MODELLING AIR CARGO SUPPLY CHAIN MANAGEMENT WITH BUSINESS PROCESS FRAMEWORK FOR AIR CARGO INDUSTRY IN THAILAND

SOMVANG KAVANH

A THESIS REPORT SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT
INTERNATIONAL COLLEGE
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
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THESIS TITLE	Modeling Air Cargo Supply Chain with Business Process Framework for Air Cargo Industry In Thailand
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ABSTRACT

The air cargo service provision represents the cumulating effect of multiple organizations and their relationship to offer products and services to end customers. From the supply chain overview, air cargo industries have been the essential role in the air transportation industry which connects several businesses in global networks.

The planning and management for air transportation supply chain requires properly specifying participates and identifying the relationship amount them. Air cargo industry is a complex structure and has high competitive in these business areas. To realize the success, the company has to know about competitive environments for managing activities involve directly and indirectly to fulfill customer requirements. The activities should be design to reduce operation costs to improve the flow of supplier and to increase customer satisfaction.

The purpose of this study designs the business process framework and identifies the performance measurement system in air cargo supply chain. To verify whether the proposed strategies are more effective or not, a model is proposed to modeling the cargo flows both import flow and export flow. it also studies the impact of alternative strategies on the performance of the terminal by using Supply Chain Operation Reference model and Business Process Modeling and Notation to model the process flows and the performance measurement system of air cargo terminal. SCOR

model is the management tools use to address, improve and communicate supply chain management process within the company, with suppliers and customers of company. On the other hand, BPMN is the diagram to present the process flows both import and export of air cargo, link the relationship, show the condition and decision making in the processes.

With the results, the SCOR model shows the basic structure and keeps the processes and metrics from the SCOR model intact. This means, the SCOR model can be used by the up-stream in supply chain and can be used to map the supply chain from supplier or consignor of air cargo to the actual air cargo terminal and with a bottom-up approach, 68 KPIs base on the original SCOR model has been identified to measure and monitor their supply chain performance. These metrics cover the key elements of quality, time, and cost in air cargo supply chain and can assist to measure the performance. By implementing these metrics, air cargo industry is able to benchmark both internally against its previous performance and externally to set realistic targets for ongoing improvement. Moreover, it can also be used to assist the management level guideline for implementation and process improvement within the organization.

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Finally, I must express my greatest gratitude to my parents and all relatives for providing me with unfailing support and continuous motivation throughout my years of study. This accomplishment would not have been possible without them.

Somvang Kavanh

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LIST OF DEFINATIONS

AEC	ASEAN Economic Community
AS/RS	Automated Storage and Retrieval Systems
AWB	Air Way Bill
BPM	Business Process Management
BPMN	Business Process Modeling and Notation
ETV	Elevating Transfer Vehicles
IT	Information Technology
IATA	International Air transportation Association
KPIs	Key Performance Indicators
3PL	Third Party Logistics
SCOR	Supply Chain Operation Reference
SKUs	Stock Keeping Units
ULD	Unit Load Device

CHAPTER 1

INTRODUCTION

1.1 Research Background

Due to the advancing globalization and declining of trade barrier, logistics is a fast-growing industry in the global area. Especially, air transportation has grown dramatically over two decades since air transportation has become an affordable mode of transportation; it was supporting the infrastructure well established. In particular, transportation by aircraft is well suited to quick transportation over long distances, whereas automobile remain the dominant travel model in short distances because of its convenience, low cost and high accessibility, as demand for air travel are growing, congestion issues are becoming more and more severe due to the service of capacity does not match up to their growth.

In the supply chain overviews, the air cargo service provision represents the cumulating effect of multiple organizations and their relationship to offer products and services to end customers. It involves several suppliers, airlines operation, stakeholders, and government agencies as a customs department, securities and immigrations. On other hand, air cargo industries have been playing an essential role in the air transportation industry which connects several businesses in global network. Currently, the air cargo industry has grown more than 35% of global trade value and the demand measured in freight grew by 3.8% in 2016 compared to 2015 (IATA, 2017). Several companies trended toward the production move by air, because several factors include high value, urgent of need or use, products sensitivity, being lightweight but important in the production process.

The planning and management for air transportation supply chain requires properly specifying participates and identifying the relationship amount them. Air cargo industry is a complex structure and high competitive in these business areas. With the development of the time, the air cargo business competition has changed from the competition between businesses to the competition between supply chains. When analyzing the enterprise internal problems and improving the weakness, these cannot just limit to the business interior but it should expand the scope look more inclusive in the supply chain networks. Moreover, to realize success the company has to know about a competitive environment for managing activities involved directly and indirectly to fulfill customer requirements. The activities should be design to reduce operation costs to improve the flow of supplier and to increase customer satisfaction. The process of air cargo supply chain management integrates internal and external company activities through the cooperative organization relationship and effective process (Handfield, 2002).

Air cargo terminal functions as the distribution center transfer the products and services form customer to consignees, companies hence to realize the importance of sharing information with their customers, distributors and consignee to make the decision. Decision making in this is more complex environments, highly relied on the degree and quality of available information (Yang, 2009). Thus, the planning and managing are one of essential role in the air cargo terminal that are complicated and difficult to control if you don't know well about the processes. Moreover, most of busy airport, operational problems are further compounded by temporal variations in workloads, due to concentrations of flight arrivals or departures within limited time widows.

To verify whether the proposed strategies are more effective or not, a model is proposed to modeling the cargo flow both import flow and export flow and to study the impact of alternative strategies on the performance of the terminal. This approach is more appropriate and feasible than a purely analytical approach, because of the high degree of interaction between the material handling system and the storage system and the fact that the material flow is partially determined by stochastic request times from the consignee or freight forwarders and cargo agents. The model used to design in this case is Supply Chain Operation Reference model and Business Process Modeling and Notation to model the process flows and the performance measurement system of air cargo terminal.

1.2 Problems Statement

Cargo airlines and freight forwarders which carry a portion of freight traffic contribute to the larger courier service industry, which simply put, delivers messages, packages, and mail. Air freights are a small portion of a much larger logistics networks which involve production, packaging, material handling, inventory, transportation, warehousing, security, and information flows.

Air transport network has 113 routes connecting Thailand to urban agglomeration around the world. A total of 26 of these routes were connecting Thailand to cities more than 10 million inhabitants, frequencies are higher to the most economically important destinations (AOT, 2016).

Air cargo in Thailand has provided cargo terminal handling Services in the free zone at Suvarnabhumi airport to support the expansion of the volume of freights and mails, both import and export including transshipment cargo both international and

domestic flights. Since their move from Don Mueang airport to Suvarnabhumi airport in the year 2006 to the present, 107 international airlines have been served.

Cargo operations consist of general cargo handling and special handling products such as fresh produce, animals, high-value goods, and temperature controlled goods. In 2015, air cargo made improvements on the quality and standards following suggestions of the customers to achieve maximum customer satisfaction by offering closed warehouse system to manage security effectively and overall export of air cargo increased overall export of air cargo increased by 8% respectively, import increased by 2%, while transit air cargo increased by 0.6%, resulting in the total volume of cargo of 1.27 million tons and 3% increasing from 2015. Given continuous intense competition in the air cargo and freight industry, reduced availability of freight space on passenger flights by 24%, and the discontinuation of freighter aircraft in April 2015 (ThaiAirways, 2016). The Company has adopted a proactive marketing approach in order to maintain the existing customer base as well as to explore new market opportunities to increase revenue (IATA, 2015). In 2016, air cargo experienced the highest growth since 2010. The international air cargo depends on trading partners' economies which showed some improvement since a several years of stagnation. Overall air cargo handled by AOT's 6 airports grew by 7.67% when compared with last year, with 1.29% of compound average annual growth over 2007 to 2016 (AOT, 2016).

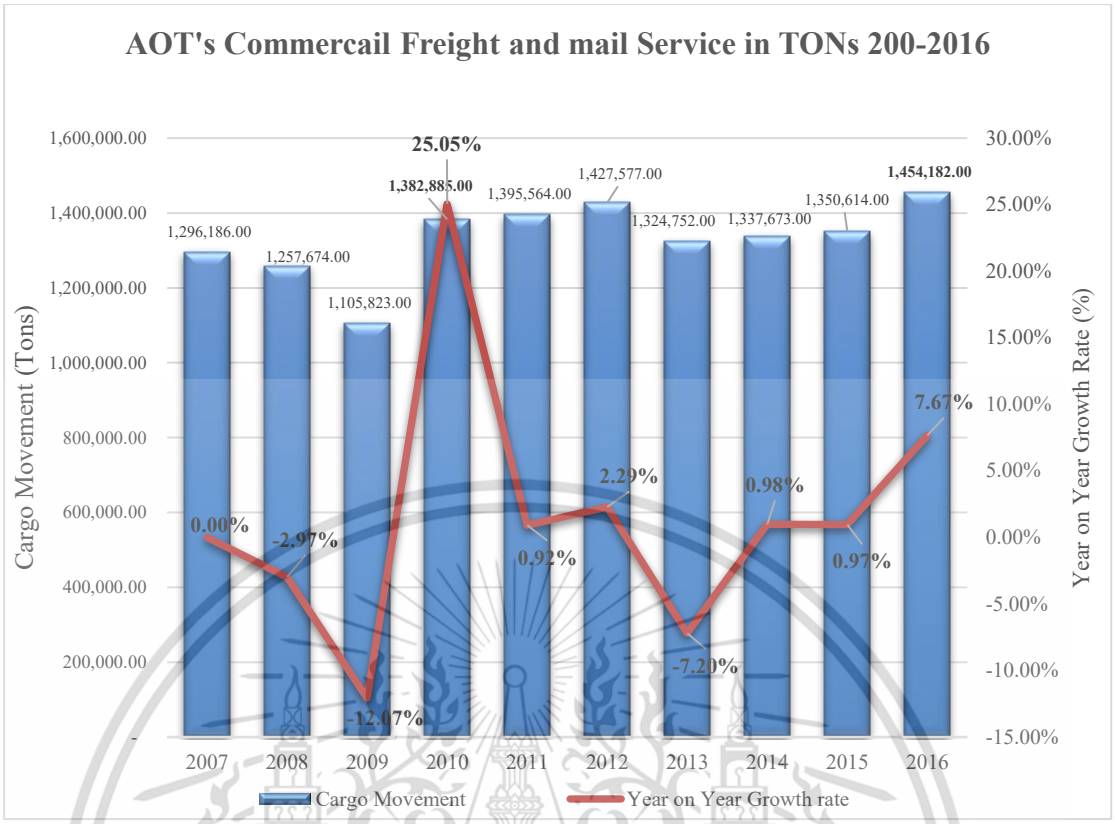

Figure 1.1 AOT's Commercial Freight and Mail Services In 2007-2016

Source: AOT Annual Report 2016, Airports of Thailand Public Company Limited.

Due to the increasing of customer demand, the air cargo industry would like to provide quality service, to achieve the highest customer satisfaction and to prepare for the increase of trade from AEC, air cargo industry wants to develop a new information and communication system, which integrated the system for cargo transport reservation, cargo management, unit loading device management and revenue account management for commercial goods and postal services. The purpose is supporting the business, increasing competitiveness and meeting with the customers' requirements. This research will choose this case study to identify, design and mapping the process to improve the business performance and competitiveness of air cargo industry.

1.3 Objectives of the Study

Thailand' cargo business strategy helps customers meet with supply chain excusive. An important part of the strategy is offering the possibilities for process analysis and decision making.

Previously, there is not standardization model to define a process of air cargo operations or air cargo industry as well; this research tries to modeling a new standardization with applies the Supply Chain Operation Reference Model (SCOR) and models with Business Process Modeling and Notation (BPMN) to support identification and visualization of the process.

Moreover, this study will develop the performance measurement system for air cargo activities. This system will base on the SCOR model and BPMN. This study wants to gain a deeper understanding about the SCOR as a whole; it has to investigate how to SCOR and BPMN framework can apply in the company services within the distribution center management. So, this study should answer some essential question:

1. How can identify the process of air cargo terminal base on SCOR?
2. What kind of metrics does Thai cargo use today regarding their distribution center?
3. To what extent are metrics from the SCOR model applicable for Thai cargo?
4. How should the possible performance measurement model the distribution center activities base on SCOR and BPMN designed and used?
5. Which metrics are used to asses that requirement goals are accomplished onthe process model?

1.4 Scope of the Study

The scope of this research will be limited measuring, designing and planning those activities that take the place in air cargo terminal since purchase order form customer, receiving product, storage, delivery to consignees, those processes need to connect with other processes between customers, freight forwarder, and inside the cargo terminal. This research focuses on air cargo operation at Suvarnabhumi airport in Thailand to design and improve new standardization of air cargo processes. The structure framework of processes will design base on SCOR and BPMN to modify the workflows and measure the performance measurement system.

CHAPTER 2

LITERATURE REVIEW

2.1. Air Cargo Supply Chain Management

Air cargo supply chains, the process of moving consignments from origin to destination are often complex and subject to a range of regulatory requirement. Especially, international movements and transport by air, air cargo is highly diverse in its physical characteristics and value. It may originate from and be delivered to almost anywhere in the world, most commonly as goods being sent from a seller to a buyer or from a consignor to a consignee. It can take the form of personal belongings, gifts and donations, product samples or equipment and even live animals for professional activities and events. It may be considered low risk , a regular shipment from a known source in a relatively safe region or high risk such as a more unusual shipment from an unknown source, presenting anomalies or identified by intelligence (ICAO, 2014).

The cargo will be handled along the chain by a number of entities with varying responsibilities, including aircraft operators, express carriers, and postal operators, regulated agents, consignors, consignees, and ground handlers. As a further complication, these entities will often be known by different names according to the state or region in which they are located.

Air cargo has played the essential role in regional and global supply chain process, the cargo may transfer between several different flights before it reaches to destination and consignments will be subjected to a variety of procedures and documentary requirements in accordance with legal and commercial frameworks. Authorities responsible for the safety and security of aviation, for the prevention of crime and protection of fiscal revenues, will all have an interest and their own rules.

Air shipping used for products that are either time-sensitive, high value or can justify high transportation cost compare to other methods. Air cargo is used normally for delivery the emergency parts of industrial machinery where on-site inventories of replacement parts are low due to the high carrying costs. Other product as sea foods and pharmaceuticals, which expert quickly, also rely on air cargo to deliver with in the short time frame.

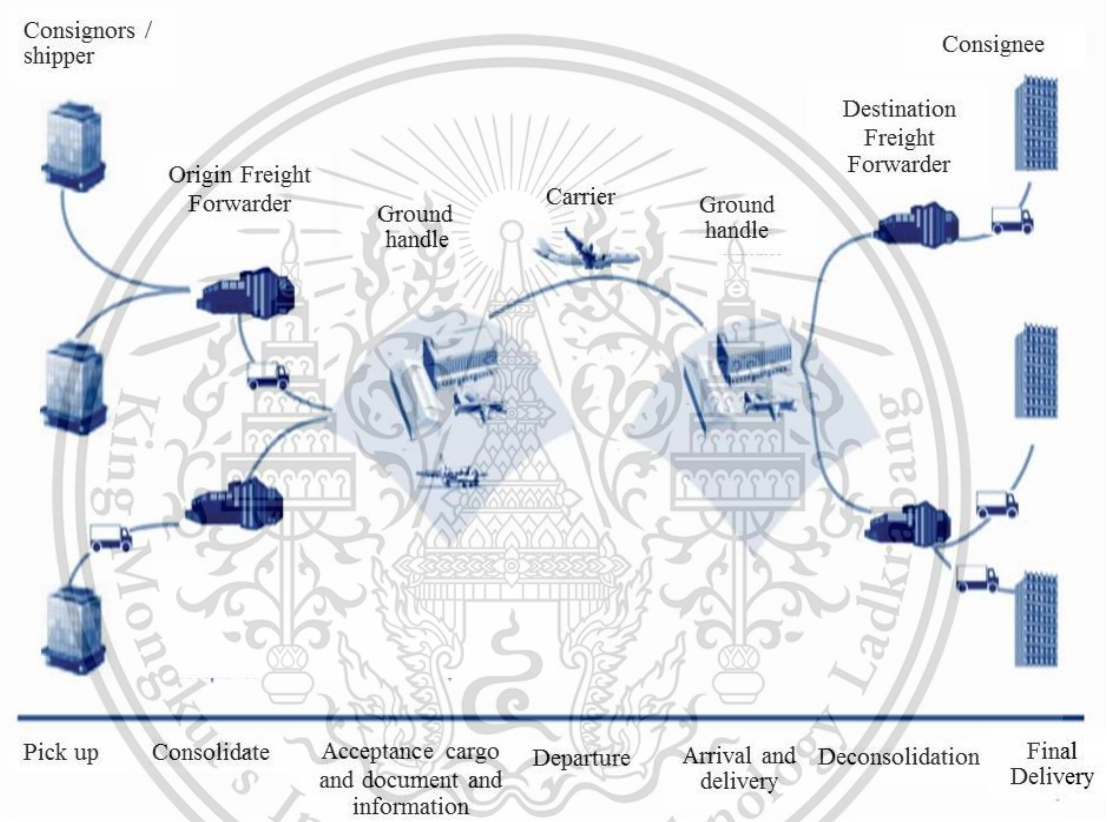

Figure 2.1 Air Cargo Supply Chain Overview

Source: ICAO (2014). Moving Air Cargo Globally In w. c. organization (Ed.), Air Cargo and Mail Secure Supply Chain and Facilitation Guidelines: world custom organization

There are two main types of supply chain exit in air freight logistics included integrated and Freight forwarding (Advisors, 2014).

The Integrated Approach

In an integrated supply chain process, a single entry is responsible for the movement of the product. Starting from the shipper (consignor) and through to the

receiver (consignee). Some approach integrators have sophisticated in house logistics platforms. Ensuring a single operation is responsible for the product form product to delivery using internal truck and plane fleets, this approach known as the delivering from manufacturer to customer (Advisors, 2014)

The Freight Forwarding Approach

In a freight forwarding process, the resources of several groups such as courier and third-party logistics (3PL) companies are involved the movement of goods. Typically, the company are specializing in logistics (A freight forwarder) arranges the pick-up, customer inspection, storage, travel, consolidation or deconsolidation and delivery of the goods using external logistics group. In this case, air cargo is one part of supply chain process, the approach can be ship cargo in two ways as pure freight operation which are devoted solely to freight and have their own fleet of cargo aircraft and combination carriers which carry cargo in the belly of passenger flight (Advisors, 2014).

2.2. Air Cargo Operation

Cargo operations at airports involved the preparation of cargo shipments, the loading and unloading of the aircraft, cargo transfer between the storage facilities and land transport. For outbound cargo, the preparation included consolidation of cargo, building up of the air cargo pallets and containers, inspection and documentation, while inbound cargo, the preparation included customs and other regulatory procedures, as well as deconsolidation. The transshipment cargo operation was generally limited to unloading, reconsolidating, and reloading the cargo but can be as simple as a direct transfer between aircraft (sometimes known as tail-to-tail transfer)(Advisors, 2014).

Although air cargo ideally remains in the airport for a relatively short time, it was necessary to provide storage facilities. Bonded facilities are required for imports and international transshipment cargo, perishable cargoes are necessary to provide cold rooms. For outbound cargo was necessary to provide x-ray scanners to inspect the cargo. Since most air cargo was low density, most of the cargo is stored on racks, preferably in large open warehouses with high ceilings (more than eight meters)(Bronsing, 2013). The storage areas must be equipped with loading docks on the landside to allow for rapid movement of goods to and from trucks. Most airports also provided offices near the warehouses for the airlines and forwarders to receive/deliver cargo and prepare shipping documents, and for customs to clear import and export cargo.

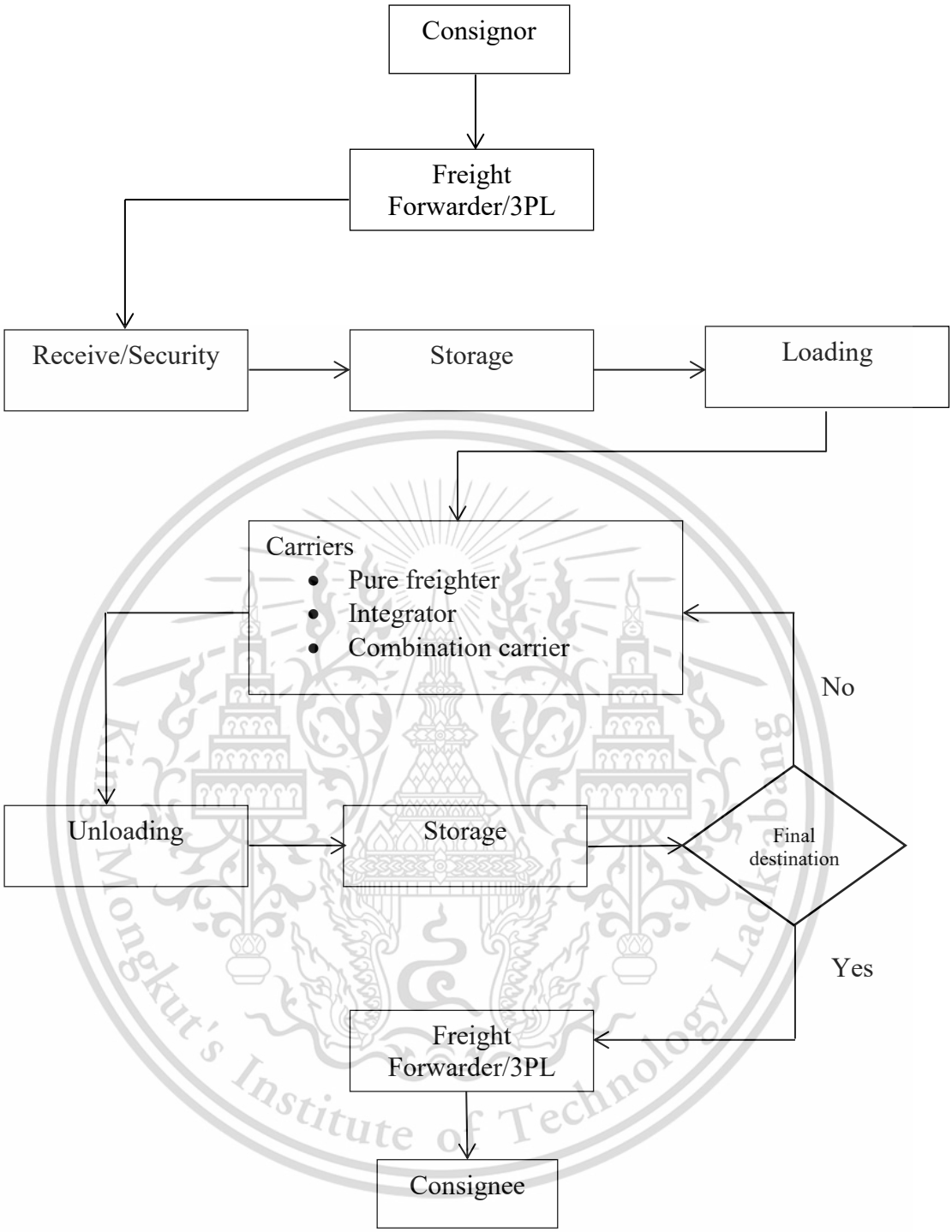

Figure 2.2 General Air Cargo Handling Flow

Source: GWL, R. a. (2014). Air cargo supply chain and the changing dynamics of airport providing new perspectives for industrial demand.

2.2.1. Air Cargo Process

Air cargo management has been defined as the combination of planning decision making, controlling inbound, storage and outbound flows (Faber, 2013). The activities of air cargo were similar with the warehouse and distribution centre. The inbound processes are represented by receiving products from customers, put away to storage whilst the outbound processes included picking and pack product and shipping to customer.

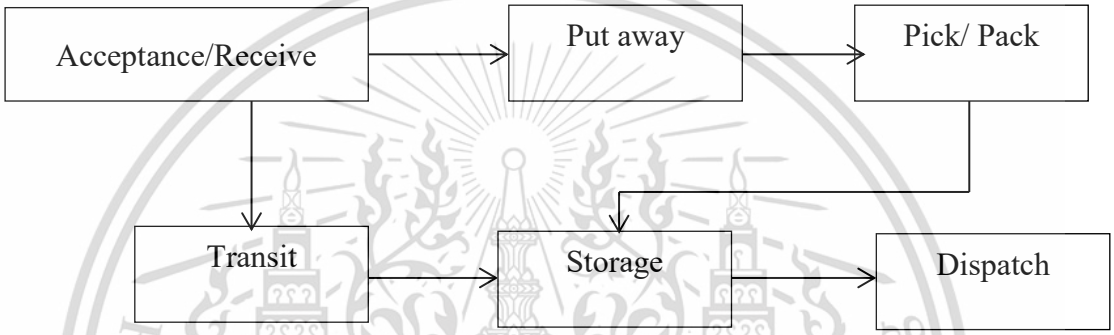

Figure 2.3 Air Cargo Process Activities

Source: Bartholdi john, h. s. T. (2011). Warehouse and Distribution Science Release, Atlanta. Georgia institute of technology Atlanta

In the following **Figure 2.3** shown the different activities in the inbound and outbound process are represented, Bartholdi john (2011) had brief the description of the process as:

1. **Receive**

The Receive process is the first activity that faces with the customers; all downstream workflows depend upon the accuracies and efficacies achieved during the receiving. The activity in the flows starts with get notification incoming goods from customers, which allow the workers to arrange the coordinated unloading of the incoming goods. Normally, the goods are also scanned and registers in company's warehouse.

2. Put Away

Put away process is triggered by the receipt of goods in the warehouse related to a vendor purchase order, returned or transferred items. It is the process between inventory and warehouse management, such as goods receipts are performed in inventory and reflected in warehouse. In this process the stock keeping units (SKUs) is being made, it's important for select the locations. The reason for this is the storage location many time reflects how quickly and how cost efficient. The process also need support quick access information about available storage location and need consider about weight of products, spacious and easily to accesses.

3. Storage

Almost activities of air cargo will throughout the storage, there are two main types for Storages includes: dedicated storage and shared storage. Dedicates storage is reserved for specific and allocated products. High frequent products are assigned to convenient location, which streamline order picking. However, a consequent of dedicated storage is often volume utilization become insufficient.

While, share storage use to be improves the utilization, hence products can be assigning to several locations, once such a location is empty, another product can be assign to this specific location.

4. Pick and Pack

Pick goods process is triggered by issuance of stock from the storage, order picking involves the process of clustering and scheduling the customer orders, assigning storage on location order line, picking the articles from storage location and disposal of the picked article. Picking line may be consisting of several picks from the

same location. Picking have been a large interest for automating due to high operating cost and manual handing.

Packing is also a quite labor intensive because of the magnitude of order that are handled, often inspection take place at this stage as well. This inspection is performed to control the orders are complete and accurate is a crucial measure and importance to create a good service to customers.

5. Dispatch

In general, the numbers of unit handle in the shipping dock are lower compared to the picking order. Because customer asks for consolidation shipments that mean orders are pack together on a single carrier. Delivery is the end of activities of outbound to deliver the goods from customers to consignees.

6. Transit / Cross dock

Transit is referred to the activity when goods are not stored in the warehouse. It is instead directly transferred, after receipt in receiving, to the shipping dock where an aggregation with other goods will coordinate in to aircraft

7. Return

The return flow is reversed movement in warehousing; return will likely become a larger function in most warehouses.

2.2.2. Air Cargo Role and Responsibility

Air cargo was played the key role in logistics often complicated movements share the responsibility for ensuring the safety and security of the cargo and for operating within the law. In particular, they are responsible for ensuring that nothing contained in the cargo will endanger an aircraft and the lives of those travelling on it.

Air cargo single entity may fulfill more than one role in the supply chain and take on the combined responsibilities.

1. **Broker**

A broker is an independent agent who facilitates the movement of goods from buyer to seller, for instance by arranging air transport or meeting Customs requirements, such as goods declarations. Brokering functions are often integrated with forwarding, consolidation and even warehousing functions within a single entity.

2. **Buyer**

The buyer is the purchaser of the goods and, in the international trade context, is also known as the importer. The buyer or importer either clears consignments on its own or utilizes the services of a broker to assist with various requirements of border regulatory agencies.

3. **Consignors**

The consignors are the entity or individual who initiates the movement or transport of the goods. In other words, it is the sender. The term 'shipper' is often used to describe the entity or individual who initiates the trade in goods. Consignor and shipper are separate roles but can be the same entity or individual.

4. **Consignees**

The consignees are the party designated on the invoice or packing list as the recipient of the goods at the end of the transport movement.

5. **Freight Forwarders**

Freight forwarders are part of the transport logistics process within the supply chain and their main task is to arrange for air shipments to be managed in such a way that they are ready for transportation by aircraft operators. Such arrangements might

include the consolidation of cargo. A freight forwarder and logistics service provider may offer a service relating to the preparation, storage, carriage and final delivery of goods, including the applicable documentary and facilitation formalities

6. Ground Handlers

Ground handlers are subcontracted and act on behalf of freight forwarders and/or aircraft operators. This occurs when the freight forwarder or aircraft operator does not have the necessary facilities. Ground handling services can include the provision of warehouses to accept, handle, prepare, and tag cargo and mail, as well as loading/unloading, transit, and storage of cargo and mail. Ground handlers are responsible for dealing with operational aspects, based on the instructions of freight forwarders and aircraft operators. Once a consignment is ready for shipment, the freight forwarder will release the cargo and instruct the ground handler to deliver it to the aircraft operator.

