Economics Factors Influencing Logistics Cost of Thai Steel Industry

Nanthi Suthikarnnarunai, *Member, IAENG*, and Kulsurat Muangthong

***Abstract*—Steel Industry is the primary industry which plays tremendous important role on the country development and economy sustainability. This industry's supply chain and logistics system is considered complex and appears to be part of other industries' supply chain and logistics systems, such as infrastructure, electronics, electrical, or automotive industries, etc. Thai government has seen an opportunity for the importance of logistics and supply chain systems development for Thai steel industry. In order to support and develop logistics systems, we were coordinating by the Ministry of Industry, to conduct research on how to develop logistics and supply chain system for Thai steel industry. The logistics cost of this industry was also considered in this research as it is one of the performance measurement of the entrepreneur. The result of the study indicated that the logistics cost of the steel industry was according to the principle of supply chain and logistics management theory and also relied on other economics factors such as oil price, the number of labor, interest rate, and exchange rate, etc. Additionally, the results indicated that Thai steel industry has potentiality of developing logistics and supply chain system strived for cost and time reduction in supply chain and has the important guideline as 1) increasing the performance efficiency by reducing the non-value added activities, 2) planning effective transportation, 3) increasing the effectiveness of predicting the demand in relevant to the need of customer and transportation plan, and 4) developing the information technology system to link and exchange information within organization, between organization, and between government sector and entrepreneur.**

***Index Terms*—Economics Factors, Logistics Cost, Steel Industry Chain, Supply Chain and Logistics Management**

I. Introduction

On February 2007, the cabinet of Thailand approved Thailand's Logistics Systems Strategy of 2007 - 2010, which mainly aimed at putting Thailand to be the logistics hub of Asia. From this strategy, the government sectors have been assigned to restructure and improve plan, regulation, infrastructure, information systems, and human resources which involved with nation's logistics systems. The ultimate goals of the strategy are to reduce the nation's logistics cost, to improve the speed in responding to customer's need in all industry and service sectors, and to perform security and certainty of logistics systems. Therefore, the Bureau of Industrial Logistics, Department of Primary Industries and Mines, Ministry of Industry, who has responsibility and mission in developing and improving the supply chain and logistics systems of major industries, has cooperated with Logistics Research Center, University of the Thai Chamber of Commerce to conduct the study of steel industry chain in Thailand.

In 2007, Thai steel industry decelerated due to sluggish economic condition in the country, while the global steel industry underwent large-scale structural changes, such as consolidations among giant producers and China's restrictions on exports [1], [2]. The latter development caused a tightening of raw material supplies and considerable price fluctuation. To reduce its exposure to this risk and ensure the sustainable of Thai steel industry, the economics factors influencing logistics cost was also studied.

II. Global and Thai Steel Industry

In 2007 and 2008, the global steel industry was estimated to grow at about 6.5% – 7% a year, in terms of both supply and demand [3]. It has been reported by [4] that world's production of crude steel in 2007 amounted to 1.344 billion tonnes, up 7.5 percent from 2006 - the highest yearly spurt in history, and the second consecutive year in which the world's output of crude steel rose by more than 7 percent. On the other hand, world steel consumption grew from 1.121 billion tonnes in 2006 to 1.198 billion tonnes in 2007, representing a 6.8 percent increase [4]. The global steel industry once again underwent major readjustments in 2007 and 2008. Since 2006, China, who used to be a net importer of steel, has become a net exporter of steel, and its exports have risen significantly during the past year. To counter this, the Chinese government issued a number of export restriction measures, including higher export taxes on semi-products and lower export rebates on steel products [5]. The domestic production capacity in China was also reduced. In response, the prices of both semi-products and finished products in the world market jumped up sharply. Another major development was a trend towards consolidation in the industry, highlighted by the mergers of TATA Steel with Corus Steel and Arcelor with Mittal [6]. The world's biggest players are now that much larger, and fewer in number. This shift gave them more bargaining power while it reduced the need to compete on price.

