Evaluating the Conceptual Model of the Fuel Supply Chain from Terminal to Small Scale Fuel Stations using Soft System Methodology Approach

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Abstract

The fuel supply chain is one of the important activities in the downstream oil and gas business in Indonesia. However, the company encountered several obstacles in distributing fuel oil through small-scale fuel stations. This study aimed to apply the Soft System Methodology (SSM) approach in obtaining the concept evaluation of fuel oil supply chain activities from terminal to small-scale fuel oil stations. However, this study only performed four SSM steps by adding a System Diagram and Multi Actor Analysis tables to understand the problems better. Nevertheless, this study has successfully identified the problems, the actors involved, and the relationship between actors in fuel supply chain activities. Therefore, it can provide an overview for the stakeholders involved, especially the heads of the company, to take transformation steps. This study will be continued by solving problems using the AHP-TOPSIS hybrid method in future research.

Keywords
Soft System Methodology (SSM), Fuel Oil, Supply Chain Management and AHP-TOPSIS Hybrid.

1. Introduction

Total Indonesian energy consumption in 2021 was 909.24 million BOE (Barrel Oil Equivalent), with the most significant percentage of consumption in the transportation sector of 388.42 million BOE or 42.72%. Based on the type of energy, 430 million BOE of fuel oil is still used as the largest energy source in Indonesia (HEESI 2021). One of the important activities in downstream oil and gas business activities in Indonesia is trading activities. PT Pertamina Patra Niaga, one of the oil companies in Indonesia, has built fuel oil stations that are smaller than the average number of stations. Through this small-scale station development, they hope to increase fuel oil sales, make it easy for the public to access fuel oil purchases, and help the government create an equitable distribution of fuel oil availability and distribution.

Based on Reid & Sanders (2013), Supply chain management (SCM) involves managing the flow of materials and information from suppliers and buyers of raw materials to the final customer. A supply chain is a network of all the activities involved in delivering a finished product or service to the customer. The objective is to have everyone in the chain work together to reduce overall costs and improve quality and service delivery. The performance of a supply chain is characterized by its ability to remain market-sensitive without losing integration through the chain (Gupta and Singh 2015).

The fuel supply chain is one of the important activities in the downstream oil and gas business in Indonesia. These activities consist of two network systems, which are the supply system network and the distribution system network. In the fuel oil distribution system, fuel oil terminals and stations play an essential role. Their performance will determine how fuel oil can be delivered to end customers. Nowadays, in Indonesia, smaller fuel stations have been developed. It help customer in rural areas to get easier the fuel oil, but on the other hand, companies must face challenges in distributing fuel oil to this smaller fuel station so the process will more effective and efficient. By using the Soft System Methodology framework approach, the pattern of these fuel oil distribution activities can be analyzed and modelled, so it will help the company know the problem and the transformation that must be applied.

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Soft System methodology (SSM) helped define the decision problem context and the main actors involved and unveil the relevant objectives for each stakeholder (Neves et al. 2009). In supply chain analysis, SSM has been widely used. For example, Nurhasanah et al. (2020) have applied A soft system methodology approach to design the conceptual model for the intelligent supply chain model of the natural fiber agroindustry. A soft systems methodology approach also has been used to improve the supply chain of the construction project in Gauteng Province, South Africa (Tsuro et al. 2020).

This study only carried out four SSM steps with the addition of a System Diagram and Multi Actor Analysis tables to understand the problems better. From the study, the stakeholders involved will get an overview of decision-making.

2. Literature Review

2.1. Supply Chain Management

Based on Reid and Sanders (2013), a supply chain is a network of all the activities involved in delivering a finished product or service to the customer. These include sourcing raw materials and parts, manufacturing and assembling the products, warehousing, order entry and tracking, distribution through the channels, and delivery to the customer. The supply chain consists of suppliers, manufacturing centres, warehouses, distribution centres, and retail outlets, as well as raw materials, work-in-process inventory, and finished products that flow between the facilities (Gupta and Singh 2015).

