MODELING THE GLOBAL LOGISTICS BUSINESS PROCESSES FOR OPTOELECTRONICS FIRMS

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ABSTRACT

Optoelectronics is one of the fastest growing industrial sectors in the world. Industries in this sector produce components such as liquid crystal flat panel displays that are used in a diverse range of electronic products including notebook computer screens, flat panel televisions, mobile phones, and Personal Digital Assistants (PDA's). Since optoelectronic components are primarily used for consumer goods, manufacturing companies must be efficient and agile to respond to the ever-changing market needs. Thus, a well managed global logistics hub frequently becomes the core value and competitive advantage for these firms. This research surveys optoelectronics firms in Taiwan to map their current, as-is, logistics models. Using Petri Net theory, the business process models and the container logistic operations of the prime (i.e., the optoelectronic end-product manufacturer) and the inter-organizational operations between the prime and its supply and demand chains are studied. These processes are then modified to construct idealized logistics processes (the to-be models) for components supply and goods shipment. Since global logistics management plays a critical role in optoelectronics industry, the derived to-be logistics and business models help optoelectronics industry visualize and improve logistics operations. The derived models cover goods tracking, safety inventory, and global logistics coordination.

Key Words: *Global Logistics, Optoelectronics, Petri Net, Electronic Commerce, TFT-LCD.*

1. INTRODUCTION

Optoelectronics industry logistic processes are very costly since many of the products manufactured are delicate and expensive components that feed into a global network of companies collaborating to build the end product. Many of the members in the chain strive to lower manufacturing and shipping costs as a means to increase revenues. Since the margins of components continue to fall as the products mature, firms must improve the agility and efficiency of their global logistic operations to gain competitive advantages.

The current logistics of the optoelectronics industry is one-way and disintegrated. After producing Thin Film Transistor Liquid Crystal Display (TFT-LCD) products, manufactures hire Logistics Service Providers (LSP) to pick up and transfer goods to overseas forwarders or deliver gods to local wholesalers and retailers. These LSPs are limited in their capability to improve service processes primarily because of poor information sharing and planning. This paper studies the as-is business process models and the container logistic operations of the prime (i.e., the optoelectronic end-product manufacturer, Section 2 and Section 3) and the inter-organizational operations between the prime and its supply and demand chains to construct idealized logistics processes (the to-be models, Section 4) for components supply and goods shipment. Since global logistics management plays a critical role in optoelectronics industry, the derived to-be logistics and business models help optoelectronics industry visualize and improve logistics operations. The derived models cover goods tracking, safety inventory, and global logistics coordination.

The literature related to our study is related to the reduction of intermediaries and the formulation of global logistics strategies. Electronic commerce, as a new media for a full range of commercial activities, has had a major impact in many industries. Marketing channels, as trading intermediaries, are considered to add extra cost and provide limited value. Thus, companies try to pursue electronic commerce strategies to eliminate or reduce layers of market intermediaries using the means of electronic commerce (Bakos, 1998; Vandemerwe, 1999).

Intermediaries are adding electronic commerce to their existing businesses as a countermove for disintermediation, such as adding multiple marketing channels in supply chains (Bucklin, 1966). Multiple strategies have implications for marketing channel strategy but also for logistics management concerning the demands and possibilities of electronic commerce in the supply chain and how logistics may support the new development of marketing channels with high flexibility, agility and efficiency.

Electronic commerce has been defined as any form of business transactions in which the parties interact electronically rather than physical exchanges or direct contacts. This research regards electronic commerce as one of several marketing channels, including the use of the Internet to support inter-organizational processes, such as marketing, ordering and related service activities. The magnitude of electronic commerce may however differ from the evolutionary usage (e.g., e-ordering) to the revolutionary usage of electronic commerce (e.g., new markets or new customer segments as described by Venkatraman, 1994).

The horizontal and vertical dimensions of logistics are discussed by Wouters et al (1999). Horizontal logistics concerns relations between parties within a group of firms at the same level in a supply chain, while vertical logistics concern relations between firms at different levels in a supply chain. Andersson (2002) describes and compares the purchasing processes of advanced versus basic logistic services. Further, some specific observations are presented depicting the business models of advanced third-party logistics (3PL) services with respect to their service definitions, providers' evaluations and service contracts. For the state-of-the-art logistic warehousing operations, Hwang (2002) considers an integrated design of multi-warehouse structured logistics system. The system consists of a set of customers with diverse demands and possible discrete set of location sites of warehouses or distribution canters. Nonetheless, these canters provide integrated services that can fulfil large and fluctuating demands.

Simchi-Levi et al. (2003) discuss the general advantages, disadvantages, and strategies for utilizing global supply chains effectively. It is important to be aware of the cultural, infrastructural and economic differences between regions when decisions are made for linking particular foreign locations in the global supply chain management. For the innovative logistics hub development case, Lee and Yang (2003) look at strategies that may enable the incremental development of a 'Winged City' around Incheon International Airport (IIA), Korea. This project involves the creation of a super hub for services related to transportation, logistics and international business trades.