While the global steel industry continued to grow, Thai steel industry, however, headed in the other direction.

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Nanthi Suthikarnnarunai is now with the Department of Logistics Engineering, University of the Thai Chamber of Commerce, Dindang, Bangkok, 10400, Thailand. (phone: +66-2-697-6730; fax: +66-2-692-3014; e-mail: nanthi_sut@utcc.ac.th, ssjnsj@yahoo.com).

Kulsurat Muangthong is now with Logistics Research Center, University of the Thai Chamber of Commerce, Dindang, Bangkok, 10400, Thailand. (e-mail: utcclogistics@hotmail.com).

According to the Iron and Steel Institute of Thailand, the Country's total steel consumption in 2007 amounted to 12.158 million tonnes, 0.1 percent lower than 12.154 million tonnes in 2006 [7]. The main reasons for this decline were hesitancy in the face of economic and political uncertainties, a lack of public investment and implementation of fiscal and monetary policies to stimulate economy growth in the expectation of being replaced by those of a new government, and soaring fuel prices that depressed spending among consumers and retarded public and private-sector investment. These factors all had negative impacts on the downstream users of steel, particularly the automotive and construction industries. The automobile and auto parts industries were less affected by this slowdown than construction, as the former sector could compensate by higher exports for the lower consumption at home. In 2008, especially the second half, was another year in which the volatility of raw material and finished product prices in the global market had a major impact on domestic competition. Importers of semi-products, such as steel billet and slab, encountered a tight supply situation resulting in a sharp jump in prices. Users of steel scrap as raw material in production were not so dramatically affected, as steel scrap did not rise as much or as quickly. At the same time, Thailand's consumption of hot-rolled steel sheet was slow down for both high-grade and commercial grade steel sheet. The high-grade steel sheet market was hurt by a drop in the cold-rolled steel sheet market [8], which in turn was caused by the supply of cheap imports from China and slower growth in the automotive industry. In the long term, the high-grade steel sheet market, however, offers strong growth prospects and more stability, as it emphasizes on product quality and is less sensitive to price changes. Growth of commercial-grade steel sheet market, which is more sensitive to price changes, was also down due to a weaken construction industry. As a result, product prices could not be raised to reflect the increase in raw material prices, and manufacturers, particularly those using semi-products as raw material, took a defensive approach by scaling back production and sales.

III. THE EVOLUTION OF STEEL SUPPLY CHAIN STUDY

Over the past decade, many of the steel industry studies have been carried out. Most of them aimed to improve the performance of the industry [10], [11]. However, the results provided by those papers laid us to an understanding of the supply chain in steel industry. The steel industry has distinct characteristics that separate it from other industries [12] as follows.

1) High capital needed to be invested.
2) Long life of products.
3) Lots of players in the global market

Therefore, this industry needs a well designed of methodologies or techniques to manage and integrate the supply chain leading to control cost while still having a competitive advantage.

A schematic of the steel supply chain which is shown in Figure 1 was presented by [13] and [14]. The steel supplier can be classified as a general steel producer who converts steel scrap into billets, which are then rolled into a variety of steel products. The end user sources their material from a steel stockholder who performs a break bulk role within the supply chain. They order in large quantities from the main producers on long lead times and then sell the material in small quantities on short lead times, according to the customer's requirements [13].

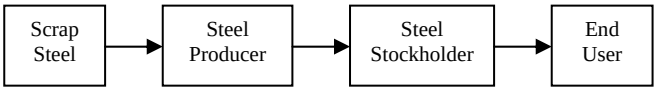

Figure 1 A Schematic of the steel supply chain [13]

The hierarchical framework indicated that there are changes in the supply chain in various level – strategic, tactical, and operational has been stated by [15]. The developments that have occurred within the steel supply chain over the past decade can be mapped onto this framework as shown in Table 1.