Supply chain management is the vital business function that coordinates and manages all the activites of the supply chain. Supply chain management provides the compfigureany with a sustainable, competitive advantage, such as quick response time, low cost, state-of-the-art quality design or operational flexibility (Reid and Sanders 2013).
Based on Raharja et al. (2020), supply chain management has been implemented in many areas, and its goals are not only the transportation of materials but also the management of cash and information flows. The goal of supply chain management as the fulfillment of consumer demans and the maximization of profits. Achieving the main goals of supply chain management involves many stakeholders and activities.

In supply chain management, selecting storage (warehouse) and distribution locations is one of the important things. The optimal location for storage depends on several criteria. Singh et al. (2018) have identified criteria related to the selection of warehouse locations for global supply chains, consisting of 3 categories: infrastructure, government, and market. Each category consists of 3 sub-criteria, which are Transport and Connectivity (T&C), Electricity & Water Supply (E&WS), IT & Tele-communication Setup (ITS) for Infrastructure category, Cost of Land (CoL), Taxation Policies (TP) and Incentives (Inc) for Government category and Market Size (MS), Proximity to maintain market (PMM) and Scope of Market Growth (SMG) for the Market category.

Saha et al. (2022) identified nine criteria in selecting the warehouse site for the automotive industry, which are Energy availability & cost, Proximity to the customer, Skilled labor, Proximity to production centers, Proximity to the port & customs, Transport & logistics operations, Installing & operating costs, Disaster risks, and Proximity the residence.

2.2. Fuel Oil Supply Chain Activities

Fuel oil supply chain is one of the important activities in the downstream oil and gas business in Indonesia. Based on the picture below (Figure 1), the fuel oil supply chain consists of two main networks:

1. Supply system network

A supply system network is created to meet the supply of domestic fuel, which includes the fuel supply from the supply source to the fuel terminal (storage). Sources of supply can come from imports or domestic refineries (processing made from crude oil and processing made from waste materials containing fuel components).

2. Distribution system network

A distribution system network is used to distribute fuel from fuel terminals to end consumers. For the transportation sector, fuel oil is distributed through the fuel station. Nowadays, in Indonesia, smaller fuel stations have been developed. These stations are prepared to serve the needs of consumers of non-subsidized fuel, non-subsidized LPG, and other retail products by prioritizing service locations in villages or cities that require retail product services (Pertamina 2022). The maximum land area of this station is usually only 500 m^2.

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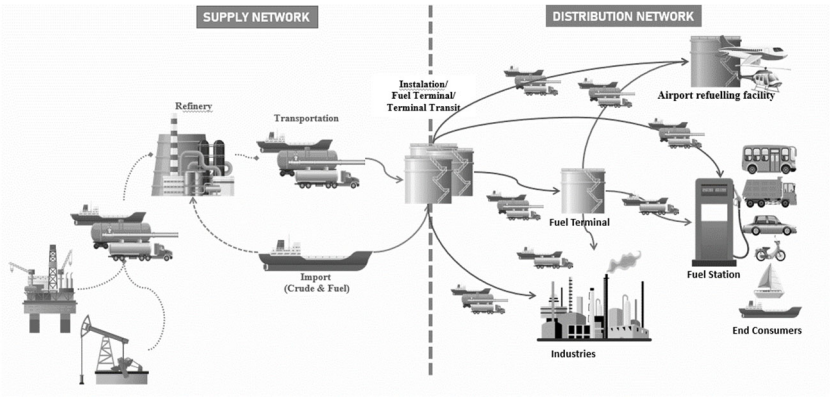

Figure 1. The pattern of the fuel supply chain
(Source: Downstream Oil and Natural Gas Regulatory Agency)

2.3. Soft Systems Methodology

Based on Aryee et al. (2022), Soft Systems Methodology (SSM) is a widely used qualitative research methodology based on systems thinking theory and action research. SSM is a cyclic learning system that uses models of human activity to explore the actors in the actual world problem situation, their perceptions of that situation, and their readiness to decide upon purposeful action that accommodates different actors' perceptions, judgments, and values. The Soft Systems Methodology (SSM) was developed as a set of tools for identifying and making incremental steps to improve situations with poorly defined causes or solutions (Tsuro et al. 2020).