2. OPTOELECTRONICS MANUFACTURING

Due to the consumer-oriented nature of the TFT-LCD applications, the optoelectronics industry experiences unexpected demand fluctuation, mass customization, long lead time procurement, market-driven order changes, and short product life-cycles. The three main manufacturing processes of TFT-LCD manufacturing are array processing, cell processing, and module packaging.

Array Processing

Array processing in TFT-LCD manufacturing is similar to semiconductor wafer fabrication except for the composition of the material components. As shown in Figure 1, the raw material for the array process consists of a glass substrate that requires cleaning, coating, exposure, developing, etching, and stripping.

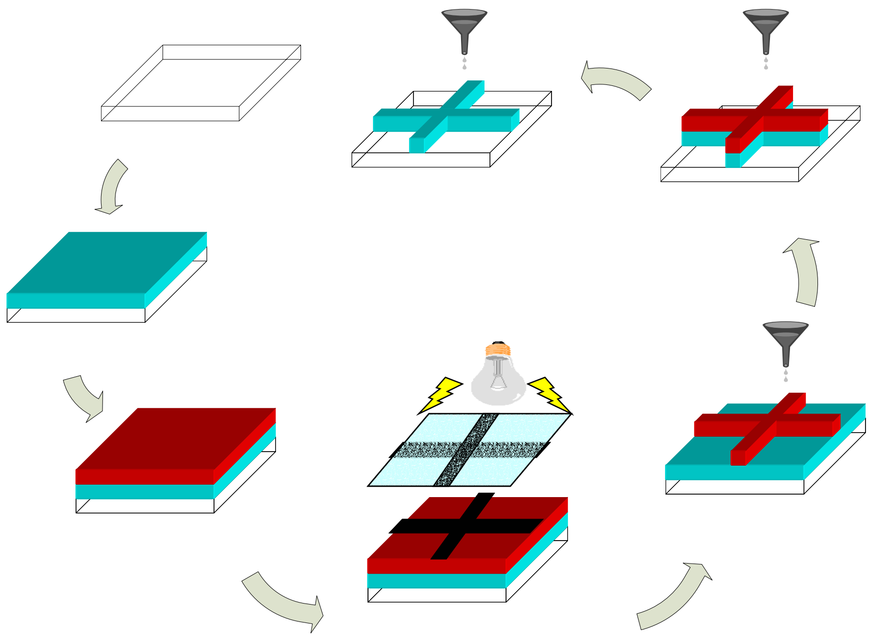
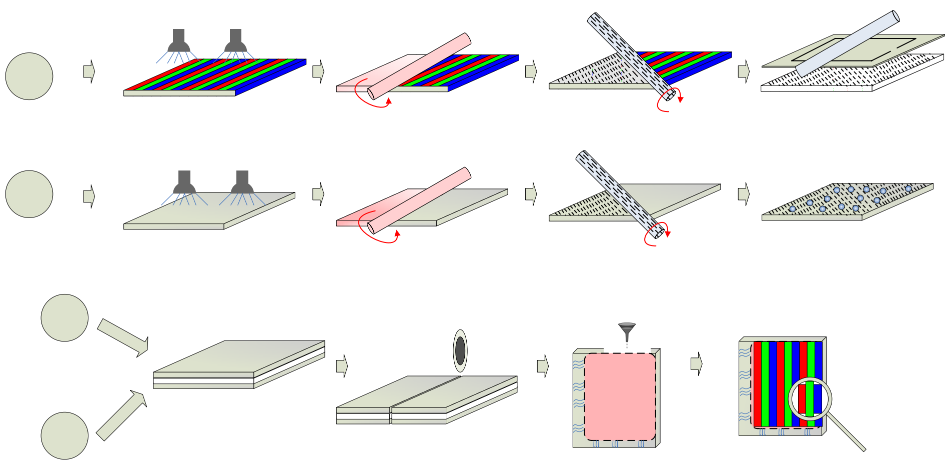


Figure 1. Array processing

(Lin, et. al. 2004)

Cell Processing

Cell processing is the step whereby two components, the colour filter (CF) and the thin film are joined through cleaning, alignment-layer printing and rubbing. After the CF is adhered to the TF, the liquid crystal is injected into the space between them as shown in Figure 2. For planning and scheduling, the cell process requires consideration of changing manufacturing lead time and material matching. Further, each machine group produces different batches of cells which makes the lead time hard to predict. Both the materials and capacities of the machines are the key constraints in this process.



Glass

Figure 2. Cell processing

(Lin, et. al. 2004)

Module Packaging

Module packaging is the final stage of TFT-LCD manufacturing processes. In this process, the TFT-LCD panels passed from cell processing are attached to components such as electrical connector tabs, polarization attachments, back lights, integrated circuits, and Printed Circuit Boards (PCB) as shown is Figure 3. The packaging process also requires quality control inspection and aging of the newly connected circuits to “burn-in” the panel.