Table 1 Positions of the steel supply chain within Steven's model [14]

Characteristics	1990				1995				1999				2001			
	Stage I	Stage II	Stage III	Stage IV	Stage I	Stage II	Stage III	Stage IV	Stage I	Stage II	Stage III	Stage IV	Stage I	Stage II	Stage III	Stage IV
Physical Flow	■					■				■					■	
Inventory	■				■					■				■		
Lead Times	■					■				■					■	
Information flow: Decision	■					■				■					■	
Information flow: Data Transfer	■					■				■				■		
Information flow: Visibility	■					■				■					■	
IT systems	■				■				■					■		
Focus	■					■				■					■	
Relationship management	■					■				■				■		
KPI	■				■					■				■		

In 1999, the major strategic change has been functional integration within the steel company, with the production units now having combined goals and targets [16]. This has facilitated the implementation of several tactical improvements including an integrated information control system and distinctive production processes for different product types. To achieve this, there have been a number of operational changes. The main driver behind these changes has been cost reduction with the need to keep abreast of developments in information technology another influence. Customer service has only recently emerged as a driver of change. The impact of these changes on the supply chain was considered with respect to inventory, lead times, and asset utilization.

The integration that occurred has embraced both inbound and outbound material flows with the resultant characteristics being representative of a supply chain that has progressed beyond Stage II of the Stevens model. Using the table of characteristics, management can reflect upon where potential improvements can be made in order to improve the supply chain. By comparing their position with other companies within or outside the sector, opportunities for benchmarking better practice can be identified. For progression beyond Stage III, integration must cross the organisational boundaries that currently exist to include both raw material suppliers and stockholders [14].

IV. RESEARCH METHODOLOGY

In order to accomplish the aim of the research, the following steps have been employed.

1) Studying supply chain and logistics management for a secondary process and the downstream of supply chain with a survey by the use of a questionnaire and in-depth interview. The objectives were to study a supply chain and logistics management system and to find out time spent in logistics process for Thai steel industry.
2) Studying logistics cost in different activities, such as transportation, inventory, warehousing, and administrative costs.
3) Conducting an equation that shows the relationship between economic factors and logistics cost.
4) Providing a guideline for developing and improving logistics efficiency in steel industry by considering mainly on the reduction of logistics cost.

V. SUPPLY CHAIN AND LOGISTICS MANAGEMENT OF THAT STEEL INDUSTRY

Since Thai steel industry consists of manufacturers who produce only semi-finished product (mid-stream steel manufacturer) or only finished product (down-stream steel manufacturer) and manufacturers who has the continuous manufacturing process from mid-stream to down-stream process, it has found that they are all related. Some manufacturers are suppliers of other manufacturers. At the same time, they are customers of the other manufacturers as well. If we bring a supply chain of several companies and link them together in the steel supply chain. Then divide the positions of those involved in steel industry according to special terms used by steel manufacturers, a Thai steel supply chain can be shown as Figure 2.

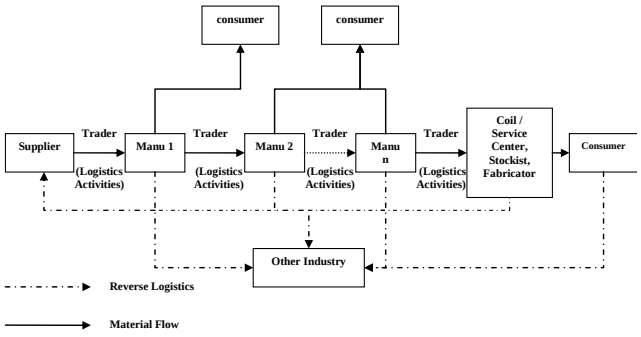

Figure 2 Thai Steel Industry Supply Chain

The special terms of the parties involved in Thai steel supply chain are trader, coil center, stockist, and fabricator. Trader means a middleman for the purchasing and providing of raw materials or products between buyers and sellers. The special characteristic of the trader is that the products will never come through this trader at all. They concern only in terms of finance and documentation. Coil Center or Service Center is a business which will buy products from several manufacturers and resize them for further delivery to customers according to their requirements. Stockist or Stock Holder is a business which will buy several products from several manufacturers, stock them for further sales to customers who needs several types of products at one times. For this business, there is no reform, nor resize of any product. Fabricator is the one who bring several products, reform them by doing composing, welding and reshaping them from the original form and may serve different objectives in term of utilization.