According to the SSM stages, there would be seven stages. The first and second stages are how the problem situation is expressed from the unstructured situation, including the actors, the process, and the boundaries (Maulana 2022). The way to do this is through rich pictures, which tell the story better than words (Aryee 2022).

The third stage is defining the root definition of the system, turning the rich picture as expressed situation into a system framework. These can be structured using other constructs such as CATWOE, PQR, and Conceptual Models (Aryee 2022). CATWOE stands for:
• Customers (those people who are the recipients of the system's output),
• Actors (the people who perform the activities of the system),
• Transformation (the change that the system brings about),
• Worldview (the viewpoint that justifies the activities of the system),
• The owner (the person or system that can create, change, or destroy the system) and
• Environment (external systems or constraints that must be taken as given).

The four stages are developing the conceptual model that describes every process of the transformations section of the root definition. The third and fourth stages should ideally develop because the model that is developed based on real-world conditions would be compared again with the existing real-world conditions (Maulana 2022).

The next stages use the models to structure the further questioning of the situation (the stage five 'comparison') and to seek to define the changes which could improve the situation, the changes meeting the two criteria of 'desirable in principle' and 'feasible to implement' (stage six). Stage seven then takes action to improve the problem situation, thereby changing it and enabling the cycle to start again (Checkland 2000).

3. Methodology

This study analyzes and models the fuel supply chain pattern through the Soft System Methodology framework approach. Based on SSM, better known as Checkland Methodology, seven steps must be taken in solving a problem. However, as previously explained, only 4 SSM steps will be carried out in this study. The steps will be used to evaluate the fuel oil supply chain from the terminal to the small-scale fuel oil station.

The first and second stages are how the problem situation is expressed from the unstructured situation, including the actors, the process, and the boundaries. The third stage is defining the root definition of the system, turning the rich

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picture as expressed situation into a system framework. Finally, the four stages are developing a conceptual model that describes every process of the transformation section of the root definition (Maulana 2022).

4. Results and Discussion

4.1. Problem Situation and Description

The structure situation that will be discussed can be seen in Figure 2. The rich picture presents the problem in the fuel supply chain process from the terminal to the small-scale fuel station. There are some actors involved in supply chain activities. The development of fuel stations that are smaller in size than the regular ones and widely distributed in areas provides distinct advantages and disadvantages for the company and stakeholders. Various obstacles in fuel distribution through small-scale stations must be overcome through various steps.

