ANALISIS PERILAKU DINAMIS TERHADAP PERMINTAAN PREMIUM DENGAN MODEL SIMULASI SISTEM DINAMIK PADA DEPOT PARE-PARE PT XYZ

ANALYSIS OF DYNAMIC BEHAVIOR OF PREMIUM DEMAND USING THE DYNAMIC SYSTEM SIMULATION MODEL IN PARE-PARE DEPOT OF PT.XYZ

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ABSTRACT

Purchases of private and public vehicles which increase with increasing population are easily seen in big cities like Sulawesi. The existence of vehicles that are used to support community work activities, making this area have the opportunity to use energy that is less controlled, especially fuel type Premium. Existing premium stock is experiencing depletion due to high vehicle growth so that it becomes a dynamic pattern of premium consumption behavior. Sulawesi itself also experienced a shortage of supplies in 2018 until now. This scarcity of premiums occur because of a surge in consumption from the public continues. Therefore one of the Depot in the Pare-pare area which distributes premiums to 63 gas stations, which are divided into the regions of South Sulawesi and West Sulawesi, are trying to consumer demand. Many variables in the system involved are considered in the supply and distribution of premium. With the interaction between variables in the system, it is proposed to create dynamic system models and simulations that produce 3 policy scenarios from the initial scenario. An effective scenario in meet the demand for premium consumption is the policy of adding 400,000 kiloliter tank capacity which will cause more stable stock so that consumer demand is fulfilled in the future.

Keywords: Modeling, Simulation, System Dynamics, Demand.

I. INTRODUCTION

Fuel oil is a vital commodity that is needed by many communities as an energy source. In accordance with Law Number 22 of 2001 concerning Oil and Gas, that the Government is obliged to guarantee the availability and smooth distribution of fuel oil throughout the territory of the Unitary Republic of Indonesia. In this case, the Parepare Depot as one of the facilities that was built serves as a temporary pile of fuel, to serve the distribution of the Parepare depot distribution area which includes 63 gas stations spread across the City of Parepare, Kab. Pinrang, Kab. Barru, Kab. Sidrap, Kab. Enrekang, Kab. Soppeng, Kab. Wajo, Kab. Toraja, Kab. Bone, Kab. Mamuju (Sulbar), Kab. Majene (Sulbar), Kab. Polman (Sulbar), and Kab. Mamasa (Sulbar). Barat continuously as needed. In Sulawesi it self has people who come from various types of groups from various types of workers, which makes this area always crowded with people who carry out work activities. So that makes many people who buy vehicles as a support in carrying out work activities. This scarcity of premiums occur because of a surge in consumption from the public continues. So there are many queues at each gas station, and the queues occur only at gas stations that have premium stock, not the other stock. Therefore, in this study only discussing the problem of availability of premiums due to the frequent occurrence of premium stock vacancies at the time of a purchase made by consumers at a gas station (General Fuel Filling Station). This is the background of research to identify consumption behavior patterns that affect the increase in premium demand, which is then used to build a system dynamics approach model that can describe the phenomenon of premium availability and demand in the long run. In the sense that the simulation model is due to the ease and availability at the time of the study. Dynamic modeling consists of interrelated variables. By using software, the model is made graphically with symbols on variables and their relationship which includes two things, namely structure and behavior. Structure is a phenomenon forming element [1].

II. RESEARCH METHODS

2.1 Library Study and preliminary survey

Literature study is collecting data for research through literature, references, and other library materials related to the problem discussed [2]. This is done by understanding the knowledge of Inductive studies and Deductive studies. Inductive studies in the form of previous studies that have conducted a study in predicting a production in the future. These studies are also used as a reference in the context of this study. Whereas Deductive studies in the form of understanding of demand and supply theory, dynamic system simulations, dynamic systems approaches, simulation techniques, and simulation techniques.

2.2 Model Limits

In a system modeling to avoid the occurrence of a model that is very widespread due to interrelationship of each of the existing factors, it is necessary to impose limitations [3]. The limitation of the model is certainly based on the pattern in the context of the discussion that is relevant to the objectives to be achieved by the model. Conversely, a model with too many restrictions will make the model occur far from the actual system [4]. A good model is if you can present the system being modeled. The following will set forth the limitations used in the model development stage.

Dynamic simulation approaches, however, are used to express also the dynamic characteristics of the system and predict the behavior of the system under changing conditions [5].