Considering supply chain of the Thai steel industry in Figure 2, it has found that there are logistics activities both inbound and outbound processes or even during the in process. The main logistic activities are as follows:

A. Purchasing and Material Management

It has found that the procurement of raw materials for Thai steel industry is very complex. Raw material purchasing plan of Thai steel manufacturers will base on forecasts both in terms of quantity and quality and the forecast of the steel price in the world market. This is also based on the available capital of the manufacturers. The reasons of this complexity are as follows:

1) Raw materials cost which is the major cost of steel production will be fluctuate all the time. This has made the purchasing plan cannot run according to normal period of time as it should be. At times, when the manufacturers realized that the price of raw materials decreased and there is a trend that it will increase in the near future and if the manufacturers have sufficient capital to buy a big quantity of raw materials in order to reduce risk on the increasing price in the future, they will order a big quantity of raw materials which are much more than what they normally need in each production cycle.

2) Due to the fact that Thailand has not yet developed an up-stream steel industry, it is necessary to import most of raw materials from abroad. However, this demand is proportionately smaller compared to other countries such as Vietnam etc. This has made it difficult for the negotiations on quality, price and the obtaining of raw materials.

3) Besides, it has found that purchasing procedures of most of the manufacturers were made through traders. Only a few major manufacturers purchased raw materials directly from manufacturers. In case that the purchasing was made through trader, manufacturer has to issue purchase order specifying type and quality of raw materials to the trader. The trader will then contact both local and foreign manufacturers in order to provide raw materials to the company accordingly.

4) The manufacturers did not order raw materials only for its production but also for further sales. If they find out that they could make profit from selling of raw materials to other manufacturers when the value of Baht altered. It has been found that in some years, some companies had gained 100% profit from selling of raw materials when the value of Baht altered.

B. Warehouse Management

Warehouse acts as a linking activity between seller of raw materials and steel manufacturers or between steel manufacturers and consumers. Raw materials will be kept at the warehouse for further use in the production process. If there is no warehouse, the factory might lack of raw materials in the production process. In another case, warehouse was

used to keep the finished products to wait for further deliveries to the customers. So, warehouse acts as a support to the production process to run according to the schedule and it has an important role in terms of marketing in order to respond to the needs of the customers. From the research, it has found that the characteristics of warehousing of raw materials in steel industry are as follows:

1) Pig Iron and Scrap will be store at an open air stock yard.

2) Raw materials which are intermediate and finished products will be stored in the warehouse or an open air stock to wait for production. In case of the production of the quality products, raw materials will be stored in the warehouse which can prevent rust caused by sunlight and rain.

3) The locations of the warehouse of steel products are mostly in the same location as the production area waiting for future transportation or delivery to the customers. This is because the steel industry products are very heavy and has very low flexibility in terms of moving. In case of moving, it is necessary to use special and expensive equipment and tools.

4) There are others activities that might happened in warehouse to support other marketing activities i.e. packaging, labeling, quality controlling.

C. Inventory Management

Inventory management activities in steel industry are logistics activities which happened during the inbound, in process, and outbound logistics process. Inbound logistics of raw materials are quite complicate in the quantity calculation. Sometimes, the quantity of raw materials ordered for the production is according to the economical quantity but it is necessary to take into consideration the quantity required for each production cycle because the lead time to purchase raw materials from abroad is 45 to 60 days. If the raw materials purchased are not sufficient for the production in that purchase ordered, it will have direct effect to the production and will create a very high production or opportunities lost cost. In another case, when the company who is also steel manufacturer has got a chance to make profit from sales of raw materials to other manufacturers, the calculation of inventory quantity and inventory management will be much more complex accordingly.