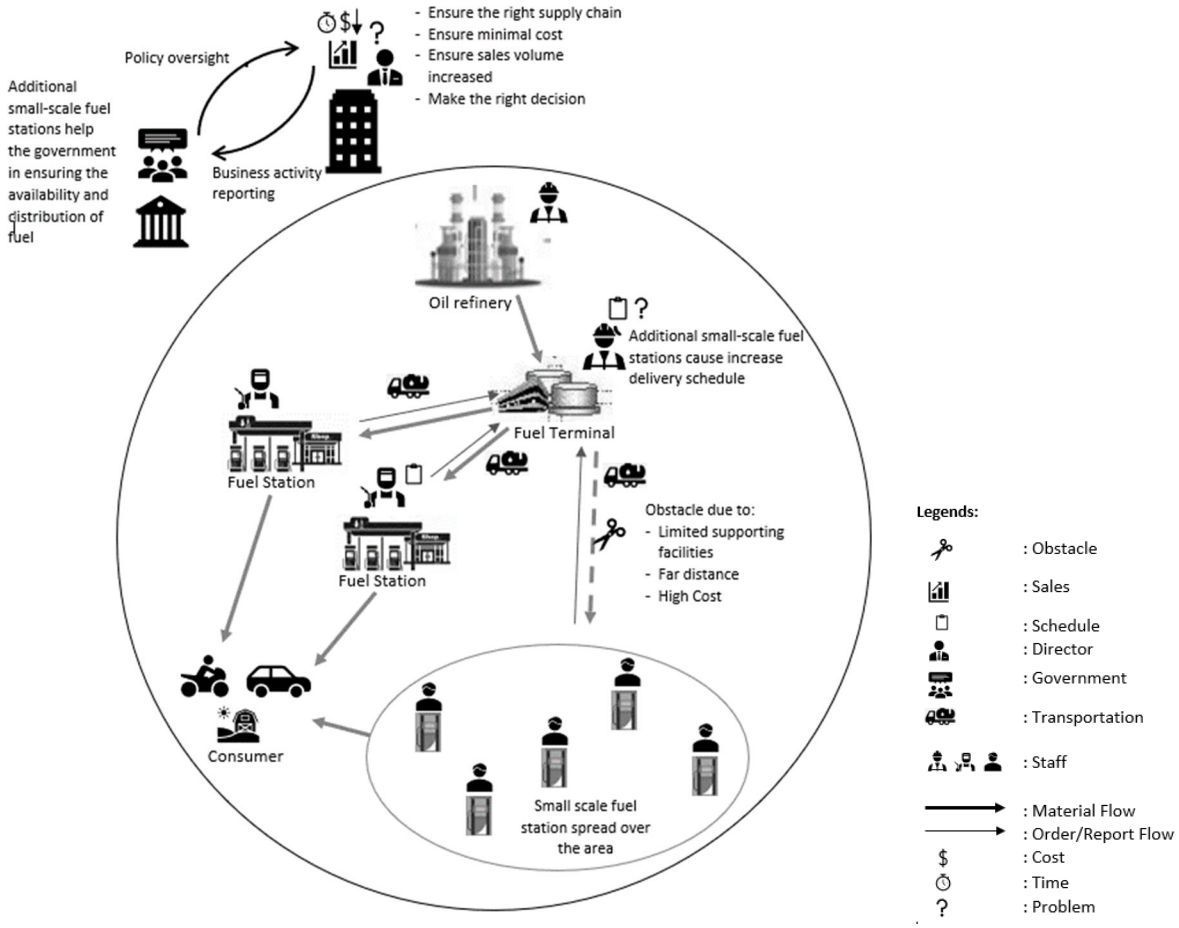

Figure 2. Rich Picture

4.2. Defining System's Problems

As seen in the previous rich pictures (Figure 1), the problems that arise from the supply chain of fuel oil to small-scale stations are the existence of obstacles due to limited supporting facilities such as the availability of fleets at terminals, far distances from terminals to small-scale fuel stations and high transportation costs. In addition, an increase in the number of small-scale fuel stations caused an increase in the delivery schedule that terminal employees must complete. In detail, the following CATWOE analysis provides an overview of the root definition of the system (Table 1).

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Tabel 1. The CATWOE Analysis

Root Definitions	**CATWOE**	**Elements**
The company will have a more effective and efficient supply chain by evaluating the performance of each stakeholder involved in supply chain activities and making the right decisions to reduce the obstacle.	Customers	Small-scale fuel station employee
	Actors	1. Government as a policy maker 2. Fuel terminal employee 3. Fuel station employee 4. Small-scale fuel station employee
	Transformation	A decision making to achieve a more effective and efficient supply chain process for distributing fuel to small-scale stations is selecting a regular fuel station as a station hub that will connect fuel distribution from the terminal to the small-scale stations.
	Worldview	Sustainability of the fuel oil supply to small-scale station.
	Owner	Head of the company
	Environment	1. Fuel consumers are mainly in the transportation and agricultural sectors 2. Government regulations regarding the supply and distribution of fuel oil.