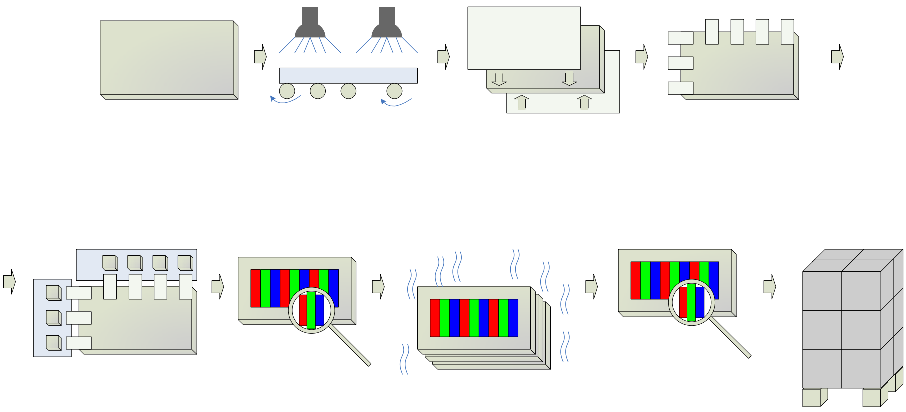


Figure 3. Module packaging

(Lin, et. al. 2004)

Given the various stages and sub-steps of the manufacturing processes, different objective functions are considered. From the global point of view, enhancing the fulfilment rate to customers is the most common goal. However, local view goals most also be considered for each process. For example, array and cell processing requires sharing finite facilities where the primary goal is to maximize the utilization of resources and the availability of materials. Therefore, both processes require capacity-oriented production planning. On the other hand, a key consideration for module packaging is the use of the correct sub-components as ordered. Thus, this process requires material-oriented production planning and the goal is to meet customer’s demands for specific materials and diverse grades of TFT-LCD panels.

3. AS-IS MODEL

C Company is one of the top three TFT-LCD manufacturers in the greater China region. Since C Company’s LCD panels are exported to many countries as key components for numerous consumer products, the global logistics are complex and critical to profits. The as-is model describe the organization model, the behaviour model and the object model of the company.

Cell

3.1. The As-Is Organization Model

The current organization model of C Company includes three departments that work together for end product fulfilment (Figure 4). Even though the local forwarder is external to the company, it is treated as a department. The manufacturing department and the shipment department are internal to the organization. The shipment department decides when and where to deliver goods for order fulfilment. The manufacturing department controls the production quantity and quality based on customer demand.

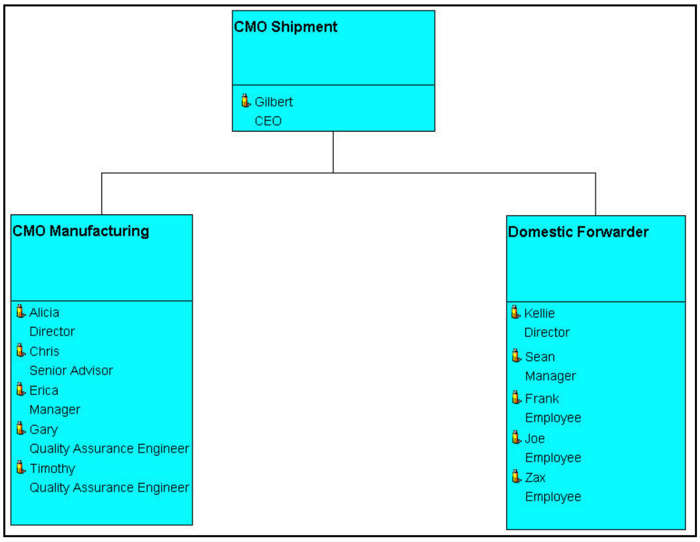


Figure 4. The C Company organization model

3.2. The As-Is Behaviour Model

The C Company's export strategy is also complicated and its activities are best described in three tiers. From the most abstract level, the final products are classified into several classes and, then, the products are delivered to retailers as shown in Figure 5.

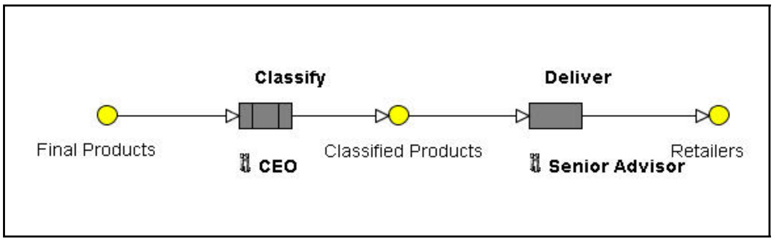


Figure 5. The C Company export strategy

As shown in Figure 6, in the first tier of sub-process (or Petri-net process drill-down), the CEO focuses on classification. First, the CEO classifies final products by quality using factory standards and customer specifications. Second, goods are classified by shipment destinations for logistic scheduling. Finally, the goods are classified by sizes. The larger sizes are shipped to clients making LCD-TVs whereas the smaller sizes are shipped to clients making cellular phones or Global Positioning Systems (GPS) or PDA assemblies (Figure 7).