2.2.1 Model Scope

The discussion in this study focuses on the ability of the Premium demand system to meet consumer needs. The ability of this system is identified as being in the system continuity of demand can be maintained from disruption of distribution and the amount of temporary premium capacity can be reduced. In connection with the foregoing, the scope of the model is developed by involving sub-systems that directly influence the rate of consumption behavior.

2.2.2 Variable Exogen

Exogenous variables are variables from outside the system that have an effect on the system under review, but do not affect other variables in the system. The oxyogen variables in question are [6]:

1. Premium Rates
2. Profit
3. Transportasi
4. Raw Materials
5. Irregularities

6. Type Of Gas Station

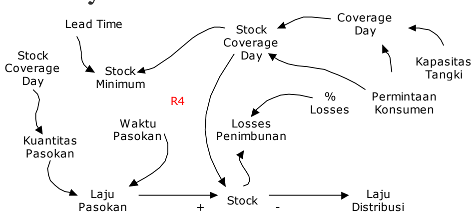
2.2.3 Variables Outside the Model Discussion

1. Downstream Oil and Gas Business Activities
2. Source of Crude Oil
3. Investment Value
4. Social Function

2.3 Casual Chart System

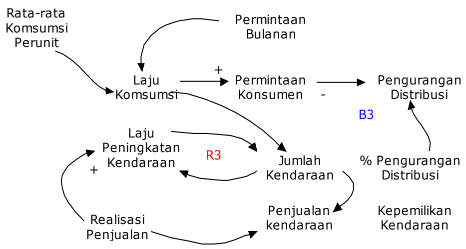
In developing this model, it will be divided into 3 sub-models, namely:

2.3.1 Premium Inventory sub-system



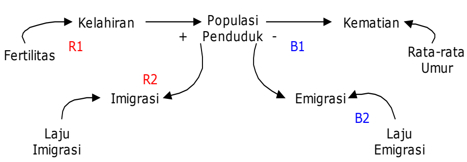
Picture 1 Diagram of Cause and Effect of the Premium Inventory Sub-system

2.3.2 Premium Consumption sub-system



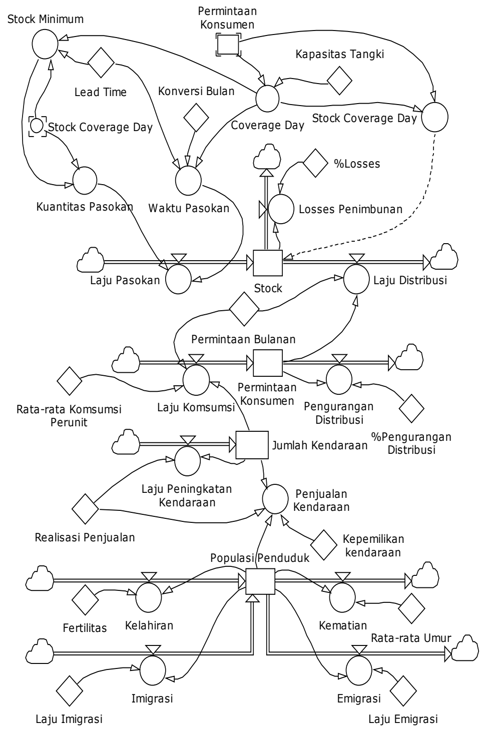
Picture 2 Diagram of Cause and Effect of the Premium Consumption sub-system

2.3.3 Sub-population Population system



Picture 3 Diagram of Cause and Effect of Population Sub-system Population

2.4 Stock Flow Diagrams and Model Formulations



Picture 4 Overall Stock Flow Diagram

The benefit of transforming the real picture in the field into a dynamic model is to find out the causality dynamically, ie to see the dynamics of change in the context of time. The aim is to understand the rarity of behavior according to the development of time and understand the interrelationship of the influence of all factors in one period of time [7].

