Indonesian High-Speed Railway Optimization Planning for Better Decentralized Supply Chain Implementation to Support e-Logistic Last Miles Distribution

E B Setyawan*, N Novitasari

Department of Industrial Engineering, Telkom University, Bandung, Indonesia

*erlangga.setyawan@gmail.com

Abstract. E-logistics must have better strategy because they must satisfy unpredictable demands which came from customer. Other consumer behaviours which affect e-logistics must work more efficiently are the requirement of last miles fast delivery and more competitive pricing. Decentralized supply chain model can handle all these issues and complex logistics activity although it only has one echelon model in the supply chain structure. Decentralized supply chain model doesn’t need a distribution centre but requires inventory sharing policy. Key to success inventory sharing policy is low lead time delivery. In Indonesia, only two transportation type which can handle product in low lead time, i.e., train cargo and aircraft cargo. Train cargo still needs high lead time but has low operation cost. Aircraft cargo can handle product in low lead time but need high operation cost. The trade-off in this condition is e-logistics need low lead time transportation tenant to satisfy demand until last miles delivery but has low operation cost not as expensive as aircraft cargo. Indonesia is developing high-speed train which connects Jakarta to Surabaya. In this research, we will review the level of effectiveness high-speed train in Indonesia to realized decentralized supply chain distribution network for handling e-logistics last miles shipping using dynamic system simulation. The output of this research is efficiency review of Indonesian high-speed railway cargo to support decentralized e-logistics supply chain distribution network, compared by aircraft cargo. After we perform simulation using dynamic system simulation, delivery of products between regions by using fast train is declared feasible to deliver products with fast delivery type if in one day there are six departure time (delivery batch). If less than six departures, the railway is declared unfeasible to deliver products with fast delivery type. However, the train can save about 37% batch delivery when compared to cargo aircraft.
1. Introduction

Supply chain management plays an important role in fulfilling the demand. There are two types of demand that must be met, namely, demand growth in the upstream supply chain, which fulfils the demand for the production process, and the fulfilment of demand in the downstream supply chain, where the demand for the distribution process to the consumer.

In the development of the modern era, downstream supply chain requires significant improvement and innovation. This is because in the modern era there is also a shift in the culture of public spending, from conventional shopping culture, where consumers come to a shopping centre, now turn to the culture of online shopping or called e-commerce. The change in shopping culture is evidenced by the research that has been done by e-commerce foundation which is the world's e-commerce survey institute [1]. From the results of this study, there is an increasing trend in e-commerce across the country from 2014 to 2016, where countries in the Asia Pacific and Latin America region occupy the largest e-commerce increase, i.e., 28% [2]. Figure 1a is a graph showing the growth of transactions on global e-commerce from 2013 to 2016. While Figure 1b shows the comparison of growth of e-commerce transactions in each country by 2015.

![Figure 1](image_url)

Figure 1. (a) The Growth of Global E-Commerce; (b) Turnover Rate e-Commerce in 2015

The rapid development of e-commerce will indirectly trigger the development of marketplace that acts as a container of transactions, that is, where sellers meet with buyers. Marketplace requires supply chain role to handle consumer demand, so the term e-logistics is developed. E-logistics integrates logistics activities with multiple electronic activities, such as, managing demand in e-commerce and logistics activity logging in ERP systems aimed at increasing fulfillment of incoming demand from consumers [3].

E-logistics must work hard to meet the unexpected demand of its consumers. Fulfilling demand for such inter-region, e-logistics must be balanced with fast delivery of goods and have a more competitive price [4]. The purpose of this study is to show the level of efficiency and minimum needs of high-speed railway departures every day. The level of efficiency and the minimum requirement of high-speed railway departures every day have an effect on the level and cost of fulfilment request by e-logistic, the more the number of high-speed railway departures in a day, the more desirable to substitute the aircraft cargo that has been used to deliver inter-region on the island of java. If the high-speed railway performance is below the prescribed minimum limit, then the high-speed railway is not feasible to substitute aircraft cargo because it cannot fulfil the consumer demand maximally.

2. Research Methodology

Things needed to understand and make improvements to the system are system dynamics, systems thinking, and soft operations research (soft OR). System dynamic is a description that leads to model equations, simulations to understand dynamic behaviour, alternative policy evaluation, education and
policy options, and better implementation [5]. System dynamics is a simulation method used to solve systemic and complex problems by considering both quantitative and qualitative methods. System dynamics involves interpreting real life systems into computer simulation models that allow one to see how the structure and decision-making policies in a system create its behaviour. The method used at this time can assess dynamically changing systems by simulating to learn and plan future events. In addition, this method can also be used for decision making according to the system [6]. Tools that are often used to simulate is Powersim. Powersim is a tool used to do business modelling or simulation. These tools are designed to handle to cope with real - world business situation, addressing complexity as well as dynamic and risk related issue [7].

