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DESIGNING AN INVENTORY MODEL FOR THE BEHAVIOR OF DEPENDENCE ON LPG GAS CONSUMPTION OF 3 KG USING THE DYNAMIC SYSTEM SIMULATION METHOD IN LUWUK BANGGAI REGENCY

Izzul Aziz[1], Abdul Mail, Muhammad Nusran, Anis Saleh, Dirgahayu Lantara, Muhammad Fachry, Nurhayati Rauf

Industrial Engineering Study Program, Faculty of IndustrialTechnology, Indonesian Muslim University
Jl. Urip Sumoharjo Km. 5 Makassar., South Sulawesi 90231
Email: izzulazizdj1999@gmail.com

ABSTRACT

Liquefied Petroleum Gas (LPG) or more commonly known as LPG gas is a gas stove fuel that comes from the results of liquefied petroleum gas and is then put into a tube, one of which is a 3-kilogram tube. The behavior of dependence on the consumption of 3-kilogram gas cylinders from the people of Banggai Regency can be seen from the use of non-subsidized 3 kilogram LPG gas, namely (±) 32. 002 people/group, the second is the consumption rate from subsidies and non-subsidies, namely 38. 864 units from total users, namely (±) 45. 000 people/groups with a supply of 30. 800 units and the third about frequent scarcity in 2020 and early 2021 reported by Banggai News and Obormotindok. Simulation Method Dynamic systems are modeling and running simulations of real systems to analyze problems and present solutions from policy scenarios from the researcher's perspective. By using this method, researchers can identify the behavior of 3 kilograms of gas consumption from the rate of consumption and demand through tables and graphs using the Powersim Studio 7 software. The results of the study present 3 policy scenarios, namely the first scenario regarding an increase in the transition to 99% non-subsidized gas cylinders with simulation results, namely September 1 2021 - October 1 2022 the demand is fulfilled, the second scenario regarding the addition of a 7th agent with simulation results, namely September 1 2021 - April 1 2023 demand can still be fulfilled and the third scenario regarding an increase in the transition to 99% non-subsidized gas cylinders and the addition of a 7th agent with simulation results, namely 1 September 2021 – 1 September 2023 the demand for needs is fulfilled. The conclusion is that the third policy scenario will be taken because among the policy scenarios presented, the preparation of tube supplies is fulfilled within two years, namely September 1 2021 - September 1 2023.

Keywords: Inventory Design, 3 kilogram Gas Cylinder, Consumption Dependent Behavior, Dynamic System Simulation, Powersim Studio 7

I. PENDAHULUAN

Luwuk is an area that gets a subsidy for 3 kg gas cylinders as a distribution center area in Banggai Regency with 6 agents and one of the gas cylinder refueling centers in Central Sulawesi. The number of inhabitants in a region greatly affects the number of users of a product. The number of users growing will be closely related to the large rate of consumption and demand. The definition of consumption rate is the amount of use/duration of use of the product calculated within a certain period of time and the request is an order made by the user of a product. The use of gas cylinders 3 kg which affects the rate of consumption consists of households for daily cooking needs and the use of food stall business activities and fishermen's activities.

The household subsidy category Based on Presidential Regulation No. 104/2007 and Minister of Energy and Mineral Resources Regulation No. 21/2007 has an income below Rp 1.5 million per month. The micro-business category is where the level of education is relatively low, the number of workers is less than 10 people, assets are IDR 50 million, and a maximum turnover of IDR 300 million per year. According to Presidential Regulation (Perpres) Number 38 of 2019 category for fishermen to drive fishing boats to meet the needs of daily life. People who do not meet the criteria for pre-welfare, industry players, and the State Civil Apparatus (ASN) can use BRIGHT GAS LPG of 5.5 Kg and 12 Kg.

If the need for this use increases unbalanced by inventory, there will be a loss of scarcity and if the inventory is excessive, it will affect the storage capacity in the warehouse. Consumer behavior is a process that is closely related to the existence of a purchasing process, at that time consumers carry out activities such as searching, researching, and evaluating products and services (product and services) (Ginting, 2019). Consumer behavior in addition to product quality also includes product prices, promotions are also about the place where the goods are sold (distribution) (Ginting, 2019).