2.5 Running Simulation

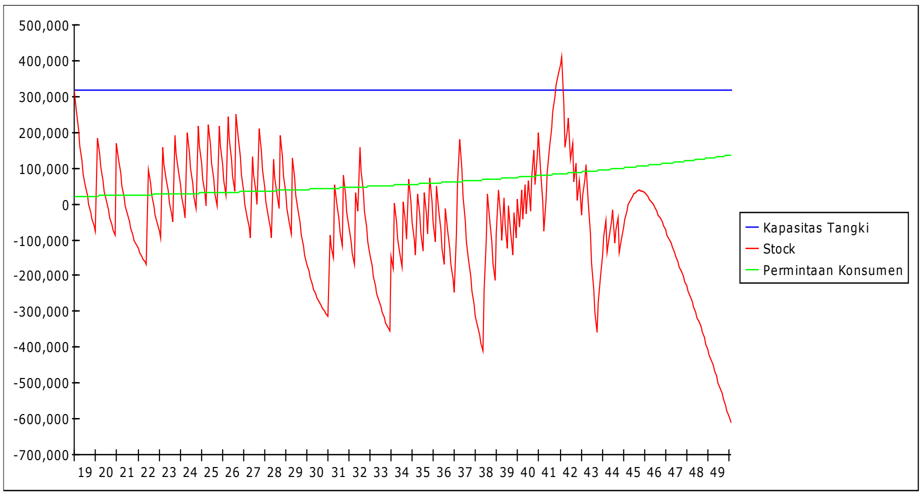
Policy analysis will be carried out with an optimization facility in powersim studio 7 to see the extent to which the ability of the Parepare Depot to meet consumer demand is influenced by the dynamics of the vehicle population. For this purpose, the simulation is carried out in 3 stages.

a. Initial simulations are simulations performed with constant input into the same model as the real system.
b. Model validation is to see whether the model has been able to present a real system that is done by calibrating the results of the initial simulation with actual data [7].
c. Policy optimization is to simulate a number of policy scenarios to view system behavior as a basis for setting optimum decisions [8].

Initial simulations are carried out by including relevant information as inputs which are the same as the conditions in the Parepare Depot. The goal is to see whether the behavior of the system is in accordance with the system being modeled.

Table 2 Preliminary Simulation Results Without Policy Scenarios

Time	Laju Komsumsi (kl/mo)	Stock (kl)	Permintaan Konsumen (kl)
1 Jan, 2019	20,857.00	318,810.00	20,857.00
1 Jan, 2020	22,143.41	-74,473.18	22,480.62
1 Jan, 2021	23,509.17	170,216.44	23,867.18
1 Jan, 2022	24,959.17	-124,823.56	25,339.25
1 Jan, 2023	26,498.59	-74,491.20	26,902.12
1 Jan, 2024	28,132.97	54,690.26	28,561.39
1 Jan, 2025	29,868.15	112,911.87	30,322.99
1 Jan, 2026	31,710.35	109,406.16	32,193.25
1 Jan, 2027	33,666.17	37,230.12	34,178.86
1 Jan, 2028	35,742.63	47,275.87	36,286.93
1 Jan, 2029	37,947.16	30,426.97	38,525.03
1 Jan, 2030	40,287.66	-167,649.77	40,901.17
1 Jan, 2031	42,772.51	-312,978.54	43,423.87
1 Jan, 2032	45,410.62	-65,928.62	46,102.16
1 Jan, 2033	48,211.45	-141,090.07	48,945.64
1 Jan, 2034	51,185.03	-146,297.67	51,964.50
1 Jan, 2035	54,342.01	-49,108.51	55,169.55
1 Jan, 2036	57,693.71	-52,590.47	58,572.29
1 Jan, 2037	61,252.13	-247,214.43	62,184.90
1 Jan, 2038	65,030.03	-311,414.04	66,020.33
1 Jan, 2039	69,040.93	-77,793.22	70,092.32
1 Jan, 2040	73,299.23	12,173.17	74,415.46
1 Jan, 2041	77,820.16	198,568.02	79,005.24
1 Jan, 2042	82,619.94	388,096.05	83,878.11
1 Jan, 2043	87,715.76	-32,515.32	89,051.53
1 Jan, 2044	93,125.88	-143,228.04	94,544.04
1 Jan, 2045	98,869.68	-66,377.06	100,375.31
1 Jan, 2046	104,967.74	31,413.81	106,566.23
1 Jan, 2047	111,441.92	-73,197.14	113,139.01
1 Jan, 2048	118,315.42	-229,213.32	120,117.17
1 Jan, 2049	125,612.85	-404,547.31	127,525.74
1 Jan, 2050	133,360.38	-592,786.47	135,391.25



Graph 1 Initial Simulation Results without Policy Scenarios

Based on the simulation results above shows fluctuations in the scarcity of premium-type fuel. It turns out that the scarcity of scarcity at one time tends to be followed by the situation of scarcity at a later time. Scarcity tends to repeat itself in a faster tempo after a previous scarcity shock.

