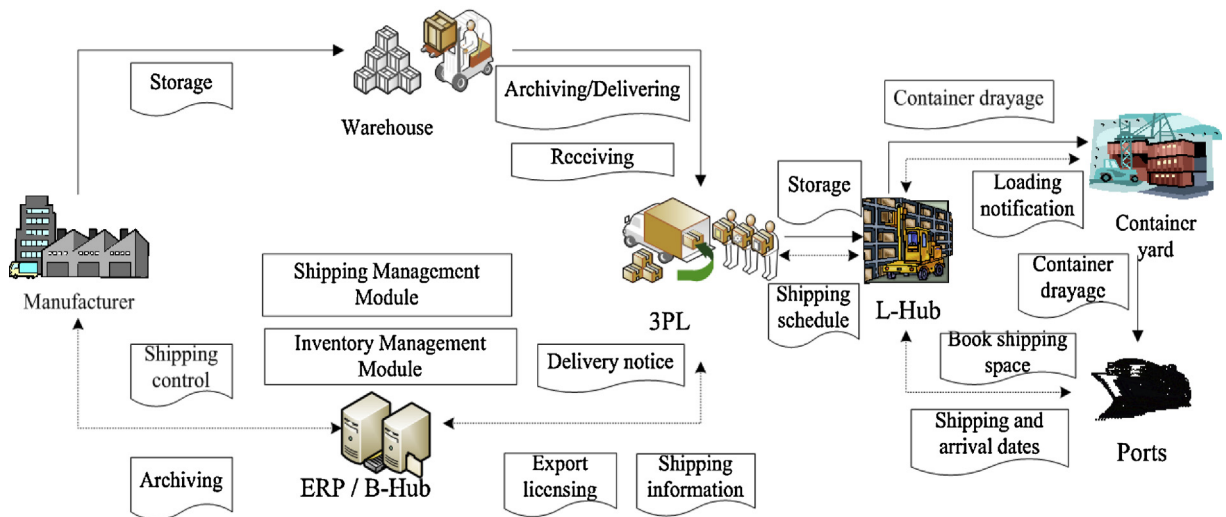


Fig. 2. Logistics processes between the manufacturers and the 3PLs in the SETZ.

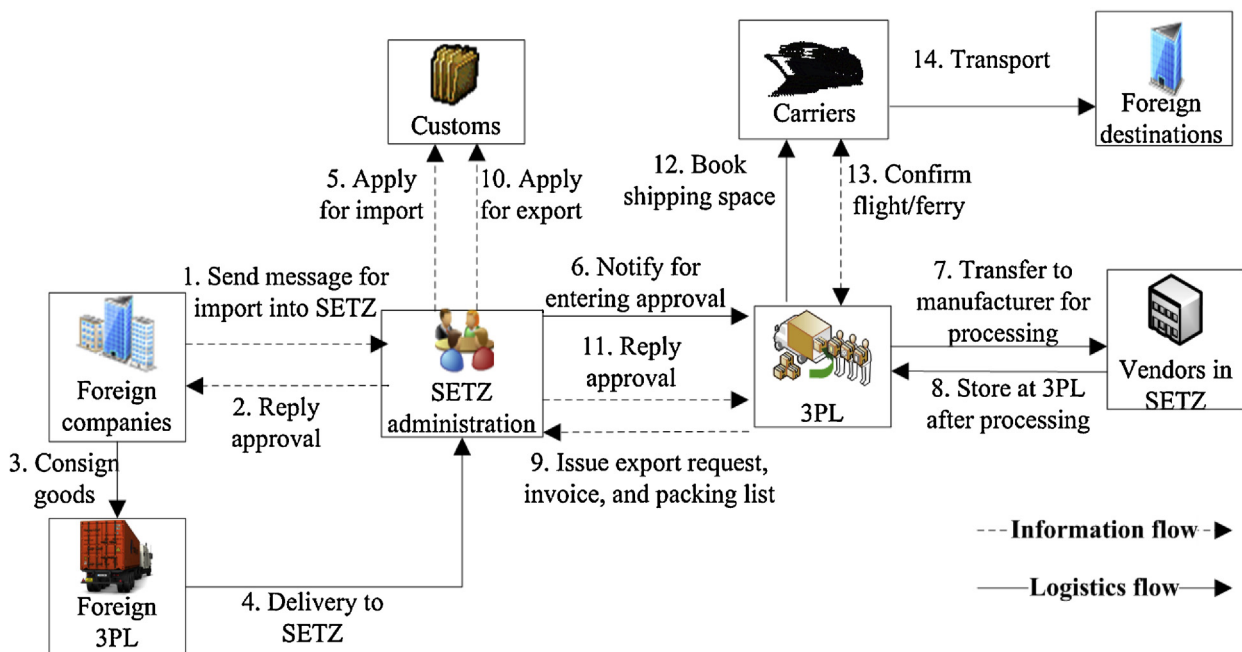


Fig. 3. Logistics processes between 3PLs and SETZ administrators.