For the inventory of Work in Process (WIP), it is very important in the production process to prevent stoppage of overall production process due to the lack of raw materials. If there is the lack of raw materials during the production process, it will effect directly to the production cost. The reason that inventory management of the work in process is very important because most of the steel industries have long continuing production process and use high temperature and energy in the production. From the research, it has found that some factories spent up to 100 million Baht as monthly energy costs. If there is any stoppage in the overall production process, it will create a very high cost and will waste a lot of time to bring the production process back to normal status.

The production in steel industry is mostly made to order. However, for some products which are considered as having high demand in the market, the manufacturers will produce in big quantity or Made to Stock and then wait for further distribution to customers.

D. Transportation and Material Handling Activities

Transportation and material handling is an important logistics activity which creates the circulation of products throughout all the supply chain efficiently. From the research, it has found that management of transportation of steel industry in Thailand uses mainly Outsource companies. This is due to the fact that these Outsource companies are more efficient in managing transportation to prevent empty trips, as they are able manage transportation between several customers. Besides, it has found that the characteristics of raw materials and products transportation in steel industry are as follows:

1) Inbound transportation

Transportation of various raw materials imported from abroad is mostly in CIF (Cost, Insurance and Freight) term. Various transportation costs incurred before the arrival at the destination port, has already included in the raw materials costs. Transportation mode is the Bulk Vessel. For the local companies, the transportation costs will be the transportation costs from the port to the factory. For the transportation of raw materials from local sources, each agent or broker will handle the delivery to the factory by truck. There will be Weighing Scale at the factory to weight both incoming truck and outgoing truck (empty truck) in order to find the weight of scrap sold to the factory. The type of truck depends on the quantity of the scrap they transported. Transportations of raw materials within the factory are mostly handled by 6 wheel and 10 wheel trucks and using over head crane to move materials into the production process.

2) Outbound transportation

Due to the fact that the steel products are very heavy in weight and/or very long in size, it is necessary to use long truck called Flat Base Trailer which could handle more weight than other trucks. The moving of intermediate steel products needs lifting machines i.e. Forklift and Crane. Besides, there are other special tools designed for each type of steel i.e. Plate Clamp which is used to seize the steel plate during transportation.

E. Customer Response Management

From the research, it has found that most of Thai steel manufacturers have organized customer services in order to respond to customer's needs very well by using small amount of staff for such activity. This is due to the fact that most of the manufacturers sell their products through brokers. There is no direct contact between manufacturers and consumers. However, if there is any mistake incurred with the products under delivery schedule, between delivery processes or after delivery to consumers, all companies also have efficient measures to correct these mistakes.

F. Reverse Logistics Activities

Reverse Logistics are modern logistics activities which focus on four areas of work as - logistics for the return of products and sending back of products, logistics for the collection of container or packages from destinations for reuse, logistics for recycle purpose which is the collection of containers, waste materials or used products to be reused as

raw materials or spare parts, and logistics for the destroying of used products, waste materials or various containers. In Thai steel industry, it has found that it covers reverse logistics in the first three activities mentioned above. From the survey, there are following operations:

1) Steel manufacturers have got processes and management to handle returned products from their customers when the quality of the products delivered did not meet customer's needs by changing the correct ones or offer discount for the next purchases etc.

2) Some steel enterprises i.e. Steel Centers use palettes which are strong and durable in order to be able to bring back and reuse for future deliveries.

3) In all types of steel industries there is management of wastes incurred during the production process in order to resell them to other steel manufacturers who can use those wastes as raw materials in another production.

4) For the slack which are waste incurred during production process and could not be reuse in steel production process, they were used for land fill.