7. Airport Operators

Airport operators are the entity responsible for the provision and security of the airport infrastructure. The operator will establish a secure environment through which the goods move and may also be responsible for the provision of 'on airport' cargo services. In some cases, an airport operator will be the party responsible for the protocols for dealing with incidents resulting from a positive identification of a physical threat in air cargo.

8. Aircraft Operators

Aircraft operators, also known as airlines and air carriers, provide air transportation for goods. A transport contract (air waybill) binds an aircraft operator

with the relevant contracted parties for the safe and secure transport of cargo and mail from one location (e.g. the airport of departure) to another (e.g. the airport of arrival).

2.3. Air Cargo Performance Measurement System

Measuring the airport performance is one key to successful and efficient management in airport. The air cargo committee determined that airport desiring to measure performance world benefit from the creation of a listing potential measure rather than a price formula of ingredient. The process identifies the understanding of meaning in relation to business and serving the cargo industrial improves their performance. Air cargo managers may wish to evaluation their own performance internally over the time and also look externally at other comparable air cargo industries. Such external comparisons however are extremely difficult given the substantial differences to occur in cargo operation at airports which form many business elements other than cargo may be considered comparable (ACI, 2010).

For the most airports, air cargo and its underlying business and operation dynamics are less understood elements of the aviation industry particularly to airport commissions and regional municipalities that sometimes evaluate their airports and airport management's performance based on cargo data and statistics. This will help the managers create a set of airport specific criteria that will enable them to:

- Better understand and manage the business elements of air cargo as they relate to airports
- Anticipate potential problem areas or issues to be more responsive to the service requirements of tenants and users and

- Select performance measures that are meaningful to their airports and enable them to reflect airport performance accurately to their governing bodies

The use of performance measures to compare one airport to another has little actual utility in terms of air cargo. The variables are so extensive and the industry dynamics so volatile and subject to anomalies that any results could prove uninformative. It is particularly important that in establishing performance measures that those are adopted are not forced or inappropriate. They should address specific airport needs and not attempt to compare cargo functions at major gateways to small domestic operations at inland airports (Chung, 2015).

Airports play a prominent role in facilitating air cargo national and regional accessibility while also driving the economies of the areas or regions served by airports. Advances in technology and improvements in supply chain and modal transportation processes coupled with forecasted growth in the air cargo business have presented airports with many challenges (Wayne, 2008). These include operational efficiency, cost effectiveness, and security. To achieving performance standards can be the deciding factor when determining to whom to award business or how to route air cargo in or out of a country or region. Internally, airports should know their competitive position in the market place. By establishing performance measurement, airports can develop a better understanding of both individual performance of stakeholders as well as the overall performance of the airport (Timothy, 2008)

2.4. Business Process Management

Before performing and working decision model, it is necessary to clearly identify the business processes. An implementation of some formal rules to the final results of the air cargo process is in itself, an improvement, since it is a small step from

order to delivery. There are two principal areas: reducing operations and improving business performance. There are plenty of techniques for modelling and optimizing business processes (Ismahene, 2011). A few of those, which are low-budget and immediately applicable, are shown here (Miers, 2006). During the last 20 years, the BPM methodology has received plenty of attention and it has been growing in many different ways. Many scientists and writers have proposed their own ways of improving the Business Process (BP), however BPM is definitely the most popular and useful tool for it.

According to Miers (2006) gave the briefly description about BPM as "Business process management is a systematic approach to management, aimed at improving the organization and its processes. This approach enables organizations to define their processes, to organize their implementation, as well as improve the quality as a result of processes and procedures for the execution" (Miers, 2006)

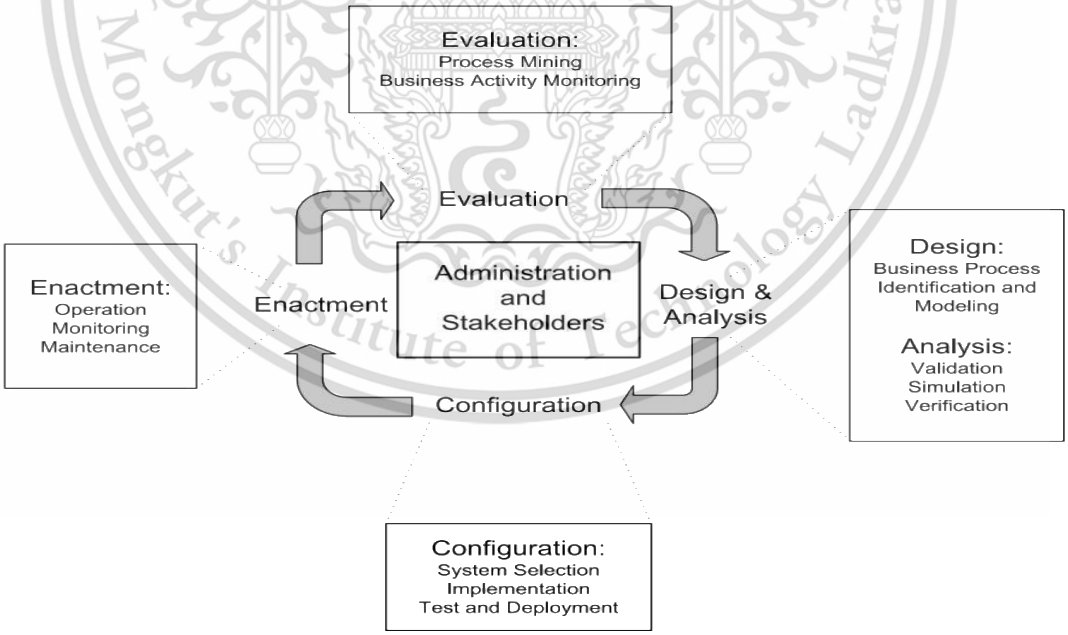

Figure 2.4 The Business Process Lifecycle or Process Management Cycle.

Source: Miers, D. (2006) The Keys to Business Process Project Success.

The main objective of business process management is to bring the process into line with the objectives of the organization. Each process must be configured so that the results of the process lead to the achievement of the business goals (Alfathi, 2016). Business process management uses the following approaches:

- Comprehensive, clear and documented process standardization, which includes the creation of a set of standardized processes and the ability to configure them to changing conditions;
- Continuous improvement of processes, including the daily monitoring, measurement, analysis and change of the processes;
- The application of information technology and software, including the modelling of business processes, the use of case tools, automation of business processes and their optimization on the basis of information technologies (Miers, 2006)

2.5. Business Process Model and Notation

Business Process Modeling and Notation (BPMN Version 2.0) was introduced by the object management group (OMG)as one of the standardized tool visualizing diagrams used to model and interpret the business process diagram(Reale, 2016). The purpose was facilitating communication of an end-to-end process to all cross-functional organization units by means of information structure in both professional management and technical IT terms. In this regard, BPMN standardizes blocked-structured process execution languages, between the business process design and process implementation (Cornu, 2013). BPMN is targeted both as a high-level process specification for business users and as a low-level process description for implementers. The business users should be able to easily read and understand a BPMN business process diagram. On the

other hand, the process implementer can add further details to a business process diagram in order to represent the process suitable for a physical implementation (Portiz, 2015). As a result, BPMN models can help define process interactions and facilitate communication in the process design and analysis phase. BPMN models can also act as a blueprint for the subsequent implementation.

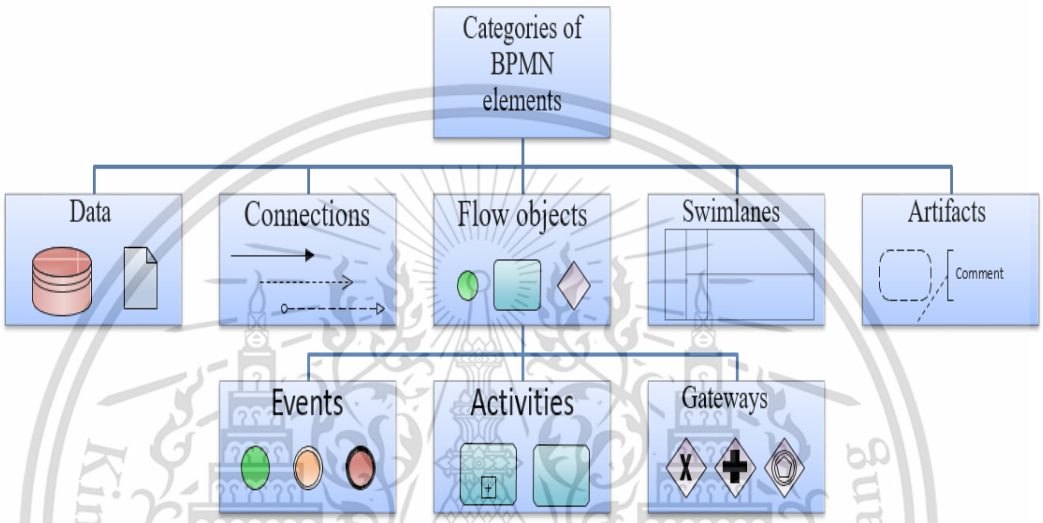

Figure 2.5 Business Process Modeling and Notation Core components

Source: Reale (2016). Business Process Modeling and Notation, An Overview of BPMN 2.0

BPMN was popular in both business and IT communities because it's symbolic visuals can provide a simple way to communicate process information to other business users, process implementers, customers and suppliers (Reale, 2016). There are four basic categories of elements in BPMN models – flow objects, connecting objects, swim lanes, and artifacts as **Figure 2.5**. Flow objects consist of three core elements – events, gateways, and activities.

Events

An event is denoted as a circle and represents something that happens. An event can associate with other elements such as a message envelope or a clock to perform a

complex event. Every process has only one start event and one end event. There are three main types of events:

- Start – indicates where a particular Process will start.
- Intermediate – occur between the start and end events and affect the flow of the process.
- End – indicates where the process ends.

Gate ways

A gateway determines forking and merging of paths depending on the conditions expressed. Events and Activities are pretty easy to understand. The real magic in a process, though, happens at the gateways. Gateways can tell a process to continue exclusively down one path vs. another or instruct participants in the process to begin working in parallel. In still other scenarios, there could be multiple pathways in which some of the pathways only become active under certain circumstances. There are three 3 main gateways include:

- Exclusive - This Decision represents a branching point where Alternatives are based on conditional Expressions contained within the outgoing Sequence Flows. Only one of the Alternatives will be chosen.
- Parallel (Fork) - BPMN uses the term “fork” to refer to the dividing of a path into two or more parallel paths (also known as an AND Split). It is a place in the Process where activities can be performed concurrently, rather than sequentially.
- Inclusive - This Decision represents a branching point where Alternatives are based on conditional Expressions contained within the outgoing Sequence Flows. In some sense it is a grouping of related independent Binary (Yes/No) Decisions. Since each path is independent, all combinations of the paths may be

taken, from zero to all. However, it should be designed so that at least one path is taken. A Default Condition could be used to ensure that at least one path is taken.

Activity

An activity element can be a task which represents a single unit of work, or a sub process, which has its own self-contained sequence flows and start and end events. Connecting objects represent linkages between flow objects, with sequence flows linking flow objects in the same pool and message flows linking flow objects in different pools. Swim lanes consist of pool and lane elements. A pool represents a major participating company in a process, whereas a lane represents a division of a company. Nevertheless, pool and lane elements are interchangeable and different companies can also be separated by lanes in the same pool.

2.6. Supply Chain Operation Reference Model

The supply chain operation reference model (SCOR) established by the supply chain council (SCC) for the supply chain standardization, measurement and improvement. The SCOR modeling framework is based on five keys of process- plan, source, make, delivery and return. The SCOR modeling framework provides a systematic approach to describe, characterize, and evaluate complex supply chain processes. Standardization of business processes is necessary to allow the communication and integration between business partners of the supply network(Patel, 2001). The model attempts to capture business operations including (1) customer interactions, from order entry through paid invoice, (2) product transactions, from supplier's supplier to customer's customer, and (3) market interactions, from the understanding of aggregate demand to the fulfillment of each order(Frederick, 2017).

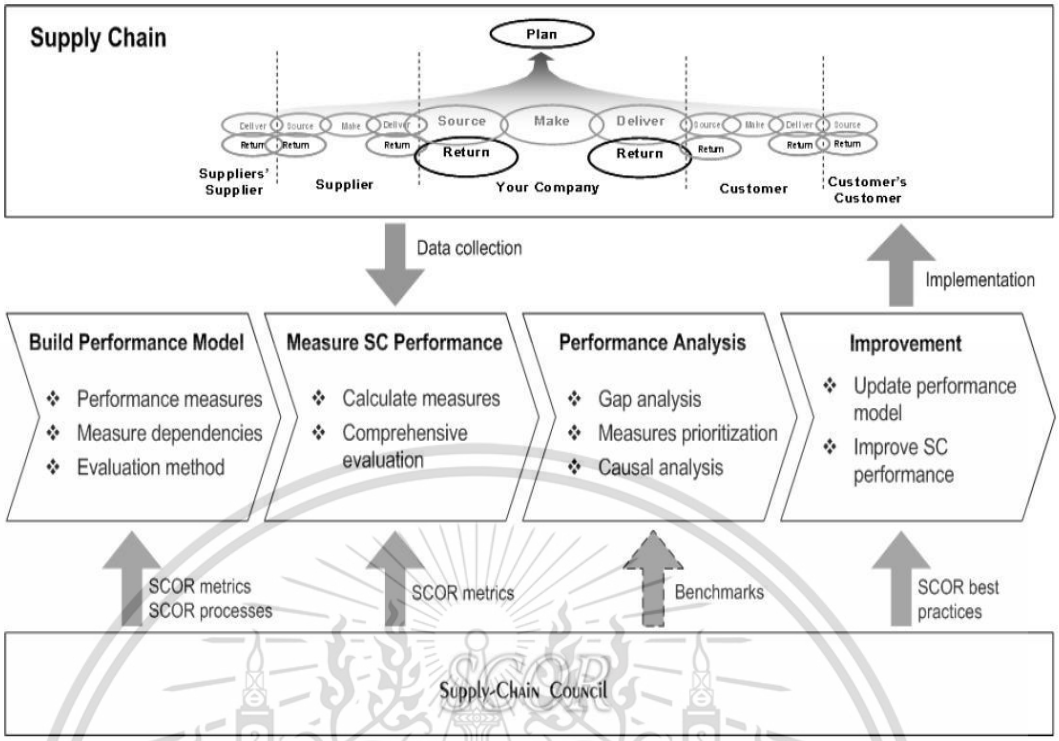

Figure 2.6 SCOR Process Model

Source: Frederick (2017). Supply Chain Operation Model (SCOR Vol. 12): Supply Chain Council

The SCOR model contains several sections; it is organized around the six primary management processes of Plan, Source, Make, Deliver, Return and Enable- to meet planned and actual demand shown in **Figure 2.6**. Plan includes processes that balance resources to establish plans that best meet the requirements of a supply chain and it's sourcing, production, delivery, and return activities. Source includes processes that manage the procurement, delivery, receipt, and transfer of raw material items, subassemblies, products, and services. Make includes processes that transform products to a finished state. Deliver includes processes that provide finished goods and services, including order management, transportation management, and distribution management. Return includes post-delivery customer support and processes that are associated with returning or receiving returned products. By describing supply chains using these processes building blocks, the model can be used to describe supply chains

that are very simple or very complex using a common set of definitions (Frederick, 2017).

2.6.1. The SCOR Process

The SCOR framework allows users to model supply chain structures and relationships in a progressive and systematic manner. There are four levels of model development in the SCOR framework as **Figure. 2.5.** Level 1 modeling provides a broad definition of the scope and content for the SCOR model in **Figure2.4**. Level 2 modeling divides the five basic management processes into process categories, which allow companies to describe the configuration of their supply chains. Level 2 models conceptually specify the relationship and interactions among supply chain members. The conceptual specification can be extended to describe the process workflow through Level 3 modeling (Lu, 2016). Level 3 modeling provides companies with the information for detailed planning and setting goals. Level 3 processes also provide the basis for defining the supply chain performance metrics. Level 4 modeling focuses on implementation. Since SCOR Level 4 models are unique to each company, the specific elements at this level are not defined within the SCOR framework. In Level 4 modeling, users need to design the implementation details of each Level 3 process to meet their own needs. Through the four levels of development, the SCOR models can be extended to capture and represent complex interactions among supply chain partners (Lepori, 2013).

Level 1 Management Process

SCOR is structured around six processes called: Plan, Source, Make, Deliver, Return and Enable. All have been acknowledged as characteristic processes, which need to be executed in order to fulfill customer orders. Source, Make, Deliver and

Return are connected to warehousing and Plan covers all the organizations. Level 1 processes are also called management processes or top level and are further described below according to SCOR version 12.

Plan

These processes refer to the development of plans to function the supply chain. Gathering of information on accessible resources and congregation of information on requirements is being made so as to conclude what breaches and capabilities that exist in demand or in resources.

Source

The processes of Source exemplify for example the issuance of procurement orders, including receiving, validation, and storage as well as the authorization of invoices from the supplier.

Make

Make denotes the processes related to the establishment of content or transformation of materials for services. Make represents all types of conversions, which is why the terms manufacturing or production is not used. In addition, repairing, recycling, renovation and even remanufacturing are also included in Make although it could be part of a Return process.

Deliver

Here, deliver represents the processes connected to creation, maintenance and fulfillment of customer orders such as validation, receipt, establishment of customer orders, scheduling deliveries, picking, packing, and finally shipping and invoicing customers.

Return

The reverse flow of material is what it's referred to in this sense. Here, identification of the need of returns, the arrangement of decision-making or the scheduling of activities as well as the shipment and receipt of the returned goods are included. Other activities such as recycling and remanufacturing are not described here, but in the make processes as described above.

Enable

Enable designates, the processes are related to the managing of a supply chain. These processes cover management of business policies, performance management, data management, resource management, contract management, supply chain network management, compliance management and risk management.

Level 2 Defining Process

Level 2processes, denoted as the configuration level, define the strategy of an operation, Level 2process diagrams can help in most projects to find a potential issue or redundancy in the supply chain, process level 2 focus on analysis the relationship between the supply chain in the organization. (Frederick, 2017). Examples of level 2 processes are "Source Make-to-order Product", "Deliver Stocked Product".

Level 3 Operational Process

In level 3, the formation of individual processes is defined;it sets out the execution of level 2 processes and is focused on more detailed actions (SCC, 2012). Furthermore, level 3 processes specify a firm's capability to be competitive in its designated markets and it's on these level corporations "fine tune" their operations strategy. If a company operates a warehouse, it is on level 3 one finds the connection to the warehouse's certain activities, such as picking, Another example of a level 3

process is “receive, enter and validate a customer order”, which most, if not all companies need to perform (Axelsson, 2014).

The focus of level 3 processes is to ensure that correct skills of staff, inputs and outputs, process performance, technology skills and/or practices are captured which enables a company to run their warehouse operations as defined by the organization’s strategy. Furthermore, process diagrams on level 3 can help sort out decision points, process disconnections and triggers that are needed to structure an organization’s operations.

Level 4 Process

Level 4 processes are industry, product, location or technology specific and not included in the scope of SCOR. The SCOR model cannot supports all different processes that are used on this level due to the modifications every company faces. Level 4 processes description are therefore up to every company to perform (Frederick, 2017). All 4 level are shown in **Figure 2.7**

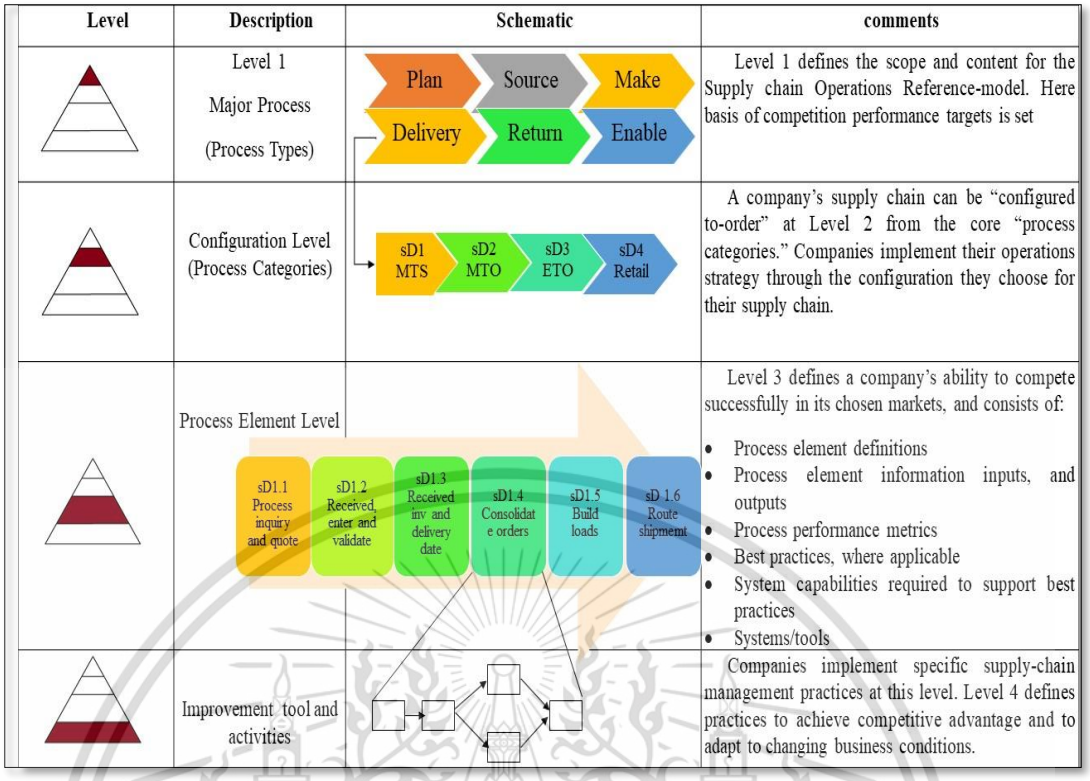

Figure 2.7 4 SCOR Business Process Level

Source: Frederick (2017). Supply Chain Operation Model (SCOR Vol. 12): Supply Chain Council

2.6.2. SCOR Performance and Metrics

The SCOR model describes supply chain activities for business at each level and defines as set of performance metrics used to evaluate the process. The performance section of SCOR consists of two types of elements: Performance Attributes and Metrics. A performance attribute is a grouping of metrics used to express a strategy and attribute, it cannot be measured; it is used to set strategic direction. There are five dimensions to performance measurement shown in **Table 2.1**.

Table 2.1 SCOR Performance Attributes

Performance Attribute	Definition
Reliability	The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the reliability attribute include: On-time, the right quantity, the right quality.
Responsiveness	The speed at which tasks are performed. The speed at which a supply chain provides products to the customer. Examples include cycle-time metrics
Agility	The ability to respond to external influences, the ability to respond to marketplace changes to gain or maintain competitive advantage. SCOR Agility metrics include Flexibility and Adaptability
Costs	The cost of operating the supply chain processes. This includes labor costs, material costs, and management and transportation costs. A typical cost metric is Cost of Goods Sold
Asset Management Efficiency (Assets)	The ability to efficiently utilize assets. Asset management strategies in a supply chain include inventory reduction and in-sourcing vs. out sourcing. Metrics include: Inventory days of supply and capacity utilization.

Source: Frederick (2017). Supply Chain Operation Model (SCOR Vol. 12): Supply Chain Council

Reliability, Responsiveness and Agility are considered customer focused. Cost and Asset Management Efficiency are considered internal focused. All SCOR metrics are grouped within one of the performance attributes. Each performance attribute has one or more level1/strategic metrics. The SCOR metrics is the standard measurement guidance for linking metrics to support the decision-making process. The SCOR

metrics are organized in a hierarchical structure as well as the SCOR process model framework. SCOR describes level 1; level 2 and level 3 metrics, the relationships between these levels are diagnostic. At Level1 has ten strategic metrics primary which are the key performance indicators (KPIs) for company strategic measurement. It is used as a framework for multiple SCOR processes in supply chain. Level 2 metrics indicate the root cause of performance gap for level 1 metrics, and level 3 metrics are linked to the operational processes. The efficient and effective process design should consider the correlation of process and performance metrics at sub-levels, referring from the SCOR-based alignment framework and best practices (Frederick, 2017).

2.7. Performance Measurement System

Supply chain performance measurement system can development based on SCOR matrices and best practice. The correction between matrices and process of the system enable management to comprehend the relationship across the system and accomplish organizations goal and overall performance. Ineffective performance measurement system affects the entire supply chain management system as mangers could not monitor and gather all necessary information for decision making. In addition, the performance measurement system could make the process improvement possible (Harrington, 1991).

Performance and matrices have a significant role in supply chain management in determination of company's abject and future course of action plan and in evaluation performance (Ganasekaran, 2004). There are many methods used in supply chain performance system designed to measure operational performance, evaluate effectiveness and efficiency Continuously to improve overall supply chain performance to achieve company's competitive advantages.

A set of “balance” and multi-dimensional” performance measurement for supply chain is important, but it is difficult to measure the correct performance in each level together, SCOR provided the comprehensive performance metrics in each level 2 and level 3 for supply chain measurement, SCOR devices into five performance attributes as in **Table 2.1**. The measure defined by SCOR can be used to evaluate processes at each level of the process hierarchy. The measure caters to various goals and depends on company’s strategy. The SCOR model calculates the measure base on precise formula with standard definition.

CHAPTER 3

METHODOLOGY

In this section describe the overall research design and motivate why the chosen method were selected. It also aims to describe how the method was conducted to sum up the processes and performance measure in air cargo supply chain.

3.1 Research Design

This research works with adapting the Supply Chain Operation Reference model (SCOR) by applying to the cargo terminal or cargo warehouse. The design of process has follows design base on SCOR model but change the character of processes follow the activities of cargo terminal since receive the products from consignor until dispatch products to consignee.

The initial information given about this research was air cargo industry would like design blueprint for air cargo operation to modernize and standardize. To be clarify the initially information and to be able to construct the research issues, the purpose and delimitations for this study are performed. Step one was interviewed with the staff in team leader level, manager level at air cargo company. This type of purpose concept of meeting and interview are important in the design phase of a research to get data for design model.

The main objective of the interview should be to generated ideas than the data by following of the objectives and approach of the project as:

- To conducts “As-is’’ process of air cargo industry in free zone, at Suvarnabhumi airport.

- This will be followed by create a logical and appropriate SCOR model utilizing the process element and performance measure
- From the SCOR model created, the performance metrics will be select which are appropriate and recommended in air cargo industry at Suvarnabhumi airport.

3.2 Empirical Information

In case study, there are two main methods for gathering empirical information: the qualitative method and quantitative method. The quantitative method often based on the surveys with numerical outcome, is most commonly used when there's already a good perception about the phenomena and a broader analysis is preferred. The qualitative method is based on interviews and offers more information due to those interviews allow more detail and nuance answer than the survey does. Moreover, the qualitative methods is commonly used in exploratory research where the subject is new or sensitive to unexpected conditions

When using to conductive research approach, the method for gathering data in this research is mostly qualitative because process resources is specific in each process, interviews are the best choice to conduct the data use in actual processes. The information for the project was attained via meeting and interviews with relevant stakeholders of the airfreight operation such as warehouse include acceptance and allocation department, dispatch and delivering department, operation managers, and operation team leaders.

3.3 The Research Process

The processes in the scope of SCOR model have been generated. However, the implement of supply chain management with in the company processes, a good thing

of SCOR model is the hierarchical decomposition, where each level's process can be further described with more detail in low level. By doing this, it's easier to find what the metrics and processes are important in each role. The work with adapting the method in the process of air cargo supply chain has followed the design of SCOR model in total 5 main processes as **Figure 3.1** shown the general structure of air cargo industry. Then, author change the processes following task in air cargo terminal.