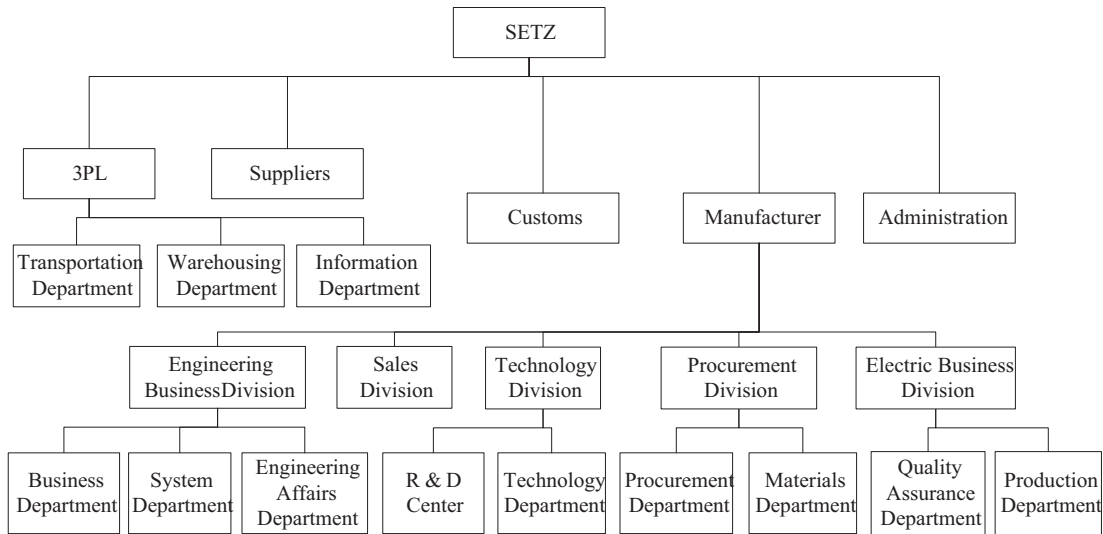


Fig. 4. The SETZ virtual organizational structure for transformer export-oriented manufacturing.

as whether the goods are at the docks or in the control of the forwarder, can be tracked and shown in real time. The detailed processes of customs clearance are depicted by the activity diagram in Fig. 8. The 3PL receives information about the shipments from the manufacturers and confirms the shipping schedule with the forwarder. After uploading the e-documents to SETZ administration system, the SETZ system determines whether the goods should be inspected based on historical records. After receiving an export permit from the SETZ administrators, the 3PL arranges the loading and shipping operations with the freight forwarder.

3.2. The completely knocked down (CKD) delivery mode

Fig. 9 depicts the export workflow for extremely large size transformer delivery where size and weight restrictions make complete assembly and delivery either too difficult or too costly. As expected, the manufacturer is still required to test the transformer

before shipping. After testing is completed, the transformer is disassembled and packed in boxes which are transferred to the 3PL service provider. The 3PL arranges the shipping schedule, processes customs clearance with the administrative center of SETZ, and transports the containers to the overseas client (Lan, 1999; Coyle et al., 2003). When all transformer components arrive at the customer's site, the transformer is re-assembled as a final product for inspection, final testing, and order fulfillment.

