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# Developing KPI's of Supply Chain LPG Using Analytic Hierarchy Process: a Case Study of LPG Scheduling at Indonesia's LPG Main Terminal

Andhita Dodi Risnata and Armand Omar Moeis



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# Developing KPI's Of Supply Chain LPG Using Analytical Hierarchy Process: A Case Study Of LPG Schedulling At Indonesia's LPG Main Terminal

Andhita Dodi Risnata*
Energy Systems Engineering Study Program, University of Indonesia, andhita.dodi@ui.ac.id

Armand Omar Moeis
Department of Industrial Engineering, University of Indonesia, armand.omar@ui.ac.id

Since the implementation of the kerosene to LPG conversion program in Indonesia in 2007, LPG has become an essential commodity, so that the distribution process must be carried out correctly. One of the crucial activities in the LPG distribution process is planning the supply from the main terminal to the depots using a ship scheduling system. The current condition is that with the increasing consumption of LPG and the growing number of depots, there is often a deviation between planning and realization, which causes additional operating costs for LPG distribution. With the development of technology and very tight industrial competition, companies are required to run their business efficiently. One way to achieve these goals is by managing supply chain management so that products can be distributed on time, quality is maintained, and at low cost. It is necessary to determine and weigh the Key Performance Indicator (KPI) in measuring supply chain performance. The purpose of this research is to identify KPIs for scheduling LPG supply at the main terminal by identifying levels in the SCOR model, identifying, weighing, and determining KPIs using the Analytical Hierarchy Process (AHP) method.

CCS CONCEPTS
Computing methodologies~Modeling and simulation

**Additional Keywords and Phrases:** LPG Supply Chain, KPI, AHP

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## 1 Introduction.

Liquefied Petroleum Gas (LPG) is a hydrocarbon compound with $C_3$ and $C_4$ main components. The composition of the LPG consists of propane compounds $C_3H_8$, propylene or propane $C_3H_6$, butane $C_4H_{10}$, butylene or butene $C_4H_8$, and small amounts of ethane $C_2H_4$, ethylene $C_2H_4$, and pentanes $C_5H_{12}$. LPG is produced from gas produced from refineries or natural gas separation, LPG is sold commercially in 3 grades [1], namely LPG butane, LPG propane, and mixed LPG.

In 2007 the Government of Indonesia implemented kerosene to LPG conversion program. This aims to reduce the burden of fuel subsidies that the government bears. Also, LPG can minimize the impact of environmental pollution caused by burning kerosene [2]. With this conversion, the domestic demand for LPG will increase rapidly. LPG demand in 2007

was only 21 thousand MT, but in 2018 LPG demand had reached 7.5 million MT [3]. The household sector consumes nearly 96% of LPG in Indonesia [4], due to the kerosene to LPG conversion program, which has made LPG a vital commodity [5].

## 1.1 LPG Supply Chain in Indonesia

A Supply Chain (SC) is a network extending from the suppliers to the customers and involving resources,

people who exchange information, goods, and services. SCs could also contain different echelons representing suppliers, facility plants, warehouses, distribution centers, and customers [6]. LPG supply chain in Indonesia is divided into four echelons. In the Indonesian LPG network, PERTAMINA manages the LPG supply chain from the first echelon (refineries or refrigerated storage), to the fourth echelon (end-customers) of a distribution system. It is also included the LPG transporters in each echelon, the storage facilities and the LPG stocks [7].

To meet the needs of LPG, it is obtained from domestic sources of LPG-producing refineries and foreign sources or imports. The provision of substances itself reaches 75% of the total national LPG demand in 2019, while it is only 25% for domestic sources. LPG supply from import sources will be stored in refrigerated tanks in the Main Terminal by refrigerated tankers. 4 main LPG Terminal locations are used to receive imported LPG where there are two ground tank facilities, namely the Tanjung Uban LPG Terminal and the Tanjung Sekong LPG Terminal and two floating storage facilities or STS (Ship to ship operation) at Semangka Bay STS and Kalbut STS. Then the LPG from the main terminal will be distributed to pressurized LPG Depots throughout Indonesia using tankers.