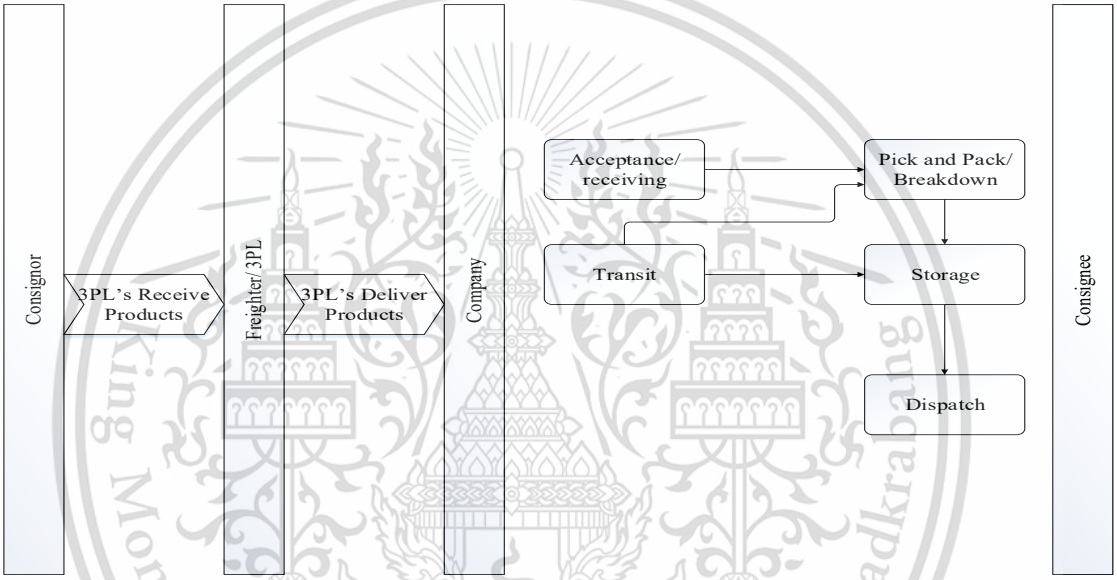

Figure 3.1 The General Structure of the SCOR Model

Source: Thai Airways. (2016). Thai Airways International Public Company Limited Annual Report 2016

To adapt SCOR in the processes, author composes the SCOR model by two parts include design processes base on SCOR by using BPMN and identify the performance measure base on SCOR as well. First step, research has to analysis "As-Is" model of air cargo industry, then design the new process as "To-be" model base on SCOR and using BPMN to design the decision making of the processes as well.

3.3.1. Air Cargo Operation "As-Is" Analysis

Air cargo operation consists of two process flows are Export flow and import flow, each flow has their own activities which show in **Figure 3.2** and **Figure 3.3**

Export flow process starts from the consignor reservation for booking export via the export agency or freight forwarder for book the space and represent the export document to custom department. Export flow starts when the products arrive to truck dock at acceptance, then check the document include weight and volume. Then transfer the products to storage after documents pass. Products pack and built load to ULD and export to the consignee. In case of transit products from oversea, the product receives from import department and transfer to export process, wait to pick and pack with new export products and dispatch to consignee

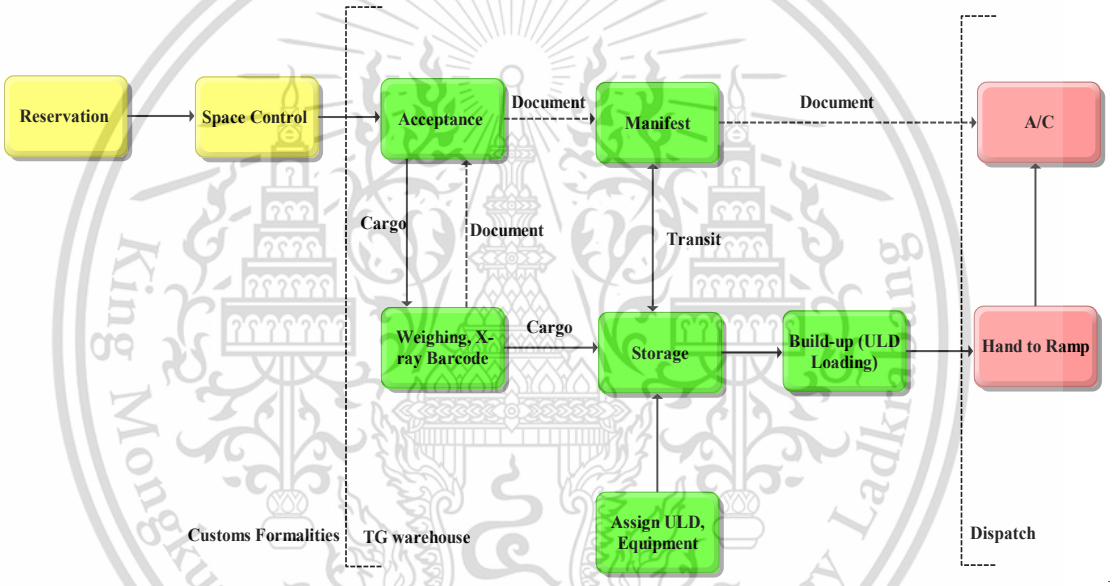

Figure 3.2 "As-IS" Model of Air Cargo Export Operation Flow

Source: Thai Airways. (2016). Thai Airways International Public Company Limited Annual Report 2016

In other hand, import processes is quite same process with export, when cargo industry receives the product form agencies or freighters, after that process break drown the products from ULD and separate to the storage area include domestic and transit products to other country. If the consignees want the products, they have to present the document for import and custom clearance to air cargo industry and can reach products out of terminal.

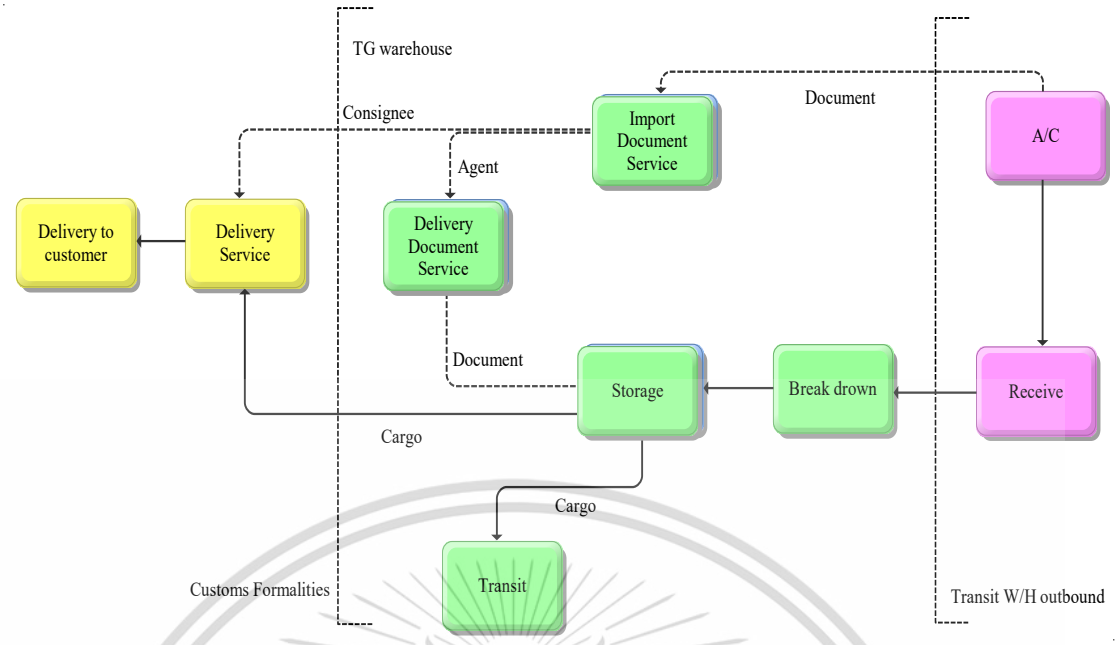

Figure 3.3 "As-IS" Model of Air Cargo Import Operation Flow

Source: Thai Airways. (2016). Thai Airways International Public Company Limited Annual Report 2016

3.3.2. Air Cargo Operation "To-be" Analysis

Air cargo operation "To-be" analysis is deign the process base on the SCOR model and BPMN, author defined the process of air cargo in 5 main process include receive, put away, pick and pack, storage and dispatch follow the task in air cargo terminal.

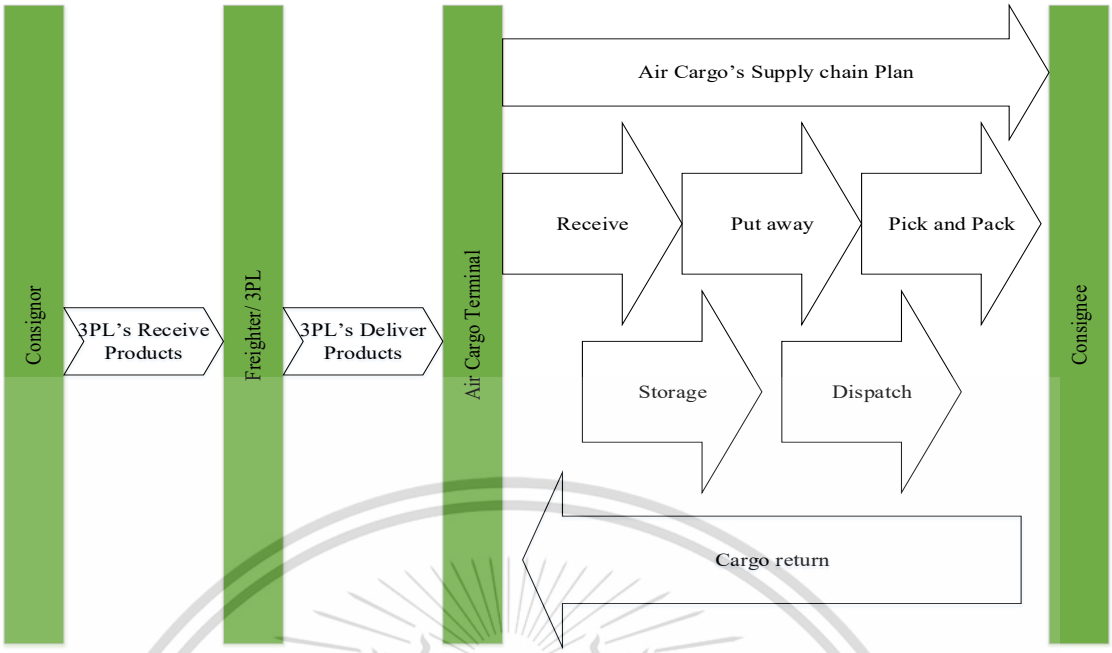

Figure 3.4 "To-Be" Model of Air Cargo Import Operation Flow

Next step, design the process in earch level include level 1 has 5 processes inculde the paln of supply chain, receive plan, put away plan, pick and pack plan, storage plan and dispatch plan, level 2 is sub- process of level 1 devide in two main activities include Source stock products and delivery stock products due to the air cargo terminal act as the distribution center. Both of process have 15 in total Processes , Enable 5 processes and Return 6 processes. level 3 is process element defind the process in cargo terminal, it describe the process from level 2. The step of designing show in **Figure 3.5**.

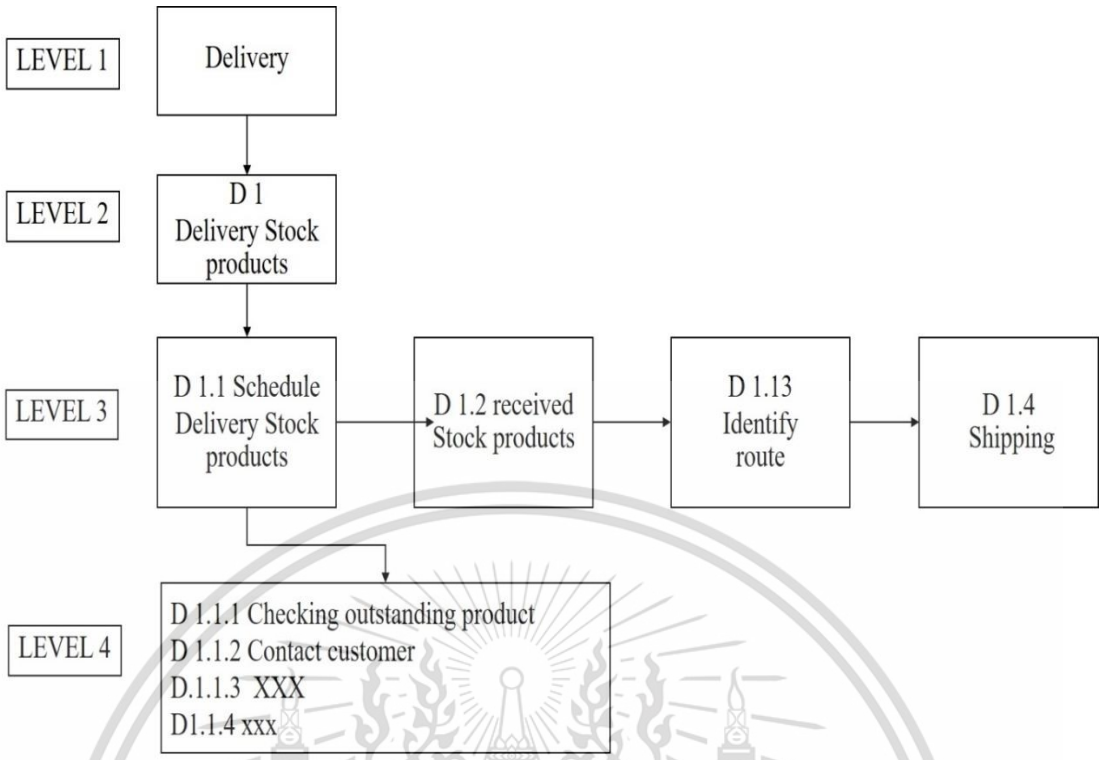

Figure3.5 Design Process Base on SCOR Model

Source: Frederick (2017). Supply Chain Operation Model (SCOR Vol. 12): Supply Chain Council

3.3.3. Link the Performance with Processes

The performance measurement system in SCOR model measure the process with 5 attributes, level 1 metrics often cross multiple SCOR process in supply chain (Frederick, 2017), but it doesn't necessarily have to be connected to a SCOR level 1 process though. When analyzing performance of metrics from level 1 to level 3, it helps to identify what process that need further investigation in order to improve performance and SCOR lists the processes influence the performance of the metrics.

Performance measurement system was defined in 4 level include organization metrics, supply chain metrics, process metrics and work flow metrics, each level have their own performance measures, it was effect and had complex relationships between the measure and process in each level.

To show how the processes and the performance are measurement systems link together in each level, the researcher uses Aris Express program to draw the process diagrams and match the performance measurement in the processes.

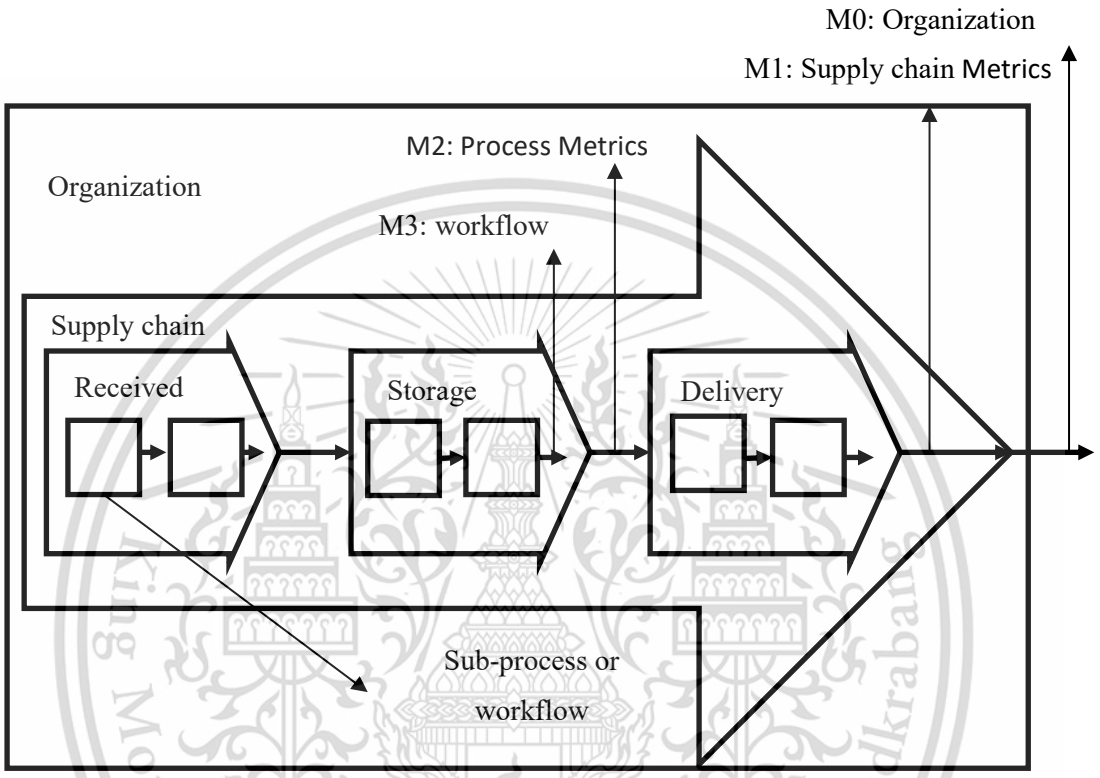

Figure 3.6 Performance Measurement in Process Flows

Source: Frederick (2017). Supply Chain Operation Model (SCOR Vol. 12): Supply Chain Council

CHAPTER 4

MODELLING APPROACH AND ANALYSIS

After analysis of the air cargo processes, the SCOR model could be suitable framework to mapping processes and measuring air cargo supply chain performance. However, adaption of the SCOR model is necessary. This section describes how the framework as such was created, first motivations to suggest changes and the underlying principles with the SCOR model are given. Finally, each process is described in more detail and how to measure the performance in each process.

4.1 The Underlying Principles with the SCOR Model

The result of the work to adapt the SCOR model to air cargo industry, the SCOR model shows the basic structure and keeps the processes and metrics from the SCOR model intact. This means that the SCOR model can be used by the supplier up-stream in supply chain and can be used to map the supply chain from supplier or consignor of air cargo to and on the actual air cargo terminal.

Before describing each element and process level in SCOR model, it is necessary to describe the underlying principles with the SCOR model to suggested adjustment. In order to design, it is required an overview of the framework. The flow of products in level 1 modeled with the process of air cargo supply chain include receive, put away, pick and pack, storage, dispatch and return. The air car planning process is used to modeling the plan procedures and shows the overall of relationship with air cargo supply chain with in SCOR model level 1 as shown in **Figure 4.1**.

Level 1 corresponds with the top level of the supply chain it is devised follow the process of business and the relationship between stakeholders. The process of air

cargo supply chain in level 1 shows the overall of plan processes with consignor, plan process with agency, the plan process in cargo terminal and plan with customer, adopting the SCOR process is described the cargo products flow and information within and throughout the air cargo terminal.

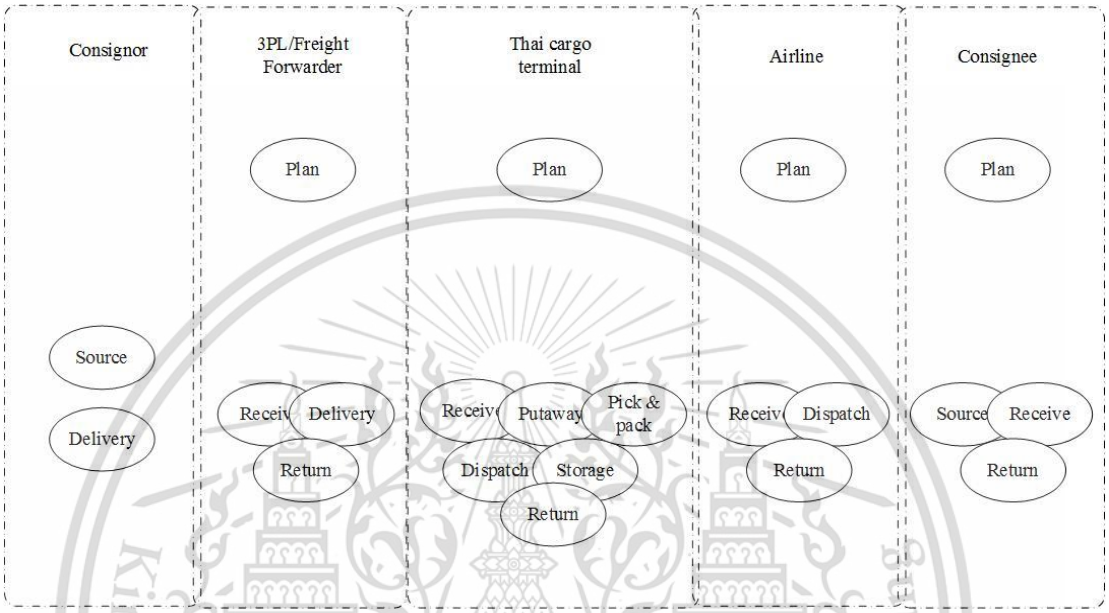

Figure 4.1 The SCOR Level 1 Process

4.2 Modeling Approach

The SCOR model adapts in air cargo terminal consist of five main processes: receive, put away, pick and pack, storage, dispatch. The air cargo's process is a component that set out to model the activities performed by the supply side to deliver product to air cargo site, whereas the processes are described in more detail below. For simplicity, henceforth the processes of air cargo are denoted as RE: receive, PA: put away, PK: Pick and Pack, ST: storage and DP: dispatch.

4.2.1. SCOR Level 2 Approach

Level 2 process break drown of level 1 according to the major categories and corporate strategy, the modeling is based on S1 Source Product to Storage and D1

Delivery Stock Product, due to air cargo work as the warehousing and distributing center. This section describes the process of air cargo terminal to align with distribution process in air cargo supply chain which was defined in 7 main processes:

Plan (PL): The process to determine requirement and correct action to achieve the supply chain propose for both inbound and outbound side.

Receive (RE): The process to control ordering and receiving products from customer, including replenishment inventory and receive return for defective product.

Put Away (PA): the process is verifying and transforming products to the Storage, location, some types of products need to cross dock from this process to delivery location.

Storage (ST): the process is allocated the location of products both incoming and return deflective products and manage the inventory.

Picking and Pack (PP): This process is picking and receiving products following the order picking list to be ready for shipping

Dispatch (DP): This process of order management and order fulfillment activities to serve the customer satisfaction.

Return (RT): This process is moving the defective products back to through the supply chain supplier.

Process in level 2 links all participates of air cargo supply chain together by sharing both information flows and physical flows as **Figure 4.2** from consignors to consignees.

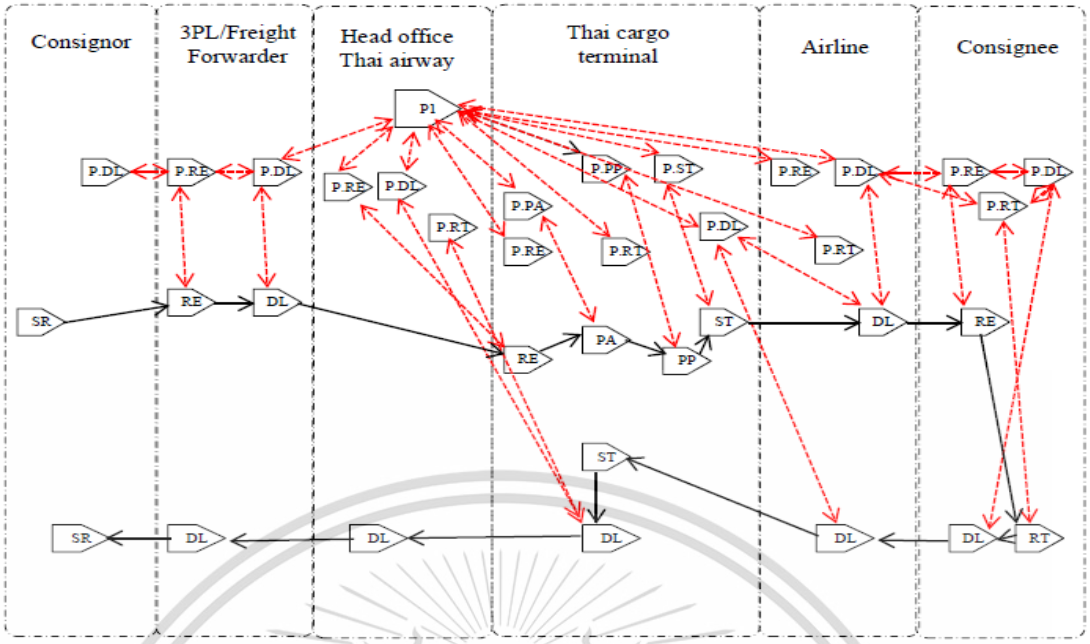

Figure 4.2 The SCOR Level 2 Process

4.2.1. SCOR Level 3 Approach

The SCOR level 3 process elements are used to determine and identify the relevant process that will enable identifications of improvement in the operation. It has determined that S1: Source stock products and D1: Deliver stocked products in level 2 process will be further elaborated on level 3 process. Both processes are under plan process that had defined the plan of each process, conditions, business roles and decisions making, etc. Air cargo acts as a distribution center, it offers the service of export and import products include transit products to and from oversea and organizing of transporters, freighter and warehousing on behalf of their clients.

Plan Process Approach

Plan process is the key process that covers and drives all process in warehouse operation. This research has defined the plan process as the process in management level, which people who are in high level management has set for their business. All of

the plans are effect directly to the main processes and sub processes. The plan processes divided in 6 plans include:

P1 Plan Supply chain: The development and establishment of courses of action over specified time periods that represent a projected appropriation of supply chain resources to meet supply chain requirements for the longest time fence constraints of supply resources.

P2 Plan Receive: The development and establishment of activities to be taken over specified time that characterize a project adoption of air cargo receiving meet resource

P3 Plan Put away: The development and establishment of courses of action over specified time periods that represent a projected appropriation of production resources to meet put away requirements

P4 Plan Storage: The development and establishment of courses of action over specified time periods that represent a projected appropriation of storing resources to meet storage requirements

P5 Plan Pick and Pack: The development and establishment of courses of action over specified time periods that represent a projected appropriation of order picking resources to meet picking and pack requirements

P6 Plan Dispatch: The development and establishment of courses of action over specified time periods that represent a projected appropriation of delivery resources to meet dispatch requirements.

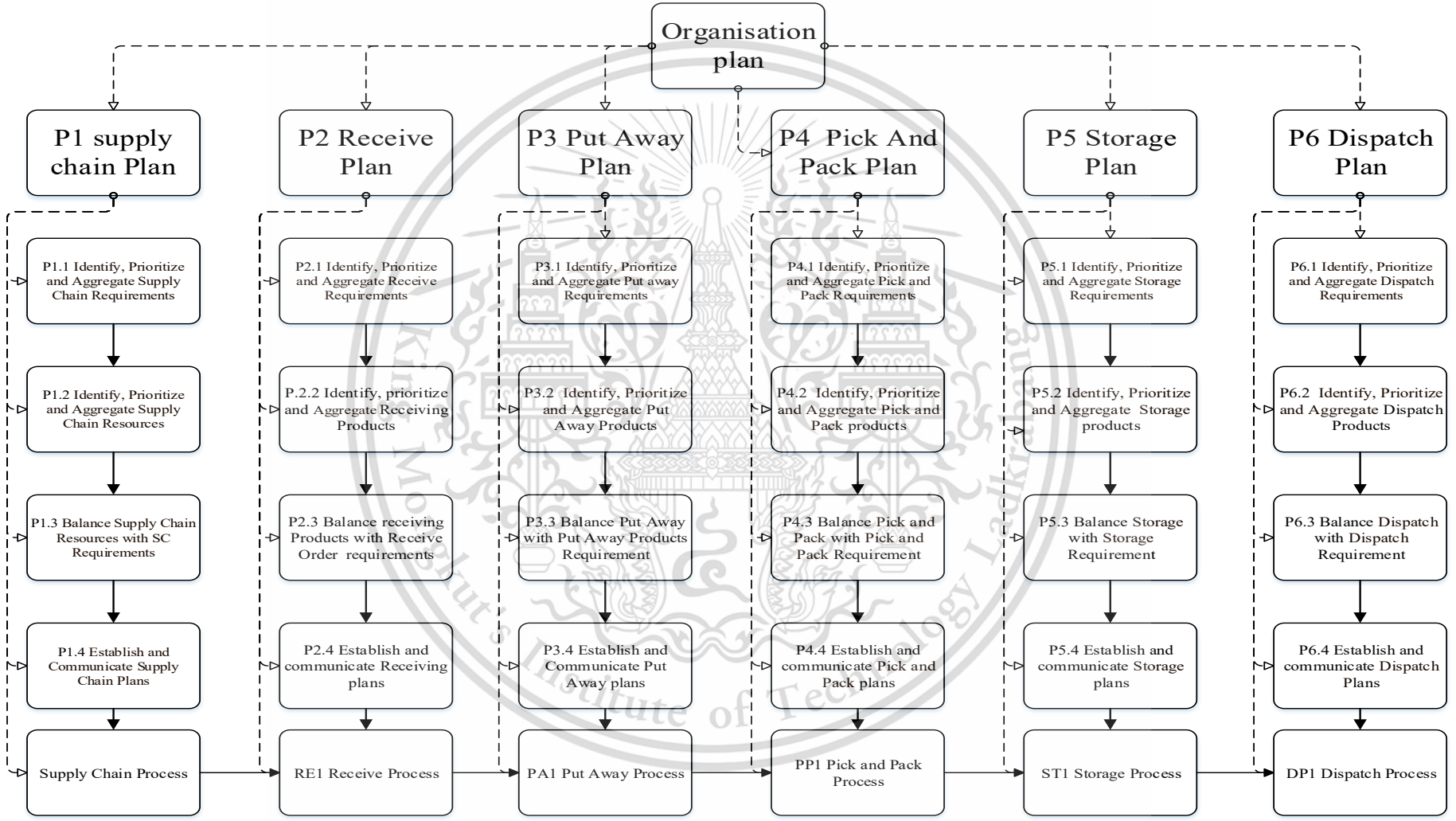

Figure 4.3 Plan Process Approach

Source Stock Products

In the content of air cargo operation, the inputs and outputs of these particular activities are concern with the management of exchanging relevant documents between the consignor, freighter, shipping line, warehouse and transportation. Source stock products consist of 3 main processes: receive, put away and pick and pack process.