3.3. After-sales services

Fig. 10 shows how after-sales services are provided in the SETZ. In the past, the transformer manufacturer's engineers would only provide very limited after-sales services to overseas customers. When a transformer malfunctioned or required maintenance, local contractors were hired. However, the SETZ enables on-site managers to streamline procedures for granting entry and

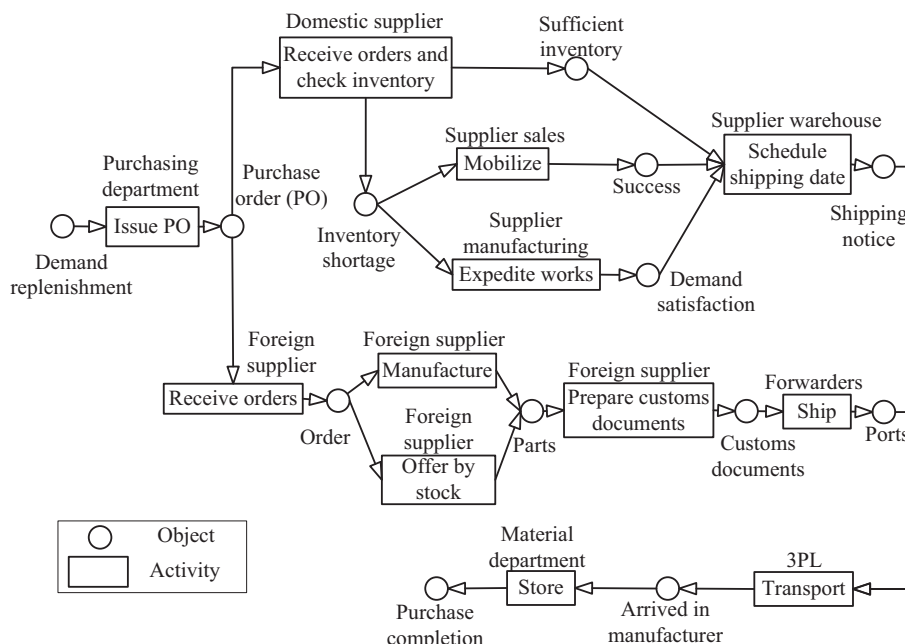


Fig. 5. The material-import logistics replenishment model for the SETZ facility.

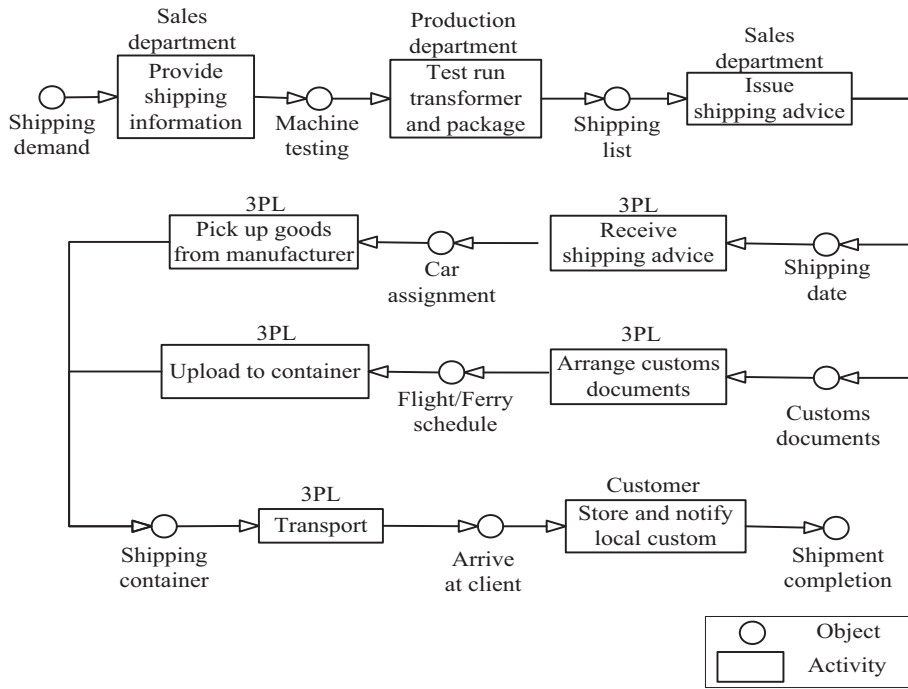


Fig. 6. The SETZ product delivery export logistics model.

issuing landing visas for contractors and maintenance personnel. Therefore, an additional competitive advantage is gained by the manufacturer since it is extremely convenient to move personnel between the special zones for maintenance and repair services.

The information flow for after-sales services is shown in Fig. 11. When the customer requests services, the staff of the quality assurance department provide an immediate response using historical records and current requests stored in the information system. After reviewing the records and forming an initial diagnosis, the

maintenance technician is set to provide repair and maintenance services for the customer. The content of services provided, pending, or forecasted are recorded in the information system. Fig. 12 depicts the activity diagram for the after-sales services.