In Table 2, the roles of actors and the transformation process in the system will be explained. The actors' analysis is essential to describe all actors' perspectives, interests, problem perceptions, objectives, and positions in the system, which will help determine the solutions' purpose (Maulana 2022).

Table 2. The Actor Analysis

Actor(s)	**Government**	**Head of Company**	**Fuel Terminal Employee**	**Fuel Oil Station Employee**	**Small Scale Fuel Oil Station Employee**
Problem perception	Lack of Fuel stations in rural locations	The distribution of fuel to small-scale stations in rural areas is less effective and efficient	Fuel distribution to small stations requires an accurate schedule and adequate facilities	The need for the availability of additional resources if selected as a fuel station hub	A delay in supply from the fuel terminal will cause problems of oil distribution to end consumers
Objective(s)	Availability of fuel at remote locations	Providing fuel at a good price and quality	Meet requests for fuel delivery	Ensuring the smooth distribution of fuel to small-scale stations and end consumers	Ensuring the smooth distribution of fuel to end consumers
Interest(s)	• Increase community welfare • Reducing the sale of illegal fuel	Increase in fuel sales volume to remote locations	• Delivery of fuel according to the schedule • Guarantee the quality of fuel	Meet customer satisfaction	Meet customer satisfaction

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Cause of problem	There is an increase in fuel demand from people in rural areas	Small-scale stations are pretty far from the terminal	The increasing number of small-scale stations	There are additional duties and functions as a fuel station hub	• A far distance from the terminal • Limited facilities to support fuel distribution activities
Resource(s)	National authority in regulating the supply and distribution of fuel	Authority in determining the company's development strategy	Allocation of facilities for the distribution of fuel to stations	Allocation of facilities and additional facilities in serving small-scale stations and end consumers	Allocation of owned facilities
Position	Provide support for all forms of establishing and implementing energy policies that are beneficial to society	Make decisions according to the needs of the company	Ensuring the smooth supply and distribution of fuel	Ensuring the smooth distribution of fuel	Ensuring the smooth distribution of fuel

4.3. Conceptual Model of System's Problem

From the CATWOE, the conceptual model is developed (Figure 3). The system goal is decision-making in selecting the fuel station hub to support the fuel oil supply chain from the terminal to the small-scale stations. As the problem owner, the company's head can take three policy interventions. First, alignment with government regulations is a policy taken to fulfill the company's obligations to the applicable regulations. The second and third are business commercial activities, and supply chain management strategies are developed to achieve sustainable system development.

By analyzing the inputs and outputs of the system, the fuel oil supply chain from the terminal to the small-scale stations is evaluated to achieve the system goal. The input of the system diagram consists of the number and area distribution of small-scale stations, regular station area distribution, data of regular station facilities, and data of terminal facilities. Ensuring the smooth distribution of fuel to end consumers, reducing fuel delivery costs, and meeting the regulations set by the government will be generated as the system outputs. In the diagram, we can also see the stakeholders involved in the system.

