# AN ANALYSIS OF HEAVY EQUIPMENT SUPPLY CHAIN IN SUPPORTING INFRASTRUCTURE CONSTRUCTION

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**ABSTRACT**

The construction of infrastructure networks is a complex task that requires tight coordination amongst actors ranging from owners, investors, designers, constructors, and various suppliers. Heavy equipment suppliers hold an important role to ensure the realization of the construction project. However, the common practice of construction mainly focuses on project delivery rather than heavy equipment supply chain. This research is conducted to identify barriers and opportunities in heavy equipment supply chain in Indonesia and to provide recommendations in supporting infrastructure clients to coordinate in acquiring, mobilizing, and utilizing heavy equipments.

**KEY WORDS:** Heavy Equipment, Construction, Infrastructure, Supply chain analysis

## 1. INTRODUCTION

Resources availability becomes very important to support infrastructure construction for ensuring effective and efficient deliverables. Infrastructure development generally requires three sources including materials, manpower, and heavy equipment. Heavy equipment determines the success of the construction and serves as a focal point to synchronize specifications and materials with the project sites. The spectrum of construction equipment includes simple construction equipment used by non-skilled workers to large and heavy equipment which requires special skills. The use of heavy equipment in infrastructure can be divided into three main categories, namely heavy construction equipment, heavy road equipment, and heavy transportation equipment.

Business opportunities of heavy equipment in Indonesia appear to become the target of heavy equipment manufacturers to expand their markets. This is of course based on the growing macro-economic conditions and the rapid growth of development. After more than a decade underinvested in infrastructure, the government resumes investing in infrastructure to support economic growth. Poor roads, crumbling bridges, delayed shipping, and inefficient bureaucracies are an expensive burden to the country. Deficiencies in transport systems add unnecessary logistics costs that reduce the productivity and competitiveness of business and households. Investment in infrastructure becomes one of the government priorities. As a consequence, the public works in the future certainly require more heavy equipments.

Heavy equipments are not just needed by infrastructure construction but also by other sectors in mining, farming, forestry, and industry for the purpose of mobilization of goods and services. Limited national supply of heavy equipment manufacturers affects the availability of heavy equipment for construction. The production capacity of the national heavy equipment in 2011 was approximately 7,353 units, while the national demand for heavy equipment in 2011 is expected to reach 20,126 units. Demand for heavy equipment was largely met through imports. Heavy equipment shortage situation makes the seizure of heavy equipment from various sectors such as mining, forestry, plantation and construction.

Increased investment in infrastructure has not been balanced by the availability of heavy equipment (Natsir, 2012). The balance of the future demand and conditions of heavy

construction equipment availability seems not to be the focus of attention. On the one hand, the government was worried about not getting the supply of heavy equipment while increasing the value of investment in infrastructure. On the other hand heavy equipment suppliers have not been able to respond to the demand because it was not possible to develop the production capacity of heavy equipment in a relatively short time. This condition may hamper the development of the national construction industry as a whole.

To answer the challenge of meeting the needs of heavy equipment in support of the construction of infrastructure in the future, there is a need to nurture a synergy among the stakeholders to manage heavy equipment supply chain better so as the infrastructure in Indonesia to run smoothly. Therefore, this current research intends to assess heavy equipment supply chain in support of infrastructure investment. The results are expected to obtain depth information regarding the conditions and issues of heavy equipment supply chain and build understanding among relevant stakeholders to address the various problems faced.

## 2. HEAVY EQUIPMENT SUPPLY CHAIN

Infrastructure investment is a basic necessity to ensure national and regional connectivity that facilitates the flow of goods, people and services. The smooth flow of goods, people and services can reduce the high cost economy and create a more competitive and cohesive region. Connectivity will also enhance balanced growth and reduce development disparities. In spite the importance of infrastructure role, the current practice of infrastructure construction heavily focuses on quality, cost, and delivery with little attention paid to supply chain management (Xue *et al.*, 2008). Infrastructure construction consisting of different actors from contractors, designers, investors, suppliers, and transporters requires proper coordination to transform materials with the aid of equipments into physical facilities to the user according to the required value. Therefore, control of the construction supply chain must include all parties involved in the supply of resources from the upstream to the downstream chain of events.