2.6 Model Validation

Based on the simulation results, the number of consumer requests in February 2019 was 212.74 kiloliters. While the actual data of total consumer demand in July 2016 was 209.90 kiloliters. Calculation of MAPE (Mean Absolute Percentage Error) test using POM-QM software for Windows 3 which is performed on data on the number of consumer requests from February to December 2019 obtained a value of 4%. This means that there is a 4% deviation between the simulation results and the actual data. Based on the accuracy criteria of the model, the MAPE value is less than 5% (Barlas, 1989). so it can be concluded that the model can be accepted.

Table 3 Test Data Validation Mape with POM-QM Windows 3

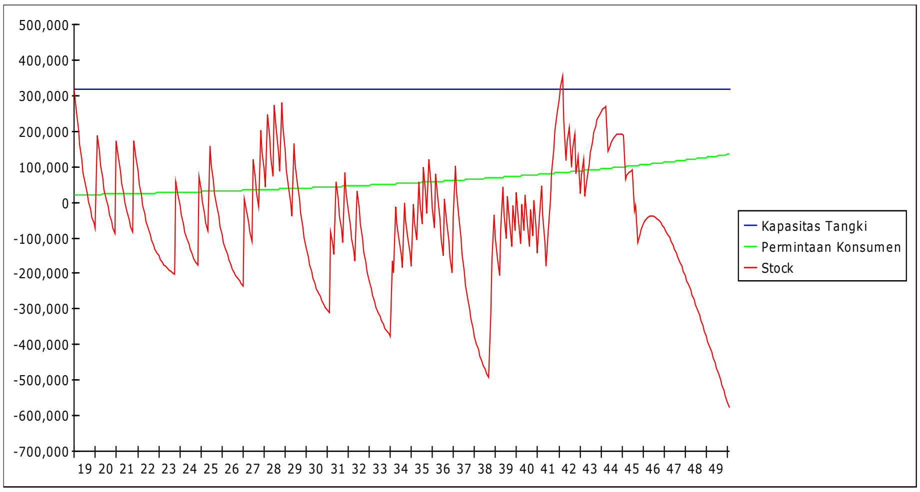
Permintaan Konsumen Solution						
	Actual	Forecast	Error	|Error|	Error^2	|Pct Error|
February	209	212	-3	3	9	.01
March	212	213	-1	1	1	0
April	211	214	-3	3	9	.01
May	219	216	3	3	9	.01
June	220	217	3	3	9	.01
July	224	218	6	6	36	.03
TOTALS	1295		5	19	73	.09
AVERAGE	215.83		.83	3.17	12.17	.01
			(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	4.27	

III. RESULTS AND DISCUSSION

3.1 Scenarios with policies on adding and reducing distributions to consumer demand. If there is a fluctuation in consumer demand, it will be difficult for companies to keep their inventory stable.

Table 4 Simulation Results with Addition policies to reduce distribution in meeting consumer demand

Time	Laju Komsumsi (kl/mo)	Stock (kl)	Permintaan Konsumen (kl)
1 Jan, 2019	20,857.00	318,810.00	20,857.00
1 Jan, 2020	22,143.41	-73,086.54	22,254.69
1 Jan, 2021	23,509.17	172,632.75	23,627.31
1 Jan, 2022	24,959.17	85,933.46	25,084.59
1 Jan, 2023	26,498.59	-151,240.46	26,631.75
1 Jan, 2024	28,132.97	-9,117.79	28,274.34
1 Jan, 2025	29,868.15	34,916.41	30,018.24
1 Jan, 2026	31,710.35	-90,374.55	31,869.70
1 Jan, 2027	33,666.17	-235,187.00	33,835.35
1 Jan, 2028	35,742.63	89,739.85	35,922.24
1 Jan, 2029	37,947.16	147,455.83	38,137.85
1 Jan, 2030	40,287.66	-127,827.29	40,490.11
1 Jan, 2031	42,772.51	-301,607.85	42,987.45
1 Jan, 2032	45,410.62	-19,567.51	45,638.82
1 Jan, 2033	48,211.45	-220,870.85	48,453.72
1 Jan, 2034	51,185.03	-375,572.84	51,442.24
1 Jan, 2035	54,342.01	-180,938.11	54,615.09
1 Jan, 2036	57,693.71	-15,250.97	57,983.62
1 Jan, 2037	61,252.13	-37,904.85	61,559.93
1 Jan, 2038	65,030.03	-376,855.94	65,356.81
1 Jan, 2039	69,040.93	-98,402.17	69,387.87
1 Jan, 2040	73,299.23	29,165.04	73,667.57
1 Jan, 2041	77,820.16	-142,385.68	78,211.22
1 Jan, 2042	82,619.94	291,520.37	83,035.12
1 Jan, 2043	87,715.76	25,143.02	88,156.54
1 Jan, 2044	93,125.88	254,705.97	93,593.84
1 Jan, 2045	98,869.68	192,032.93	99,366.51
1 Jan, 2046	104,967.74	-62,035.29	105,495.22
1 Jan, 2047	111,441.92	-71,605.30	112,001.93
1 Jan, 2048	118,315.42	-205,782.64	118,909.97
1 Jan, 2049	125,612.85	-374,982.65	126,244.07
1 Jan, 2050	133,360.38	-560,387.08	134,030.53