The third tier of drill down is the delivery process. For the overseas delivery process, there is a problem with the shipping process (Figure 8). When goods are exported and delivered by air cargo, the distributor will not know in real time where the goods are and at what time the goods will arrive. This creates uncertainly in the shipping processes and creates bottlenecks in information flows when inquires are forwarded by customers. Figure 9 depicts the drill-down process of the domestic forwarder.

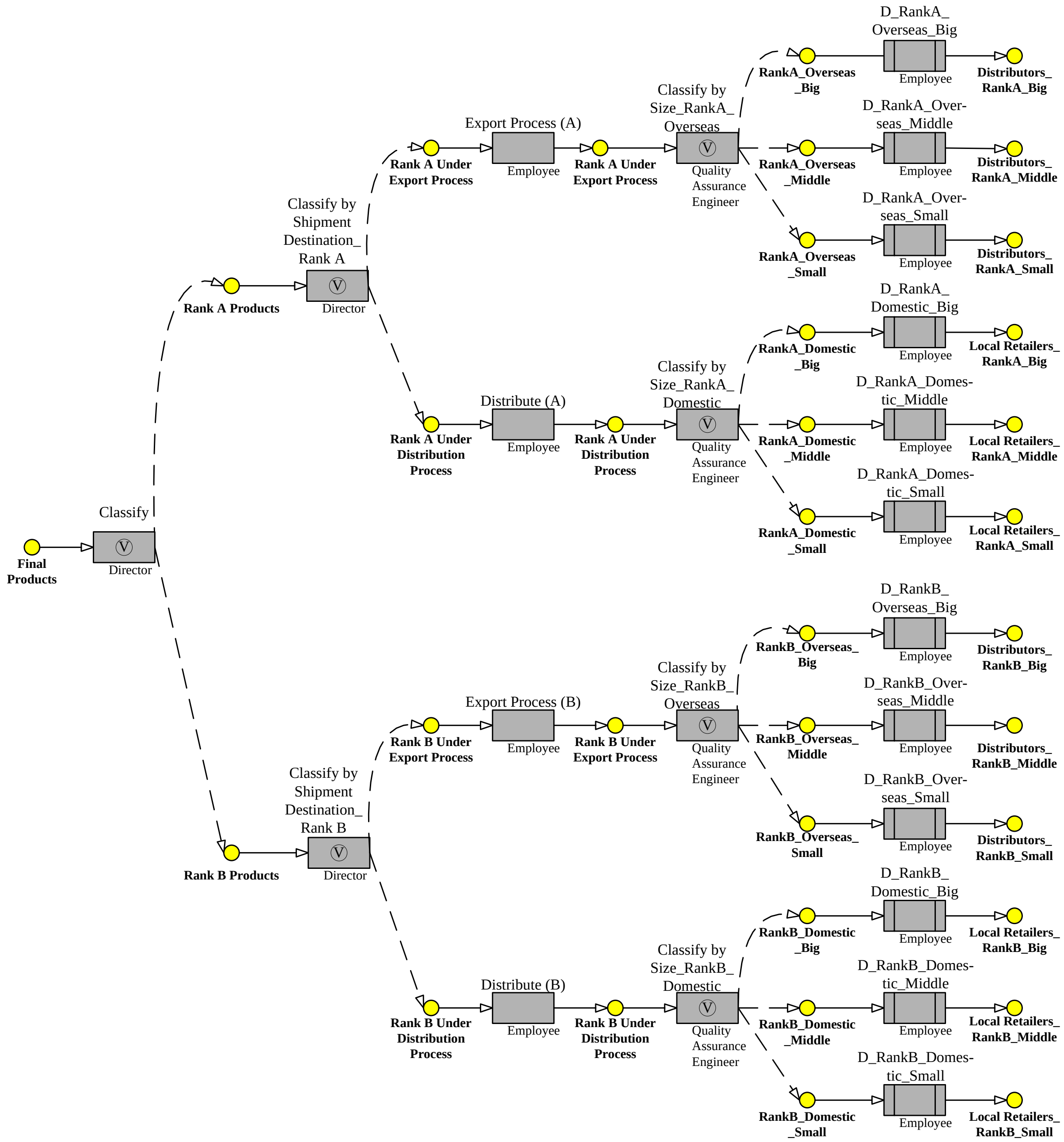


Figure 6. The drill-down of the C Company export strategy