#### 4. Discussion

The purpose of placing manufacturing companies within the SETZ is to provide greater and sustainable competitive advantage

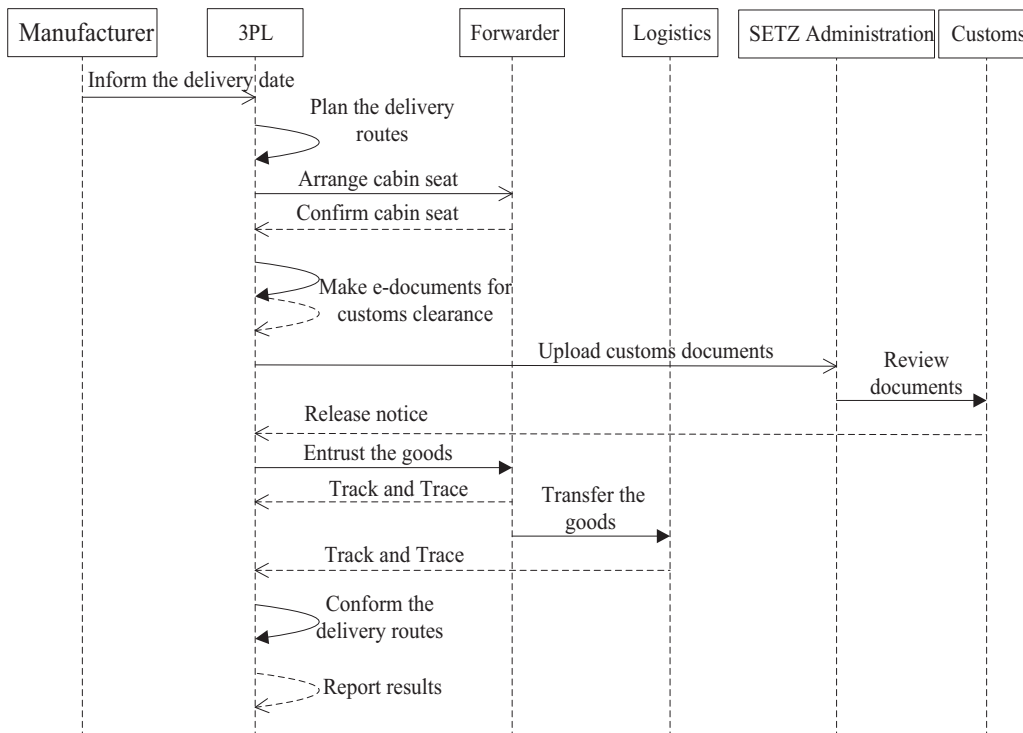
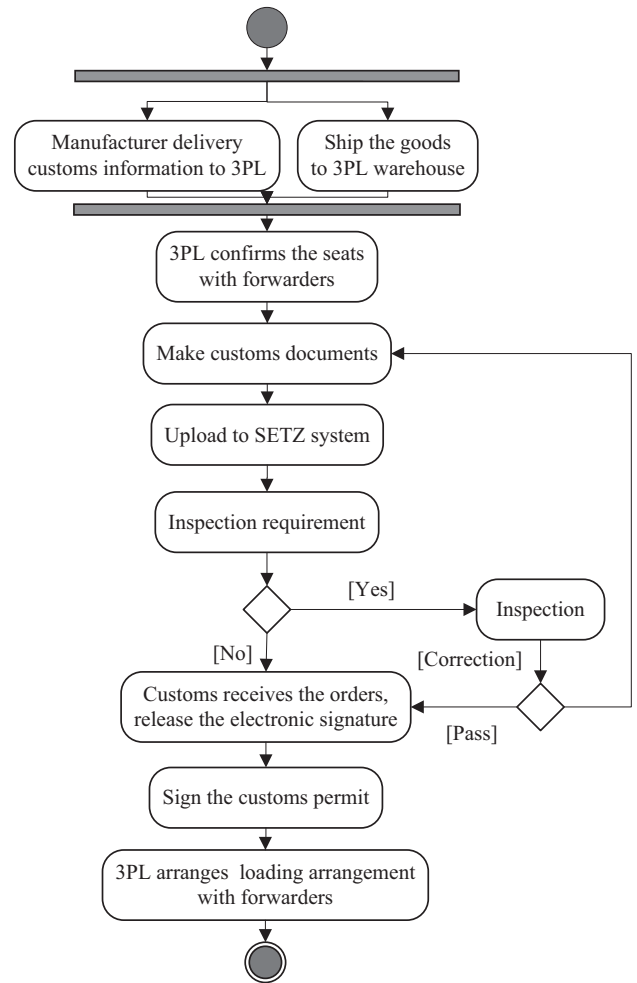