Construction supply chain management offers new approaches to coordinate different actors to improve delivery time and reduce the costs of facility construction (Sullivan *et al.*, 2010). The way to procure materials and services determine overall efficiency and effectiveness of the project. Emphasis on construction supply chain management makes it possible to deal with global sourcing of materials, labour shortage, and the scarcity of construction materials and equipment. Cranes, bulldozers, backhoes, excavators, and shovels are among the heavy equipment items used in construction. Multi-tier construction supply chain management becomes an emerging practice used to gain advantages in efficiency and effectiveness. The heavy equipment supply chain is the second tier starting from equipment requirements to specific site characteristics and technical complexity to utilize reliable heavy equipments in the construction site. Therefore, managing heavy equipment supply chain in ensuring efficient delivery of the project appears to become a critical point in the construction supply chain.

Heavy equipment is usually up to the users through a series of procurement processes that may relate with rentals, distributors, and owned and operated heavy equipment companies. On the one hand, the users or contractors for a particular project might be different over time. They need reliable supply of heavy equipment to improve productivity. On the other hand, the providers of heavy equipment are the same companies that maintain the conditions of heavy equipments. This situation makes the use of heavy equipment in construction dissimilar to other sectors in mining, plantation, and forestry. Rather than as fixed assets, heavy equipments in construction are mobilized to different project sites and act as a means of service.

Heavy equipment supply chain as a main object in construction is relatively new. Other research treats heavy equipment as an input to construction supply chain (Sullivan *et al.*, 2010). Prasertrungruang and Hadikusumo (2007) explore practices of heavy equipment management in transports. There is little attention paid to assess heavy equipment supply chain to support the development of infrastructure.

## 3. RESEARCH METHOD

The issue of supply chain coordination among the actors related to heavy equipment supply chain is explored in this research. Most notably, the analysis would seek the huge issue of integrating demand and supply, the need to synchronize the supply chain with the demand chain, and the opportunity for multi-lateral collaboration amongst actors through a shared information network. The main approach used is supply chain analysis that assess about inputs and outputs between actors and value added along a supply chain through agent accounts. The links between inputs and outputs can be expressed in physical flows of material and services needed to manufacture, distribute, and utilize heavy equipment. Building a supply chain analysis requires to gather data to draw a flowchart showing flows of material in physical and informational through heavy equipment supply chain. The process of supply chain mapping is important to obtain an overview of the chain, the equipment flows, the position of the actors, and type of interaction between the actors.

Research method employed in this study is descriptive in nature. There are three main questions, namely to what extend the map of heavy equipment supply chain in Indonesia, what problems are faced by supply chain heavy equipment, and to what extent the government provides support to heavy equipment supply chain. The objectives of analysis are two fold. First, the achievement of the fulfilment of heavy construction equipment is reflected in the availability of sufficient and good quality of heavy equipment. Second, the identification of several initiatives is obtained to encourage different actors along the supply chain in helping the government in infrastructure development.

The original contribution of this research is developing effective and streamlined supply chain system to avoid a crisis of heavy equipment in the future. The benefit of this research for research community is the contribution in the area of construction supply chain. For business and government, this research contributes as a reference of knowledge in defining strategy and program in heavy construction equipment in supporting infrastructure.

There are several steps conducted in this research starting from supply chain mapping of heavy equipment, identification of supply chain issues, SWOT analysis, and identification of strategic initiatives of heavy equipment fulfilments. The variables used in the research include heavy equipment definition, life cycle of heavy equipment, equipment catalogue, indicator of availability, demand indicator, matching demand with supply, problems faced by actors, and trading terms of heavy equipments.

Data sources were stemmed from secondary and primary data. Secondary data from research reports and the internet such as alat berat (www.alatberat.org/), HINABI (www.hinabi.org/), Info alat berat (http://alatberat.info/), Portal Alat Berat (www.alatberat.web.id/), Industry Update Alat Berat 20 April 2012, Cari Alat Berat (http://www.carialatberat.com/artikel/daftar-perusahaan-alat-berat-di-indonesia.html), Pusat Pelatihan Operator Alat Berat Bersertifikasi Pertama di Indonesia (http://ugm.ac.id/index.php?page=rilis&artikel=4688), Tender Indonesia (http://www.tender-indonesia.com/tender_home/innerNews2.php?id=11545&cat=CT0019), Indonesia Finance Today, Pusat Alat Berat (http://pusat-alatberat.indonetwork.co.id/pusat-alat-berat.htm), Pusat Informasi Kredit (http://kredit-ku.com/kredit-alat-berat-truk/), and Sewa Rental Alat Berat Indonesia (www.rentalalatberat.net/).