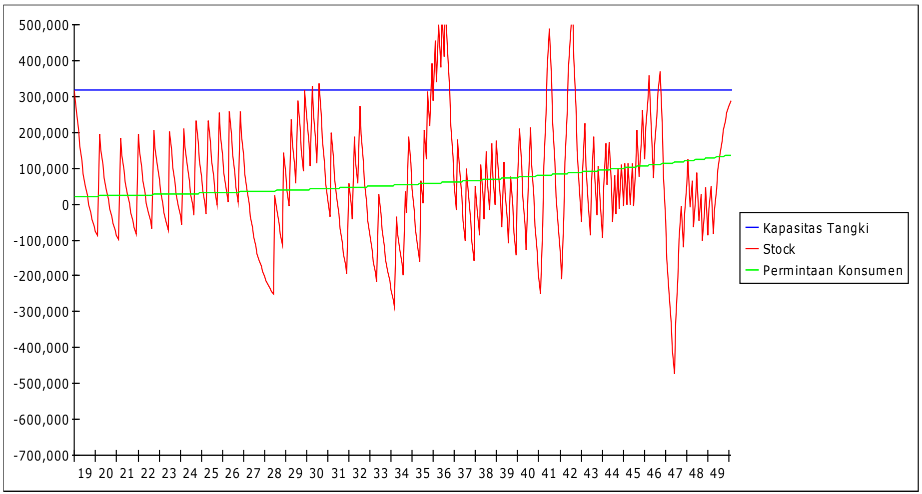
Graph 2 Simulation Results with Addition policies to reduce distribution in meeting consumer demand

In this simulation increasing demand makes stockouts occur each year. other variables in the initial simulation do not change. This affects the inventory or stock that is too much (Over Inventory). In this simulation model, company managers must adopt a policy of better forcast for the accumulation of percent premium which will cause more stable inventory so that consumer demand can be met and no stockout occurs because consumer demand depends on available stock.

3.2 Scenarios with lead time reduction policies. If the lead time that influences the supply time (as described in the initial simulation) can increase stock when the lead time is reduced so that the fulfillment of consumer demand is more stable.