SPPBE is a business unit managed by PT. Pertamina or private sector in the form of a legal entity with transportation or receiving activities, as well as administrative activities in accordance with the terms and work procedures that have been determined by Pertamina as stated in the letter of agreement for the establishment of SPPBE (Subakdo & Nugroho, 2016).

An agent is a company in the form of a Limited Liability Company which is appointed officially by PT. Pertamina to distribute LPG gas 3 Kg. Pangkalan is a sub-agent that is also an individual business officially recognized by PT. Pertamina in distributing 3 kg of elpiji gas from agents (Effendy, 2017)

Dynamic System Simulation Method is a method of modeling real systems and running simulations to analyze so that the conclusion of this method is to present policy scenarios from the perspective of researchers. Modeling is a tool in decision-making (Khotimah, 2015). The model is described as a restricted system. Simulation is a decision support technique in modeling, for example, solving business problems economically and precisely facing complicated calculations and a lot of data. (Khotimah, 2015) . Modeling and running simulations are carried out using Powersim Studio 7 *Software.*

II. RESEARCH METHODS

2.1 Time and Place of Research

This research was conducted for 1 month in July-August 2021. The place where this research was conducted at SPPBE PT. Mitra Trio Arba Putra and 6 Agents are located in Luwuk District, Banggai Regency.

2.2 Data Collection

2.2.1 Data Primer

The primary data related to the 3 kg gas cylinder in this study is the production and distribution flow, gas cylinder replenishment data at SPPBE, inventory data, and scheduling of distribution of each agent to the base (sub-agent).

2.2.2 Secondary Data

Secondary data related to the 3 kg gas cylinder in this study are data on consumption and demand rates, and inventory studies regarding dynamic system simulation methods.

2.3 Data Processing

The data processing used in this study uses the Dynamic System Simulation method: identification of model variables, causal loop diagrams, stock flow diagrams, and model formulations. Furthermore, the running stage of the Simulation consists of initial simulation,

initial verification, and validation, and design of policy scenarios.

III. RESULTS AND DISCUSSION
3.1 **Model Variable** Identification

Table 1. Observation Sheet

| Analyzes	Review
SPPBE PT. Mitra Trio Arba Putra	**Serves 6 agents with an average filling of 3-5 times a week. Every 1 time 560 and 1120 units are charged.**
Agent	**The supply of tubes is 3 kg from each 5 agents, namely 2240 units and 1 agent is 1120 units. The average base stock is 40-50 units.**

Table 2. Demand for 3 Kg LPG Gas Cylinders in 2021

Moon	Demand (unit)	Supply **Rate** (units)
March	**32. 365**	**30.800**
April	**34. 675**	
May	**36. 675**	
June	**38. 856**	
July	**38. 864**	
August	**40. 846**	

The limitations of the model in this study are exogenous variables consisting of raw materials and profits, variables outside the discussion of the model, namely downstream oil and gas business activities

3.2 Diagram Causal Loop

A causal loop diagram is a relationship between causal variables caused by a problem in the form of a series of systems. Identifying and analyzing information from the supply of LPG gas 3 kg can determine the influences of variables from filling gas to tubes to distribution to the community.
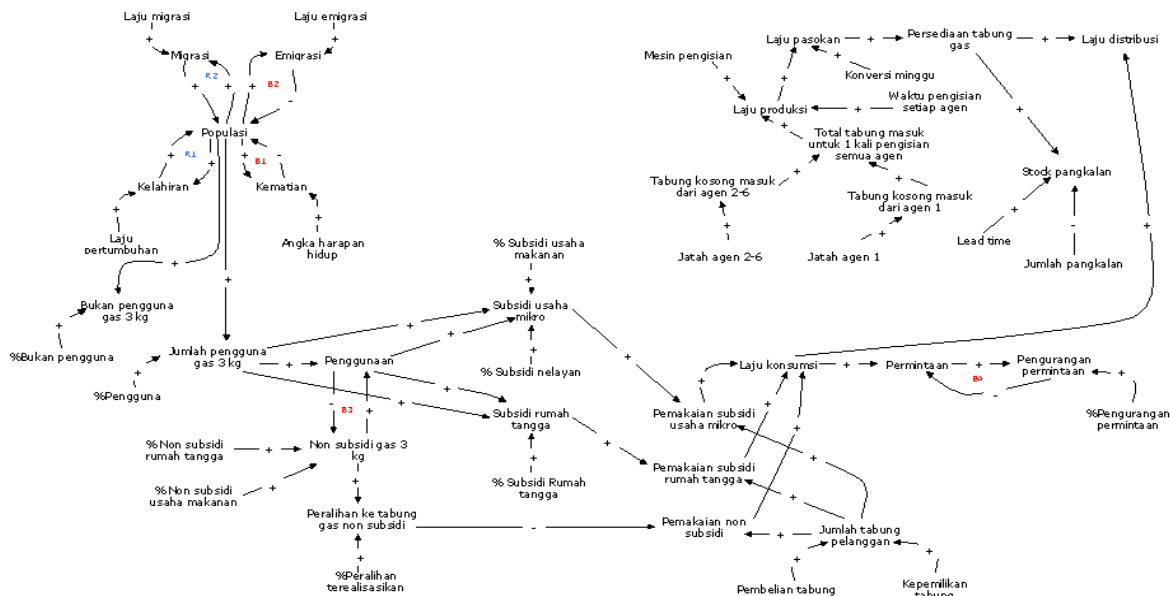
Figure 1. Overall Causal Loop Diagram