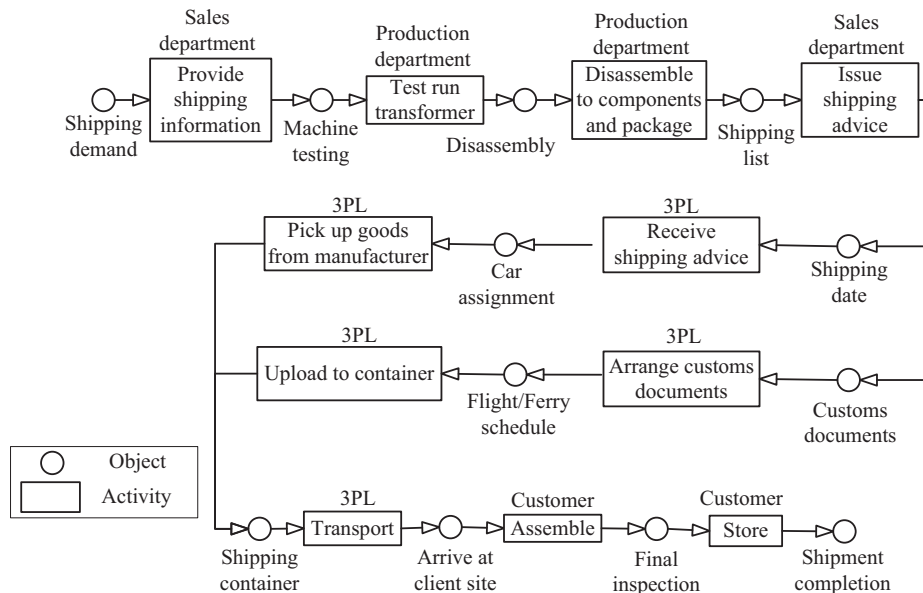
Fig. 7. The information flow for transportation and customs services in SETZ.

**Table 1**  
The comparison between as-is and to-be reference models.

| Items of comparison                   | As-is model  | To-be model   |
|---------------------------------------|--|---|
| Product shipping process              | All shipments are required to complete customs procedures before shipping.                     | SETZ takes advantage of the “within territory, but outside normal customs territory” and “point-to-point” approaches to facilitate shipment, transport, management and customs clearance. |
| After-sales service                   | Vendors assign foreign technicians to provide maintain service.                                | Vendors operating in SETZ assign their own technicians that are allowed greater freedom to travel and work between zones.   |
| Procedures of custom clearance        | Mostly handled by customs brokers that rely on paper work.                                     | The customs procedures are completed on the SETZ information platform via the Internet.   |
| Procurement cost                      | The components are mainly provided by domestic suppliers due to the outdated policies.         | SETZ allows manufacturers to purchase raw materials and components from overseas with greater freedom and better market access at lower costs.  |
| Information transparency and accuracy | Insufficient IT applications to communicate, coordinate, and measure performance of processes. | Supply chain participants communicate and share information using e-documents and data exchange approaches which apply metric measurement systems for continuous process improvement.     |
| Goods tracking during transportation  | Loosely controlled shipments by phone or fax.  | Provide timely shipments status via the Internet.   |
| Target customer                       | Focus on domestic large-scale project companies.   | Trade with international companies and provide comprehensive products and after-sales services.   |