Receive Process

Receive process start from freighter unloading products at the truck dock to the check point include of 5 element processes:

RE1.1 Schedule Receiving Products: scheduling and management the execution of the individual deliveries of product against an existing contract or purchase order. The requirements for product releases are determined based on the detailed receiving plan or types of products pull signals.

RE1.2 Receive Queue: managing of timeline and queue for receive products per order from consignor and freighter.

RE1.3 Receive Products per Order: the process and associated activities of receiving product to contract requirements.

RE1.4 Inspection Document of the Product: the process and actions require checking relevant documents and permits for import and exporting the products.

RE1.5 Security Check: the process and action required determining product conformance to requirements and criteria.

RE 1.6 Transfer Products to Parking Area: transfer of accepted products to appropriate stocking within the supply chain.

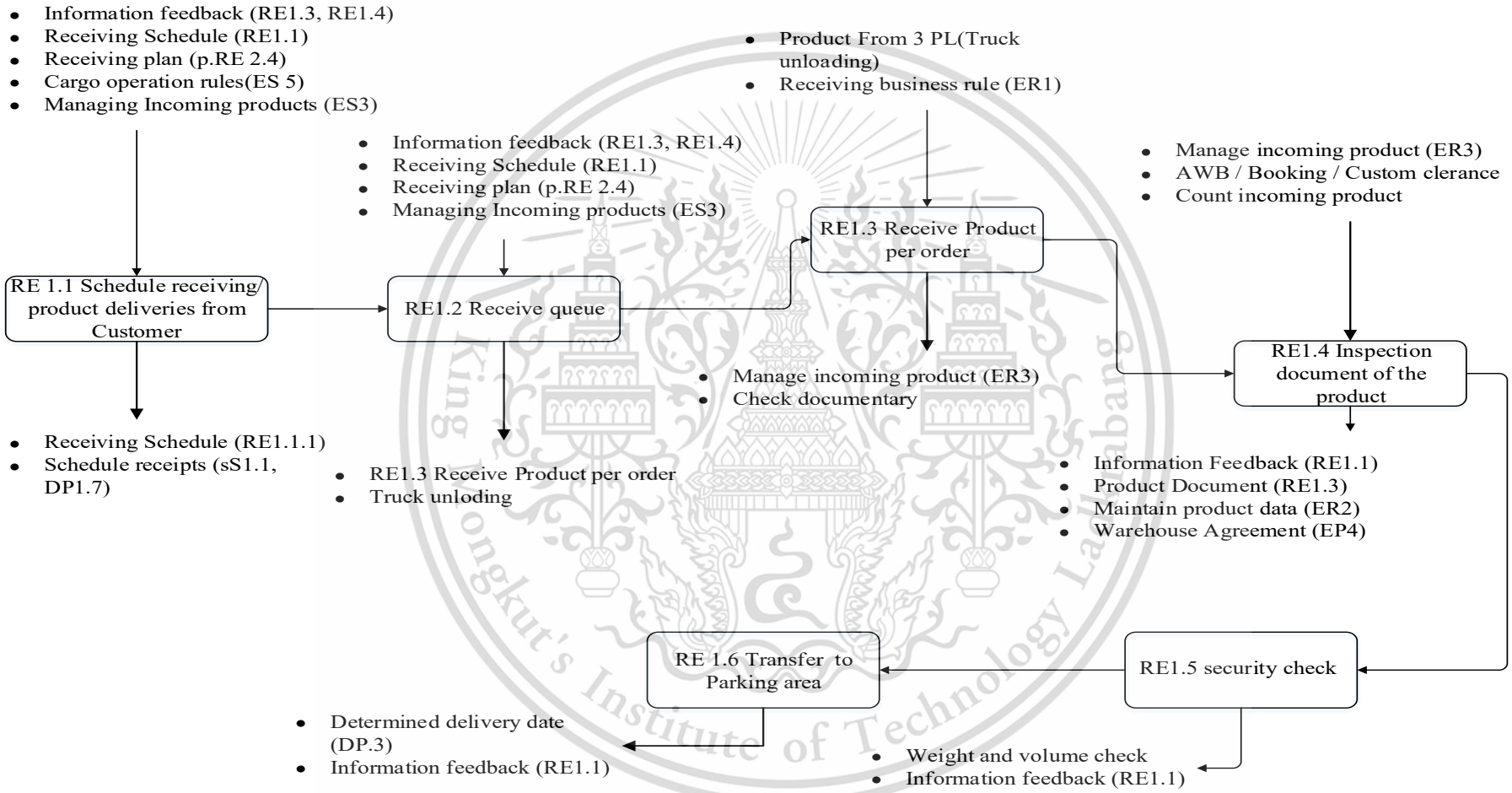

Figure 4.4 Receive Process Approach

Put Away Process

Put away process is the process after staff received the products form freight forwarder or 3 PL. After receive process, put away receive products to parking lots, identify and separate products to parking area for waiting pick and pack process start. The process of put away consists of 3 main element processes:

PA1.1: Security Check Receive Item for Put Away: after checking manual for issue checking packaging damage, weight and volume of products, the products have to scan again with machine to guarantee that products don't have explosive material and issue barcode for release to other section.

PA1.2: Analysis Available Space and Destination: after scan, we have to identify the destination rout of products and space area for parking, the destination devices in Australia, Europe, Asia and small items.

PA1.3: Create Check, Excurse and Confirm Order: issue the picking list for picking item in which are and destination routs that products have to deliver.

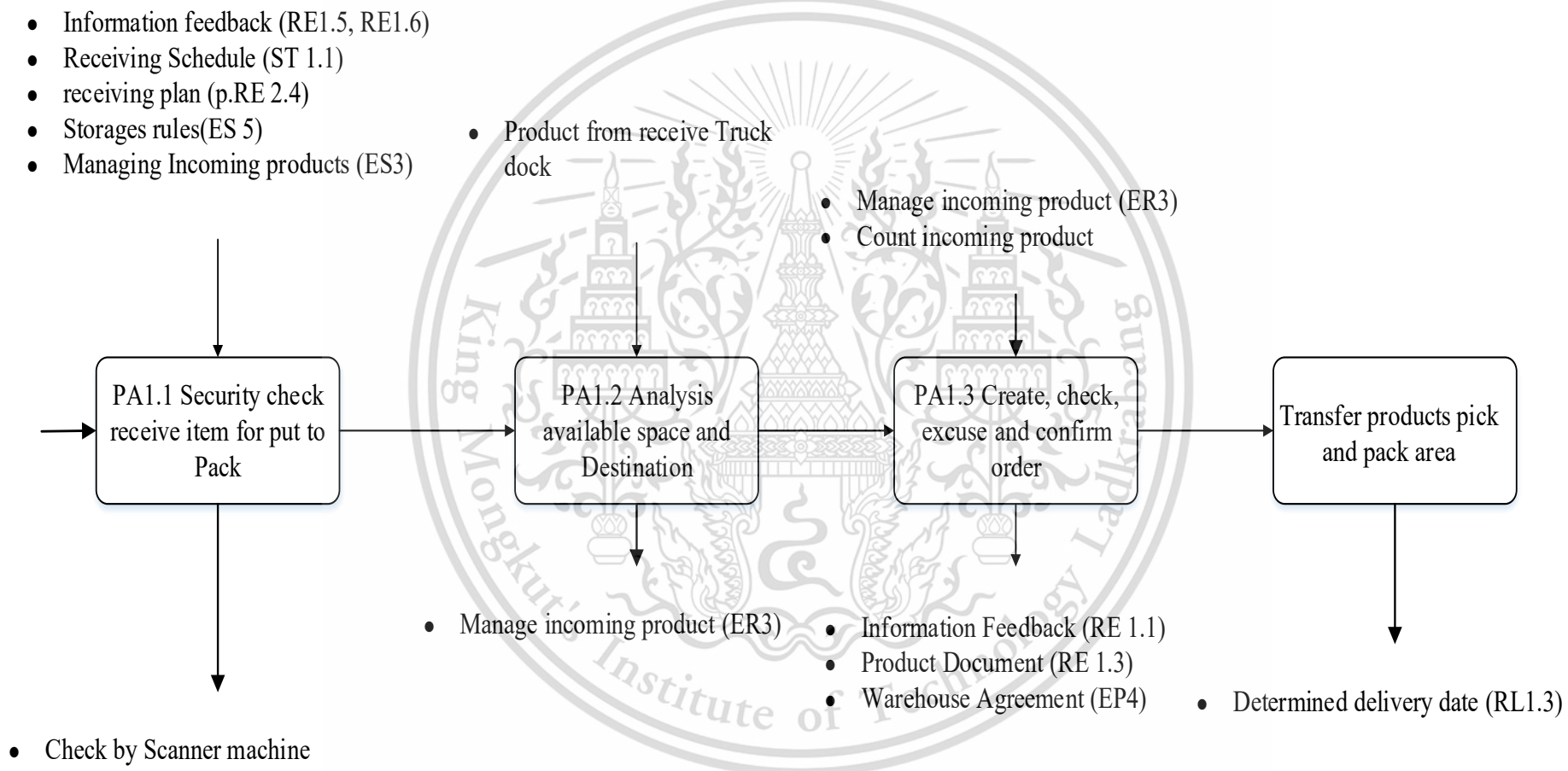

Figure 4.5 Put Away Process Approach

Pick and Pack Process

The activities include retrieving the orders to pick, determining inventory availability, and recording the pick, the sorting and combining the products and delivering of it to the shipping area for loading. The staffs pick products follow the picking list and pack them in pallet follow by the delivery route.

PP1.1 Process Inquiry and Quote: Receive and respond to general customer inquiries and requests for quotes

PP1.2 Analysis Outstanding Products Issue for Picking: check and picking missing products or wrong destination products. Then, repack products to correct destination with other products.

PP1.3 Identify Picking Location: Picking products at put away area for pack and transfer to the consignee.

PP1.4 Receive, Enter and Validate Order: receive and enter order into company order processing system. Piking order

PP1.5 Reserve Inventory and Determine Delivery Date: inventory and /or capacity is identified and reserve for specific orders and determine the time and storage area for waiting deliver, delivery date is committed and scheduled

PP1.6 Build Load: To build load the product in pallets and unit load device (ULD) then transfer to Storage

This process picks and packs products both new products and old products are missed or transferred to wrong destination in the same pallet and ULD by follow the packing list and same destination.

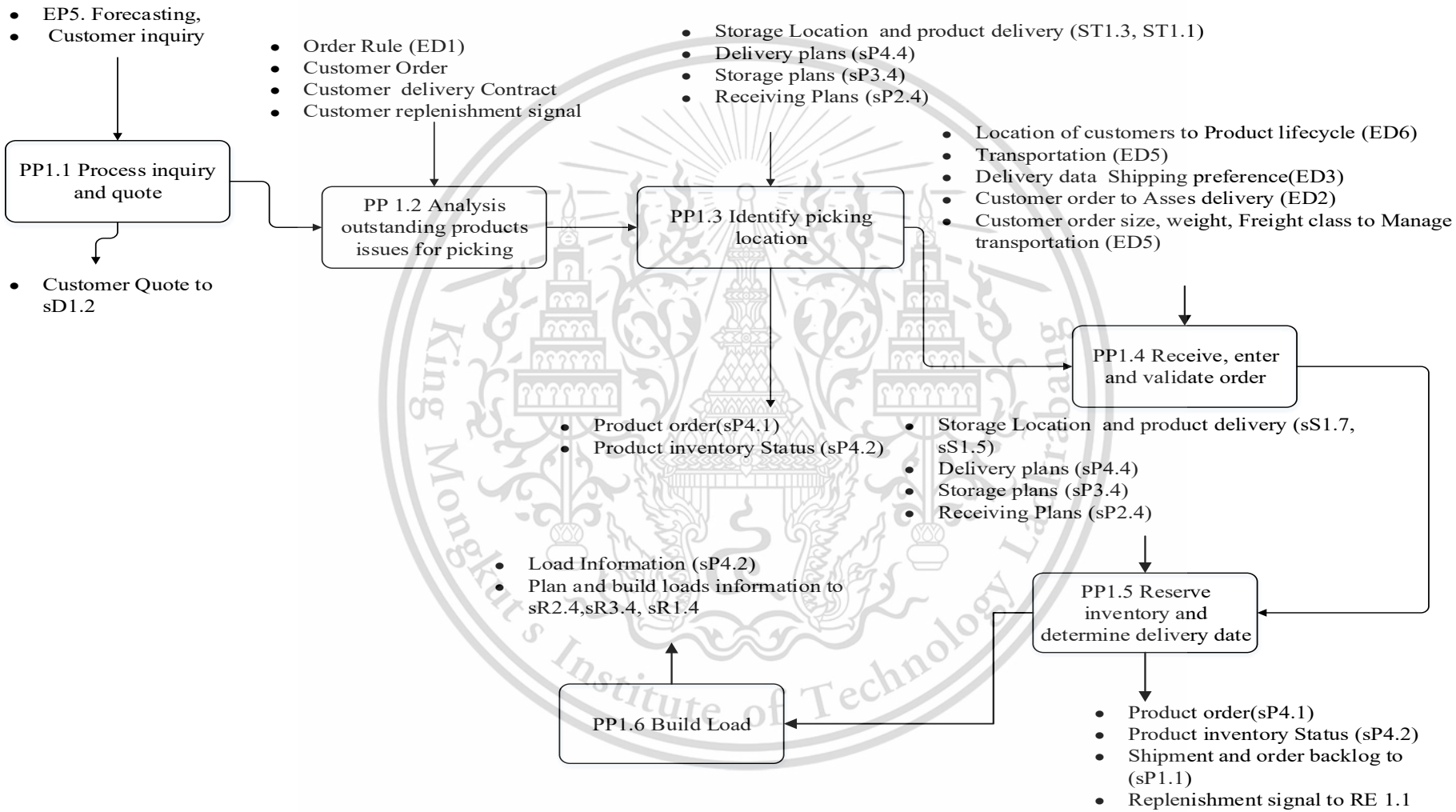

Figure 4.6 Pick and Pack Process Approach

Deliver Stock Products

The delivery stock products process elements describe the process of dispatch products out of warehouse until to final address of the consignee. This process concerned in two main parts of element process consists of storage processes and dispatch processes.

Storage Process

Storage process managed the process of storing products from receiving in its designated storage location for the easy retrieval following a storage strategy. This entails the movement of packaged products into temporary holding location to wait movement to dispatch the products to consignee.

ST1.1 Schedule Storage Activities: Scheduling and managing the execution of the storage of products from receiving. The product releases are determined by its storage location

ST1.2 Verify and Consolidate Products Area: The identification of the product and the management of the inventory quantities

ST1.3 Identify Product Storage Location: The specific location of a product to be stored over time for retrieval later.

ST1.4 Release Product to Deliver: The transfer of product to the appropriate storage location.

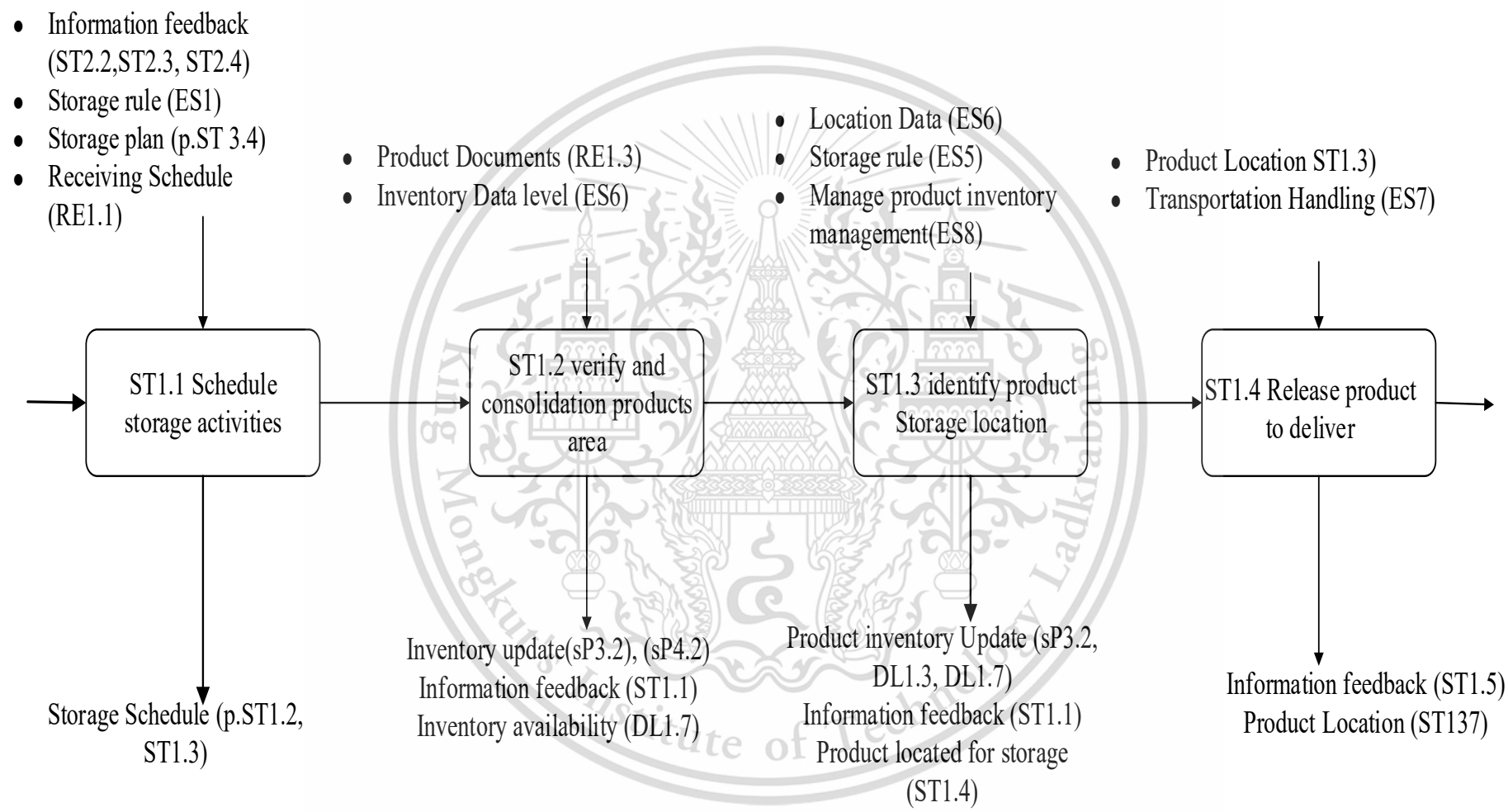

Figure 4.7 Storage Process Approach

Dispatch Process

The process of delivering product to the consignee is concern the delivery routes, type of transportation, type of products due to each product has different guarding such as dangerous good, high value products, perishable goods.

DP 1.1 Route Shipment: Loads are consolidated and routed by mode and location

DP 1.2 Locate Product from Storage: The activities such as the verifying the product, its storage location and recording the product receipt.

DP 1.3 Receive Product from Warehouse: Pick product from storage to shipping line by freighter or 3 PL

DP 1.4 Load Products and Generate Delivery Documentation: The series of tasks including the loading onto the modes of transport and the generation of documentation to meet the need of the customer, government and carrier.

DP 1.5 Ship Products: The process of shipping the product to the customer site.

DP 1.6 Receive and Verify Product by Customer: The process of receiving the shipment by the customer and verifying that the order was shipped complete and the product meet the delivery terms.

DP 1.7 Invoice: A signal to be sent to the financial organization that the shipping process is complete and the billing process should begin. Payment should be received from the consignors.

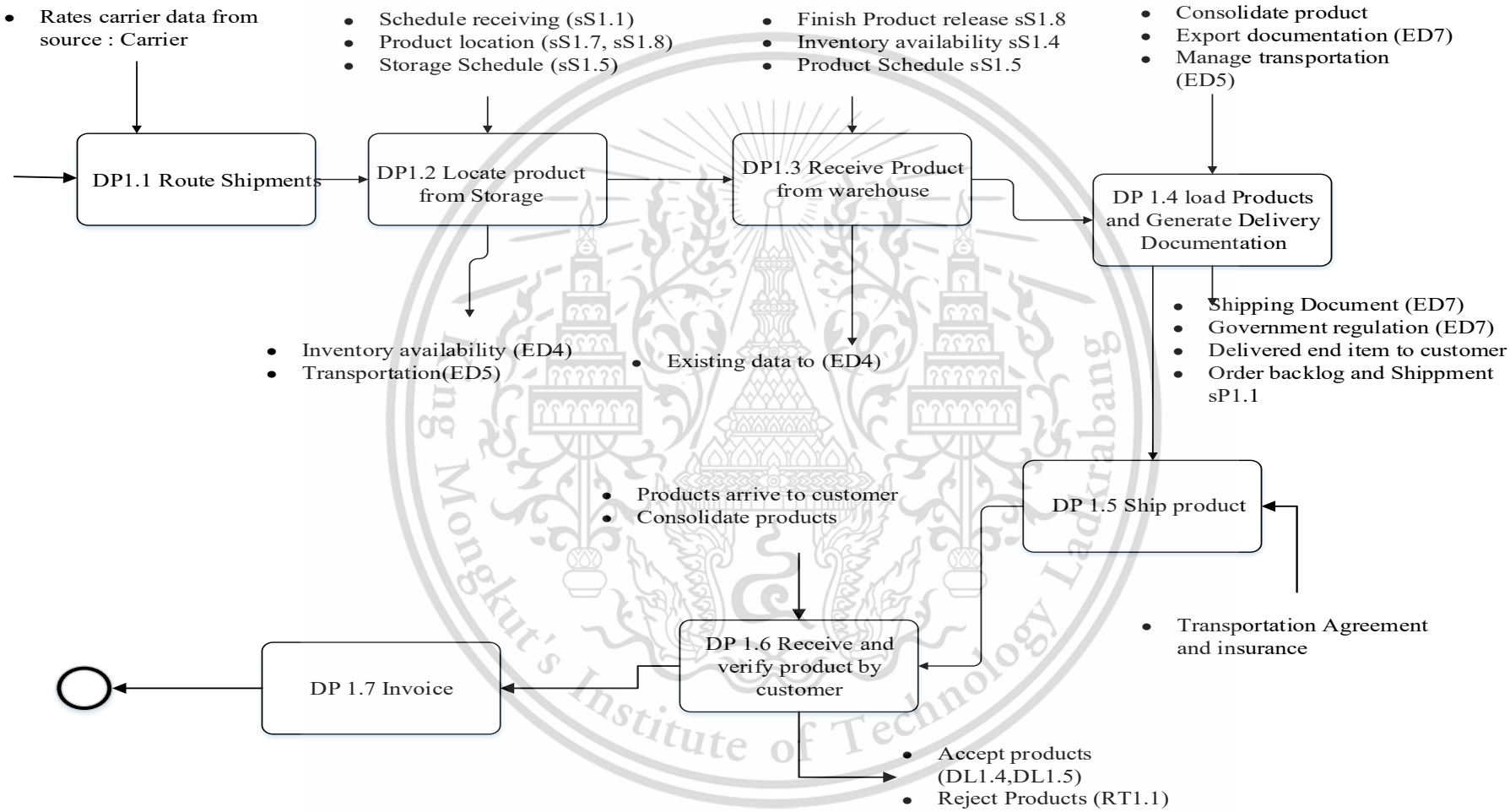

Figure 4.8 Dispatch Process Approach

4.3 The Process Analysis through BPMN

The SCOR level 3 is the sub processes that describe the workflow of each process in air cargo terminal from receive to deliver process by design the workflow structure and decision making through the BPMN. BPMN shown the relation between the workflow process and supply chain by using BPMN tools. Different pools are used to represent the consignor, the custom, the air cargo terminal operation and consignee, the truck dock, the head office, the warehouse and the airline or freight forwarder are separated by lanes. SCOR level 3 is broken down processes into the operation decision level of air cargo logistic center using the generic inbound and outbound logistic throughout the processes and measure the process performance in the section.

Air cargo supply chain is complicate system, to design the process flow have to identify the task and element process in each section, air cargo operation include export, import and ground handling service. This research designs the business process framework base on SCOR model both import and export flow include transit with many types of products such as general cargo, valuable products, vulnerable, diplomatic mail, dangerous goods, live animal, ETV, etc. follow the modeling approach base on SCOR model that had mentioned in **Figure 4.9.**

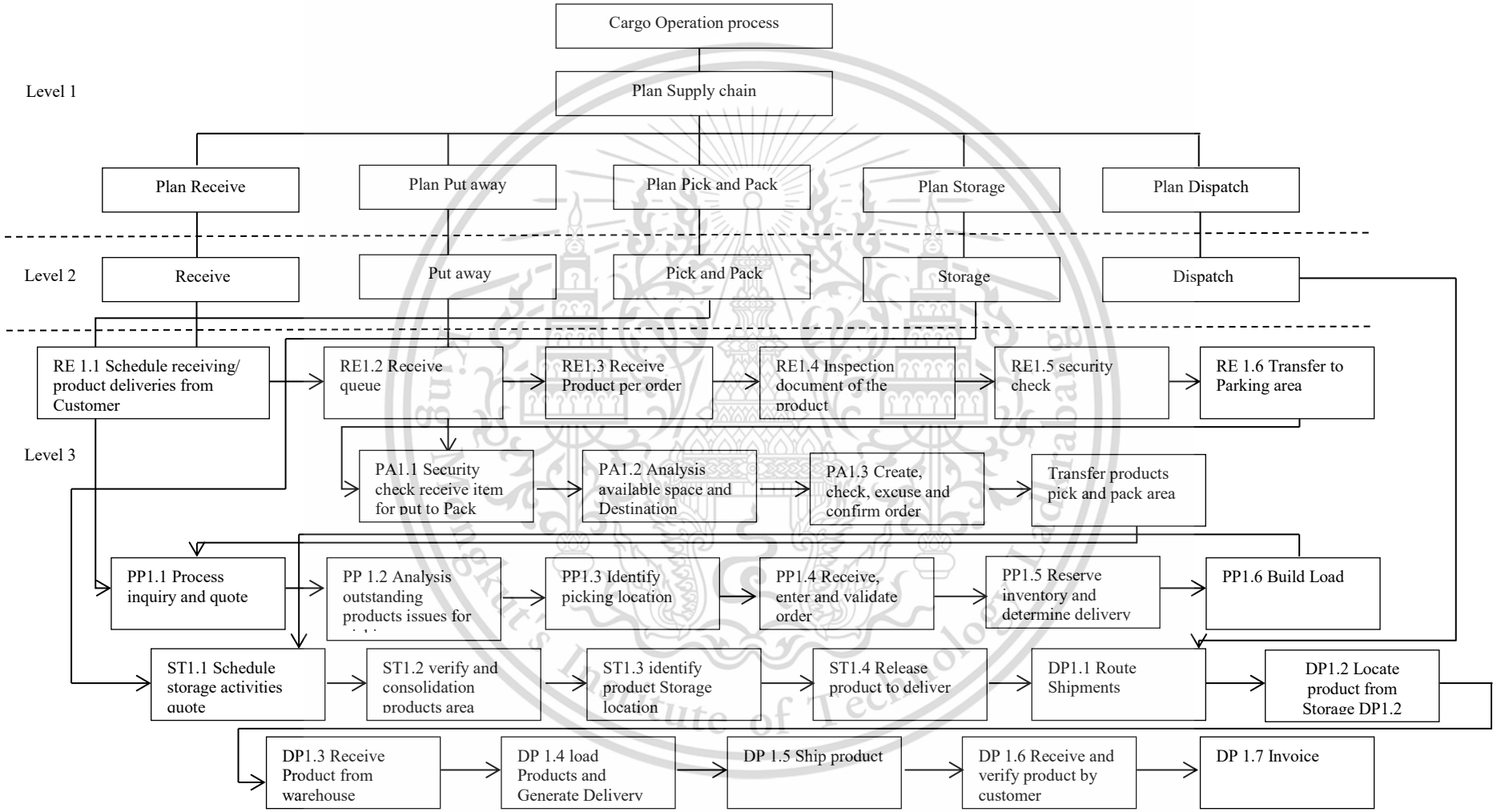

Figure 4.9 Modeling Approach base on SCOR

4.3.1 Export Process Flow.

Export flow operation cover 30% of cargo operation, almost products was exported from local such as perishable goods. Export flow start from the consignor's request export products and hire the freighter or 3 PL to operating process for them, the 3 PL or freight forwarder booking the space and export with air cargo industry and also present the documentary for request export permit with custom as well, when freighter got the export permits they sent their products to TG warehouse. The process of warehouse starts from this process, the product had unloaded at truck dock and inspection the document includes booking letter, custom clearance, export permit, AWB at the check point before checking weight and volume. If everything passes the products will attach barcode and transfer to park area wait for put away to parking zone. In other hand information flow of this process sent information which had check to the response department for issue the weight and volume balance and issue the manifest as **Figure 4.10.**

After, receiving products from freighter or 3PL, the warehouse process started from this section, the products were put in to Scanner machine to check security inside the boxes again, before transfer to parking zone which separate in each zone such as Europe, Asia, Australia and small item. In other hand, special goods also put in the specific area as well with the keeping role of each product. For export special goods, Thai cargo request the certificate of each product as well, such as dangerous good should have the permit for export and follow the role of IATA, perishable products also require the products certificate for make sure the fruits or vegetables are safe for consumption.