3.3 Stock Flow Diagram and Model Formulation

Stock and flow diagrams are types of variables given the flow chart symbol to be able to distinguish between variables with the intention of presenting the work of the system clearly and in detail. In the flow chart, there are four symbols, namely level, rate, auxillary and constant. The sub-model in the causal loop of this study is a type of level variable that is the focus of the part that will be analyzed for its occurrence factors.

The formulation of the model is written mathematically to describe the state of variables in the relationship between cause and effect. Model oformulationswill be entered to determine the value of the simulation output.
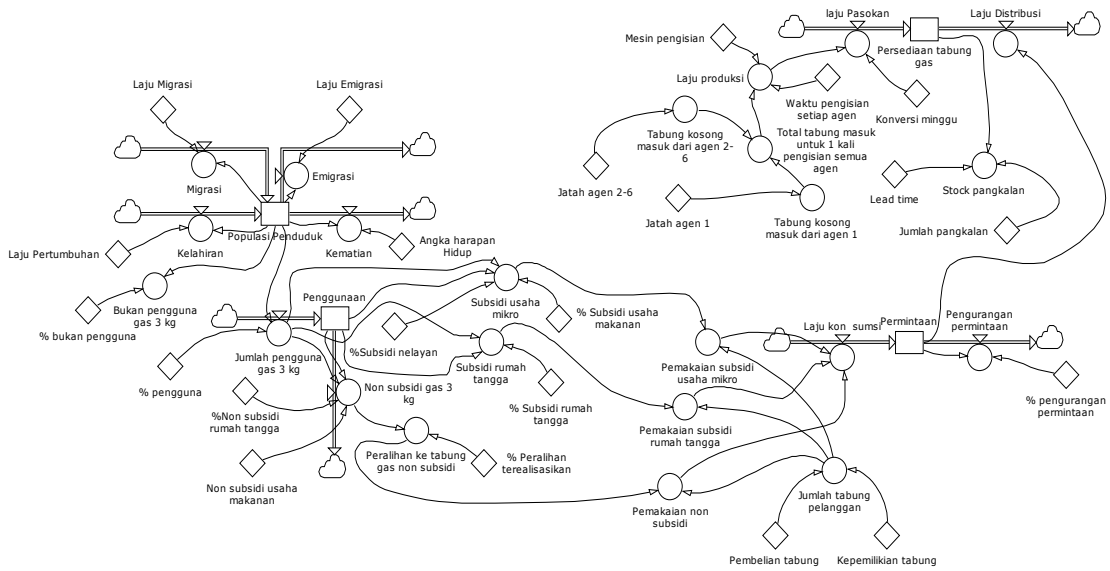
Figure 2. Overall Stock Flow Diagram

3.5 Running Simulation
3.5.1 Initial Simulation

The initial simulation is to simulate by inputting variable data into the model according to real circumstances.