**Fig. 8.** The SETZ customs clearance activity diagram.



**Fig. 9.** The SETZ disassembly export logistics model.

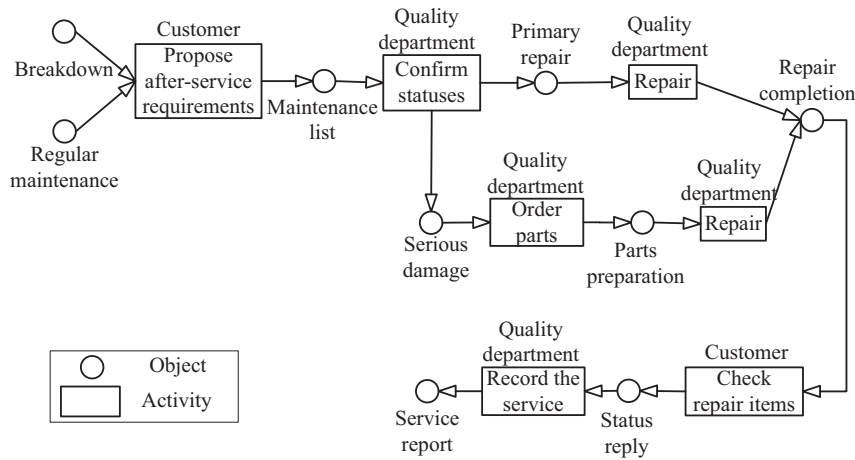


Fig. 10. The SETZ after-sales service diagram.

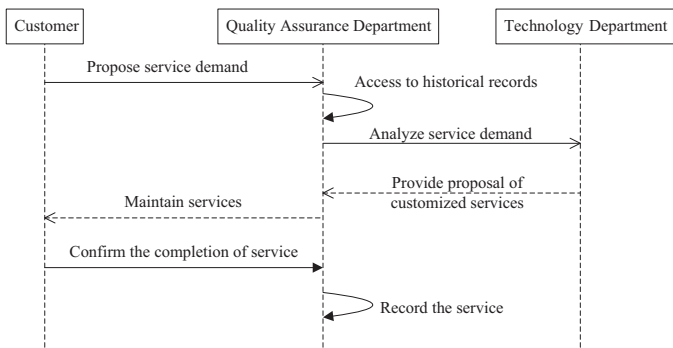


Fig. 11. The information flow for after-sales services.

to companies competing in the global supply chains. The SETZ network leverages existing facilities and adds advanced manufacturing technologies and R&D capabilities to domestic operations. In addition, the state-of-the art flow of goods and information within the SETZ attracts leading enterprises, encourages further

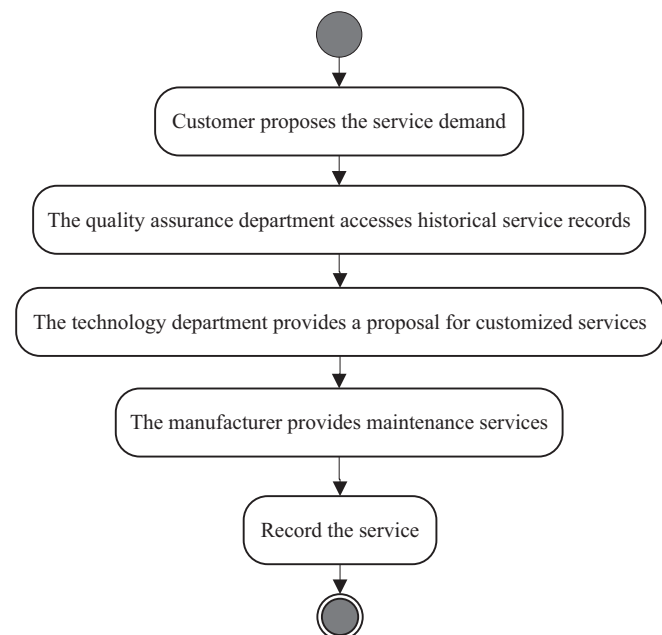


Fig. 12. The activity diagram for after-sales services.

investment, and boosts economic development. Table 1 describes the differences between the “As-Is” and “To-Be” models to contrast the benefits yielded from implementing SETZ.

5. Conclusion

In order to respond to the liberalization of the world economy, many regional industrial parks seek to provide an attractive manufacturing and trade environment for domestic and foreign companies. In addition to the original types of special zones that have been created in the past (e.g., EPZs and science-based industrial parks), the SETZ framework provides a comprehensive range of production and logistics services to create sustainable competitive advantages for its members and manufacturers. This research analyzes the critical factors derived from the logistics reference model between manufacturers, 3PLs, and SETZ administrators. The efficiencies of the approach are further demonstrated through the use of a real world case study. The proposed SETZ logistics models and information framework are adaptable to a variety of industries that are attempting to develop flexible logistics models for the highly competitive global market. Following this paper’s definition and development of the SETZ framework, reference processes models, and information flows, future research will provide a quantitative evaluation for designing a flexible SETZ information system platform operating under dynamic conditions. The comparative performance of different types of industrial zones for different industrial sectors, with real operating data, should be evaluated for strategic market research and development.

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