When products were separated or keeping in their own area, staff will pick them and pack in the pallets or ULD following the export list, routes, airline number, time, AWB and manifest. Especially, for safety regulation general products and some special products cannot pack in the pallet or ULD and have to follow the condition that concerned in packing list as well. See as **Figure 4.11**.

After finish packing the pallets and ULD will put to storage in the storage area and wait for dispatch to the consignee by airline and freight forwarder as **Figure 4.12**. All of these are export process flow of air cargo supply chain in air cargo industry.

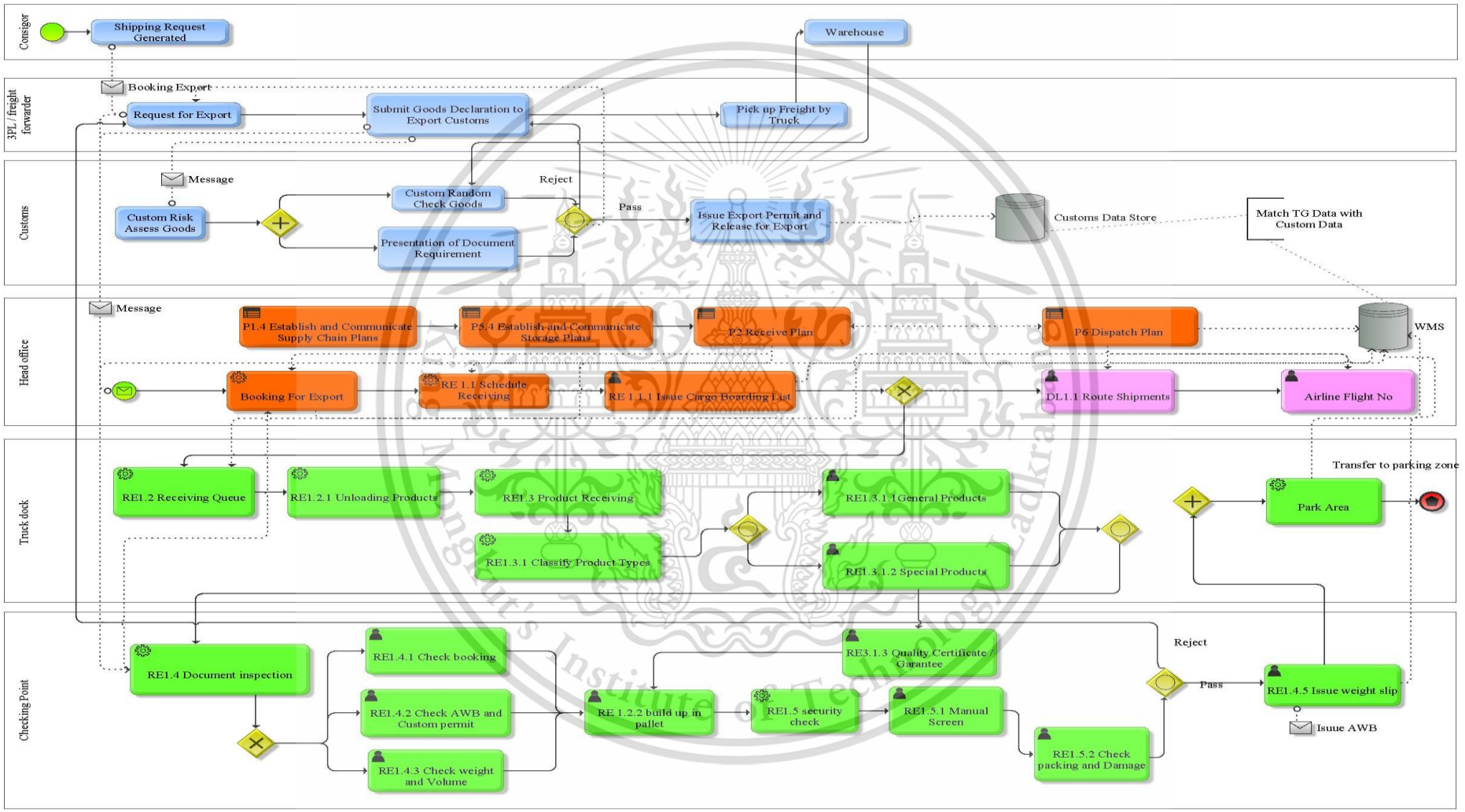

Figure 4.10 Air Cargo Acceptance Process Flow

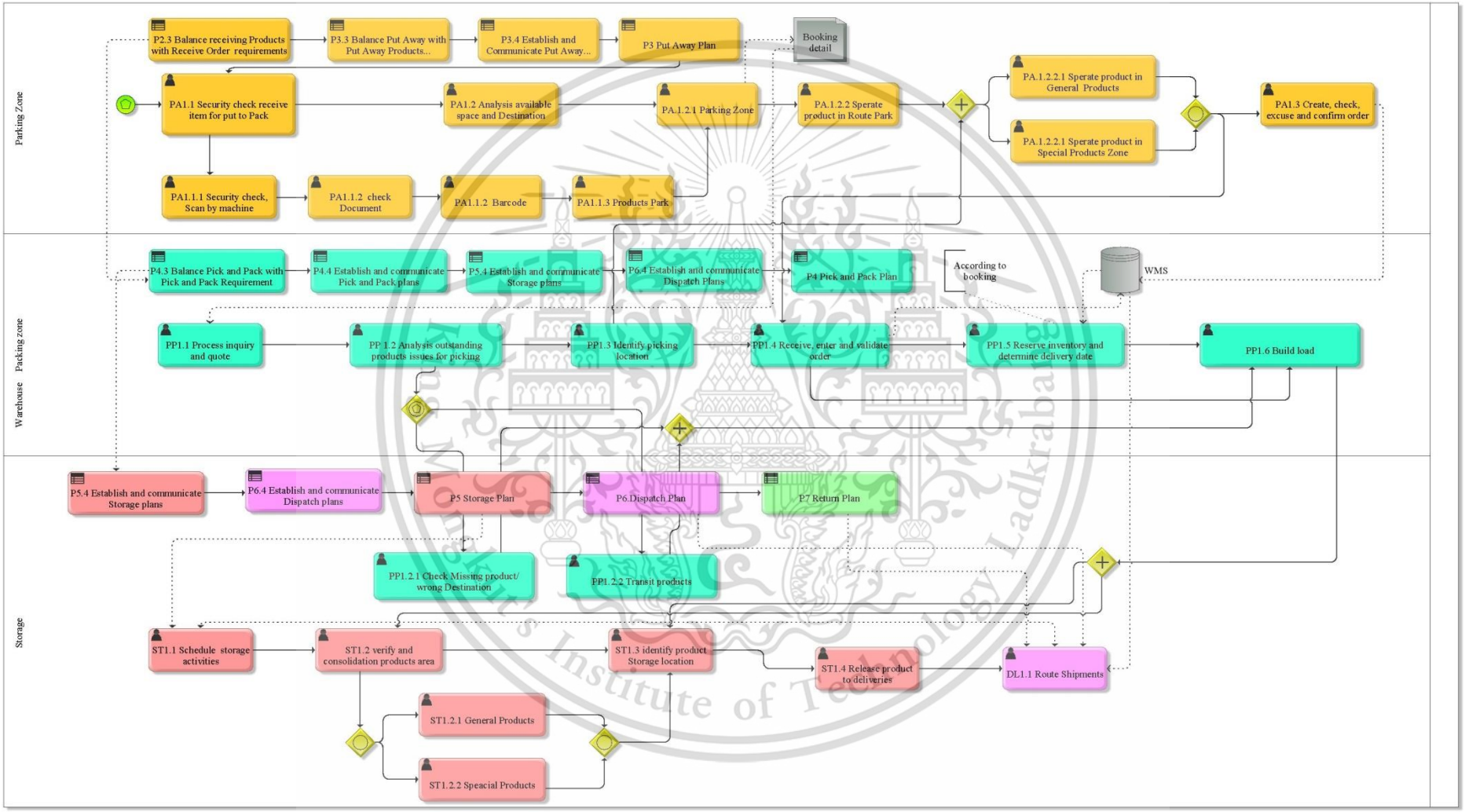

Figure 4.11 Air Cargo Warehouse Process Flow

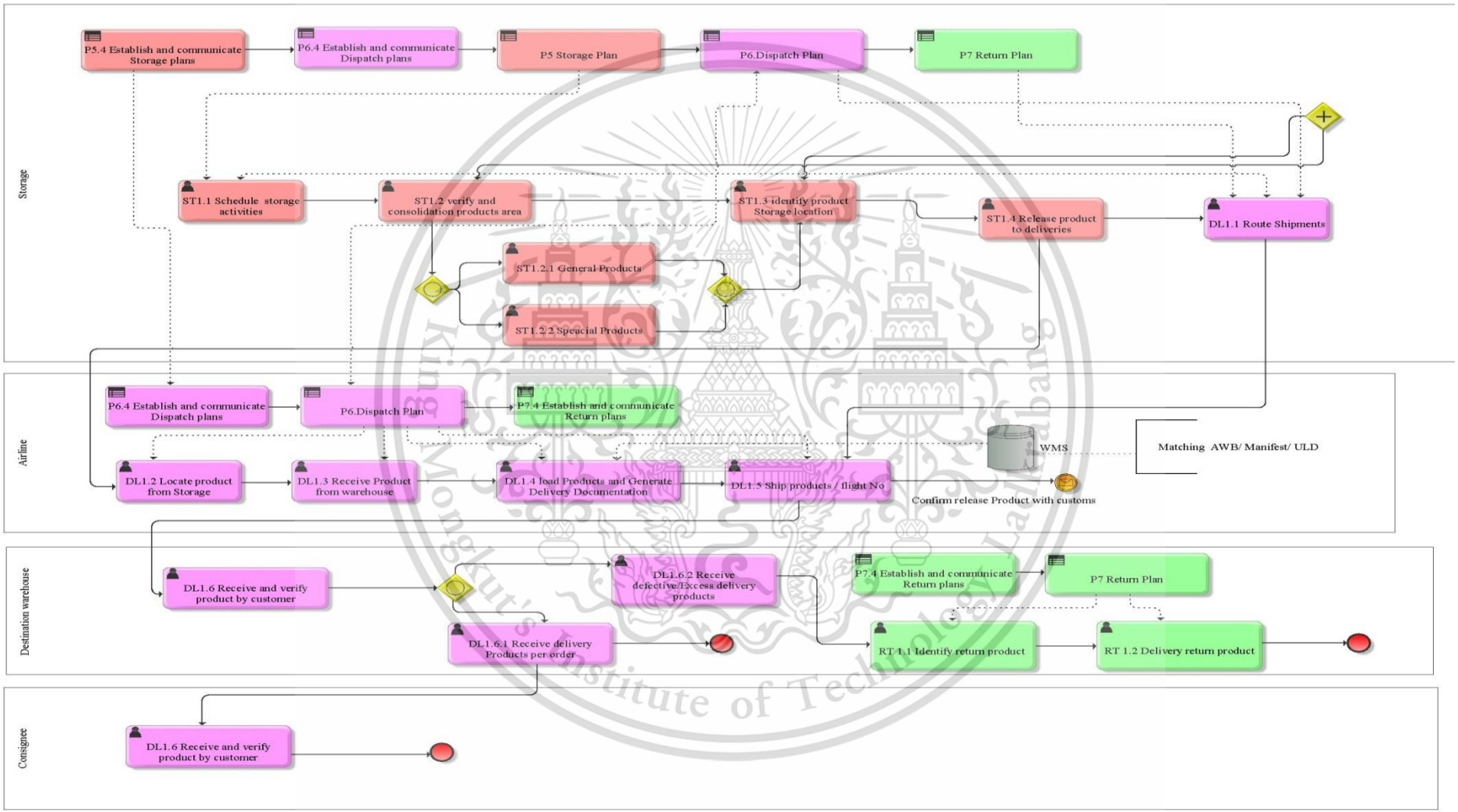

Figure 4.12 Air Cargo Outbound Process Flow

4.3.2 Import Process Flow

Import operation covers 70% of cargo operation, almost products imported from oversea such as machine spare parts, chemical liquids, etc. Import flow operation look like export flow in the process of warehouse. Import flow started from fright arrival at the destination airport. Then, freighter made the custom clearance and represented the documentation to air cargo industry for release the products, the products was unloading from aircraft then transfer the products with ramp to the warehouse. The import products device in 3 main types includes products transfer to other carriers, products transit to other destination and products import to warehouse as **Figure 4.13**. After the products were arrived the warehouse the process of Thai air cargo was started. Products were broken down at the Break drown point to separate and identify type of products then those of products had transferred to the storage area include rank storage and AS/RS, for special goods kept in the Special area follow the condition that concern in manifest and air way bill.

Before, consignee comes to pick the products from the warehouse, they have to represent the certificate, import permit and documentary relate with the import requirement. During the process to transfer to consignee at the truck dock, the customer will check the import permit as green products or red products. Green products symbol is normal products that usually import from oversea and not dangerous, red products symbol is the dangerous goods or suspicious goods, the customer will be random check before take out from truck dock, if custom found suspicious goods, consignee have to represent the document again and investigate about these products as well.

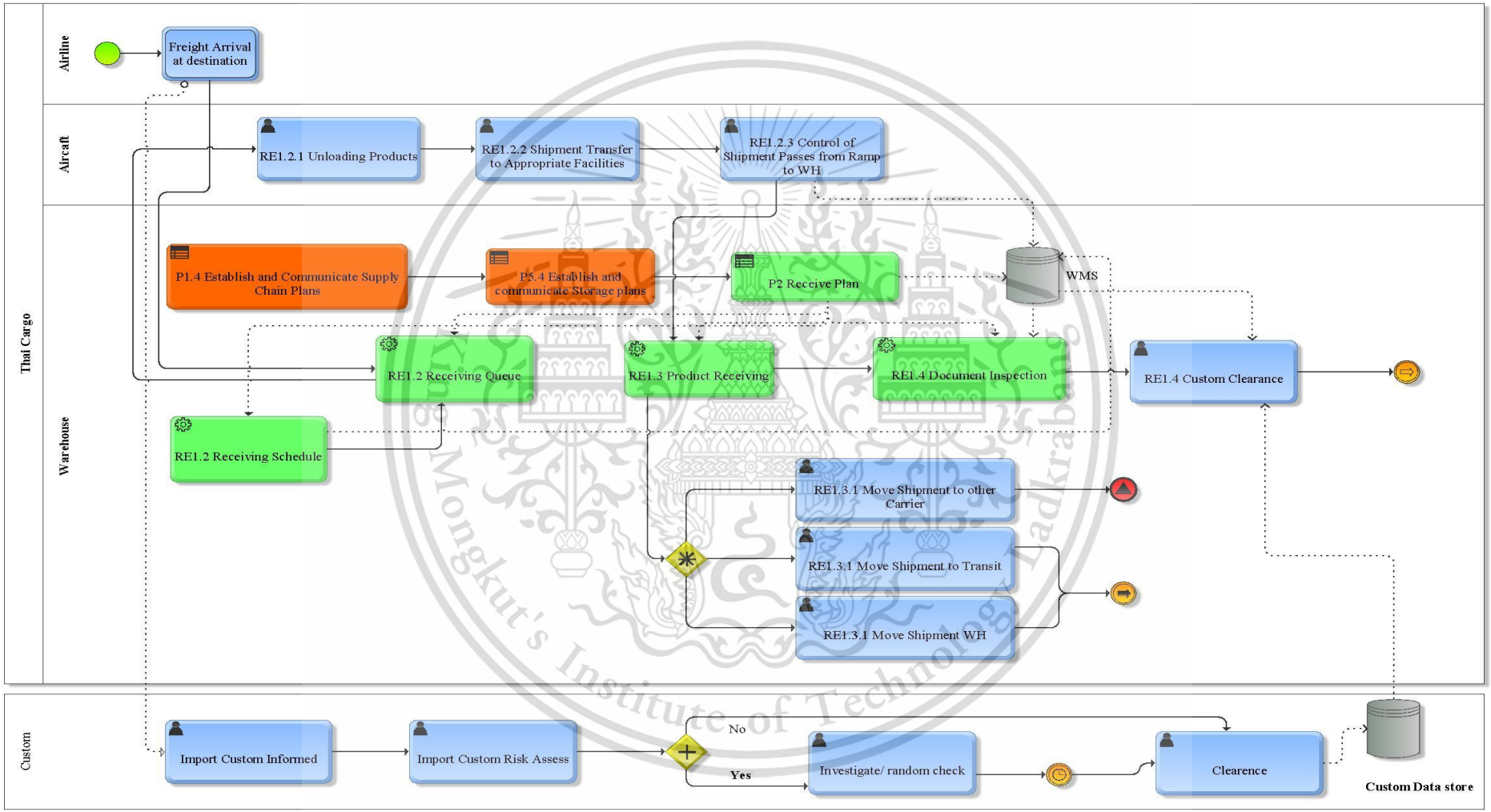

Figure 4.13 Air Cargo Freight Arrival Flow

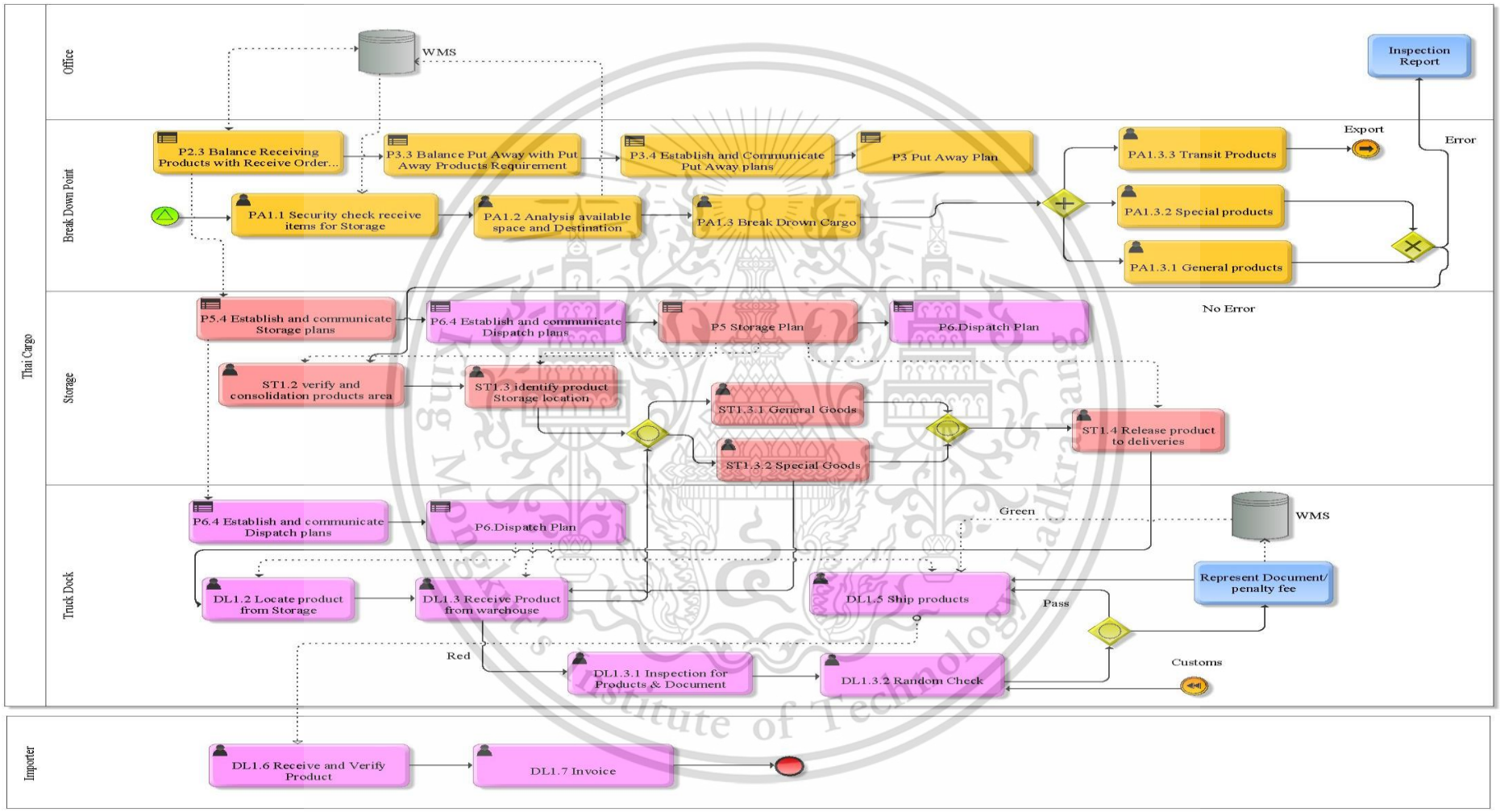

Figure 4.14 Air Cargo Import Warehouse Operation Flow

4.4 Performance Measurement Development base on SCOR

To develop a set of logistics performance indicators, this research used both the performance attribution and logistics process to classification. Base on SCOR model, there are 5 attributions in the original SCOR model: reliability, responsiveness, agility, cost and asset management. SCOR defined the reliability as the performance of the supply chain in delivering correct products to consignee at the correct time, in the correct condition and quantity, with the correct documentation. Responsiveness refers to the speed at which a supply chain provides products to customer, and agility is the ability of supply chain to respond quickly to market change, these performances are measure with the external perspective. Cost is the chief measure of logistics chain, a key aspect in air cargo operation and asset management is used the asset of investment in efficiency way.

In the content of air cargo logistics, all attributions are deemed important among the three-level processes, the SCOR process at level 1 are Plan, Receive, Put Away, Pick and Pack, Storage and Dispatch. Plan refers to planning activities in identifying and meeting demand. Receive refers activities to source and procure goods and services to meet the demand at the ground, Store refers to the activities to receive and inspect goods as well as to store or dispatch the stored goods. Delivery refers activities related to management of received goods and delivery goods to customers.

In level 2, the processes of air cargo operation are further decomposed in to several sub processes as source to stock and deliver stock products. Base on the important of these processes, researcher select and adopt related SCOR metrics in a hierarchy of three levels according to the logistics of the organizations. At level 3, similarly this research maps the supply chain of air cargo industry with the detail omit

here, there are presented follow table below, where the SCOR metrics, performance attribute, process and formula are displayed in table below.

After proposing 68 KPIs base on the original SCOR model, then conduct the KPI validate with the participation of air cargo industry. The difficult of measuring air cargo ground operation process, it was focused on the important measure that relate with the operation. The important of KPI refers to the relevance of KPI in Air cargo operation, and the degree of potential improvement by using the metric in the operation. All of KPIs was concerned in this research are based on current processes and existing data. These metrics cover the key elements of quality, time, and cost in air cargo supply chain. It can assist air cargo industry to measure the performance base on SCOR model as follow the detail in appendix A. By implementing these metrics, air cargo industry is able to benchmark both internally against its previous performance and externally and set realistic targets for ongoing improvement. The implement of multiple indicators may also help air cargo industry to review its current operation and processes for potential improvement.

The performance measurement system in this research device in 3 levels, overall of performance measurement system show in **Figure 4.15**, the performance measurement in this research had selected from the performance base on SCOR , in total 68 metrics which include level 1 was defined the strategy level include 8 metrics, level 2 was defined the tactical level include 20 metrics and level 3 was defined the operation level include 40 metrics which links to the operation process show in **Table 4.1** to **Table 4.4**, the process will be efficiency or not, it shown in the result of measuring performance of the operation processes.

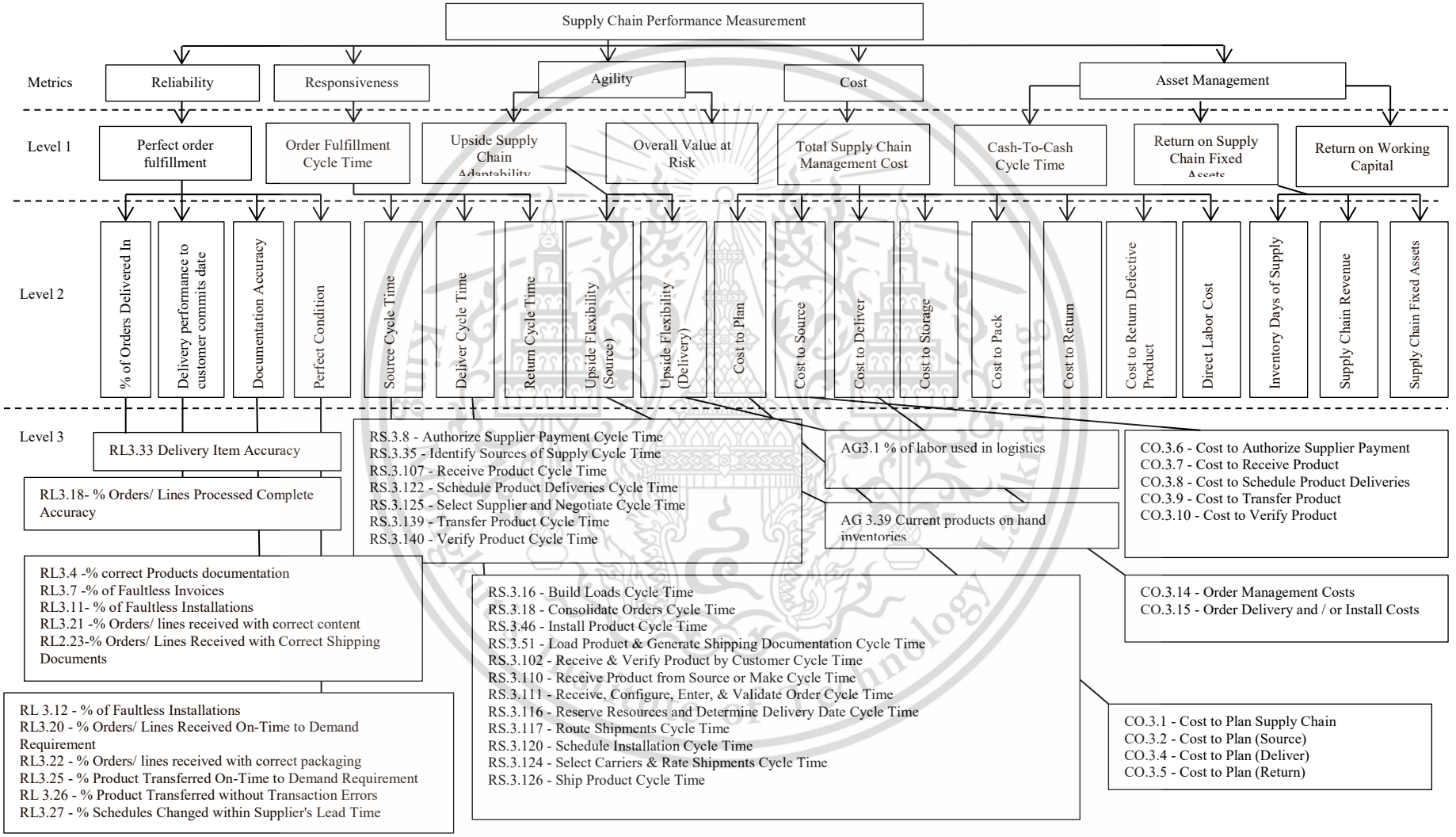

Figure 4.15 Performance Measurement system based on SCOR

Table 4.1 Reliabilities Performance Measurement

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
RL1.1	Perfect order fulfillment	Reliability	All Process	[Total Perfect Orders] / [Total Number of Orders] x 100%
RL2.1	% of Orders Delivered In Full	Reliability	Delivery	[Total number of orders delivered in full] / [Total number of orders delivered] x 100%
RL2.2	Delivery performance to customer commit date	Reliability	Delivery	[Total number of delivered with in schedule date] / [Total number of order] x 100%
RL2.3	Documentation Accuracy	Reliability	All Process	[Total number of delivered with in Accuracy document] / [Total number of order] x 100%
RL2.4	Perfect Condition	Reliability	Delivery	[Number of orders delivered in Perfect Condition] / [Number of orders delivered] x 100%
RL3.4	% correct Products documentation	Reliability	Receive, Pick and Pack, Delivery	The percent of total shipments that include the correct environmental documentation
RL3.7	% Item Location Accuracy	Reliability	Storage	[Total number of location with in accuracy] / [Total number of order] x 100%
RL3.11	% of Faultless Invoices	Reliability	Deliver	The number of invoices processed without issues and / or errors divided by the total number of invoices.
RL3.12	% of Faultless Installations	Reliability	Storage	Number of Faultless Installations divided by Total Number of Units Installed.