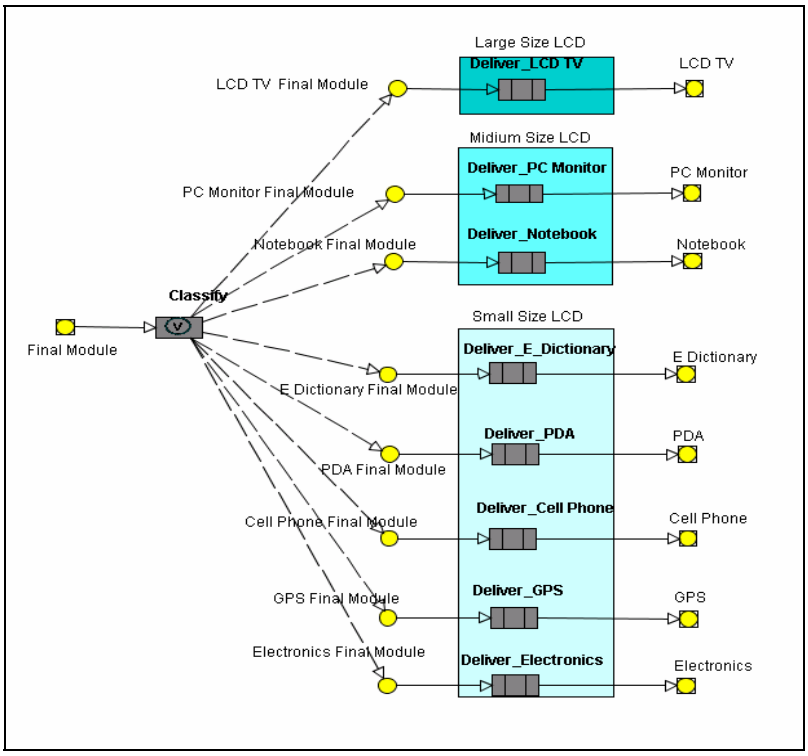


Figure 7. Final product classification by TFT-LCD panel size

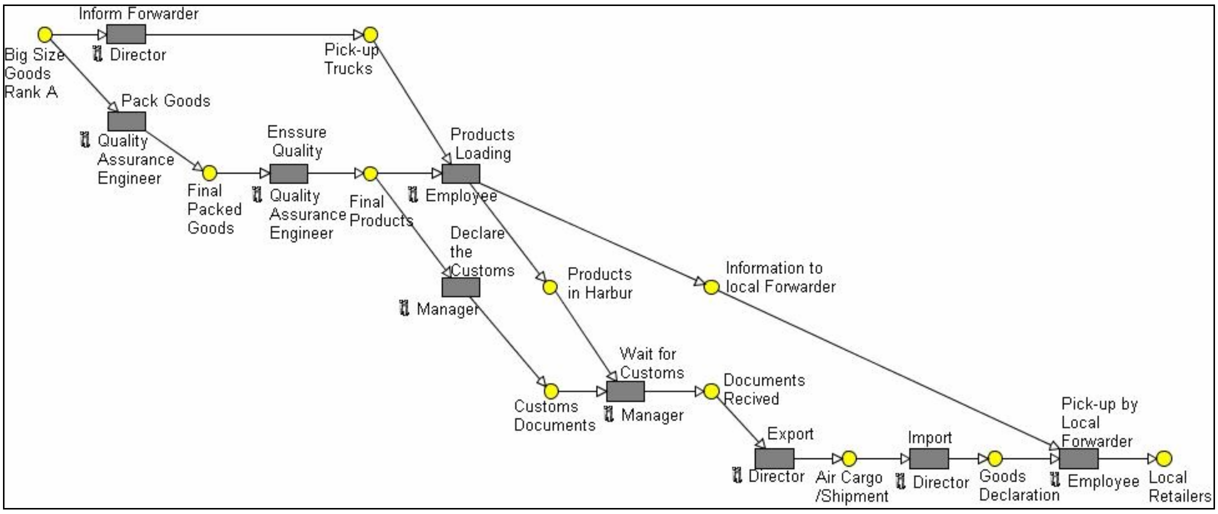


Figure 8. The drill-down of C Company's exporting/overseas forwarders

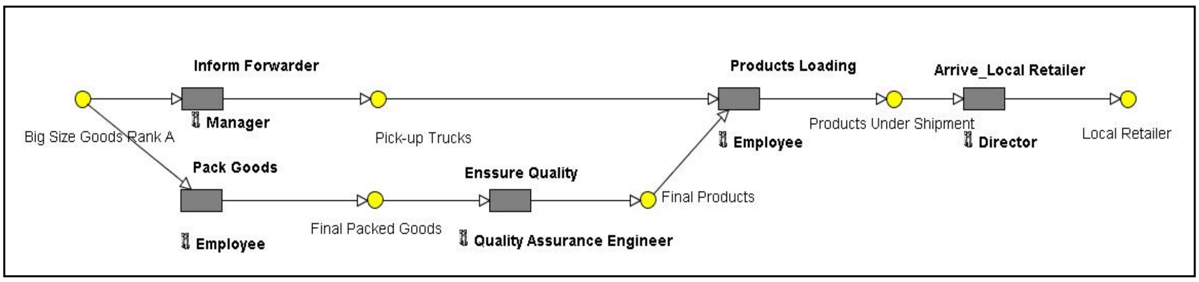


Figure 9. The drill-down of C Company's domestic forwarders

3.3. The As-Is Object Model

Figure 10 shows that when an order is received, two sets of data are generated. These are the order_detail (detailed data about the order) and the shipping_state (detailed shipping statement). In the as-is object model, no information about the overseas shipping statement is included.