Primary data were collected through interviews with the actors to focus on the problems faced by heavy equipment supply chain. The list of questions regarding heavy equipment supply chain in support of infrastructure construction includes identification of stakeholders and their concerns, current issues, and trading terms amongst actors. The strength of heavy equipment supply chain is about advantages of the service of heavy equipment and why. About drawback consists of what is bad in practice, what needs to be fixed, and that needs to be prevented. About the opportunities are related to the good opportunities facing in heavy equipment supply chain, national issues, government regulation, local developments, and some interesting trends happening in heavy equipment supply chain. About threats are

regarding obstacles in this area, national issues, government regulation, and local developments. Questionnaires and interviews with associations, manufacturers, users (e.g., PT Hutama Karya), agents, owners, Ministry of Agriculture, Ministry of Public Works, customs, and experts.

## 4. FINDINGS

Heavy equipment is often defined as equipment and/or machinery used as a production tool to complete the work or produce something. Characteristics of heavy equipment include lifting equipment, material handling equipment, transfer equipment, power tools, and not operated on the road. Heavy equipment operators are listed in the Standard Classification of Occupation Indonesia in the category of 833 farm machinery operators and other moving machinery.

Infrastructure development increases the demand for heavy equipment and technologies. Allotment provision of heavy equipment in infrastructure projects is around 10-15% of project budget. Provision of equipment determines the successful completion of a quality infrastructure that will drive economic growth. Unavailability of heavy equipment will slow infrastructure development that would hinder the economic turnaround.

Table 1 shows the main characteristics of heavy equipment supply chain. Situation of equipment supply chain were characterized by domestic heavy equipment industry is only able to meet 40 percent of national demand reached 20,000 units in 2011 (PAABI), pusbinsdi.net data shows the number of heavy equipment in good condition around 83,653 units, a total of 87.3% of the national availability of equipment listed in Jakarta, estimated number of heavy equipment in 2011 approximately 38,315 units (APPAKSI), no standard of catalogue that still refers to the catalogue producers of heavy equipment such as Caterpillar, Komatsu, Kato, Hitachi, Hyundai, Volvo and Kobelco, and producers act as dominant actors.

The number of heavy equipment is not accurate because there is no rule of equipment registration. The strength of local owners is the ability to determine economically tariff and control targets to attain definite completion. The requirement of heavy equipment depends on infrastructure procurement procedure such as terms of heavy equipment varies depending on the rules of the tender; demand is not fixed (temporal), small volume, and high variety; information investment plans segmented by location, and autonomous regions prioritize the procurement of heavy equipment with minimum purchase cost and not on lifecycle of heavy equipment.

**Table 1.** Characteristics of heavy equipment supply chain

| Characteristics | Current condition |
|---|---|
| Commodity type | Capital Good |
| Availability | Shortage |
| Actors | Users, owners, services (financing, rental, auction, repair, maintenance, recondition), distributors, producers, importers, vendors. |
| Dominant Actor | Producers and distributors |
| Market Segmentation | Mining (55%), Agro (15%), Forestry (9%), Construction (21%) |
| Trading Terms | • Price and sales according to market dynamics.<br>• Permits: producers, vendors, agents, services, recondition, financing, and importer<br>• No regulation: registration<br>• Affirmative action: none |

The term of a supply chain is used to refer to the overall group of actors of physical persons such as a producer, a distributor, a user, as well as legal entities such as an authority and a development organization that contribute directly to the utilization of heavy equipment. Heavy equipment supply chain encompasses the sequence of operations which, starting from component supplier, producer, distributor finishes downstream, after transfer of ownership to purchaser and the use of equipment at the level of the service. Stakeholders associated with heavy equipment supply chain consist of upstream and downstream actors related to how the processes occurring in the chain of equipment between actors as shown in Figure 1.

The upstream side of the supply chain produces and sells heavy equipment to downstream actors. Upstream members include supplier, manufacturers, and distributors. Supply chain starting from a manufacturing innovation to create a product that is sold. Product

manufacturing is usually up to the customer through a series of sales network consisting of distributors, vendors, and retailers. On the other hand, manufactured products are made with raw materials supplied by the supplier and other components made by manufacturers that support the creation of the various components of heavy equipment. Meanwhile, the downstream members are owners, services, and users that directly own and use heavy equipments.