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
RL3.18	% Orders/ Lines Processed Complete	Reliability	Receive	The number of orders / lines that are processed complete divided by the total orders / lines processed within the measurement period
RL.3.20	% Orders/ Lines Received On-Time to Demand Requirement	Reliability	Receive	The number of orders / lines that are received on- time to the demand requirements divided by the total orders / lines for the demand requirements in the measurement period
RL.3.21	% Orders/ lines received with correct content	Reliability	Receive	Percent of orders or lines received that have the correct material content as specified in the product design specs and supplier agreements.
RL.3.22	% Orders/ lines received with correct packaging	Reliability	Receive	Percent of orders or lines received that are packaged correctly with the right type and quantity of packaging material.
RL.3.23	% Orders/ Lines Received with Correct Shipping Documents	Reliability	Receive	The number of orders / lines that are received on- time with correct shipping documents divided by the total orders / lines processed in the measurement period
RL.3.25	% Product Transferred On-Time to Demand Requirement	Reliability	Receive	The number of product orders / lines that are transferred on-time to demand requirements divided by the total orders / lines transferred in the measurement period
RL.3.26	% Product Transferred without Transaction Errors	Reliability	Receive	The number of transactions processed without error divided by the total transactions processed in the measurement period.
RL.3.27	% Schedules Changed within Supplier's Lead Time	Reliability	Receive	The number of schedules that are changed within the suppliers lead-time divided by the total number of schedules generated within the measurement period
RL.3.33	Delivery Item Accuracy	Reliability	Delivery	Percentage of orders in which all items ordered are the items actually provided, and no extra items are provided

Table 4.2 Responsiveness Performance Measurement

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
RS1.1	Order Fulfillment Cycle Time	Responsiveness	All processes	[Sum Actual Cycle Times for All Orders Delivered] / [Total Number of Orders Delivered] in days
RS2.1	Source Cycle Time	Responsiveness	Receive, Pick and Pack	Source Cycle Time - (Identify Source of Supply Cycle Time + Select Supplier and Negotiate Cycle Time) + Schedule Product Deliveries Cycle Time + Receive Product Cycle Time + Verify Product Cycle Time + Transfer Product Cycle Time + Authorize Supplier Payment Cycle Time
RS2.3	Deliver Cycle Time	Responsiveness	Deliver	Delivery Cycle Time = MAX {[Reserve Resources & Determine Delivery Date Cycle Time +(Consolidate Orders Cycle Time + Schedule Installation Cycle Time) + Build Loads Cycle Time + Route Shipments Cycle Time + Select Carriers and Rate Shipments Cycle Time], +Receive Product from Make/Source Cycle Time} + Pick Product Cycle Time + Pack Product Cycle Time + Load Vehicle & Generate Shipping Documentation Cycle Time + Ship Product Cycle Time + (Receive & Verify Product Cycle Time) + (Install Product Cycle Time)
RS2.5	Return Cycle Time	Responsiveness	Return	Return Cycle Time = (Identify need for Return + Coordinate and Schedule Return + Return Transit time + Receive Return Product Time + Verify and Transfer Return Product Time).
RS.3.4	Asset Turns	Responsiveness	Pack	Total gross product revenue/Total net assets

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
RS.3.16	Build Loads Cycle Time	Responsiveness	Deliver	The average time associated with building shipment loads.
RS.3.17	Checkout Cycle Time	Responsiveness	Deliver	The average time required for customer checkout
RS.3.18	Consolidate Orders Cycle Time	Responsiveness	Deliver	The average time required for customer order consolidation
RS.3.20	Current logistics order cycle time	Responsiveness	Deliver	Current logistics order cycle time, including customer order processing cycle time, dock-to- stock cycle time, pick-to-ship cycle, transit time, etc.
RS.3.24	Deliver and/or Install Cycle Time	Responsiveness	Deliver	The average time required to deliver and install product.
RS.3.34	Generate Stocking Schedule Cycle Time	Responsiveness	Stock	The average time associated with the generating a stocking schedule
RS.3.35	Identify Sources of Supply Cycle Time	Responsiveness	Receive	The average time associated with the identification of sources of supply
RS.3.48	Invoice Cycle Time	Responsiveness	Deliver	The average time associated with the generation and issuance of an invoice
RS.3.51	Load Product & Generate Shipping Documentation Cycle Time	Responsiveness	Deliver	The average time associated with product loading and the generation of shipping documentation
RS.3.59	Manage Deliver Information Cycle Time	Responsiveness	Deliver	The average time associated with managing deliver information
RS.3.60	Manage Import/Export Requirements Cycle Time	Responsiveness	Deliver	The average time associated with managing import/export requirements

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
RS.3.94	Order Fulfillment Dwell Time	Responsiveness	Deliver	Any lead time during the order fulfillment process where no activity takes place, which is imposed by customer requirements. Note that this dwell time is different from idle time or non-value-add lead time,
RS.3.95	Pack Product Cycle Time	Responsiveness	Pack	The average time associated with packing a product for shipment
RS.3.96	Pick Product Cycle Time	Responsiveness	Pick	The average time associated with product pick
RS.3.102	Receive & Verify by Customer Cycle time The	Responsiveness	Deliver	The average time associated with receiving and verifying an order at the customer site
RS.3.102	Receive and Verify Product Cycle Time	Responsiveness	Deliver	The average time associated with receiving and verifying an order at the customer site
RS.3.117	Route Shipments Cycle Time	Responsiveness	Deliver	The average time associated with routing shipments
RS.3.122	Schedule Product Deliveries Cycle Time	Responsiveness	Deliver	The average time associated with scheduling the shipment
RS.3.126	Ship Product Cycle Time	Responsiveness	Deliver	The average time associated with shipping product

Table 4.3 Agility Performance Measurement

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
AG1.1	Upside Supply Chain Adaptability	Agility	All Processes	Supply chain adaptability is the least quantity sustainable when considering receive, put away, pick and pack, storage and dispatch components.
AG1.2	Downside Supply Chain Adaptability	Agility	All Processes	Downside Source Adaptability + Downside Make Adaptability + Downside Deliver Adaptability Downside Supply Chain Adaptability is the least reduction sustainable when considering Source, Make, Deliver and Return components.
AG2.1	Upside Flexibility (Source)	Agility	Receive, Put away, Pick and Pack	For all supply item order, the maximum value of (receipt date of order in which quantity increase by 100%)-(PO date of order in which quantity increase by 100%)
AG2.3	Upside Flexibility (Delivery)	Agility	Storage and Deliver	For all delivery item order, the maximum value of (delivery date of order in which quantity increase by 100%)-(the date of item ready for delivery in which quantity increase by 100%)
AG1.3	Overall Value at Risk	Agility	All Processes	VaR = Probability of Risk Event (P) x Monetized Impact of Risk Event (I)
AG.3.1	% of labor used in logistics, not used in direct activity	Agility	Deliver	Percent of labor used in logistics, not used in direct activity
AG3.39	Current products on hand inventories	Agility	Store	The amount of all item current in warehouse

Table 4.4 Cost Performance Measurement

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
CO1.1	Total Supply Chain Management Cost	Cost	All Processes	TSCMC = Cost to Plan + Cost to receive + Cost to put away + Cost to Pick and pack + Cost to dispatch+ Cost to Return + Mitigation Costs
CO2.1	Cost to Plan	Cost	Plan	Cost to Plan = Sum of Cost to Plan (Plan + receive + Put Away+ Pick and Pack + Store + Deliver + Return)
CO2.2	Cost to Source	Cost	Source	Sum up the cost relate to source to stock such as receiving, put away, pick and pack
CO2.4	Cost to Deliver	Cost	Deliver	Sum up the cost relate to delivery stock products such as Storage and delivery
CO2.5	Cost to Return Defective Product	Cost	Return	The sum of the costs associated with returning a defective product to the supplier
CO2.8	Direct Labor Cost	Cost	All Processes	Direct cost spent on labor.
CO3.1	Cost to Plan Supply Chain	Cost	All Processes	The sum of the costs associated with planning supply chain activities
CO3.7	Cost to Receive Product	Cost	Receive	The sum of the costs associated with receiving product
CO3.8	Cost to Put away Product	Cost	Put Away	The sum of the costs associated with put away product
CO3.9	Cost to Pick and pack Product	Cost	Pick and Pack	The sum of the costs associated with pick and pack product
CO3.10	Cost to Storage Product	Cost	Storage	The sum of the costs associated with storage product
CO3.11	Cost to Dispatch Product	Cost	Deliver	The sum of the costs associated with deliver product

Table 4.5 Asset Management Performance Measurement

SCOR No	SCOR Metrics	Performance Attribute	Process	Formula
AM.1.1	Cash-To-Cash Cycle Time	Asset Management Efficiency	All Processes	Cash-To-Cash Cycle Time = [Inventory Days of Supply] + [Days Sales Outstanding] - [Days Payable Outstanding] in days.
AM.1.2	Return on Supply Chain Fixed Assets	Asset Management Efficiency	All Processes	Return on Supply Chain Fixed Assets = ([Supply Chain Revenue] – [Total Cost to Serve]) / [Supply- Chain Fixed Assets]
AM.1.3	Return on Working Capital	Asset Management Efficiency	All Processes	Return on Working Capital = ([Supply Chain Revenue] – [Total Cost to Serve]) / ([Inventory] + [Accounts Receivable] – [Accounts Payable])
AM2.2	Inventory Days of Supply	Asset Management Efficiency	All Processes	[5 point rolling average of gross value of inventory at standard cost] / [Annual Cost of Goods] / 365 in days
AM2.4	Supply Chain Revenue	Asset Management Efficiency	All Processes	Operating revenue generated from a supply chain. This does not include non-operating revenue, such as leasing real estate, investments, court settlements, sale of office buildings, etc.
AM 2.5	Supply Chain Fixed Assets	Asset Management Efficiency	All Processes	The sum of the costs associated with Plan, receive, Put Away, Pick and Pack, Store, Deliver, Return
AM2.8	Inventory	Asset Management Efficiency	Storage	The amount of inventory (stock) expressed in dollars, The 5 point rolling average of gross value of inventory at standard cost

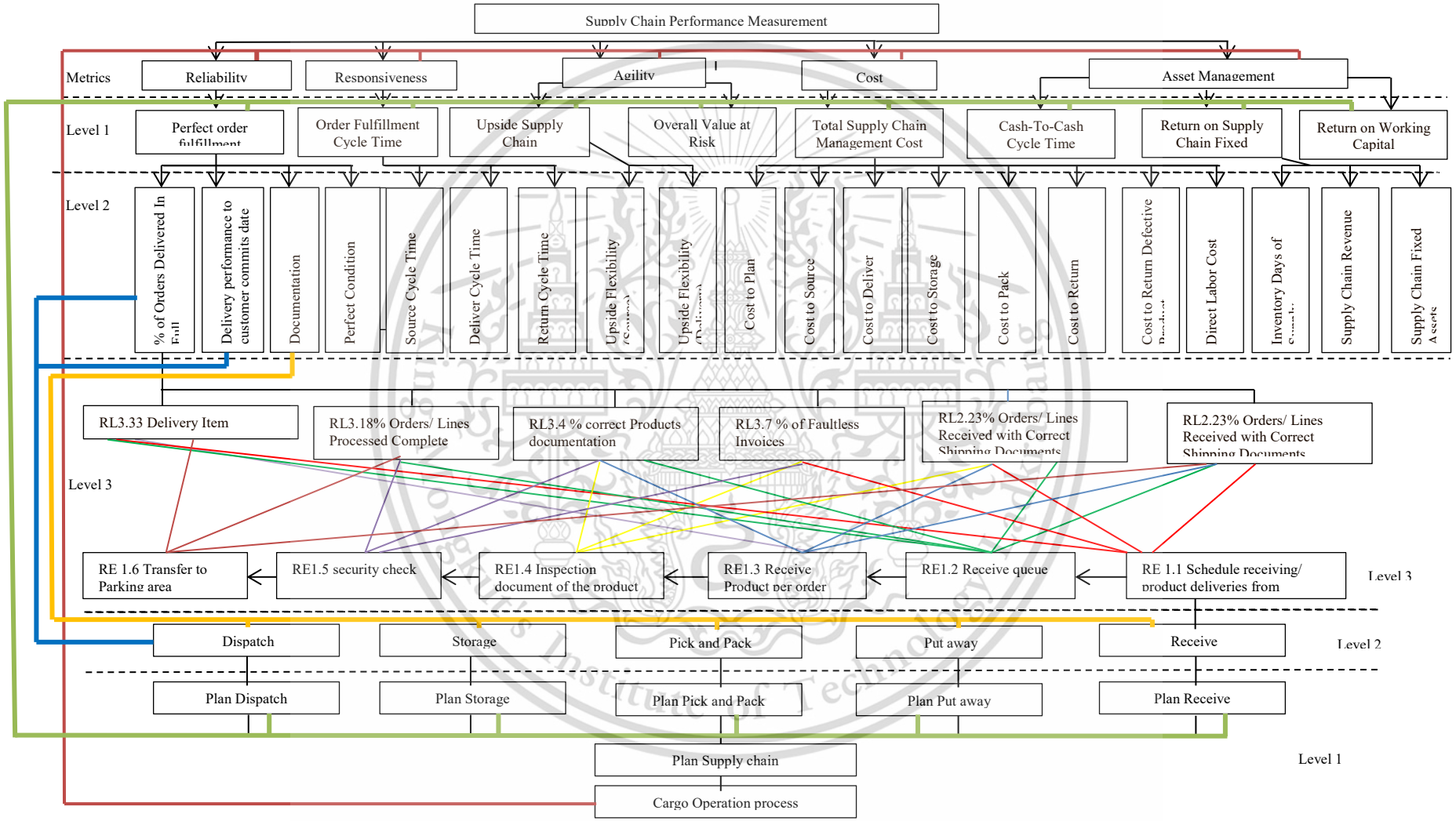

Figure 4.16 Linking Between Operation Process and Performance Measurement System

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The planning and management for air transportation supply chain requires properly specifying participates and identifying the relationship amount them. Air cargo industry is a complex structure and high competitive in these business areas. With the development of the time, the air cargo business competition has changed from the competition between businesses to the competition between Supply chains. When analyzing the enterprise internal problems and improving the weakness, these cannot just limit to the business interior but it should expand the scope look more inclusive in the Supply chain networks. Moreover, to realizing success, the company has to know about a competitive environment for managing activities involved directly and indirectly to fulfill customer requirements.

5.1 Air Cargo Process Approach and Modeling

To modeling the air cargo supply chain process, we adopt the process base on supply chain operation reference model (SCOR) through business process modeling and notation (BPMN). SCOR model is the management tools use to address, improve and communicate supply chain management process within the company, with suppliers and customer of company as well. In this research studied the generic process of the Thai cargo terminal to identify the reference model of cargo warehouse based on SCOR. Where the process of air cargo operation was defined in 3 level and 5 main processes includes receive, put away, pick and pack, storage and dispatch as follow:

Level 1 corresponds with the top level of the supply chain it is devised follow the process of business and the relationship between stakeholders. The process of air cargo supply chain in level 1 shows the overall of plan processes with consignor, plan process with agency, the plan process in cargo terminal and plan with customer, adopting the SCOR process is described the cargo products flow and information within and throughout the air cargo terminal.

Level 2 is break drown of level 1 according to the major categories and corporate strategy, the modeling is based on S1 Source product to storage and D1 Delivery Stock product due to air cargo work as the warehousing and distributing center. This describes the process of air cargo terminal to align with distribution process in air cargo supply chain.

Level 3 process elements are used to determine and identify the relevant process that will enable identifications of improvement in the operation. It has determined that S1 Source stock product and D1 Deliver stocked product in level 2 process will be further elaborated on level 3 processes.

With the result, the SCOR model shows the basic structure and keeps the processes and metrics from the SCOR model intact. This means that the SCOR model can be used by the up-stream in supply chain and can be used to map the supply chain from supplier or consignor of air cargo to and on the actual air cargo terminal. Moreover, it also can be used to assist the management level for guideline for implementation and process improvement within the organization.

5.2 Performance Measurement System Development

Performance measurement in supply chain management system is established in the commercial world, but its usage still lags behind in air cargo operation. Most air cargo industry recognize the important the important of having a suitable performance system and the benefit of its implementation to their organization. To design the reference process model that link between business process, metrics, and technology with the wide usage, has great potential in measuring the logistics performance.

With a bottom-up approach, as set of 68 KPIs base on the original SCOR model has been identified to measure and monitor their supply chain performance. These metrics cover the key elements of quality, time, and cost in air cargo supply chain and can assist Thai airway to measure the performance base on SCOR model. By implementing these metrics Thai airway is able to benchmark both internally against its previous performance and externally and set realistic targets for ongoing improvement.

5.3 Conclusions

To support air cargo industry to achieve the highest customer satisfaction and to prepare for the increase of trade from AEC, to sustain its competitive advantage in a fast grow environment, a proven methodology was required: the SCOR model and BPMN.

By using the SCOR model, the operation approach consists in the assessment of the current air cargo supply chain (Mapping of facilities, processes, systems and organizations) and the identification of strategic improvement opportunities with the

introduction of performance benchmark. By the result, it has recommended strategic initiatives to air cargo industry as follow:

1. **Supply Chain Network Design:** The result of modeling operation process and performance measurement system help the air cargo industry to Set-up a regional distribution center in Asia and oversea destination to get the best balance between responsiveness, inventory and transportation cost between air cargo supply chain. In other hand, the performance helps to identify key logistics service provider for the company and to get more visibility into the freight cost and establish service level agreement with service providers.
2. **Supplier Relationship Management**: is measuring the relationship between air cargo industry and customer to establish supplier performance measurement, educate suppliers about specific requirements and procedures to forecast, measure and develop to meet customer demand and satisfaction, also develop collaboration relationship with suppliers.
3. **Operations Planning**: to identify the operation process, the modeling with SCOR model help to review current processes and develop a standard plan process or framework for the supply chain aligned with company objectives, it evaluates and implements demand planning and forecasting tool for operation plan in process. Moreover, it helps to develop a communication and information sharing process with supply chain partners.
4. **Supply Chain Performance Measurement and Monitoring System**, SCOR help the company to build up a competitiveness pole to monitor performance and drive continuous improvement the process to be efficiency. Implement an overall process and framework to streamline flow of data to measure performance metrics and improve data accuracy

5.4 Recommendation and Future Study

Supply chain management is necessary wide the thing to do is how to apply and test the SCOR model in the supply chain operation. During the work with developing framework, changes and experience from on case study is tested in the succeeding case. However, a case study where all suggested changes are tests and validate has not been performed.

In SCOR model, something need to be future development is the measurement part. As it now, there are many metrics to measure the performance in their operation, are there any metrics missing to measure? Furthermore, suggest studying how to improve the supply chain management by integrating their internal procedure to across other function of finance, procurement, service contracting and distribution activities and prove that the processes and performance measurement system that has modeled are efficiency to use in air cargo supply chain as well.

Moreover, the knowledge from this study also can apply to other works as well such as manufacturing, transportation system, logistics system or IT structure by using SCOR model design the process structure and measure the performance.

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APPENDIX A

Performance Measurement Metrics

Receive Process

<table>
<tr><th colspan="2">RE 1.1 Schedule Receiving</th></tr>
<tr><td>Input
• Information feedback (RE1.3, RE1.4)
• Receiving schedule (RE1.1)
• Receiving plan (p.RE 2.4)
• Cargo operation rules (ES 5)
• Managing Incoming products (ES3)</td><td rowspan="2">Metrics:
• % schedules changed within suppliers lead time
• Average days per schedule change
• Average release cycle of changes
• Schedule product deliveries cycle time</td></tr>
<tr><td>Output
• Receiving Schedule (RE1.1.1)
• Schedule receipts (sS1.1, DP1.7)</td></tr>
<tr><th colspan="2">RE1.2 Receive Queue</th></tr>
<tr><td>Input
• Information feedback (RE1.3, RE1.4)
• Receiving schedule (RE1.1)
• Receiving plan (p.RE 2.4)
• Managing incoming products (ES3)</td><td rowspan="2">Metrics:
• Forecast income products
• % Income products
• % Delay products
• Schedule product deliveries cycle time</td></tr>
<tr><td>Output
• RE1.3 Receive product per order
• Truck unloading</td></tr>
<tr><th colspan="2">RE1.3 Receive Product Per Order</th></tr>
<tr><td>Input
• Product from 3 PL (Truck unloading)
• Receiving business rule (ER1)</td><td rowspan="2">Metrics:
• % Orders processed complete
• % Orders received on-time to demand requirement
• Orders received with correct shipping documents
• Cost to receive product
• Receiving product cycle time</td></tr>
<tr><td>Output
• Manage incoming product (ER3)
• Check documentary</td></tr>
<tr><th colspan="2">RE1.4 Inspection Document of The Product</th></tr>
<tr><td>Input
• Manage incoming product (ER3)
• AWB / Booking / Custom clearance
• Count incoming product</td><td rowspan="2">Metrics:
• % Correct Product document
• % Orders received with correct document
• % Orders received with correct Content</td></tr>
<tr><td>Output
• Information Feedback (RE1.1)</td></tr>
</table>

• Product Document (RE1.3) • Maintain product data (ER2) • Warehouse Agreement (EP4)	
RE1.5 Security Check	
Input • Income products	**Metrics:** • % Orders received defect free • Cost to verify product • Verify product cycle time
Output • Weight and volume check • Information feedback (RE1.1)	
RE 1.6 Transfer to Parking area	
Output • Determined delivery date (DP.3) • Information feedback (RE1.1)	• % product transferred on-time • demand requirement • % Product transferred without • transaction errors • Cost to transfer product • Transfer product cycle time

Put Away Process

PA1.1 Security Check Receive Item for Put To Pack	
Input • Information feedback (RE1.5, RE1.6) • Receiving schedule (ST 1.1) • receiving plan (p.RE 2.4) • Storages rules (ES 5) • Managing incoming products (ES3)	• % Scanning error
Output • Check by Scanner machine	
PA1.2 Analysis Available Space and Destination	
Input • Product from receive Truck dock	**Output** • Manage incoming product (ER3)
PA1.3 Create, Check, Excuse and Confirm Order	
Input • Manage incoming product (ER3) • Count incoming product	**Output** • Information Feedback (RE 1.1) • Product Document (RE 1.3) • Warehouse Agreement (EP4)
Transfer Products Pick and Pack Area	
	Output • Determined delivery date (RL1.3)

Pick and Pack Process

<table>
<tr><th colspan="2">PP1.1 Process Inquiry and Quote</th></tr>
<tr><td>Input
• EP5. Forecasting, customer inquiry</td><td rowspan="2">Metrics:
• Cost to process inquiry and quote
• Process inquiry and quote cycle time</td></tr>
<tr><td>Output
• Customer quote to sD1.2</td></tr>
<tr><th colspan="2">PP 1.2 Analysis Outstanding Products Issues for Picking</th></tr>
<tr><td>Input
• EP5. Forecasting, customer inquiry</td><td rowspan="2">Metrics:
• Cost to handling missing products
• % Missing products
• % inventory accuracy</td></tr>
<tr><td>Output
• Customer quote to sD1.2</td></tr>
<tr><th colspan="2">PP1.3 Identify Picking Location</th></tr>
<tr><td>Input
• Storage Location and product delivery (ST1.3, ST1.1)
• Delivery plans (sP4.4)
• Storage plans (sP3.4)
• Receiving Plans (sP2.4)</td><td rowspan="2">Metrics:
• % Correct Products documentation
• Pick product cycle time
• Fill rate
• Order fulfillment dwell time</td></tr>
<tr><td>Output
• Product order(sP4.1)
• Product inventory status (sP4.2)</td></tr>
<tr><th colspan="2">PP1.4 Receive, Enter and Validate Order</th></tr>
<tr><td>Input
• Location of customers to Product lifecycle (ED6)
• Transportation (ED5)
• Delivery data Shipping preference (ED3)
• Customer order to Asses delivery (ED2)
• Customer order size, weight, Freight class to Manage transportation (ED5)</td><td rowspan="2">Metrics:
• Cost to receive, enter and validate order
• Order fulfillment dwell time
• Receive, enter and validate order cycle time</td></tr>
<tr><td>Output
• PP1.5 Reserve inventory and determine delivery date</td></tr>
<tr><th colspan="2">PP1.5 Reserve Inventory and Determine Delivery Date</th></tr>
</table>

<table>
<tr><td>Input
Storage Location and product delivery (sS1.7, sS1.5)
Delivery plans (sP4.4)
Storage plans (sP3.4)
Receiving plans (sP2.4)</td><td rowspan="2">Metrics:
% orders delivered in full
Cost to determine delivery date
Delivery performance to customer commit date
Fill rate
Order fulfillment dwell time
Determine delivery date cycle time</td></tr>
<tr><td>Output
Product order(sP4.1)
Product inventory Status (sP4.2)
Shipment and order backlog to (sP1.1)
Replenishment signal to RE 1.1</td></tr>
<tr><td colspan="2">PP1.6 Build Load</td></tr>
<tr><td>Input
PP1.5 Reserve inventory and determine delivery date</td><td rowspan="2">Metrics:
Build loads cycle time
Cost to build loads</td></tr>
<tr><td>Output
Load Information (sP4.2)
Plan and build loads information to sR2.4,sR3.4, sR1.4</td></tr>
</table>

Storage Process

<table>
<tr><th colspan="2">ST1.1 Schedule Storage Activities</th></tr>
<tr><td>Input
Information feedback (ST2.2, ST2.3, ST2.4)
Storage rule (ES1)
Storage plan (p.ST 3.4)
Receiving Schedule (RE1.1)
Output
Storage Schedule (p.ST1.2, ST1.3)</td><td rowspan="2">Metrics:
Cash-to-cash cycle time
Cost to make
Downside make adaptability
Make cycle time
Order fulfillment cycle time
Return on working capital
Upside make adaptability
Upside make flexibility</td></tr>
<tr><th colspan="2">ST1.2 Verify And Consolidation Products Area</th></tr>
<tr><td>Input
Product Documents (RE1.3)
Inventory Data level (ES6)
Output
Inventory update(sP3.2), (sP4.2)
Information feedback (ST1.1)
Inventory availability (DL1.7)
Plan and build loads information to sR2.4,sR3.4, sR1.4</td><td>Metrics:
Capacity Utilization
Cost to deconsolidation
Fill Rate
Deconsolidation cycle time
Warranty and returns
Warranty costs
Yield
Yield variability</td></tr>
<tr><th colspan="2">ST1.3 Identify Product Storage Location</th></tr>
<tr><td>Input
Location Data (ES6)
Storage rule (ES5)
Manage product inventory management (ES8)
Output
Product inventory Update (sP3.2, DL1.3, DL1.7)
Information feedback (ST1.1)
Product located for storage (ST1.4)</td><td>Metrics:
Cost to stage finished product
Stage finished product cycle time
% fulfillment products</td></tr>
<tr><th colspan="2">ST1.4 Release Product to Deliver</th></tr>
<tr><td>Input
Product location (ST1.3)
Transportation handling (ES7)
Output
Information feedback (ST1.5)
Product location (ST137)</td><td>Metrics:
Cost to release finished product to deliver
Release finished product to deliver cycle time</td></tr>
</table>