Table 5 Simulation Results with Lead Time Reduction Policy

Time	Laju Komsumsi (kl/mo)	Stock (kl)	Permintaan Konsumen (kl)
1 Jan, 2019	20,857.00	318,810.00	20,857.00
1 Jan, 2020	22,143.41	-74,473.18	22,480.62
1 Jan, 2021	23,509.17	-85,758.97	23,867.18
1 Jan, 2022	24,959.17	195,452.80	25,339.25
1 Jan, 2023	26,498.59	69,819.87	26,902.12
1 Jan, 2024	28,132.97	-31,858.53	28,561.39
1 Jan, 2025	29,868.15	77,425.64	30,322.99
1 Jan, 2026	31,710.35	137,133.96	32,193.25
1 Jan, 2027	33,666.17	135,140.43	34,178.86
1 Jan, 2028	35,742.63	-202,178.43	36,286.93
1 Jan, 2029	37,947.16	88,215.84	38,525.03
1 Jan, 2030	40,287.66	238,601.98	40,901.17
1 Jan, 2031	42,772.51	8,219.84	43,423.87
1 Jan, 2032	45,410.62	57,044.85	46,102.16
1 Jan, 2033	48,211.45	-87,709.06	48,945.64
1 Jan, 2034	51,185.03	-240,441.48	51,964.50
1 Jan, 2035	54,342.01	43,812.85	55,169.55
1 Jan, 2036	57,693.71	288,249.74	58,572.29
1 Jan, 2037	61,252.13	53,343.56	62,184.90
1 Jan, 2038	65,030.03	48,752.34	66,020.33
1 Jan, 2039	69,040.93	178,424.69	70,092.32
1 Jan, 2040	73,299.23	44,587.11	74,415.46
1 Jan, 2041	77,820.16	-194,385.12	79,005.24
1 Jan, 2042	82,619.94	-141,735.60	83,878.11
1 Jan, 2043	87,715.76	-50,157.57	89,051.53
1 Jan, 2044	93,125.88	-94,574.40	94,544.04
1 Jan, 2045	98,869.68	-4,724.88	100,375.31
1 Jan, 2046	104,967.74	123,518.66	106,566.23
1 Jan, 2047	111,441.92	-44,861.67	113,139.01
1 Jan, 2048	118,315.42	55,226.13	120,117.17
1 Jan, 2049	125,612.85	-86,334.81	127,525.74
1 Jan, 2050	133,360.38	273,072.50	135,391.25



Graph 3 Simulation Results with Lead Time Reduction policy

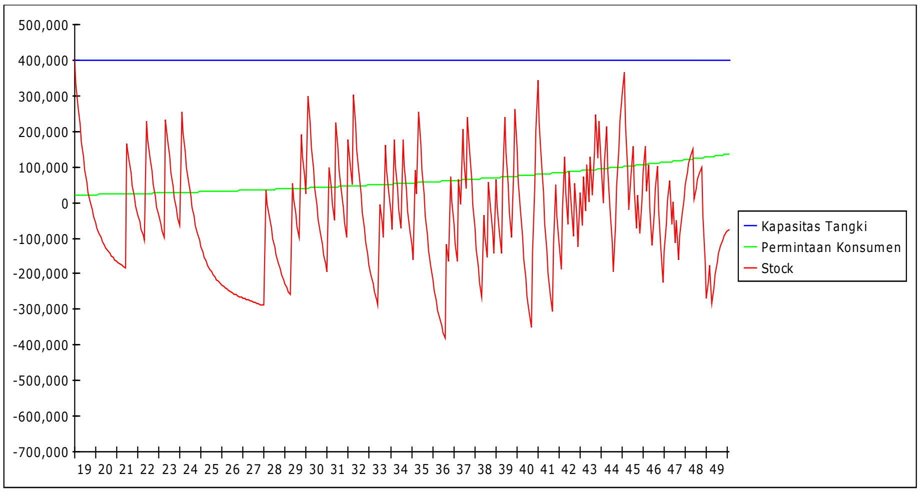
At this time, the lead time required by the depot to supply Premium is 2 days before the coverage day period runs out. This affects the available stock at the Depot. The faster the supply of Premium, the more it increases stock safety. In this model simulation, the policy to reduce lead time to 1 day waiting time to supply Premium, this could mean that Premium supplies do not wait too long to supply.

3.3 Scenarios with policies to increase tank capacity. If the addition of tank capacity can increase the security of stocks in a sustainable manner compared to current conditions (as described in the initial simulation).

Premium types of premiums owned by the Parepare Depot to be distributed to gas stations only have sufficient capacity of up to 15 days with a capacity of 318810 kiloliters. This affects the ability of distribution. The longer the coverage day, the longer the ability of the depot to be able to distribute Premium and of course affect the security of stock.