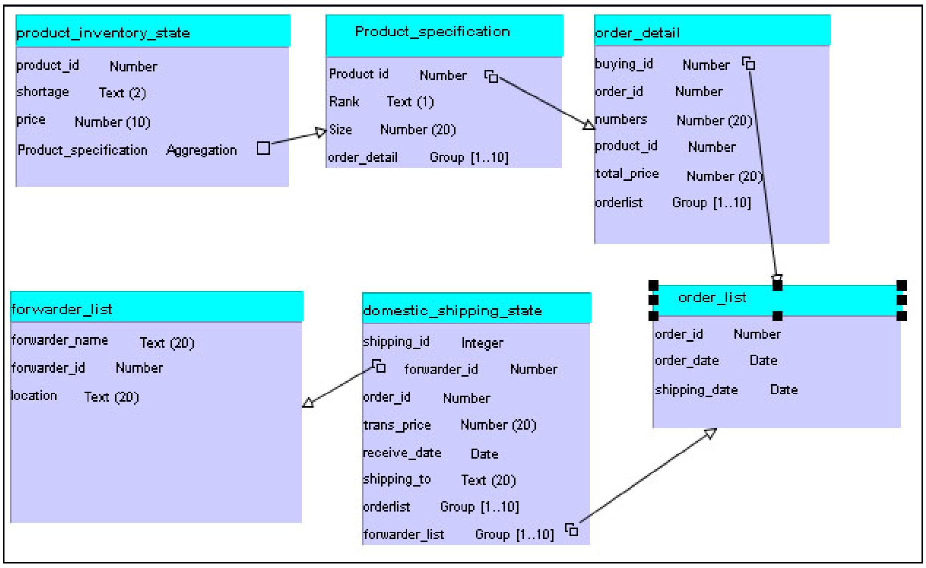


Figure 10. The as-is object model

3.4 The Disadvantage of the As-Is Model

There are three critical disadvantages of the as-is model. First, the processes do not integrate logistic information. Second, retailers and wholesalers cannot control the arrival time of products. Arrival times are planned independently without any exchange of information, which makes planning an extremely difficult task. Finally, there is no e-supply chain management and the on-line availability of information.

4. THE IMPROVED TO-BE MODEL

In order to improve the logistics efficiency of TFT-LCD panel provider, we present strategies derived from the as-is views (i.e., the to-be organization, behaviour, and object models).

4.1. The To-Be Organization Model

In the new organization model, we insert a new department called "overseas forwarder" to our supply chain management system. The overseas forwarder is not a part of the overall logistics system. However, this department becomes part of the virtual organization when a contract is signed with the service provider to perform the logistic functions. A supply chain management system is placed on the top of the organizational model to control all the states of shipment, which previously were not considered with sufficient attention. The supply chain management system also controls the logistic information flows to facilitate the order fulfilment processes.

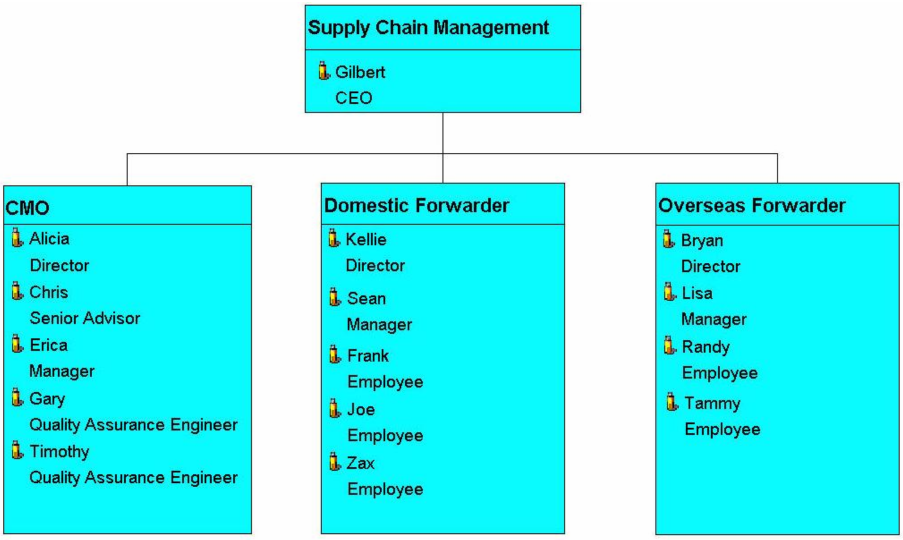


Figure 11. The to-be organization model

4.2. The To-Be Behaviour Model

For the proposed behaviour model, information integration is achieved after the goods are shipped from the warehouse. As shown in the second tier of the behaviour model, all goods shipped internationally or domestically access the activity called "Deliver". In this activity, all shipping information is collected in real time. One flaw of the as-is model was the classifications used. For instance, categories consisted of the shipping regions, the different size of panels, and the different rank of panels. These classifications are eliminated and the detailed processes are integrated with the delivery activities (Figure 13).