5) Steel industry has high investment for waste and pollution management incurred from the production process in order to manage pollution efficiently. Any waste can be used as raw materials of other industries they will be collected and delivered accordingly i.e. steel dust can be used as raw materials for cement production etc. For the wastes which cannot be reused as raw materials in any other industry, they will be destroyed efficiently in order to prevent any pollution which might happen to the public.

VI. LEAD TIME AND LOGISTICS COST FOR THAI STEEL INDUSTRY

Another output from our study is lead time which is one of the performance measures in supply chain and logistics management. Lead time in supply chain for the upstream process in case of importing raw material was approximately 109 days. However, if the industry used domestic raw material, lead time was approximately 79 days. For the down stream process, lead time in supply chain was 276 and 36 days for importing raw material case and using domestic raw material case, consecutively.

The result from calculating the logistics cost of steel industry derived from a survey and questionnaires were separated into two levels including logistics cost of steel industry in comparing with the Gross Domestics Product (GDP), called macro logistics cost of steel industry, and in comparing with the revenue of the industry, called micro logistics cost of steel industry.

Figure 3 shows the logistics cost of Thai steel industry per GDP. It composed of transportation cost which was accounted for 0.063% of GDP, warehousing cost which was accounted for 0.000197% of GDP, the inventory cost which was accounted for 0.158% of GDP, and administration cost which was accounted for 0.022% of GDP.

Figure 4 shows that the transportation cost, warehousing cost, inventory cost, and administration cost of Thai steel industry comparing to the total sales of the industry were accounting for 7.960%, 2.052%, 5.179%, and 0.724% of the revenue, consecutively.

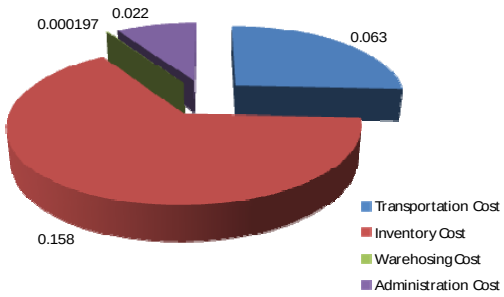

Figure 3 Macro Logistics Cost of Thai Steel Industry

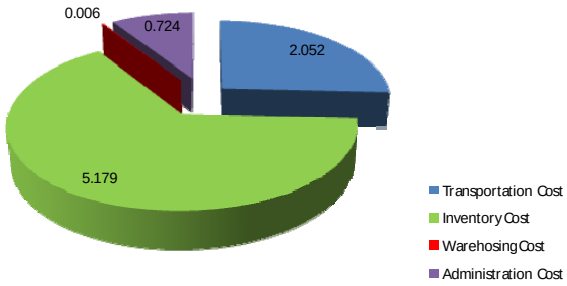

Figure 4 Micro Logistics Cost of Thai Steel Industry

VII. THE RELATIONSHIP OF ECONOMICS FACTORS INFLUENCING LOGISTICS COST OF STEEL INDUSTRY

A study of relationship between logistics cost of Thai steel industry and various economics factors through multi-regression model presented in this section. EVIEW statistical software is used as a tool to determine and analyze for parameters selection into the logistics cost model. There are several parameters related to each cost as the result of the cost function as follows:

1) Transportation cost depended on the amount of warehouse, diesel price, and the number of labor. The result from regression analysis of transportation cost is shown in Table 2.

Table 2 Transportation cost function and Statistical results.

Transportation Cost = f (amount of warehouse, diesel price, and the number of labor)	
R-squared = 0.964731	F-statistic = 72.94223
Adjusted R-squared = 0.951505	Durbin-Watson = 2.2523

2) Inventory cost depended on exchange rate, interest rate, and cost of raw material. The result from regression analysis of transportation cost is shown in Table 3.

Table 3 Inventory cost function and Statistical results.