3. Discussion and Result
The aim of this paper is to study the efficiency level of the Jakarta - Surabaya fast train that will be built by the Indonesian government in performing logistics cargo services. We will compare the rate and speed of cargo delivery service for inter-region within Java Island between the use of aircraft cargo and fast train. Since the rapid train has not been realized, the data used in this discussion is not real data, but the operational data shown in the Jakarta - Surabaya rapid train planning.

To perform the efficiency test described earlier, the authors use case studies of an e-logistic in handling the product ordered by the customer of an e-commerce ABC. In the case study, the authors will examine the reliability level of an e-logistics in sending the product with the type of fast delivery service (delivered on the next day) from Jakarta to Surabaya, which is the farthest delivery point on the island of Java (long delivery miles). The use of aircraft cargo that is normally used to handle shipments of this type of service, in this study will be substituted by the use of fast train cargo.

Some of the assumptions used in this study are:
- Operational cost and fast travel time Jakarta - Surabaya uses fast train planning data that has been prepared by the government.
- E-logistics XYZ handles e-commerce ABC in delivering goods.
- Business processes for handling product shipments using business processes from e-logistics XYZ.
- The type of shipping service used in the case study is a fast delivery service (delivered up to last miles delivery on the next day).
- If the product does not reach the consumer the next day, it will get a penalty in the form of decreased consumer loyalty to e-commerce ABC. A further consequence is that e-commerce ABC penalizes penalty charges to e-logistics XYZ.
- The delivery time is assumed in regular time based on KPI of e-logistics XYZ, not considered extra time caused by any disruption.

Figure 3 shows the number of ordered items by the consumer by day of the month. Based on historical data, most customers choose to make purchases on e-commerce ABC on Friday and it's patterned in the following weeks of the month (see Figure 3). This condition becomes a challenge for e-logistics XYZ where if there are buyers who choose shipping with fast delivery service type, they must ensure the goods can arrive at the destination location on the next day and when late, ordered items will arrive to the costumer on Monday. It causes disappointment experienced by consumers so that will have an impact on decreasing consumer loyalty shopping on e-commerce ABC.

![Figure 2](image-url)  
**Figure 2.** Number of Ordered Item in e-Commerce ABC in One Month

To perform a dynamic system simulation, the author uses the business process of cooperation between e-commerce ABC with e-logistics XYZ which can be seen in Figure 4.
Figure 3. Business Process of Order Handling from e-Commerce ABC to e-Logistics XYZ

Due to the high interest in e-commerce ABC's customer spending on Friday, the authors will assess the reliability level of demand fulfillment by sending the fast delivery type (delivered in the next day) to the inter-region if substituted with fast train mode. Customers can only choose the delivery mode with fast delivery type when finished shopping and make payment by 19:00 on Friday. After customer e-commerce ABC verifies the payment, e-logistics will start processing the product by wrapping and recapitulating the outbound process. The product will be sent to the collecting center in each region. When the product is delivered to the region, the product will be transferred to another region. This study focused on the mode of transportation used to deliver products to the inter-region. Aircraft cargo modes that are normally used to deliver products between regions within an island, will be substituted with cargo from fast trains due to minimizing shipping costs. After arriving at the destination area, the product will be forwarded to last miles delivery using local courier service. On Saturday, there are three batches of delivery. Delivery is "fulfilled" if the product reaches the customer in the three batches. If the product is not shipped in all three batches, the shipment is declared "late" and the product will be delivered to the consumer the following week on Monday. The delay is greatly avoided by XYZ e-logistics because it will get a penalty from e-commerce ABC caused by buyers of e-commerce ABC feel disappointed the goods cannot be sent on the next day. The disappointment will decrease interest in purchasing costumer e-commerce ABC.

To start the simulation, besides the company's existing business processes, we map out the weaknesses and advantages of each mode of transportation (aircraft cargo and fast train cargo). The advantages of aircraft cargo are lower travel times and more flexible schedules (many departure schedules). However, some of these advantages must be paid at an expensive price and a relatively small aircraft hull capacity. While fast train cargo, longer travel time and departure schedules between regions are not available in many schedules (not too flexible). However, fast trains have a much larger capacity and with relatively cheaper logistics cost.