Table 6 Simulation Results with the Tank Capacity Increase Policy

Time	Laju Komsumsi (kl/mo)	Stock (kl)	Permintaan Konsumen (kl)
1 Jan, 2019	20,857.00	400,000.00	20,857.00
1 Jan, 2020	22,143.41	-56,962.84	22,480.62
1 Jan, 2021	23,509.17	-164,435.30	23,867.18
1 Jan, 2022	24,959.17	-33,964.46	25,339.25
1 Jan, 2023	26,498.59	-36,480.75	26,902.12
1 Jan, 2024	28,132.97	-65,730.61	28,561.39
1 Jan, 2025	29,868.15	-123,448.55	30,322.99
1 Jan, 2026	31,710.35	-231,851.92	32,193.25
1 Jan, 2027	33,666.17	-267,889.39	34,178.86
1 Jan, 2028	35,742.63	-289,100.34	36,286.93
1 Jan, 2029	37,947.16	-227,696.63	38,525.03
1 Jan, 2030	40,287.66	23,823.06	40,901.17
1 Jan, 2031	42,772.51	-193,699.22	43,423.87
1 Jan, 2032	45,410.62	176,594.15	46,102.16
1 Jan, 2033	48,211.45	-176,817.44	48,945.64
1 Jan, 2034	51,185.03	-27,085.46	51,964.50
1 Jan, 2035	54,342.01	-120,648.68	55,169.55
1 Jan, 2036	57,693.71	-215,319.87	58,572.29
1 Jan, 2037	61,252.13	-60,849.19	62,184.90
1 Jan, 2038	65,030.03	-72,894.35	66,020.33
1 Jan, 2039	69,040.93	64,264.17	70,092.32
1 Jan, 2040	73,299.23	155,721.46	74,415.46
1 Jan, 2041	77,820.16	343,293.31	79,005.24
1 Jan, 2042	82,619.94	-118,368.56	83,878.11
1 Jan, 2043	87,715.76	26,478.87	89,051.53
1 Jan, 2044	93,125.88	107,158.87	94,544.04
1 Jan, 2045	98,869.68	302,744.78	100,375.31
1 Jan, 2046	104,967.74	89,180.19	106,566.23
1 Jan, 2047	111,441.92	-135,899.32	113,139.01
1 Jan, 2048	118,315.42	49,295.11	120,117.17
1 Jan, 2049	125,612.85	-268,312.55	127,525.74
1 Jan, 2050	133,360.38	-77,804.61	135,391.25



Graph 4 Simulation Results with Policy on Adding Tank Capacity

the simulation results above show that the depot ability to meet consumer demand is more stable. In 2025 until 2029, scarcity or stockout can occur at a time but is still within the limits of being able to meet consumer demand. However, the stock has increased where the stockout or scarcity tends to decrease. Whereas in terms of tank capacity, it is able to accommodate stock in meeting consumer demand, which can be seen from the results of tank capacity simulation that is greater than fluctuating stock according to existing consumer demand.

IV. CONCLUSION AND ADVICE

4.1 Conclusion

a. The results in analyzing the dynamic behavior of the system to determine future premium demand based on the rate of consumer demand by running simulations are:

1. Policy with the addition of reducing the distribution to meet consumer demand with an initial value of 98% to 99% shows that the stockout in 2020 to 2041 is not able to compensate for fluctuating consumer demand, while in terms of the capacity of the tank capacity that is unable to accommodate premium stock in the year 2042.
2. Policy with reduced Lead Time, show that the faster the supply of Premium, the more stock safety will increase. However, in 2040 to 2041 the depot experienced a stockout and could not meet high consumer demand. While in terms of tank capacity in 2036, 2042, 2043 and 2047 stock is greater than the existing tank capacity.
3. Policy with the addition of tank capacity, shows that the ability of the depot This affects the ability of distribution. The longer the coverage day, the longer the ability of the depot to be able to distribute Premium and of course affect the security of stock. In this model simulation, the policy to increase tank capacity to increase its coverage day to 30 days with a capacity of 400,000 kiloliters will cause a more stable stock so that demand. consumers can be fulfilled because consumer demand depends on the available stock.

b. Based on the results of simulations and the development of effective policy scenarios out of the 3 scenarios in balancing between supply and distribution systems to meet consumer demand in a sustainable manner is a scenario with a policy to increase tank capacity.

The addition of tank capacity is also inseparable from the managerial decision of the Pare-pare Depot. Need to consider the financial and investment side in the construction of new premium tanks. Therefore it is necessary to provide a spare tank. Which may be at any time in the next 10 years after 2042 the tank capacity cannot accommodate more premiums based on fluctuating consumer demand.

4.2 Advice

Model development can be done by involving financial aspects, government policies regarding subsidized premiums, the distribution process (transportation), fulfillment of raw materials, and diversion to determine the effect on the dynamics of supply of premium consumption behavior in a situation of scarcity by identifying variables in more detail in the dynamic system model. And can involve the type and capacity of premium tanks of each type of gas station that is distributed premium from the pare-pare depot by considering other assumptions related to premium distribution from TBBM to the gas station. Verification and validation of the model requires more complete data to obtain a model that can approach the real system.

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