Inventory Cost = f (exchange rate, interest rate, raw material cost)	
R-squared = 0.97296	F-statistic = 18.00190
Adjusted R-squared = 0.918927	Durbin-Watson = 2.996352

3) Warehousing cost depended on the number of labor and interest rate. The result from regression analysis of transportation cost is shown in Table 4.

Table 4 Warehousing cost function and Statistical results.

Warehousing Cost = f (interest rate, number of labor)	
R-squared = 0.962873	F-statistic = 116.7060
Adjusted R-squared = 0.954623	Durbin-Watson = 2.358660

4) Administration Cost depended on the number of labor and exchange rate. The result from regression analysis of transportation cost is shown in Table 5.

Table 5 Administration cost function and Statistical results.

Administration Cost = f (exchange rate, number of labor)	
R-squared = 0.896779	F-statistic = 39.09564
Adjusted R-squared = 0.873841	Durbin-Watson = 1.656401

Considering the logistics cost functions appeared in Tables 2 – 5, the total logistics cost of Thai steel industry tended to be decreased, due to the slow down of Thai economics condition. Partly, it was the impact from the negative factor of political situation. Considering the investment of private sector was decreased due to the lack of reliability on political and economic situation together with inflation, shown in Figure 5 which was the result from oil price, shown in Figure 6, and interest rate, shown in Figure 7, which was higher whereas the fluctuation of steel situation in the world market. That is, in 2005 the average steel price in world market mostly decreased, thus, caused the entrepreneur in steel Industry import raw material for manufacturing. Moreover, the problem of within the country of China is the excessive product manufacturing. They have to urgently transfer the goods. As a result, Thai entrepreneur purchased raw materials which influenced to the increasing the cost of inventory stocking in 2005. In 2006 the price of all kind of steel product has been increased and caused the delay of purchasing of producer to balance the steel price. In addition, the Bath Value situation which was stronger in 2005, shown in Figure 8, was about 40.77 baht per dollar. It can be seen that in 2006, Baht Value was at 37.93 baht per dollar and influenced to the export and economics expansion because it caused Thai steel industry facing the disadvantage on product/ goods price. That is, Thailand cannot compete in the global market and the steel industry entrepreneur burdened for the warehousing cost which was still high.