We will simulate the demand between 500 until 1500 ordered items in the Friday. In each item, based on regulation from e-commerce ABC, they categorized into large item and small item. Small item is the item which have average size no larger than 30cm x 30cm x 30cm (l x w x h). Large item is the item which have average size no larger than 50cm x 50cm x 50cm (l x w x h). Parameter used in this paper can be seen in Table 1.
To start the simulation, besides basic parameter setting and business processes between e-Commerce ABC with e-logistics XYZ, the authors mapped the number of products ordered by customers on Friday using a fast delivery service. The product must be delivered the next day, Saturday. The number of ordered products using this delivery service has a normal distribution (see Figure 5). Some additional parameters, such as capacity fulfillment center and processing time at the collecting center are also considered. The inventory level of ordered products is assumed always available so there is no backorder. From the simulation results using input data varies between 500 to 1500 product orders with fast delivery type, the largest batch delivery required for high speed train to deliver inter-regional products is 6 batches (if there are 1500 products using fast delivery service). In the existing conditions, delivery of all products between regions can be handled by aircraft cargo, although it requires a larger amount of batch delivery. For more details the simulation results can be seen in Table 2.

Table 1. Parameter Setting for Dynamic System Simulation

| Number of Ordered Items | 500 | 500 | 750 | 750 | 1000 | 1000 | 1250 | 1250 | 1500 | 1500 |
|-------------------------|-----|-----|-----|-----|------|------|------|------|------|------|
| Number of Small Item    | 72% | 28% | 72% | 28% | 72%  | 28%  | 72%  | 28%  | 72%  | 28%  |
| Number of Large Item    | 28% | 72% | 28% | 72% | 28%  | 72%  | 28%  | 72%  | 28%  | 72%  |
| Number of Small Item Demand | 360 | 140 | 540 | 210 | 720  | 280  | 900  | 350  | 1080 | 420  |
| Number of Large Item Demand | 140 | 360 | 210 | 540 | 280  | 720  | 350  | 900  | 420  | 1080 |
| Pallet Size L (cm)      | 120 | 120 | 120 | 120 | 120  | 120  | 120  | 120  | 120  | 120  |
| Pallet Size W (cm)      | 150 | 150 | 150 | 150 | 150  | 150  | 150  | 150  | 150  | 150  |
| Pallet Size H (cm)      | 100 | 100 | 100 | 100 | 100  | 100  | 100  | 100  | 100  | 100  |
| Pallet Capacity Small Item | 66  | 66  | 66  | 66  | 66   | 66   | 66   | 66   | 66   | 66   |
| Pallet Capacity Large Item | 14  | 14  | 14  | 14  | 14   | 14   | 14   | 14   | 14   | 14   |
| Pallet Requirements For Small Items | 6  | 3   | 9   | 4   | 11   | 5    | 14   | 6    | 17   | 7    |
| Pallet Requirements For Large Items | 10 | 26  | 15  | 39  | 20   | 52   | 25   | 65   | 30   | 78   |
| Total Pallet Requirement for Ordered Items | 16 | 29  | 24  | 43  | 31   | 57   | 39   | 71   | 47   | 85   |
| Capacity Requirement Aircraft Cargo Boeing 747.xxx (pallet) | 8  | 8   | 8   | 8   | 8    | 8    | 8    | 8    | 8    | 8    |
| Capacity Requirement Fast Train in Planning Concept (pallet) | 15 | 15  | 15  | 15  | 15   | 15   | 15   | 15   | 15   | 15   |

Figure 4. Number of Products Shipped Using Fast Delivery Services
Table 2. Simulation Result

| Cargo Type                  | Number of Ordered Items | Aircraft | Train | Aircraft | Train | Aircraft | Train | Aircraft | Train | Aircraft | Train |
|-----------------------------|-------------------------|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|
| Number of Ordered Items     | 500                     | 750     | 1000  | 1250    | 1500   |
| Ritation Needed For Aircraft| 2                       | 4       | 6     | 8       | 9     | 6       | 11    |
| Ritation Needed For Train Cargo | 2               | 2       | 2     | 3       | 3     | 4       | 5     |
| Efficiency                  | 100%                    | 50%     | 67%   | 50%     | 75%   | 50%     | 60%   | 56%     | 67%   |

Average Efficiency 37%

4. Conclusion

E-logistics, which is a third party handling the distribution of goods from an e-commerce, is required to work faster and more efficiently in establishing the product up to last miles delivery. The choice of transportation modes to make the delivery must be done properly so that the product reaches the hands of the consumers with the time in accordance with the company KPI. In this paper, we study the efficiency level of the Jakarta - Surabaya fast train that will be built by the government when it is used to deliver products between regions in Java. To do this condition, we use dynamic system simulation. Dynamic system simulation can simulate unpredictable demand time by time. The result is high-speed train can save about 37% batch delivery when compared to cargo aircraft. For the next research, we suggest to review the effectiveness of high-speed train cargo for same day delivery services.

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