Table 3. Early Simulation Without Policy Scenario

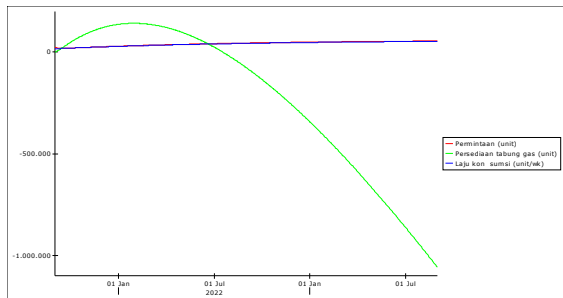| Time	Laju kon sumsi (unit/wk)	Permintaan (unit)	Persediaan tabung gas (unit)	Stock pangkalan (mo^-1)
01 Sep 2021	15.930,22	23.865,00	0,00	0,00
01 Oct 2021	19.308,23	19.374,97	48.811,38	130,63
01 Nov 2021	22.413,59	22.580,42	91.155,26	243,95
01 Dec 2021	25.268,13	25.614,81	120.006,71	321,16
01 Jan 2022	27.891,94	28.405,03	136.365,33	364,94
01 Feb 2022	30.303,50	30.969,58	141.240,02	377,98
01 Mar 2022	32.519,79	33.326,54	135.559,96	362,78
01 Apr 2022	34.556,45	35.492,51	120.179,97	321,62
01 May 2022	36.427,87	37.482,79	95.886,41	256,61
01 Jun 2022	38.147,27	39.311,44	63.402,68	169,68
01 Jul 2022	39.726,82	40.991,42	23.394,27	62,61
01 Aug 2022	41.177,73	42.534,61	-23.526,64	-62,96
01 Sep 2022	42.510,30	43.951,99	-76.796,86	-205,52
01 Oct 2022	43.733,99	45.253,61	-135.898,32	-363,69
01 Nov 2022	44.857,53	46.448,74	-200.354,41	-536,18
01 Dec 2022	45.888,94	47.545,93	-269.726,69	-721,84
01 Jan 2023	46.835,60	48.553,00	-343.611,84	-919,57
01 Feb 2023	47.704,28	49.477,17	-421.638,81	-1.128,38
01 Mar 2023	48.501,24	50.325,08	-503.466,30	-1.347,37
01 Apr 2023	49.232,22	51.102,84	-588.780,29	-1.575,68
01 May 2023	49.902,50	51.816,07	-677.291,95	-1.812,56
01 Jun 2023	50.516,94	52.469,93	-768.735,56	-2.057,28
01 Jul 2023	51.080,02	53.069,18	-862.866,68	-2.309,19
01 Aug 2023	51.595,84	53.618,19	-959.460,43	-2.567,69
01 Sep 2023	52.068,20	54.120,98	-1.058.309,97	-2.832,23

Figure 1. Haul Early Simulation Without Policy Scenario

Based on the preliminary simulation results Based on the results of the initial simulation starting From September 1, 2021, to September 1, 2023, it can be seen that the supply of gas cylinders has increased from September 1, 2021 – February 1, 2022, and began to decline from March 1 – June 1, 2022, to meet the increasing demand. On July 1, 2022, demand began to go unmet and always experienced a drastic decline from month to month.

3.5.2 Model Verification and Validation

If the system is declared verified and validated means that the model has been able to describe and explain the real system. Model validation is carried out with the MAPE Test, which is to see the difference between forecasting and actual values. Mean Absolute Percentage error (MAPE) aims to provide information about the percentage of errors in the forecasting performed. The smaller the MAPE percentage value the better or more accurate the forecasting is performed. The MAPE test was performed using the help of QM for Windows V50 software.

Table 4. Mape Test Data Validation with QM Windows V50

Permintaan Gas Elpiji 3 kg Solution						
	Actual	Forecast	Error	|Error|	Error^2	|Pct Error|
September	21876	23865	-1989	1989	3956121	9,092%
Oktober	21870	19374,97	2495,029	2495,029	6225171	11,408%
November	21756	22580,42	-824,42	824,42	679668,2	3,789%
Desember	24876	25614,81	-738,811	738,811	545841	2,97%
Januari	27453	28405,03	-952,029	952,029	906359,8	3,468%
Februari	28764	30969,58	-2205,58	2205,58	4864584,0	7,668%
Maret	32365	33326,54	-961,539	961,539	924557,4	2,971%
April	34675	35492,51	-817,512	817,512	668325,4	2,358%
Mei	36675	37482,79	-807,789	807,789	652523,2	2,203%
Juni	38856	39311,44	-455,441	455,441	207426,9	1,172%
Juli	38864	40991,42	-2127,422	2127,422	4525924	5,474%
Agustus	40846	42534,61	-1688,609	1688,609	2851402,0	4,134%
TOTALS	368876		-11073,12	16063,18	27007900	56,707%
AVERAGE	30739,67		-922,76	1338,599	2250659,0	4,726%
			(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	1643,408	