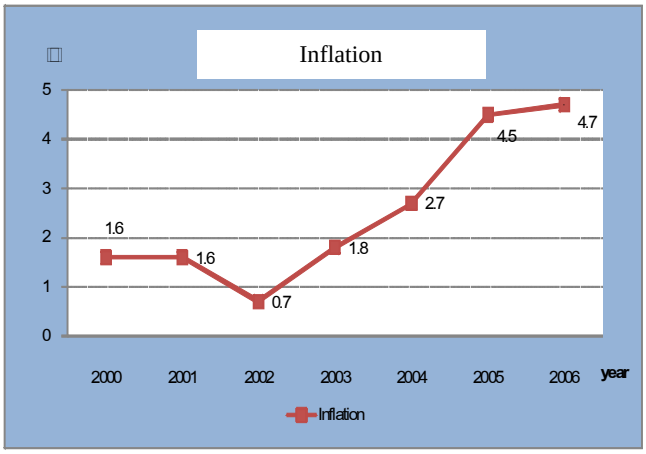

Figure 5 Inflation Rate

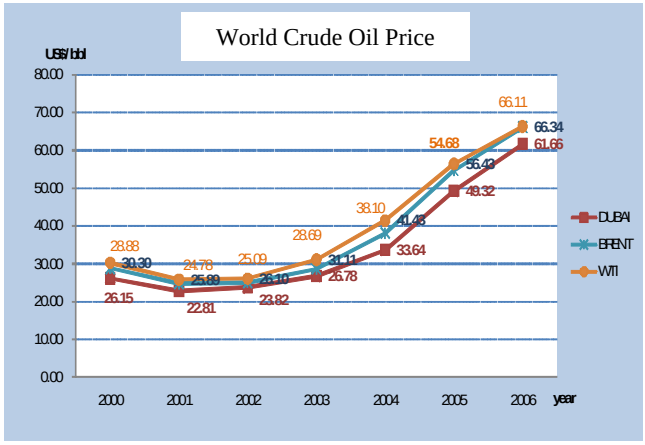

Figure 6 Oil Price

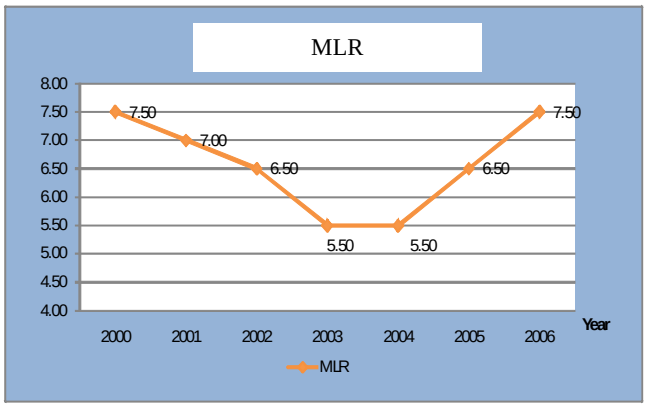

Figure 7 Interest Rate

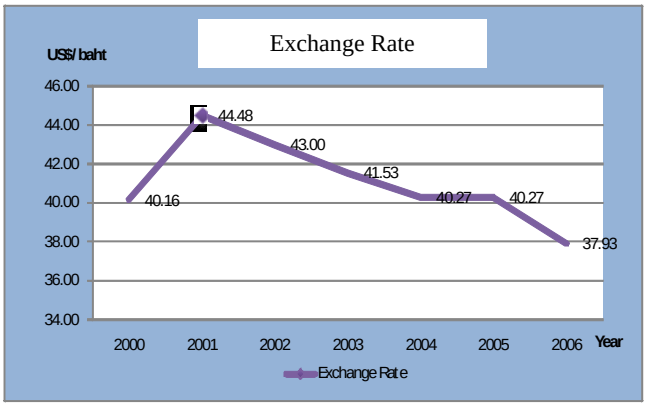

Figure 8 Exchange Rate

VIII. CONCLUSION AND RECOMMENDATION TO A DEVELOPEMENT OF AN EFFICIENT LOGISTICS MANAGEMENT IN STEEL INDUSTRY

The results received from the study revealed that Thailand's steel industry chain were broken. The upstream chain was missing. The result from the logistics cost, calculated using survey data set, and logistics cost model shows that steel industry's growth and Thailand's economy can improve by adding the upstream into Thai steel industry chain. This will reduce the total logistics cost per revenue about 4-5% while impact Thai economy by increasing GDP by 0.2%. However, the obstruction that prevented the establishment of upstream steel industry is the pollution which might be produced by the industry.

Other recommendations in increasing the competitive advantage of Thai steel industry derived from the principal of supply chain and logistics management. Those recommendations, aimed to increase the production efficiency and to cover the linkage through the supply chain, are as follows:

1) Encourage an entrepreneur to increase the efficiency on logistics management by reducing the unuseful activities by Time based process mapping to differentiate the waste activities.

2) Develop an information technology to link and exchange information within organization, be between organization and between government sector and entrepreneur to link the supply chain of Thailand steel industry perfectly and beneficially to entrepreneurs in increasing the efficiency of production, planning, monitoring and evaluation to be fast. Moreover, it has to be benefit to government sector in policy management in order to support the Iron Industry growth and it was also influenced directly to entrepreneur in facing with the change that might be occurred of Thailand steel industry.

3) Promote an integration management among all logistics activities to reduce the overall logistics cost of the steel industry.

The results and the recommendation of this research were used as the master plan in developing the steel industry in Thailand by the ministry of industry of Thailand in 2008 and 2009. The extension of this research is to use it as a guideline in creating the logistics cost model and finding the competitive advantages for other industries.

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