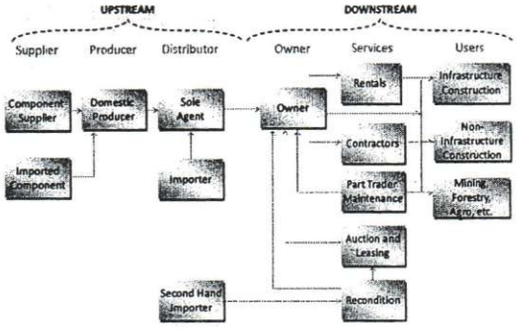


**Figure 1.** Map of heavy equipment supply chain

Domestic data, regarding the production of heavy equipment and the level of sales, indicates that the previous sales of heavy equipment in 2012 is projected to increase by 10-15% to reach 25,158, much higher than the projected figure in the range 17,000 units in 2011. While the ability of national heavy equipment industry capacity only reached 9,500 units, the gap shows the number 15,658 units, this means that nearly 62% of the national heavy equipment demand met by imported production. This is reinforced by the high level of competition in the global market due to heavy excess capacity in developed countries (global excess capacity) due to weak demand (especially Europe and China). It is expected that more imported equipments will enter the Indonesian market, where the imposition of tariffs at zero.

Table 2 describes the diagram of Strength, Weaknesses, Opportunities and Threats Analysis. This diagram explains how Strength, Weaknesses, Opportunities and Threats analysis can be applied to key planning areas in heavy equipment supply chain. The objective of heavy equipment supply chain in the construction of infrastructure is expected to increase construction productivity, efficiency, safety, and reduce negative impacts on the environment (eco-operations). The main concerns of heavy equipment supply chain are about the concept of utility through mobility and rejuvenation (new equipment investments).

**Table 2.** TOWS Analysis

| Components of TOWS Analysis | Opportunities (+)<br>O1: Increase in infrastructure investment<br>O2: Government reformation on infrastructure regulation | Treats (-)<br>T1: Insufficient heavy equipment<br>T2: Short term demand<br>T3: Burdensome import procedure of special equipment |
|---|---|---|
| Strengths (+)<br>S1: Owners with local knowledge<br>S2: Associations of actors | S1O1: Develop network amongst actors (1) | S1T1: Provide incentive for dedicated construction equipment (6)<br>S2T3: Develop import procedure of special equipment (7) |
| Weaknesses (-)<br>W1: Limited financing scheme<br>W2: Limited demand and equipment availability information<br>W3: No standards in quality, catalogue, and technology<br>W4: Lack of competent operators and mechanics | W1O1: Develop effective financing scheme (2)<br>W2O2: Develop monitoring system of equipment state (3)<br>W3O2: Specify standards of equipment (4)<br>W4O2: Develop cooperation with education and certification institutions (5) | W1T2: Promote multiyear projects (8)<br>W2T2: Develop monitoring of incoming and ongoing projects (9)<br>W2T1: Develop cooperation with suppliers of energy, parts, and tires (10) |

By using SWOT analysis of internal factors, there are several strengths in the heavy equipment industry include are: general machine owners are specialized in the construction field (S1) in addition to the supply chain actors have heavy equipment associations respectively (S2). Meanwhile, there are still some weaknesses, namely: financing pattern (W1) and information about the availability of heavy equipment is still limited (W2); standards of technology, safety, environmental and catalogue still not exist (W3), and lack of competence and composition operators and mechanics (W4).

From external factors, there are several opportunities that increased investment growth (O1) and the regulations that facilitate the planning, implementation and financing of construction projects (O2). But there are also threats such as: lack of heavy equipment to infrastructure construction activities (T1); demand for construction is not fixed, short-term,

and the criteria are not transparent tool (T2), taxation (T3), and the import of heavy equipment specific procedures troublesome (T4).

Based on TOWS analysis, strategic initiatives can be identified into four groups: SO strategy (to tap opportunities with existing strength), ST strategy (to avoid treat with existing strength), WO strategy (to tap opportunities by reducing weaknesses), and WT strategy (to avoid treat by dealing with current weaknesses). First, ST strategies by develop a network of cooperation among supply chain actors heavy equipment (S1O1): construction supply chain membership requirements; facility consolidation (WEB or cloud computing) leads to the auction, lease, sale and purchase; bid documents on the basis of supply chain support heavy equipment.

Second, ST strategies by provide incentives for heavy equipment for construction (S1T1): duty-free mobilization, fuel subsidies (subsidized diesel fuel, as long as the project goes according to hours worked), the distribution facility to the site of work (assembly between the harbour); and develop procedures for the import of specialized heavy equipment, ease of importing specialized equipment (S2T3).