The actual data of the simulation in the LPG gas demand is data in 2020-2021 and normal data based on the results of the initial simulation that has been

carried out, namely September 2021-August 2022. Based on the tests that have been carried out, the percentage of MAPE values, which is 4.726% smaller than 5% (Lomauro and Bakshi 1985 in Somantri, 2005) means that the forecasting carried out is accurate according to the real system that will occur in the future so that the model is accepted.

3.5.3 Policy Scenario Design

A scenario is an overview of the likely things that will happen in the future by taking several decisions. Design policy scenarios that are built on the analysis of the problem and the system thinking perspective of the researcher.

1. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99%

The use of 3 kg LPG gas is used by non-subsidies so it affects demand. This scenario is taken based on the policy of 3 kg tubes which are subsidized tubes so that only the subsidy group is entitled to it. It is assumed that n other model variables are considered constant.

Table 5. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99%

Time	Laju kon sumsi (unit/wk)	Permintaan (unit)	Persediaan tabung gas (unit)	Stock pangkalan (mo^-1)
01 Sep 2021	13.049,97	23.865,00	0,00	0,00
01 Oct 2021	16.331,04	16.333,31	58.713,50	157,13
01 Nov 2021	19.347,38	19.408,90	114.408,03	306,18
01 Dec 2021	22.120,19	22.355,92	157.035,85	420,26
01 Jan 2022	24.668,96	25.066,31	187.528,93	501,86
01 Feb 2022	27.011,64	27.557,60	206.866,40	553,61
01 Mar 2022	29.164,73	29.847,31	215.950,48	577,92
01 Apr 2022	31.143,40	31.951,58	215.611,17	577,01
01 May 2022	32.961,62	33.885,26	206.612,00	552,93
01 Jun 2022	34.632,23	35.662,01	189.655,37	507,55
01 Jul 2022	36.167,07	37.294,39	165.387,44	442,61
01 Aug 2022	37.576,99	38.793,97	134.402,64	359,69
01 Sep 2022	38.872,00	40.171,37	97.247,80	260,25
01 Oct 2022	40.061,30	41.436,38	54.425,96	145,65
01 Nov 2022	41.153,35	42.598,00	-6.399,89	17,13
01 Dec 2022	42.155,95	43.664,51	-46.404,70	-124,19
01 Jan 2023	43.076,25	44.643,52	-103.596,19	-277,24
01 Feb 2023	43.920,85	45.542,04	-164.814,32	-441,07
01 Mar 2023	44.695,80	46.366,52	-229.727,66	-614,79
01 Apr 2023	45.406,69	47.122,87	-298.031,34	-797,59
01 May 2023	46.058,63	47.816,57	-369.444,89	-988,70
01 Jun 2023	46.656,37	48.452,62	-443.710,30	-1.187,45
01 Jul 2023	47.204,22	49.035,65	-520.590,24	-1.393,19
01 Aug 2023	47.706,20	49.569,89	-599.866,36	-1.605,35
01 Sep 2023	48.165,97	50.059,26	-681.337,80	-1.823,38
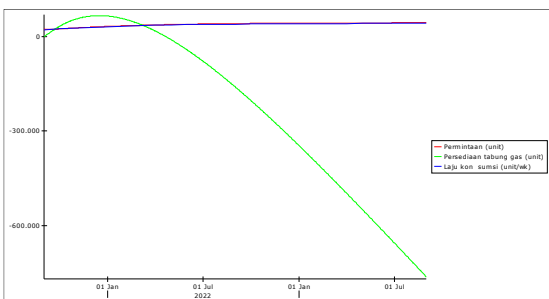
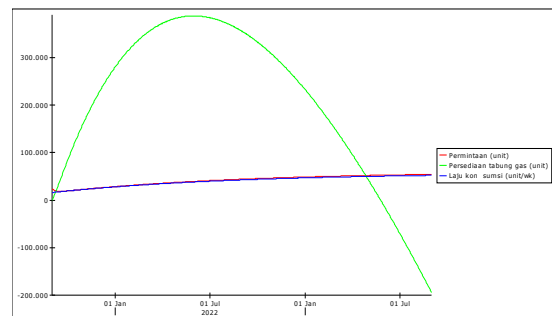**Figure 2. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99%**

The first scenario of the simulation results is September 1, 2021 – October 1, 2022, if the request is met.