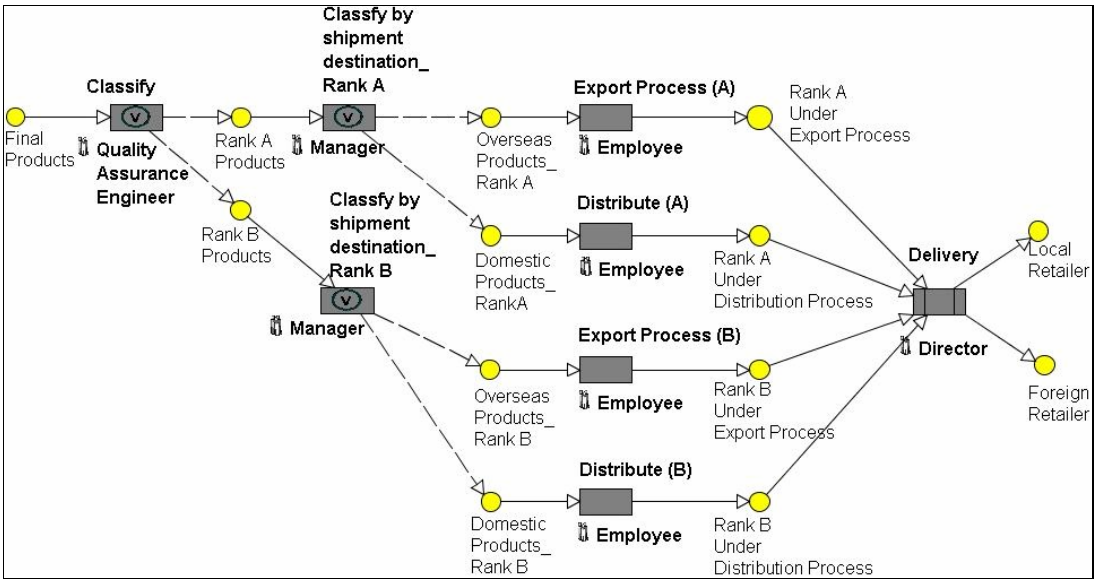


Figure 12. The to-be second tier behaviour model

The to-be third tier behaviour model builds an information platform for the company. The information platform receives all the shipping information and transportation details and relates this data to the inventory system data. In this manner it is possible to integrate the inventory state with the shipping information from warehouse to retailer. As shown in Figure 13, the inventory information and the shipping information are collected from the warehouse. During the shipment of goods to overseas retailers, the states of transportation such as whether the goods are at the docks or in the control of the overseas forwarder are traced in real time. When goods are in the control of the overseas region, the information from local forwarder and/or transferring posts is traced. Thus, all supply chain information is traceable and integrated.

The breakthrough for the Supply Chain Management information platform is the simplification of the order processes. The clients use an Internet browser to review inventories, make and/or change orders, and track the goods during shipment. Internally, the SCM information platform simplifies planning and scheduling of materials, facilitates on-time manufacturing, and allows all parties to trace shipping.