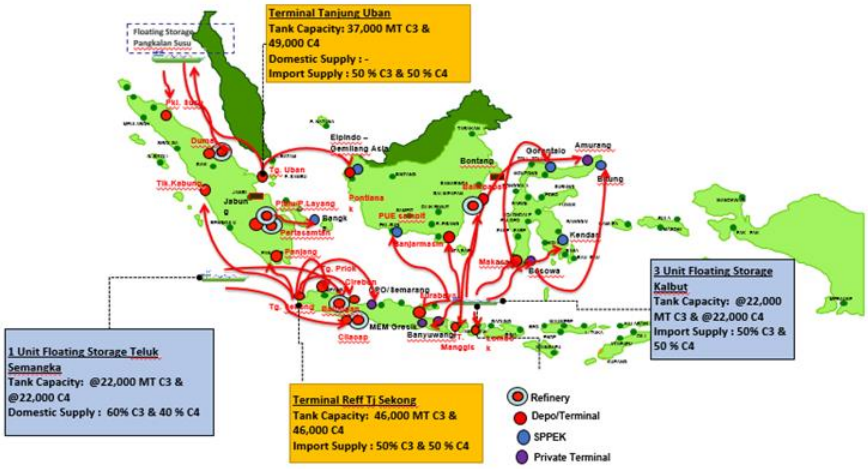


**Figure 1: Main Terminal LPG Supply Pattern to Pressurized LPG Depot**

Figure 1 above illustrates the complexity of the LPG supply to the Pressurized LPG Depot, the process of distributing LPG from the Main terminal to the pressurized LPG depot by scheduling tanker ships based on estimated daily distribution or DOT (daily objective throughput) of each depot. There are several considerations in ship scheduling planning: Main terminal stock availability, depot stock resistance, depot location, ship capacity, and cost. For import planning, ship scheduling is carried out monthly, and weekly evaluations will be carried out to maintain depot stock availability. However, in reality, some deviations from the planning caused, among others: ship damage, import delays, changes in demand, weather, damage to operating facilities and facilities, etc., thus increasing operating costs in LPG distribution.

In today's competitive world, companies are required to continuously evaluate and reconfigure their products and distribution systems to meet customer needs at minimum cost. Long-term survival capability is challenging to obtain without optimizing the strategic and tactical logistics system. One of the most important in the strategic optimization program is Supply Chain Optimization. [8]

Supply chain performance measurement can be used as a basis in determining strategies to improve company performance. In measuring supply chain performance, it is necessary to determine and weigh the Key Performance Indicator (KPI). The performance measurement system must be tailored to the specific needs of each supply chain. The correct selection of indicators and their dimensions helps identify problem areas and is essential in managing an organization and the entire supply chain in a volatile environment and a competitive global market. An adequate system of performance measurement, taking into account corporate strategy and supply chain, provides the necessary information for decision-makers [9]

**Tabel 1 The Framework of the supply chain performance indicators**

| Source | Title | Framework |
|---|---|---|
| Chae 2009 | Developing key performance indicators for supply chain: an industry perspective | SCOR model |
| Bora, Amlan 2004 | Developing key performance indicators for Performance Of Supply Chain | SCOR model |
| Leonczuk, Dorota 2016 | Categories of supply Chain performanCe indiCators: an overview of approaChes | BSC & SCOR model |
| Bukhori, Ikhsan Bani 2015 | Evaluation of Poultry Supply Chain Performance in XYZ Slaughtering House Yogyakarta using SCOR and AHP Method | SCOR model & AHP |
| A. Ramma 2010 | AHP Based Performance Measurement System of Supply Chain | AHP |

Table 1 above shows that previous research using the SCOR model and AHP methods can help determine the supply chain's performance.

# 2 Methodology

This research was conducted by identifying KPIs in the SCOR model, identifying, weighing, and determining KPIs using the Analytical Hierarchy Process (AHP) method through a pairwise comparison questionnaire. Based on questionnaires to respondents (experts/experts in measuring LPG supply scheduling), pairwise comparison results are obtained. Respondents' answers are averaged using geometric averages. Then weighting calculations are carried out with expert choice v11 software to determine the most critical KPIs, which will be used as an evaluation in the LPG supply scheduling process.

## 2.1 Identify levels in the SCOR model

The Supply Chain Council (SCC) introduced and developed a supply chain performance measurement framework known as the SCOR model, which was designed to describe the management process associated with all phases involved in meeting customer demands. Performance measurement begins with creating an initial hierarchy based on essential supply chain functions, namely plan, source, deliver, make (process), and return, with the primary measures of reliability, responsiveness, and flexibility. The initial hierarchy is adjusted to the company's conditions and integrated into several performance indicators called key performance indicators to measure performance.

## 2.2 Identification and Determination of KPIs

AHP is a tool commonly used for multi-criteria decision-making problems developed by Saaty [10]. AHP is a flexible model that provides an opportunity for individuals or groups to build ideas and define issues by making their assumptions and obtain the desired solution from him.[11]

The identification and determination of KPIs in this study were conducted to obtain KPIs that can be used to measure the company's success. KPI identification is done through the interview stage and filling out questionnaires to experts representing the LPG Supply Scheduling process.