2. Scenario with agent patching policy to 7

The agents available in Banggai Regency are 6 agents. Researchers carried out this scenario because the average maximum agent ratio was 2240 units, so there was no addition of tube rations from the previous agent but added 7 agents. As for the requirements for adding agents from Pertamina, there is no special limit on the maximum number of agents owned by the Regency/City from the relevant reference. It is assumed the value of the other model variables is considered constant only the variable number of bases consumed by the researcher's fish from 1121 units to 1276 units.

Table 6. Scenario with agent addition policy to 7

| Time	Laju kon sumsi (unit/wk)	Permintaan (unit)	Persediaan tabung gas (unit)	Stock pangkalan (mo^-1)
01 Sep 2021	15.930,22	23.865,00	0,00	0,00
01 Oct 2021	19.308,23	19.374,97	84.811,38	199,40
01 Nov 2021	22.413,59	22.580,42	163.155,26	383,59
01 Dec 2021	25.268,13	25.614,81	228.006,71	536,07
01 Jan 2022	27.891,94	28.405,03	280.365,33	659,17
01 Feb 2022	30.303,50	30.969,58	321.240,02	755,27
01 Mar 2022	32.519,79	33.326,54	351.559,96	826,55
01 Apr 2022	34.556,45	35.492,51	372.179,97	875,03
01 May 2022	36.427,87	37.482,79	383.886,41	902,55
01 Jun 2022	38.147,27	39.311,44	387.402,68	910,82
01 Jul 2022	39.726,82	40.991,42	383.394,27	901,40
01 Aug 2022	41.177,73	42.534,61	372.473,36	875,72
01 Sep 2022	42.510,30	43.951,99	355.203,14	835,12
01 Oct 2022	43.733,99	45.253,61	332.101,68	780,80
01 Nov 2022	44.857,53	46.448,74	303.645,59	713,90
01 Dec 2022	45.888,94	47.545,93	270.273,31	635,44
01 Jan 2023	46.835,60	48.553,00	232.388,16	546,37
01 Feb 2023	47.704,28	49.477,17	190.361,19	447,56
01 Mar 2023	48.501,24	50.325,08	144.533,70	339,81
01 Apr 2023	49.232,22	51.102,84	95.219,71	223,87
01 May 2023	49.902,50	51.816,07	42.708,05	100,41
01 Jun 2023	50.516,94	52.469,93	-12.735,56	-29,94
01 Jul 2023	51.080,02	53.069,18	-70.866,68	-166,61
01 Aug 2023	51.595,84	53.618,19	-131.460,43	-309,08
01 Sep 2023	52.068,20	54.120,98	-194.309,97	-456,84

Figure 3. Scenario with agent addition policy to 7

In the second scenario of the simulation results, namely September 1, 2021 – April 1, 2023, the request can still be met.

3. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99% and the addition of a 7th agent

The third scenario is a combination of the first and second scenarios.

Table 7. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99% and adding agents to 7