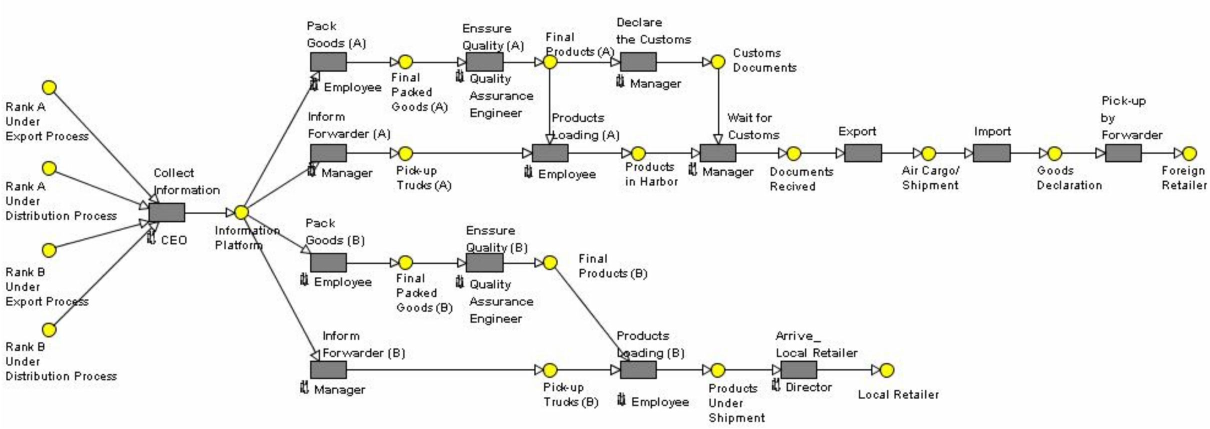


Figure 13. The improved third tier behaviour model

4.3. The To-Be Object Model

In the present process, C Company uses the inventory system and order system to process transactions. The SCM information platform includes the shipping information of overseas and local forwarders. Therefore, the company must construct objects about forwarders that can be used in the information platform. These three objects are overseas_shipping_state, retailer_list, and order_final_state.

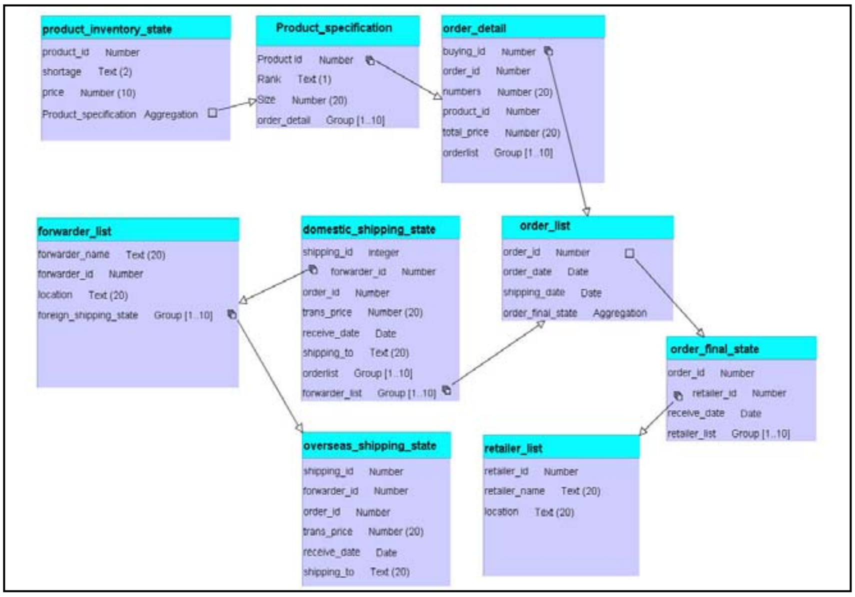


Figure 14. The to-be object model

5. CONCLUSION

In addition to simplifying and re-organizing the logistics processes, this research shows the initial re-engineering of the to-be model to create a collaborative information system to improve communication, reduce logistics costs, and improve logistics efficiency. The model serves as a reference model for optoelectronic industry and can be used as the starting point for system development. Given better communication between manufacturers, domestic and overseas forwarders, and local retailers, the prime can improve and maintain good relationships through improved services and lower costs. The logistics costs are reduced by saving the forwarders money since they are free to use the information system to plan and execute the shipping process. The information system also enhances efficiency by reducing paper work and speeding up information updates.

REFERENCES

Andersson, D. and Norman, A. (2002), Procurement of logistics services- a minutes work or a multi-year project?, *European Journal of Purchasing & Supply Management*, **8**, 3-14.

Bakos, Y., (1998), The emerging role of electronic marketplaces on the Internet. *Communications of the ACM*, **41(8)**, 35–42.

Bucklin, L. P. (1966), A theory of distribution channel structure, Berkeley: *Institute of Business and Economic Research*, University of California.

Hwang, H.-S. (2002), Design of supply-chain logistics system considering service level. *Computers & Industrial Engineer*, **43**, 283-297.

Lee, H. and Yang, H. M. (2003), Strategies for a global logistics and economic hub; Incheon International Airport. *Journal of Air Transport Management*, **9**, 113-121.

Lin, J. T., Chen, T.-L. and Huang, C.-C. (2004), A hierarchy planning model for TFT-LCD production chain, International Journal of Electronic Business Management, **2(1)**, 59-68.

Simchi-Levi, D., Kaminsky, P. and Simchi-Levi, E. (2003), *Designing & Managing The Supply Chain: Concepts, Strategies, and Case Studies.* 2nd. Ed. New York: McGraw-Hill, 2003.

Vandemerwe, S. (1999), The electronic go-between service provider: A new middle role taking centre stage. *European Management Journal*, **17(6)**, 598–608.

Venkatraman, N., (1994), IT-Enabled Business Transformation: From Automation to Business Scope Redefinition. *Sloan Management Review*, Winter, 1994, pp.73–87.

Wouters, M., Sharman, G. and Wortmann, H. (1999), Reconstructing the sales and fulfilment cycle to create supply chain differentiation. *The International Journal of Logistics Management*, **10(2)**, 83–98.