Defining a measure of consistency as a Consistency Index [12].

$$CI = \frac{\lambda max - n}{n - 1}$$

Where: $\lambda max$ = The largest eigenvalue of a metric of order n
$n$ = number of criteria

$$CR = \frac{CI}{RI}$$

Where: $CI$ = Consistency Index
$RI$ = Random Index
$CR$ = Consistency Ratio

Saaty implements that a comparison matrix is consistent if the CR value is ≤ 0.1, but if the CR value is> 0.1, it needs to be revised. The stages in weighting with AHP are as follows

### 2.2.1 Creating a Hierarchy

The hierarchy of problems is a step to identify problematic issues into sub-systems, elements, sub-elements, and so on, eventually becoming more precise and more detailed

### 2.2.2 Prioritization

AHP performs an element priority analysis using the pairwise comparison between two elements until all the parts are covered. This matrix form is usually called a square matrix. These priorities are determined based on experts' and parties' views with interest in the decision, either directly through discussions, interviews, or indirectly through questionnaires. To determine priority, it is necessary to make a pairwise comparison between the criteria. Priority determination is obtained from the results of filling out a pairwise comparison questionnaire by respondents. Respondents to the questionnaire, in this case, are those who are considered experts/experts in the field of LPG Supply Scheduling. The results of the questionnaire are then processed using the help of expert choice v11 software.

### 2.2.3 Measuring Logical Consistency

The AHP process includes consistency measurement, namely whether the value assignment in comparisons between objects have been carried out consistently. Consistency Ratio is a parameter used to check whether the pairwise comparison has been carried out consequently or not. If the criteria and alternatives have been assessed consistently, the CR value should be <0.10. If there are inconsistencies in making the assessment, it is still necessary to revise the review.

# 3 Discussion

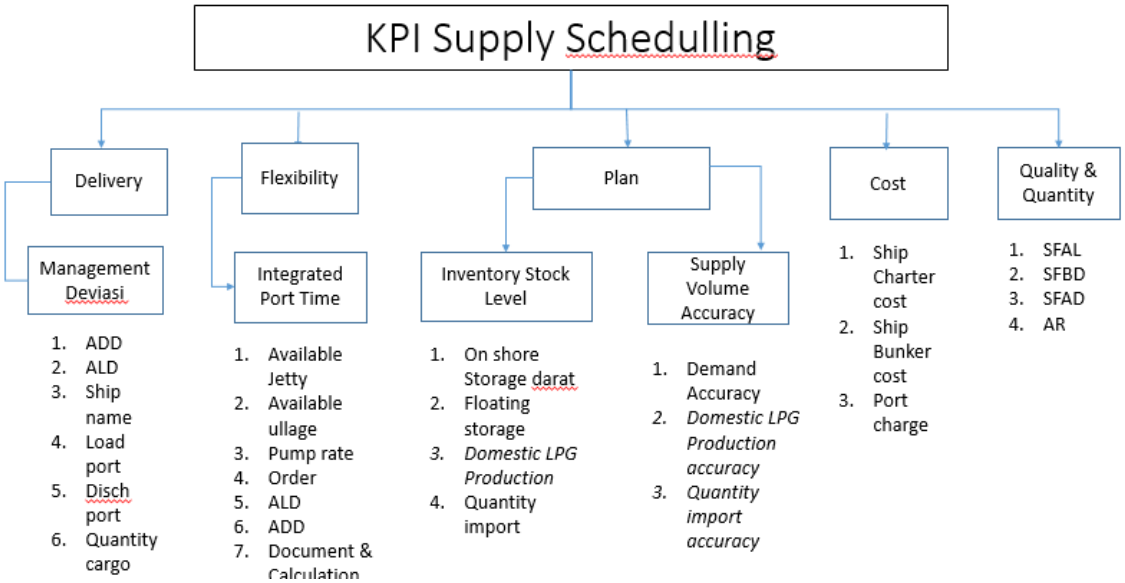


**Figure 2: LPG Supply Scheduling KPI hierarchy**

# 4 Conclusion

Based on the research, we obtained 6 Key Performance Indicators adjusted to the SCOR model, namely plan, source, deliver, make (process), and return. Weighting using AHP weighting at level 1, level 2, and level 3 hierarchy using expert choice v11 software.

This study's results can then be used for further research, namely measuring the performance of LPG supply scheduling based on the SCOR model.

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