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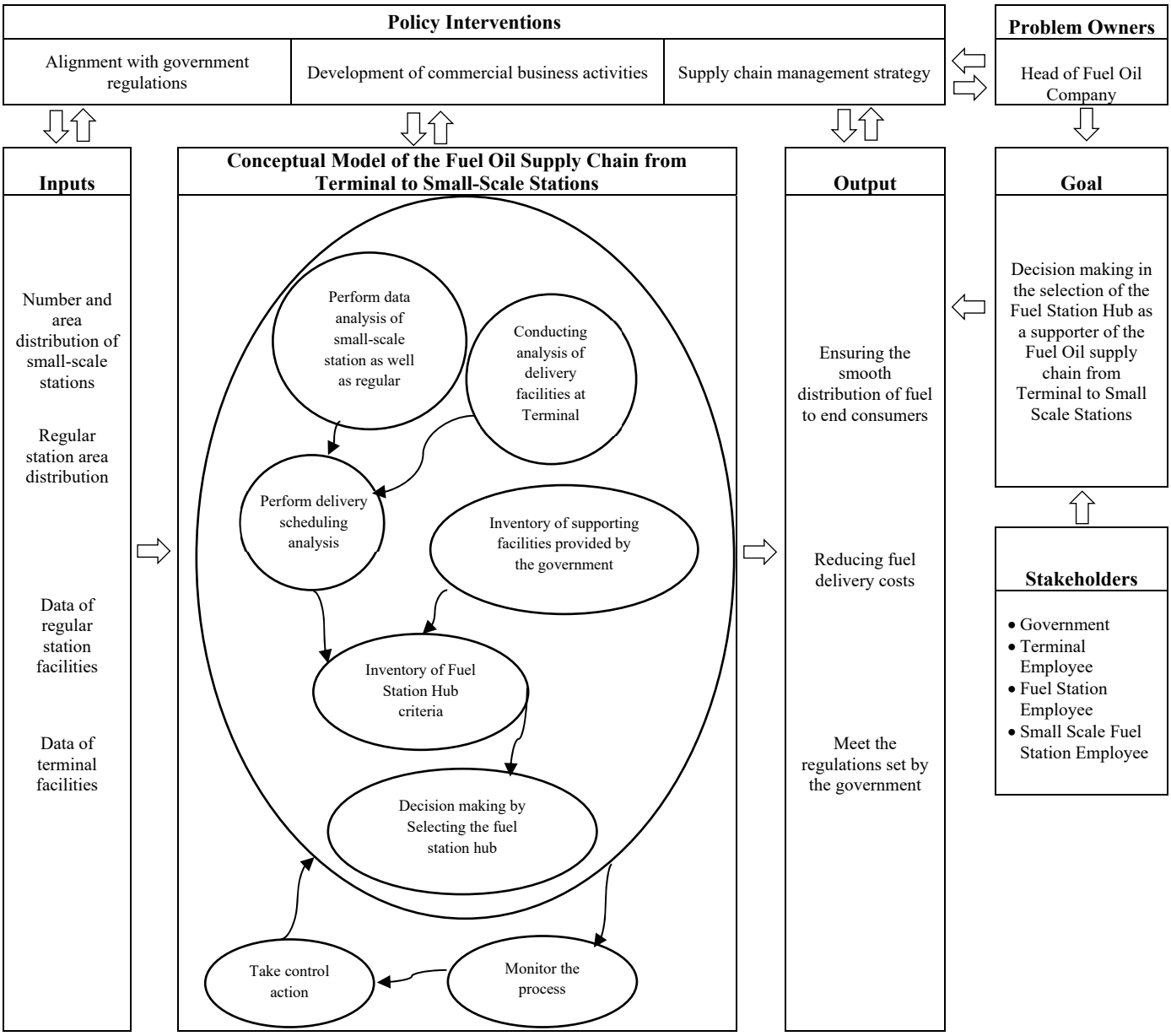

Figure 3. System Diagram of Conceptual Model of the Fuel Oil Supply Chain from Terminal to Small-Scale Fuel Oil Stations

5. Conclusion

Making the right decision to solve a problem involving many criteria needs to be done appropriately. The decision cannot be adequately taken if the problem is not explained clearly and in detail. Using the Soft System Methodology, this research has identified problems in the fuel oil supply chain from the terminal to the small-scale stations. The actors involved and the relationship between actors in supply chain activities have been analyzed in detail to provide an overview for the stakeholders involved, especially the head of the company, to take transformation steps. This research will be continued by solving problems using the AHP-TOPSIS hybrid multi-criteria decision-making method in selecting the fuel station as a station hub.

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Biographies

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