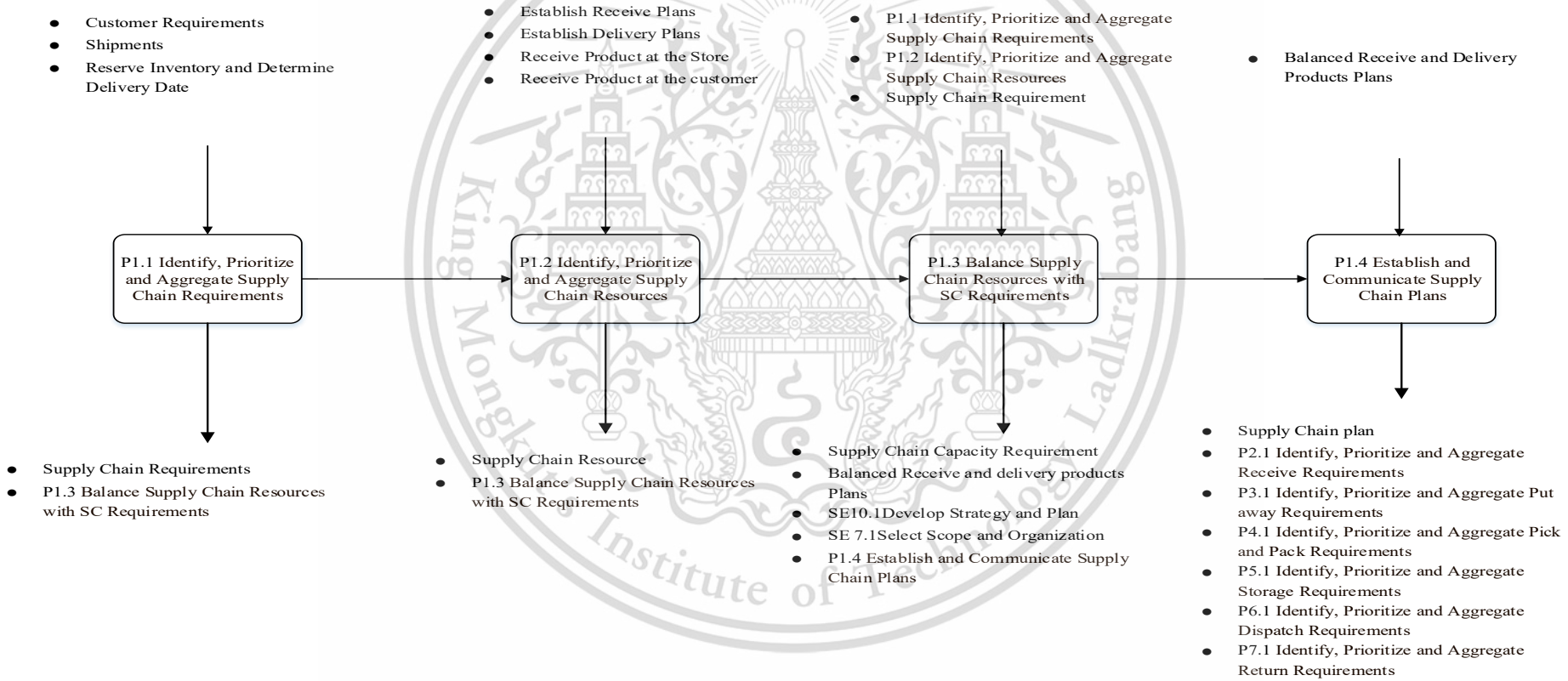
Dispatch Process

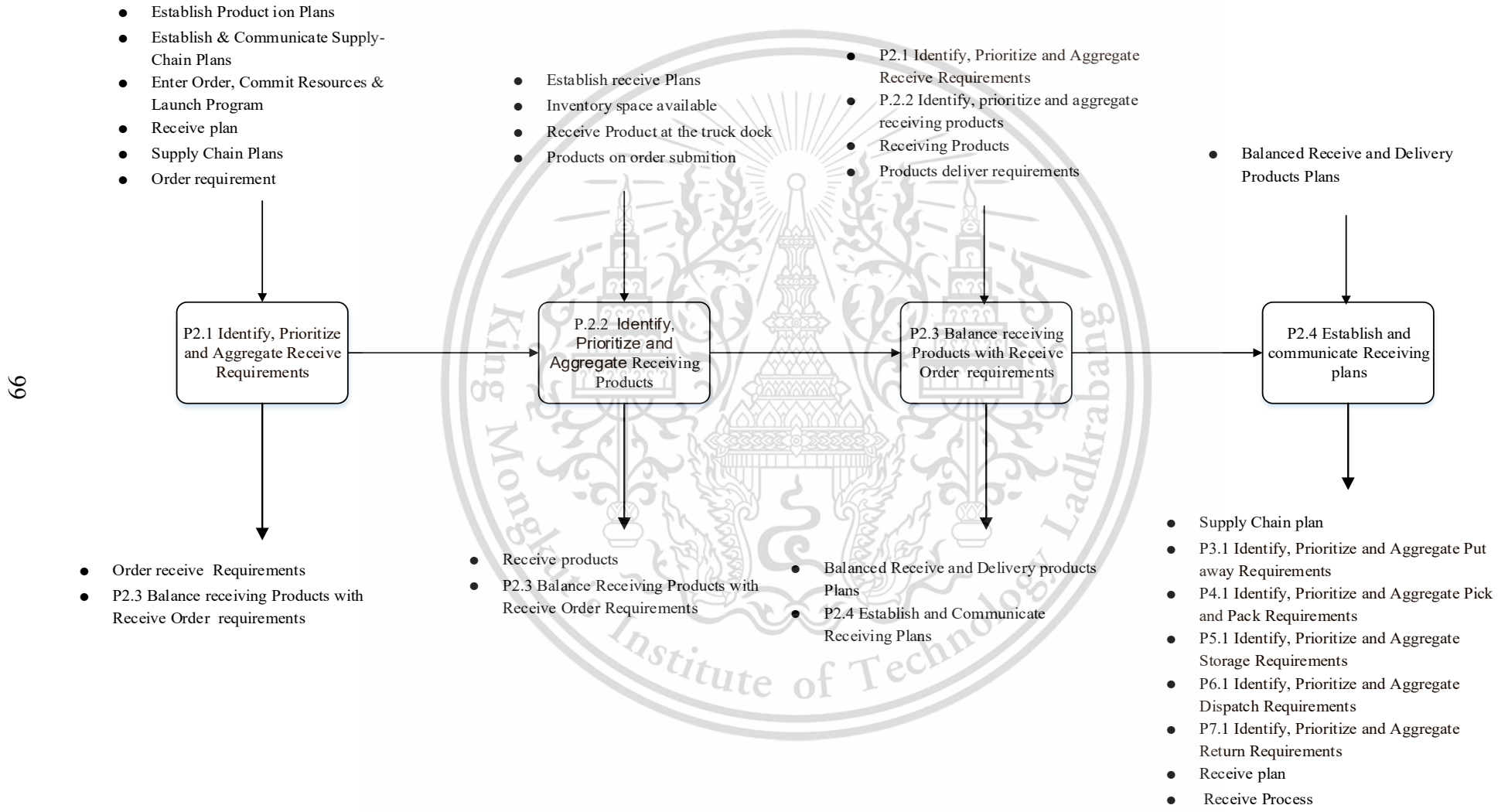
<table>
<tr><th colspan="2">DP1.1 Route Shipments</th></tr>
<tr><td>Input
Rates carrier data from source: Carrier cost to route shipment
Route shipment cycle time</td><td rowspan="2">Metrics:
Cost to route shipment
Route shipment cycle time</td></tr>
<tr><td>Output
DP1.2 Locate product from Storage</td></tr>
<tr><th colspan="2">DP1.2 Locate Product from Storage</th></tr>
<tr><td>Input
Schedule receiving (sS1.1)
Product location (sS1.7, sS1.8)
Storage schedule (sS1.5)</td><td rowspan="2">Metrics:
Full fill rate
% Of faultless installations
% Item location accuracy</td></tr>
<tr><td>Output
Inventory availability (ED4)
Transportation (ED5)</td></tr>
<tr><th colspan="2">DP1.3 Receive Product from warehouse</th></tr>
<tr><td>Input
Finish Product release sS1.8
Inventory availability sS1.4
Product schedule sS1.5</td><td rowspan="2">Metrics:
Cost to receive product from Storage
Receive product from storage cycle time</td></tr>
<tr><td>Output
Existing data to (ED4)</td></tr>
<tr><th colspan="2">DP 1.4 load Products and Generate Delivery Documentation</th></tr>
<tr><td>Input
Schedule receiving (sS1.1)
Product location (sS1.7, sS1.8)
Storage schedule (sS1.5)</td><td rowspan="2">Metrics:
Documentation accuracy
Load product and generate delivery
documentation cycle time
Delivery performance to customer commit date</td></tr>
<tr><td>Output
Inventory availability (ED4)
Transportation(ED5)</td></tr>
<tr><th colspan="2">DP 1.5 Ship Product</th></tr>
<tr><td>Input
DP 1.4 load Products and Generate Delivery documentation</td><td rowspan="2">Metrics:
% orders delivered in full
Delivery performance to customer
commit date
Deliver product cycle time</td></tr>
<tr><td>Output
Transportation agreement and insurance</td></tr>
<tr><th colspan="2">DP 1.6 Receive and Verify Product By Customer</th></tr>
</table>

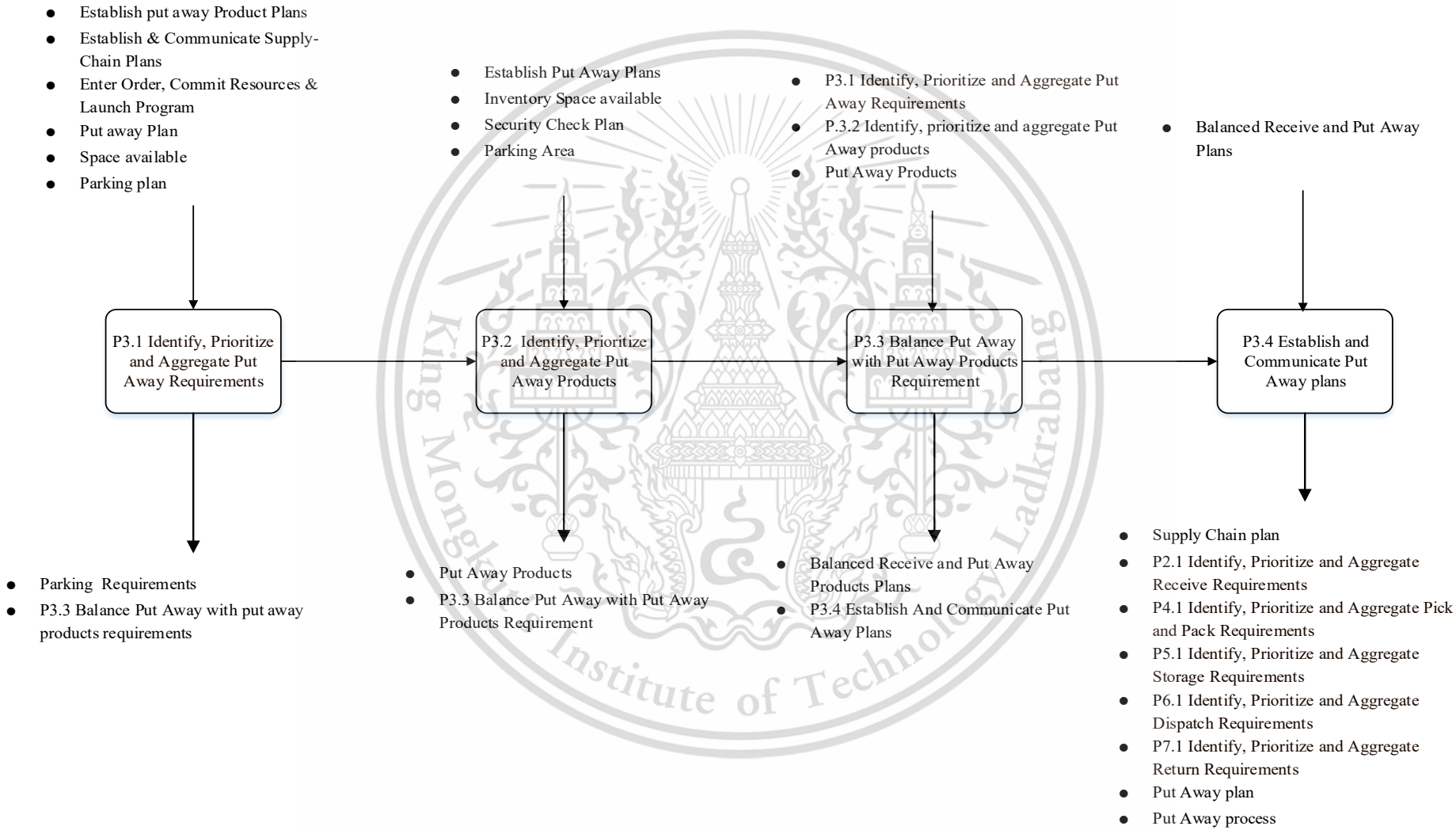
Input • Products arrive to customer • Consolidate products	**Metrics:** • % orders delivered in full • Delivery performance to customer commit date • Perfect condition • Receive and verify product by customer cycle time
Output • Accept products (DL1.4, DL1.5) • Reject Products (RT1.1)	

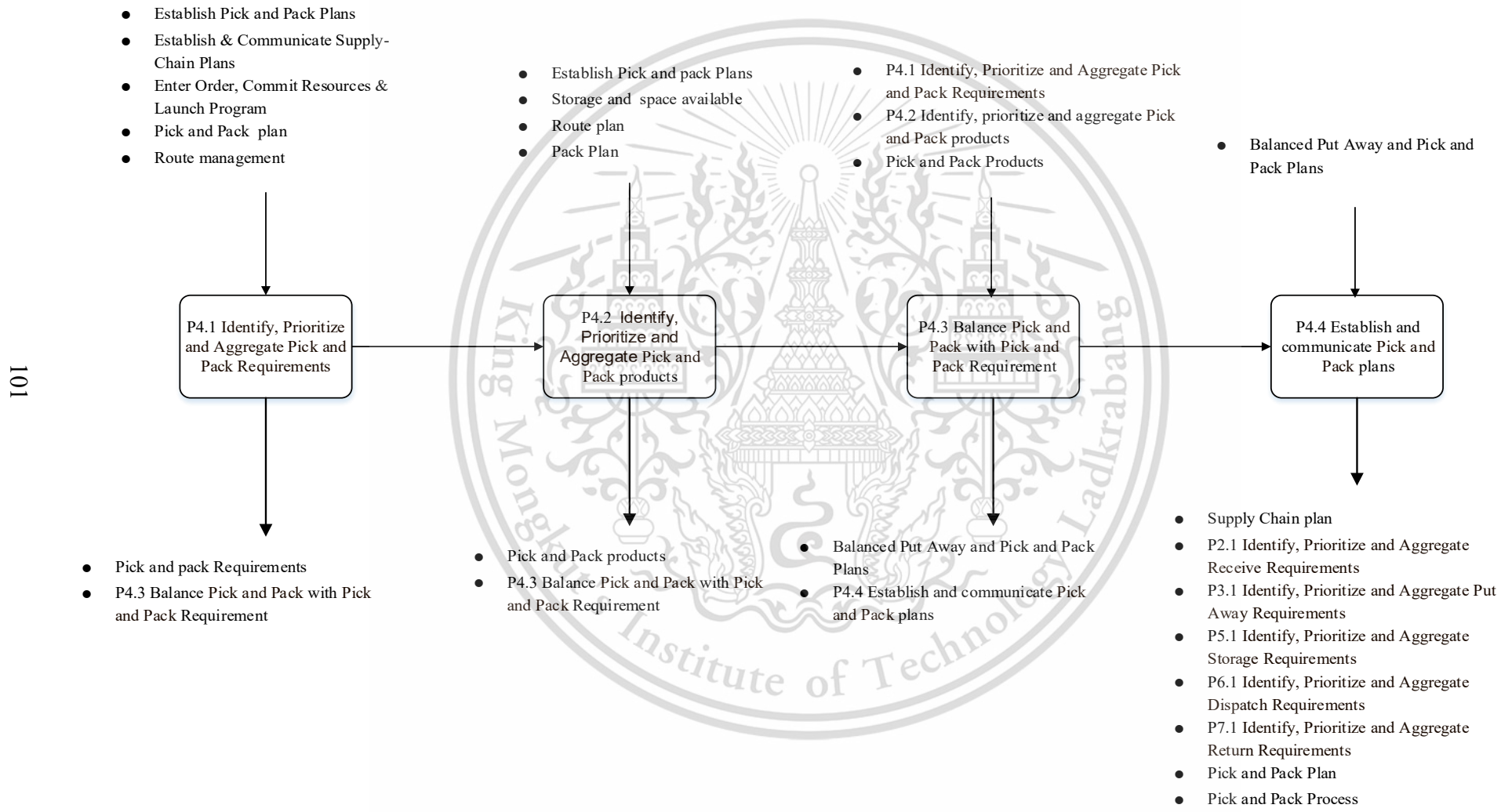
APPENDIX B

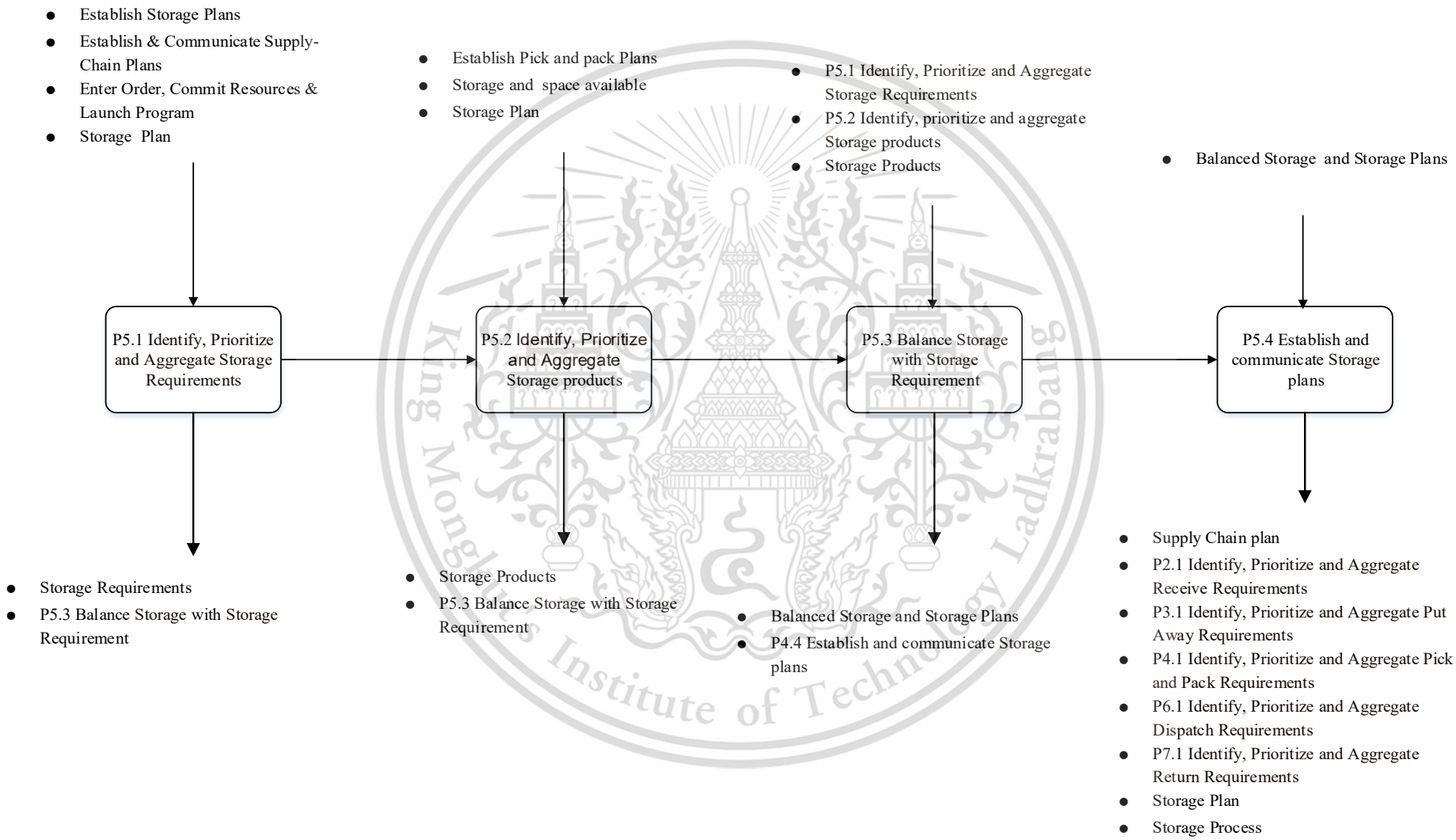
Plan Processes Approach

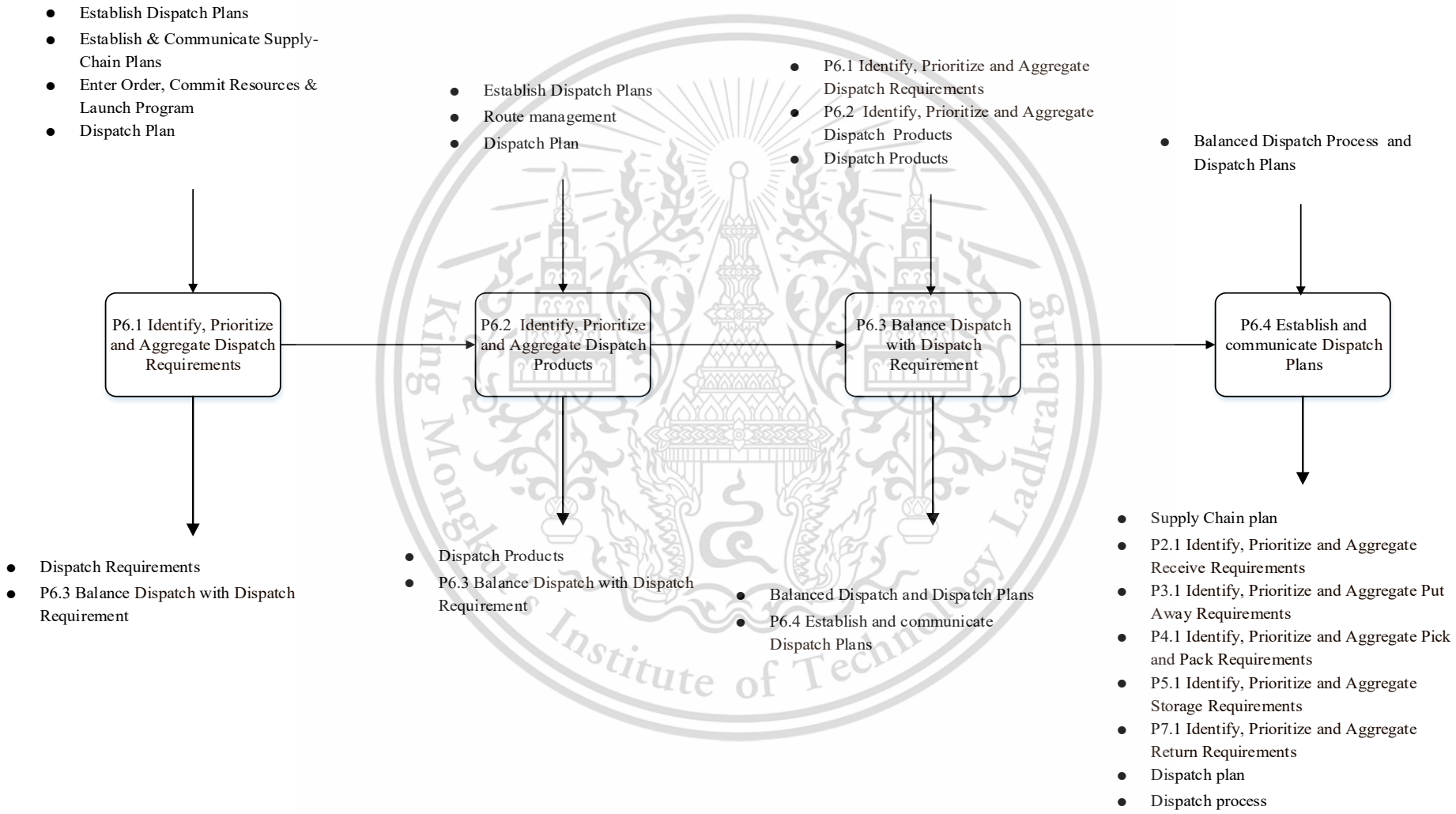



Establish Product ion Plans
Establish & Communicate Supply-Chain Plans
Enter Order, Commit Resources & Launch Program
Receive plan
Supply Chain Plans
Order requirement
P2.1 Identify, Prioritize and Aggregate Receive Requirements
Order receive Requirements
P2.3 Balance receiving Products with Receive Order requirements
Establish receive Plans
Inventory space available
Receive Product at the truck dock
Products on order submition
P.2.2 Identify, Prioritize and Aggregate Receiving Products
Receive products
P2.3 Balance Receiving Products with Receive Order Requirements
P2.1 Identify, Prioritize and Aggregate Receive Requirements
P.2.2 Identify, prioritize and aggregate receiving products
Receiving Products
Products deliver requirements
P2.3 Balance receiving Products with Receive Order requirements
Balanced Receive and Delivery products Plans
P2.4 Establish and Communicate Receiving Plans
Balanced Receive and Delivery Products Plans
P2.4 Establish and communicate Receiving plans
Supply Chain plan
P3.1 Identify, Prioritize and Aggregate Put away Requirements
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
P7.1 Identify, Prioritize and Aggregate Return Requirements
Receive plan
Receive Process


Establish put away Product Plans
Establish & Communicate Supply-Chain Plans
Enter Order, Commit Resources & Launch Program
Put away Plan
Space available
Parking plan
P3.1 Identify, Prioritize and Aggregate Put Away Requirements
Parking Requirements
P3.3 Balance Put Away with put away products requirements
Establish Put Away Plans
Inventory Space available
Security Check Plan
Parking Area
P3.2 Identify, Prioritize and Aggregate Put Away Products
Put Away Products
P3.3 Balance Put Away with Put Away Products Requirement
P3.1 Identify, Prioritize and Aggregate Put Away Requirements
P.3.2 Identify, prioritize and aggregate Put Away products
Put Away Products
P3.3 Balance Put Away with Put Away Products Requirement
Balanced Receive and Put Away Products Plans
P3.4 Establish And Communicate Put Away Plans
Balanced Receive and Put Away Plans
P3.4 Establish and Communicate Put Away plans
Supply Chain plan
P2.1 Identify, Prioritize and Aggregate Receive Requirements
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
P7.1 Identify, Prioritize and Aggregate Return Requirements
Put Away plan
Put Away process


Establish Pick and Pack Plans
Establish & Communicate Supply-Chain Plans
Enter Order, Commit Resources & Launch Program
Pick and Pack plan
Route management
Establish Pick and pack Plans
Storage and space available
Route plan
Pack Plan
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P4.2 Identify, Prioritize and Aggregate Pick and Pack products
Pick and pack Requirements
P4.3 Balance Pick and Pack with Pick and Pack Requirement
Pick and Pack products
P4.3 Balance Pick and Pack with Pick and Pack Requirement
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P4.2 Identify, prioritize and aggregate Pick and Pack products
Pick and Pack Products
P4.3 Balance Pick and Pack with Pick and Pack Requirement
Balanced Put Away and Pick and Pack Plans
P4.4 Establish and communicate Pick and Pack plans
Balanced Put Away and Pick and Pack Plans
P4.4 Establish and communicate Pick and Pack plans
Supply Chain plan
P2.1 Identify, Prioritize and Aggregate Receive Requirements
P3.1 Identify, Prioritize and Aggregate Put Away Requirements
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
P7.1 Identify, Prioritize and Aggregate Return Requirements
Pick and Pack Plan
Pick and Pack Process


Establish Storage Plans
Establish & Communicate Supply-Chain Plans
Enter Order, Commit Resources & Launch Program
Storage Plan
Establish Pick and pack Plans
Storage and space available
Storage Plan
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P5.2 Identify, prioritize and aggregate Storage products
Storage Products
Balanced Storage and Storage Plans
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P5.2 Identify, Prioritize and Aggregate Storage products
P5.3 Balance Storage with Storage Requirement
P5.4 Establish and communicate Storage plans
Storage Requirements
P5.3 Balance Storage with Storage Requirement
Storage Products
P5.3 Balance Storage with Storage Requirement
Balanced Storage and Storage Plans
P4.4 Establish and communicate Storage plans
Supply Chain plan
P2.1 Identify, Prioritize and Aggregate Receive Requirements
P3.1 Identify, Prioritize and Aggregate Put Away Requirements
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
P7.1 Identify, Prioritize and Aggregate Return Requirements
Storage Plan
Storage Process


Establish Dispatch Plans
Establish & Communicate Supply-Chain Plans
Enter Order, Commit Resources & Launch Program
Dispatch Plan
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
Dispatch Requirements
P6.3 Balance Dispatch with Dispatch Requirement
Establish Dispatch Plans
Route management
Dispatch Plan
P6.2 Identify, Prioritize and Aggregate Dispatch Products
Dispatch Products
P6.3 Balance Dispatch with Dispatch Requirement
P6.1 Identify, Prioritize and Aggregate Dispatch Requirements
P6.2 Identify, Prioritize and Aggregate Dispatch Products
Dispatch Products
P6.3 Balance Dispatch with Dispatch Requirement
Balanced Dispatch and Dispatch Plans
P6.4 Establish and communicate Dispatch Plans
Balanced Dispatch Process and Dispatch Plans
P6.4 Establish and communicate Dispatch Plans
Supply Chain plan
P2.1 Identify, Prioritize and Aggregate Receive Requirements
P3.1 Identify, Prioritize and Aggregate Put Away Requirements
P4.1 Identify, Prioritize and Aggregate Pick and Pack Requirements
P5.1 Identify, Prioritize and Aggregate Storage Requirements
P7.1 Identify, Prioritize and Aggregate Return Requirements
Dispatch plan
Dispatch process

APPENDIX C

TSU- AFBE International Conference 2018

(The 21th AFBE Conference 2018)

"Creativity and Innovation for Smart Societies and Sustainable Development"

A BUSINESS PROCESS MODELLING FRAMEWORK FOR AIR CARGO SUPPLY CHAIN MANAGEMENT

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ABSTRACT

In supply chain management, air cargo supply chains are complex in its structure and competitions .Air cargo industries cannot just be limited to the business interior but it should expand the scope more inclusive in the supply chain networks. This paper demonstrates the business process framework, SCOR model, to employ for modeling the air cargo supply chain .The framework is typically used to model the network structure and operational strategic planning purpose with BPMN 2.0) Business Process Model and Notation(to support identification and visualization of the processes, this will result to making the decision in the key business decisions and implementation can improve performance in various areas in air cargo business processes.

Keywords: Air cargo supply chain, SCOR model, BPMN, Network structure and operation strategic planning

INTRODUCTION

The planning and management for air transportation supply chain requires properly specifying participates and identifying the relationship amount them. Especially, the challenging in air cargo industry because air cargo supply chains are complex in structure and often composed of a large number of participates who work together. Currently, the air cargo industry has grown dramatically over two decades more than 35% of global trade value, the demand measured in freight grew by 3.8% in 2016 compared to 2015 (IATA, 2017). Several company trended toward the production of high value and light weight goods as much as 80-90 percent of their international movement by air. Not just the high-tech product, jewelry and perishables, but fashion clothing, seasonal toys, even footwear are moving by air also.