Third, WO strategies by develop effective financing scheme( W1O1): terms, interest rates, credit, insurance, right to use, underwriting; develop a system of monitoring the status of construction equipment (W2O2): Registration tool (registered), the use of GPS is connected to the internet portal; applying these standards, and the use of tools W3O2): warrant of fitness (WOF), operators, safety, environment, security maintenance (asset management), the catalogue of equipments, technical standards work (kind of tools that should be used for a specific job); developing partnerships with educational institutions and certification (W4O2): competence operators and mechanics, facilities asset management upgrades heavy equipment operator and mechanic BLK facilities, facility safety and health training

Fourth, WT strategies by applying multiyear project scheme (W1T2); develop a project plan and monitoring of the project (W2T2): construction project infrastructure certainty information (schedule, location, and absorption); cooperating with energy suppliers, parts, and tires (W2T1).

In summary there are ten strategies to develop heavy equipment supply chain to support infrastructure construction, those are outlined as follows.

1. Develop a network of cooperation among supply chain actors heavy equipment: construction supply chain membership requirements; facility consolidation (WEB or cloud computing) leads to the auction, lease, sale and purchase; bid documents on the basis of supply chain support heavy equipment. One idea that needs to be developed is a Smart Mobility is divided into three components, namely information tools, transporters, and the integration of the user (users) and the owner of the machine (e.g., Dudek and Stadtler, 2005; Liu *et al.*, 2007).

2. Develop effective financing scheme (terms, interest rates, credit, insurance, right to use, underwriting).

3. Develop a system of monitoring the status of construction equipment: registration tool (registered), the use of GPS is connected to the internet portal.

4. Apply industrial standards of heavy equipment: warrant of fitness (WOF), certification of operators and mechanics, safety, environment, asset management, equipment catalogue, technical work (equipment types that should be used for a specific job).

5. Develop partnerships with educational institutions and certification: competence operators and mechanics, training facilities for asset management upgrades, training facilities for heavy equipment operators and mechanics, and safety and health training.

6. Provide incentives for heavy equipment for construction: duty-free mobilization between districts, fuel subsidies (subsidized diesel fuel, as long as the project goes according to hours worked), the provision of facility to the site of work (assembly between the harbour), tender that considers total cost of ownership.

7. Develop procedures for the import of specialized heavy equipment, ease of importing specialized equipment.

8. Promote multiyear project scheme.

9. Develop a project plan and monitoring of the project: construction project infrastructure certainty information (schedule, location, and absorption)

10. Cooperate with energy suppliers, parts, and tires.

## 5. CONCLUDING REMARKS

Future projection shows that there will be increased infrastructure development to accelerate and expand the economic and social development. In addition, the National Logistics System Blueprint is highly dependent on the development of logistics infrastructure. This implies that effective and efficient construction supply chain is the key to infrastructure development. This research indicates that heavy equipment supply chain determines the success of the infrastructure construction. Without attention to ensure reliable and efficient heavy equipment, infrastructure construction can delay and incur unnecessary costs. Supply chain analysis in this context is relevant since this method is able to capture characteristics of heavy equipment supply chain and the identification of a policy scenario that covers a number of supply activities of heavy equipment services to support infrastructure construction.

The preliminary finding of this research shows the importance of networking amongst actors of heavy equipment provision, information system for monitoring heavy equipment states, and incentives for heavy equipment dedicated to construction. Several programs need to be implemented in the near future include a pilot project related to heavy equipment for infrastructure construction on certain economic corridor. The study of heavy registration and accuracy of available heavy equipment including mobility of equipment needs to be addressed. It also relates to communications system for the actors involved that includes the incorporation of the concept of supply chain systems with energy supplies and spare parts that are greener, cheaper, efficient, and safe. The concept of supply chain heavy equipment can not be seen only as one sector alone, but it is an ecosystem that is closely related to the construction supply chain wider.

Management of supply chain heavy equipment aims to achieve the fulfilment of the conditions for the holding of heavy construction equipment reflected in the effective and efficient availability of sufficient and good quality. Moreover there are 10 (ten) proposed policy development strategic initiatives to develop heavy equipment construction supply chain. However, the initiatives still need to be verified about importance, usefulness and acceptance. Particularly, more details are needed to be drafted to be potential regulation or guideline.

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