Time	Laju kon sumsi (unit/vk)	Permintaan (unit)	Persediaan tabung gas (unit)	Stock pangkalan (mo^-1)
01 Sep 2021	13.049,97	23.865,00	0,00	0,00
01 Oct 2021	16.331,04	16.333,31	94.713,50	222,68
01 Nov 2021	19.347,38	19.408,90	186.408,03	438,26
01 Dec 2021	22.120,19	22.355,92	265.035,85	623,13
01 Jan 2022	24.668,96	25.066,31	331.528,93	779,46
01 Feb 2022	27.011,64	27.557,60	386.866,40	909,56
01 Mar 2022	29.164,73	29.847,31	431.950,48	1.015,56
01 Apr 2022	31.143,40	31.951,58	467.611,17	1.099,40
01 May 2022	32.961,62	33.885,26	494.612,00	1.162,88
01 Jun 2022	34.632,23	35.662,01	513.655,37	1.207,65
01 Jul 2022	36.167,07	37.294,39	525.387,44	1.235,24
01 Aug 2022	37.576,99	38.793,97	530.402,64	1.247,03
01 Sep 2022	38.872,00	40.171,37	529.247,80	1.244,31
01 Oct 2022	40.061,30	41.436,38	522.425,96	1.228,27
01 Nov 2022	41.153,35	42.598,00	510.399,89	1.200,00
01 Dec 2022	42.155,95	43.664,51	493.595,30	1.160,49
01 Jan 2023	43.076,25	44.643,52	472.403,81	1.110,67
01 Feb 2023	43.920,85	45.542,04	447.185,68	1.051,38
01 Mar 2023	44.695,80	46.366,52	418.272,34	983,40
01 Apr 2023	45.406,69	47.122,87	385.968,66	907,45
01 May 2023	46.058,63	47.816,57	350.555,11	824,19
01 Jun 2023	46.656,37	48.452,62	312.289,70	734,22
01 Jul 2023	47.204,22	49.035,65	271.409,76	638,11
01 Aug 2023	47.706,20	49.569,89	228.133,64	536,36
01 Sep 2023	48.165,97	50.059,26	182.662,20	429,46
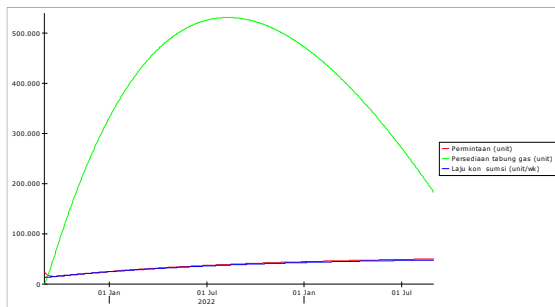
Figure 4. Scenario with a policy of increasing the switch to non-subsidized gas cylinders by 99% and adding agents to 7

The third scenario of the simulation results is September 1, 2021 – September 1, 2023, the demand for needs is met.

IV. CONCLUSION AND SUGGESTIONS
4.1 Conclusion
1. The occurrence of dependence on the consumption of 3 kg LPG gas in the Banggai Regency is due to lighter tubes and cheaper tube construction prices with subsidy rates of IDR 22,000 - 25,000 in August 2021. The second reason for the consumer behavior is that this type of tube is still open distribution, which means that it does not meet the criteria for receiving subsidy users so that the public (non-subsidized) is free to make requests.
2. The design of the model has been carried out using causal loops and stock diagrams, namely the population of Banggai Regency, usage, demand for LPG gas of 3 kg, and supply of LPG gas of 3 kg. There are 3 policy scenarios according to the researcher's perspective, namely the first scenario, namely the policy of increasing the switch to non-subsidized gas cylinders by 99% with simulation results,

namely September 1, 2021 – October 1, 2022, the demand is met. In the second scenario, namely scenarios with the policy of adding agents to 7 with simulation results, namely September 1, 2021 – April 1, 2023, the request can still be met. The third scenario is the policy of increasing the switch to non-subsidized gas cylinders by 99% and adding agents to the 7th with simulation results, namely September 1, 2021 – September 1, 2023, the demand for needs is met. The conclusion is that the third policy scenario will be taken because among the policy scenarios presented the preparation of tube supplies is met with a time of two years.

4.2 Advice
The researcher's advice related to the research that has been carried out is

1. It is necessary to collect public data which is classified as subsidized and non-subsidized at each base as a requirement for exchanging 3 kg tubes so that the closed distribution runs well and restrictions on taking the number of tubes taken, namely 1 unit or 1-2 units. In addition, for non-subsidized tube exchange rates such as 5.5 kg tubes for IDR 90,000 and 12 kg for IDR 190,000, the tariff is considered more than the price in force in August 2021 so that the transition of non-subsidized users to non-subsidized tubes can run according to the third scenario according to the researcher's perspective. The addition from the researcher is related to the distribution time at the base adjusted to the schedule and it is necessary to supervise the course of this distribution
2. Further research can be carried out on model development by adding a sub-model for filling gas cylinders at SPPBE so that the construction of the model can be started from the receipt of LPG stock from PT. Pertamina and the private sector.

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