With the development of the time, the Air cargo business competition has changed from the competition between businesses to the competition between Supply chains. When analyzed the enterprise to find out problems and improve the weakness, these cannot just limit to the business interior but it should expand the scope look more inclusive in the Supply chain networks. Modeling the Structures and Supply chain networks can help understanding the complexity and the organization in supply chain and also facilitate the identification the bottlenecks and provide the basic for the supply chain reconfiguration and re-engineering. The standard frameworks for modeling supply chain structure in air cargo are commonly represent as a network diagrams that show the supply chain members as well as the links between them.

The supply chain operation reference model (SCOR) established by the supply chain council (SCC) for the supply chain standardization, measurement and improvement (SCC, 2012). The SCOR modelling framework is based on five keys of process- plan, source, make, delivery and return. It is the hierarchically structure into four levels, these standard processes allow business of all varying supply chains to be able to describe their supply chains using these common set of divinations for supply chain improvement. The SCOR framework is employed for modeling the Air cargo warehouse supply chain. The framework is typically used to model the network structure and operation strategic planning purpose (Huan, 2004). According to Gunasekaran (Gunasekaran, 2004), controlling the supply chain process is crucial for improving the processes are controlled through the metrics measurement, this control is the part of supply chain management that can be defined as the coordination of supply chain stakeholders or networking in the process.

There are several reference models for evaluation the air cargo supply chain. The model of (Beamon, 1999), (Kaplan, 1996) and (Gunasekaran, 2004) have recommended a list of metrics by classify the metrics in the categories, the absence of explicit link between metrics and stand process, SCOR descried the all activities relating to the flow of materials, products and focus on the operation efficiency, it helps to improve the performance of supply chain and every link with the supply chain (Lockamy, 2004) and (Bolstorff, 2007). SCOR make it possible to model difference structures of varying complexity levels (Danish, 2008). Several authors used and gained inspiration from SCOR model for apply to their model indifferent domain such as a reference model of the distribution center in hospital (Angkana, 2015), construction section (Jack, 2010). In Airport section, (Oum, 2003) noted that air cargo service is becoming more significant to the economy and airline business, (X.-M. Yuan, 2010) reported the role of air cargo plays in economic development by presenting the basic relationship between air cargo and trade, (M. yuan, 2010) focused on the air cargo supply chain reference model to integrated the impact of airport strategies and industrial forces on airport performance and the inter relationship among airport's performance by introduction

and testing the validity of air cargo supply chain reference model in the light of Singapore and Hongkong statistics(Joyce, 2008).

However, the pervious researches were failed to identify research within the scope of Air cargo warehousing. In this paper, the proposed contribution to modeling and decomposition of air cargo supply chain using the SCOR framework and Business Process Modeling and Notation (BPMN) describes the development of supply chain process in the case of Thai Airway cargo industry, Thailand. The full scale in the process from the model will connect the role and responsibility of data interface and activities in air cargo supply chain. The well-designed structure and suitable process will improve activities, response time and the decision making as a result.

This paper is organized as follow: section 2 describe about the experimental methodology that use in this paper. Then section 3 describe application SCOR model and BPMN in air cargo supply chain as the result and the last section is the conclusion of this research.

EXPERIMENTAL METHOD

In this paper used a variety of method to employed in air cargo terminal process, this organized the review method as follows, first, introduce the SCOR model, with provides the end to end guideline for supply chain process. Then the different models and techniques developed in the past, respectively for supply chain design/ planning and business process management are review and compared.

1.1. Supply Chain Operetion Reference Model (Scor)

The SCOR modeling framework is worldwide concepts as the cross-industry standard for supply chain management, designed to facilitate the blending of business objectives, strategy, process and technology. The SCOR model not only provide the structured vocabulary of definition of supply chain process, but also defines a set of measures that can be used to evaluate process at each level of the process hierarchy.(Dong, 2006; Szoltysek, 2012)

The SCOR model provides a systematic approach to describe, characterize, and evaluate complex supply chain processes. Standardization of business processes is necessary to allow the communication and integration between business partners of the supply network(Patel, 2001). The SCOR model is a process reference model for standardization purposes. The model attempts to capture business operations including (1) customer interactions, from order entry through paid invoice, (2) product transactions, from supplier's supplier to customer's customer, and (3) market interactions, from the understanding of aggregate demand to the fulfillment of each order(SCC, 2012).

FIGURE 1: SCOR model and Six management process (SCC, 2012).

The SCOR-model contains several sections and is organized around the six primary management processes of Plan, Source, Make, Deliver, Return and Enable- to meet planned and actual demand (shown in Figure 1). Plan includes processes that balance resources to establish plans that best meet the requirements of a supply chain and its sourcing, production, delivery, and return activities. Source includes processes that manage the procurement, delivery, receipt, and transfer of raw material items, subassemblies, products, and services. Make includes processes that transform products to a finished state. Deliver includes processes that provide finished goods and services, including order management, transportation management, and distribution management. Return includes post-delivery customer support and processes that are associated with returning or receiving returned products. By describing supply chains using these processes building blocks, the model can be used to describe supply chains that are very simple or very complex using a common set of definitions. As a result, disparate company can be linked to describe the depth and breadth of virtually any supply chain. The model has been able to successfully describe and provide a basis for supply chain improvement for global projects as well as site-specific projects.

2.2. Scor Process

The SCOR framework allows users to model supply chain structures and relationships in a progressive and systematic manner. There are four levels of model development in the SCOR framework (Figure. 2). Level 1 modeling provides a broad definition of the scope and content for the SCOR model (Figure.1). Level 2 modeling divides the five basic management processes into process categories, which allow companies to describe the configuration of their supply chains. Level 2 models conceptually specify the relationship and interactions among supply chain members. The conceptual specification can be extended to describe the process workflow through Level 3 modeling. It provides companies with the information for detailed planning and setting goals. Level 3 processes also provide the basis for defining the supply chain performance metrics. Level 4 modeling focuses on implementation. Since SCOR Level 4 models are unique to each company, the specific elements at this level are not defined within the SCOR framework. In Level 4 modeling, users need to design the implementation details of each Level 3 process to meet

their own needs. Through the four levels of development, the SCOR models can be extended to capture and represent complex interactions among supply chain partners.

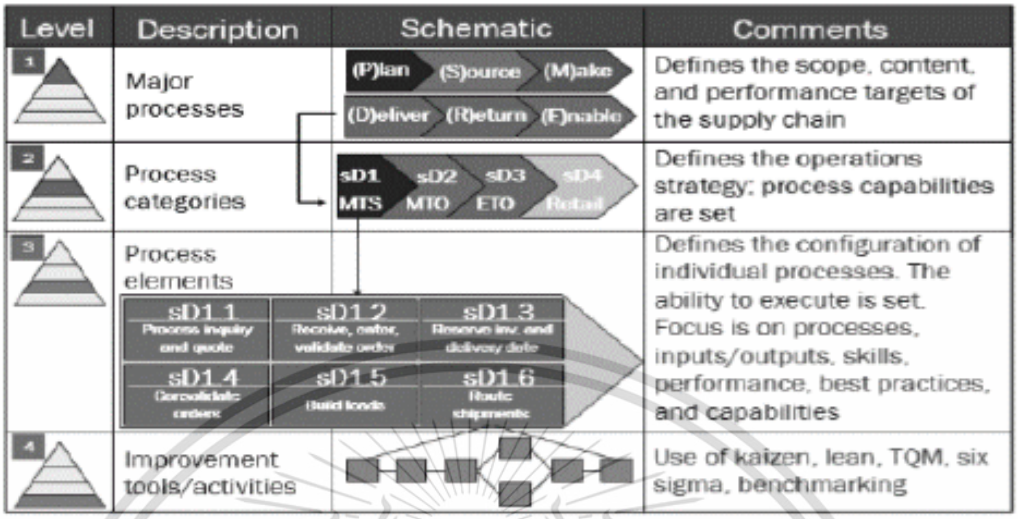

FIGURE 2: SCOR process hierarchy (SCC, 2012, 2017).

Supply chain usually classified the decisions in to three levels, respectively strategic, tactical, operational level, according to the planning. The supply chain requires decision making related to Supply chain design and planning, which are mostly at the strategic and tactical level. It concerned how to build up the supply chain structure. Supply chain planning consists in determining the policies or the rule under the supply chain is operated.

2.3. Business Process Management

Today, business process gained much attention from both academic and industry. Business process play the essential role in supply chain operation. The realization of all strategic changes has to rely on the operational business processes.

Before performing a networking decision model, it is necessary to clearly identify the business processes. An implementation of some formal rules to the final results of the air cargo process is, in itself, an improvement, since it is a small step from order to delivery. There are two principal areas: reducing operations and improving business performance. There are plenty of techniques for modelling and optimizing business processes. A few of those, which are low-budget and immediately applicable, are shown here (Kovalev, 2015). During the last 20 years, the BPM methodology has received plenty of attention and it has been growing in many different ways. Many scientists and writers have proposed their own ways of improving the Business Process (BP), however BPM is definitely the most popular and useful tool for it.

According to Miers gave the briefly description about BPM as "***Business process management (Business Process Management) is a systematic approach to management, aimed at improving the organization and its processes. This approach enables organizations to define their processes, to organize their implementation, as well as improve the quality as a result of processes and procedures for the execution***" (Miers, 2006)

The main objective of business process management is to bring the process into line with the objectives of the organization. Each process must be configured so that the results of the process lead to the achievement of the business goals. Business process management uses the following approaches:

- Comprehensive, clear and documented process standardization, which includes the creation of a set of standardized processes and the ability to configure them to changing conditions;
- Continuous improvement of processes, including the daily monitoring, measurement, analysis and change of the processes;
- The application of information technology and software, including the modelling of business processes, the use of CASE tools, automation of business processes and their optimization on the basis of information technologies (Miers, 2006).

2.3.1 Adopted Business Process Modeling And Notation Method (Bpmn)

Business process modeling is used to represent the air cargo system applicable in supply chain environment. BPMN Version 2.0 was introduced by the abject management group (OMG, 2011) as one of the standardized tool visualizing diagrams used to model and interpret the business process diagram. The purpose is to facilitate communication of an end-to-end process to all cross-functional organization units by means of information structure in both professional management and technical IT terms. In this regard, BPMN standardizes blocked-structured process execution languages, between the business process design and process implementation(Cornu, 2013). BPMN is targeted both as a high-level process specification for business users and as a low-level process description for implementers. The business users should be able to easily read and understand a BPMN business process diagram. On the other hand, the process implementer can add further details to a business process diagram in order to represent the process suitable for a physical implementation. As a result, BPMN models can help define process interactions and facilitate communication in the process design and analysis phase. BPMN models can also act as a blueprint for the subsequent implementation.

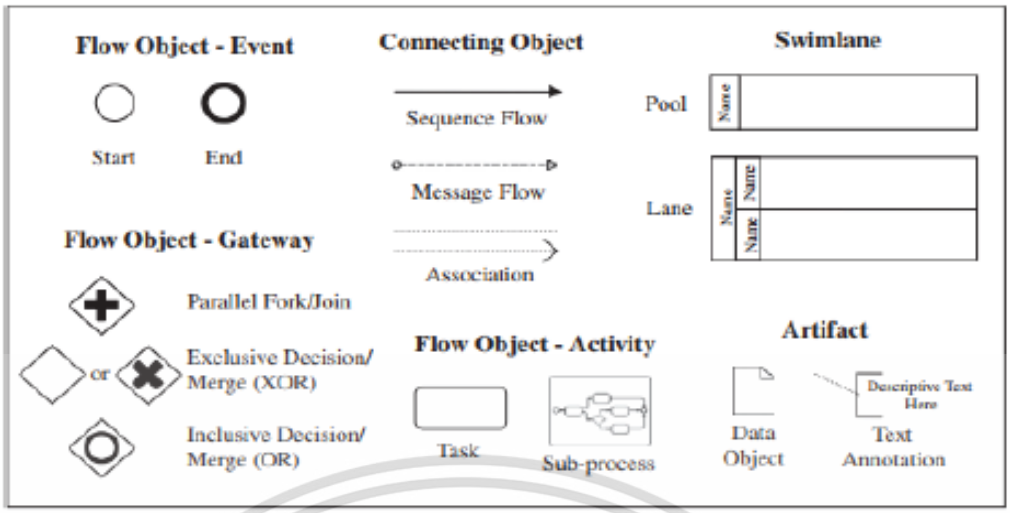

FIGURE 3: Core Component in BPMN(OMG, 2011)

BPMN is popular in both business and IT communities because its symbolic visuals can provide a simple way to communicate process information to other business users, process implementers, customers and suppliers. There are four basic categories of elements in BPMN models – flow objects, connecting objects, swim lanes, and artifacts (Figure 3). Flow objects consist of three core elements – events, gateways, and activities. An event is denoted as a circle and represents something that happens. An event can associate with other elements such as a message envelope or a clock to perform a complex event. Every process has only one start event and one end event. A gateway determines forking and merging of paths depending on the conditions expressed. An activity element can be a task which represents a single unit of work, or a sub-process, which has its own self-contained sequence flows and start and end events. Connecting objects represent linkages between flow objects, with sequence flows linking flow objects in the same pool and message flows linking flow objects in different pools. Swim lanes consist of pool and lane elements. A pool represents a major participating company in a process, whereas a lane represents a division of a company. Nevertheless, pool and lane elements are interchangeable and different companies can also be separated by lanes in the same pool.

APPLICATION SCOR AND BPMN IN AIR CARGO SUPPLY CHAIN

3.1. Case Study

Air transport network has 113 routes connecting Thailand to urban agglomeration around the world. On average there were 2.8 outbound flights per day along these routes. A total of 26 of these routes were connecting Thailand to cities more than 10 million inhabitants, frequencies are higher to the most economically important destinations. Thai Airway international public limited is one of air cargo industries that has the higher volume of freight traffic in Thailand.

THAI Cargo has provided Cargo Terminal Handling Services in the Free Zone at Suvarnabhumi Airport to support the expansion of the volume of freight and mail, both import and export including transshipment cargo both international and domestic. Since the move from Don Mueang Airport to Suvarnabhumi Airport in the year 2006 to the present,

107 international airlines have been served. Currently, THAI Cargo and Mail Services routinely ship to 78 cities in 32 countries (ThaiAirways, 2016).

The cargo operations of the Company consist of general cargo handling and special handling products such as fresh produce, animals, high-value goods, and temperature-controlled goods. In 2016, THAI Cargo made improvements on the quality and standards following suggestions of the customers to achieve maximum customer satisfaction by offering closed warehouse system to manage security effectively and overall export of air cargo increased by 8% respectively, import increased by 2%, while transit air cargo increased by 0.6%, resulting in the total volume of cargo of 1.27 million tons, increasing from 2015 by 3%. Given continuous intense competition in the air cargo and freight industry, reduced availability of freight space on passenger flights by 24%, and the discontinuation of freighter aircraft in April 2015 (ThaiAirways, 2016), the Company has adopted a proactive marketing approach in order to maintain the existing customer base as well as to explore new market opportunities to increase revenue(IATA, 2015). In order to provide quality service, to achieve the highest customer satisfaction and to prepare for the increase of trade from AEC, THAI Cargo want to develop a new information and communication system, which is an integrated system for cargo transport reservation, cargo management, unit loading device management and revenue account management for commercial goods and postal services. The purpose of the new system is to support the business, increase competitiveness and meet with the customers' requirements. This research will choose this case study to identify, design and mapping the process to improve the business process and competitiveness of air cargo terminal.

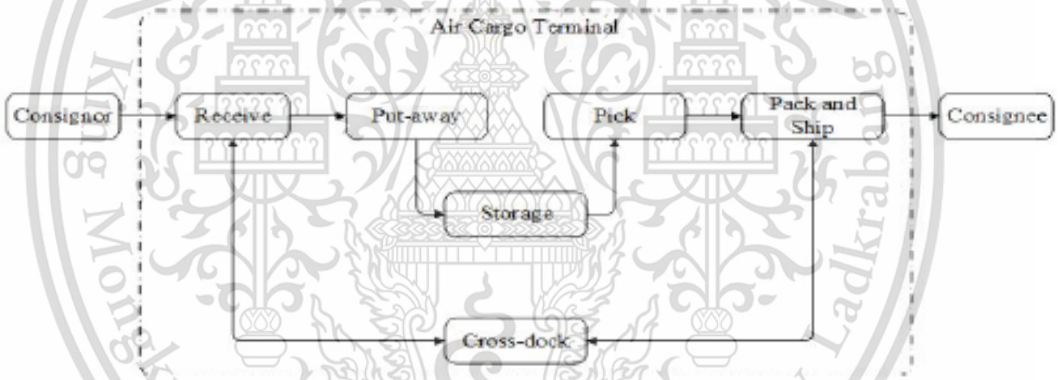

FIGURE 3: General air cargo process

3.2. Reference Process Model

Air cargo terminal function as distribution warehouse for transfer freights. Products movement types are identified according customer demand. The demands have to be analyses and modelled on a daily or monthly basis and it can be defined from the frequency income product and export forecast which can classify follow the products type as dangerous goods, perishables, high value and general goods, this paper apply the SCOR model to describe the products flow and information flow within and through the air cargo terminal, the activities that are used to determine on process in SCOR model as below.

3.2.1. Scor Level 1 And 2 Process Modeling

- **Level 1** corresponds with the top level of the supply chain it is devised follow the process of business and the relationship between stakeholders. The process of air cargo supply chain in level one with the relation between stakeholder, then adopt the

SCOR process to describe the cargo products flow and information within and throughout the warehouse shows as figures 4.

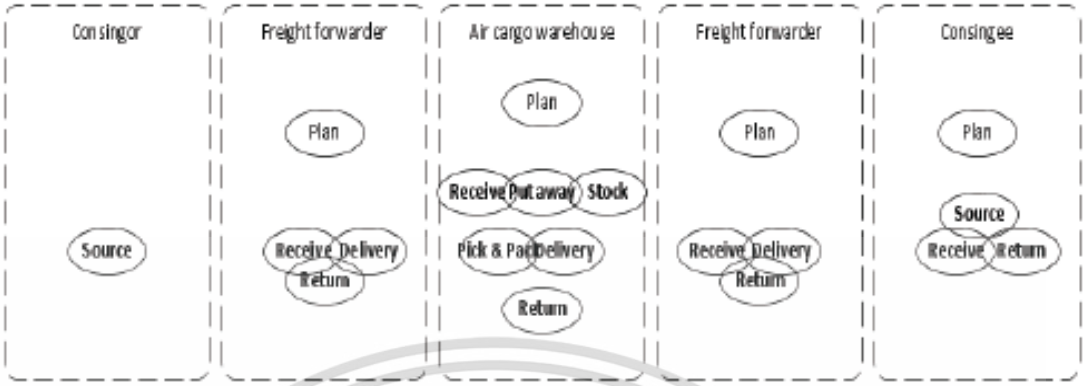

FIGURE 4: SCOR level 1 Air cargo supply chain

- **Level 2** is break drown of level 1 according to the major categories and corporate strategy. The model base on Source product to storage and Delivery Stock product due to air cargo work as the warehousing and distributing center. Which this paper renames the process of air cargo terminal to align with warehouse process, distribution process and air cargo supply chain follow:

- **Plan (PL):** the process to determine requirement and correct action to achieve the supply chain propose for both inbound and outbound side.
- **Receive (RE):** The process to control ordering and receiving products from customer, including replenishment inventory and receive return for defective product.
- **Put Away (PA):** the process is verifying and transforming products to the Storage, location, some types of products need to cross dock from this process to delivery location.
- **Storage (ST):** the process is allocated the location of products both incoming and return deflective products and manage the inventory.
- **Order Picking and pack (OP):** this process is picking and receiving products following the order picking list to be ready for shipping
- **Deliver (DL):** this process of order management and order fulfillment activities to serve the customer satisfaction.
- **Return (RT):** this process is moving the defective products back to through the supply chain supplier.

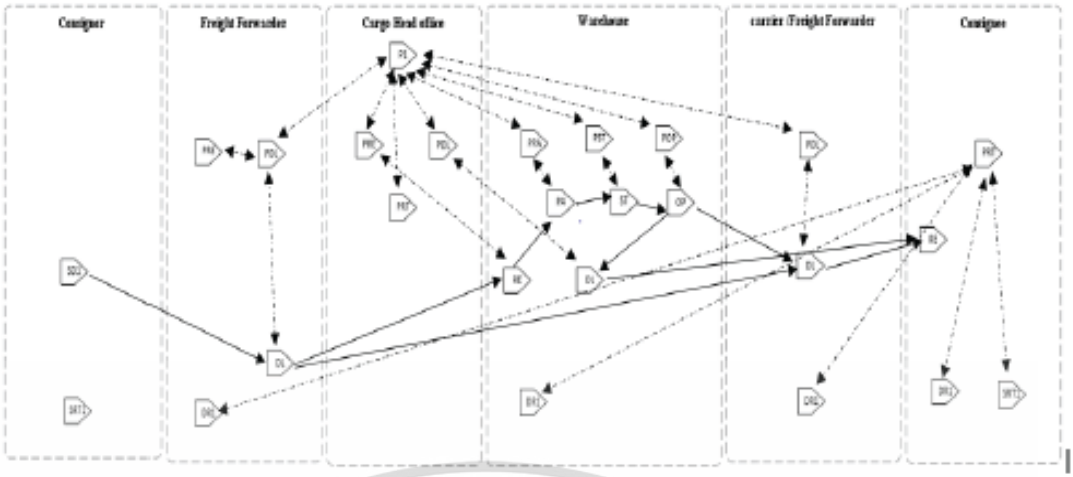

FIGURE 5: SCOR level 2 Air cargo process model

3.3. SCOR LEVEL 3 APPLY THROUGH BPMN

The level 3 process in this paper focus on the air cargo warehouse process (Thai cargo), the level 3 is the sub processes that describe the workflow of each process in air cargo warehouse from receive to delivery process by design the workflow structure and decision making through the BPMN as figure 6. This figure described the networking structure of air cargo supply chain, SCOR model can also be leveraged in the development of information system for supply chain integration and management. In SCOR level 3 model for typical supply chain for air cargo terminal (warehouse) represented in BPMN model from start to end process of information flow and product flow for the whole process. Different pools are used to represent the consignor, the custom, the air cargo terminal operation and consignee, the unloading state, the head office, the warehouse and the airline or freight forwarder are separated by lanes. SCOR level 3 is broken down processes into the operation decision level of air cargo logistic center using the generic inbound and outbound logistic throughout the process.

SCOR level 3 also shown the roadmap on how the model can be implemented in such environments. The important for this part to design how to each information link together and using that to select the accurate to achieve the most efficiency performance in process. Moreover, the model also used to support the capability requirement, network design, facilities consideration and the operation planning.

To determining the case study scenarios into reference model based on the SCOR. This paper can have classified the process categories according to process with in the terminal as Plan (PL), Receive (RE), Put away (PA), Storage (ST), Order picking and pack (OP), Delivery/Shipping (DL) and Return (RT). With this classification, the management of air cargo can see the operation scale and manage in which position is required for each activity and can design workforce at each process for the required to be fulfilled.

Frist, each role will be triggered by receiving information to start the process. For example, the head office will start with PL1.1 to identify, prioritize and aggregate air cargo supply chain requirements from the warehouse level, then establish and communicate supply chain plan PL 1.2 summit to consignor with the RE 1.1 receive schedule to deliver to the Storage (ST1.1) in warehouse or cross dock delivery to consignee. Other hand, when consignee rejected the products the process will be return to deliver back to warehouse or customer as well. The workflow process will continue to the roles and activities respectively as well as, product and information movement where the process necessary along the role and responsibilities.

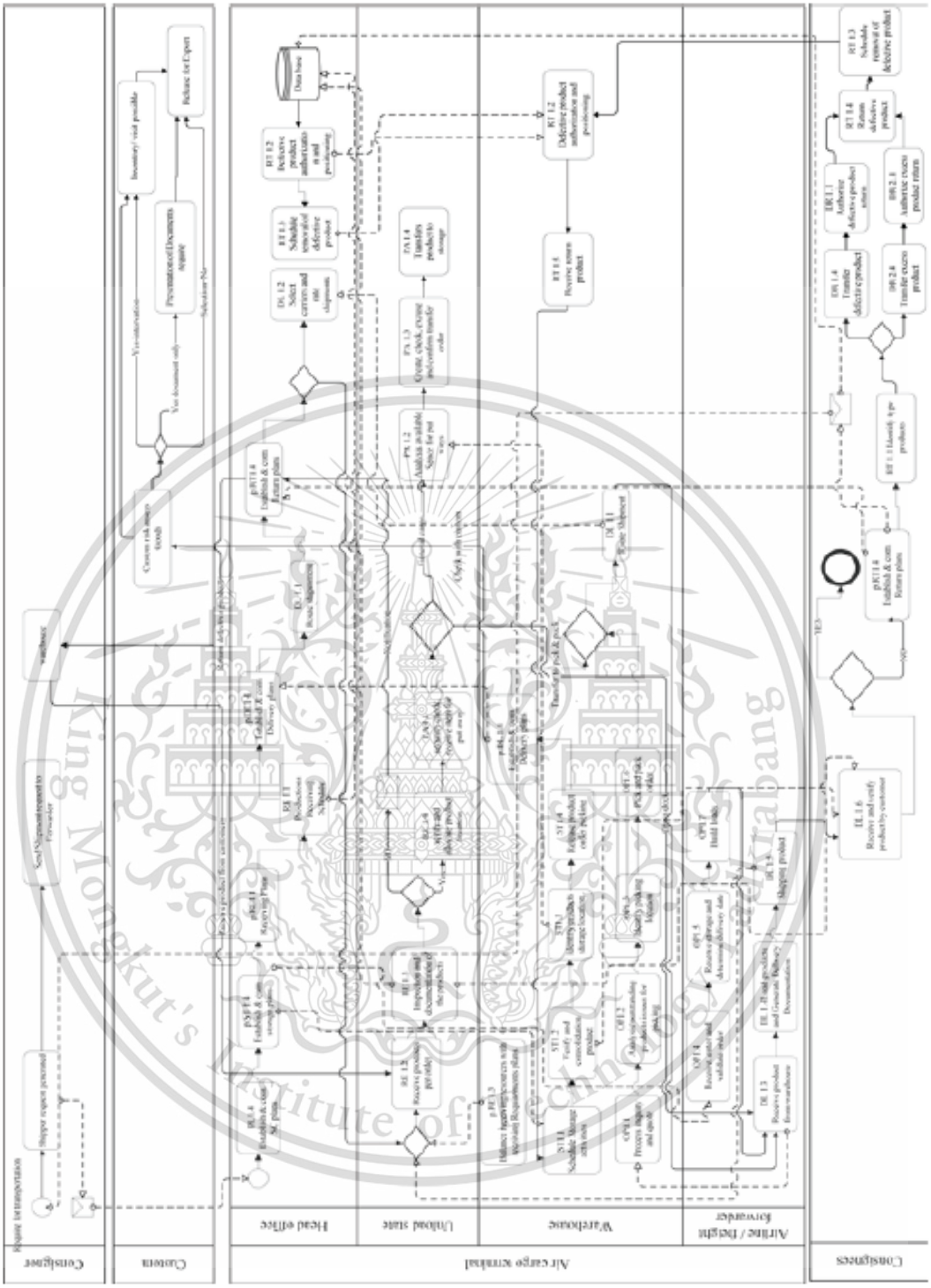

FIGURE 6: SCOR Level 3 of air cargo process

3.4. Scor L 4 Modeling

When all activities have been documented and matched towards a SCOR level 3 process that can be future descried in company level 4. The more detailed work descriptions make it possible to implementation for difference workflow in SCOR level 4 process. In fact,

SCOR level 4 model is the specific to companies and products. The process need to define the level 4 model according to their own needs and fit with the situations. The SCOR documents do not provide the detail process component, process structures and implementation. So, this process is not including in our scope.

DISCUSSION

Air cargo supply chains are complex in its structures and competitions, to defined the process, this paper represented to use SCOR model and BPMN. SCOR model is the management tools use to address, improve and communicate supply chain management decision within the company and with suppliers and customer of company as well. In this research studied the generic process of the Thai cargo terminal to identify the reference model of cargo warehouse based on SCOR. With BPMN notation to implementation purpose. With the result, it can be used to assist the management level for guideline for implementation and process improvement within the organization.

This research has reached its objective and shown how a process models can be designed for the air cargo warehouse. The SCOR frameworks applied to main activities in the warehouse as plan, receive, put away, storage, order picking and packing, shipping and return, where the specific roles and responsibilities are defined at each process. Detail process guideline herewith will be useful for managing its operations and supply chain integration and future development.

FURTHER STUDY

In this research has applied the SCOR model based on the management point of view, policies and existing system accessibility and facilities at the section air cargo company environment. As the result, this research provides only the process structure modeling depend on an extensive case study in air cargo company to meet the requirement for future implementation.

Nevertheless, they may have some important opportunities for future development to apply this model in other fields to implement and development their process. Moreover, this research is not yet design for the performance measurement system. It will be helpful if further research study on it.

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