Equipment Development Analysis Based on System Dynamics

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Abstract

The equipment development is an important part of national construction. It must be systematically studied. According to the method of system dynamics, the system dynamics model of equipment development is established. Taking the development of equipment as an example, the simulation experiments are carried out. The results show that this model is feasible. Provide an important means for equipment development decision-making.

Keywords

System dynamics, equipment development, simulation, decision.

1. Introduction

Equipment development refers to the activities of building new equipment, expanding the scale of equipment and raising the level of equipment, and involves activities in all aspects of equipment development strategy, planning, research, production, procurement, and management [1].

System Dynamics(SD) is an important system analysis method [2]. The idea of solving the problem is to construct the SD model through system analysis, and use the model to simulate different countermeasures to realize the countermeasure analysis[3]. In this paper, the principle of system dynamics and modeling are used to establish SD dynamic model of equipment development. According to the model, simulation is carried out to analyze the relationship between equipment development and various factors, which provides an important basis for equipment development decision-making.

2. Equipment development direction

Equipment development, should be analyzed demand and weaknesses in the existing equipment system, the state's economic and technological support capabilities and system objectives and other aspects of the program, and to plan equipment development direction, the final formation of the optimal equipment system.

Mainly based on the following three situations: First, potential rivals have developed equipment has been used to pose a threat to us. Second, a technical breakthrough that allows us to apply new technologies in the development of new equipment. Third, equipment System defects or active equipment has been achieved, need to be updated. In view of the above three cases, there are three main solutions to this problem: one is to develop new equipment; the other is to improve the existing equipment; the third is to produce the existing equipment and increase its quantity.

3. Causal analysis diagram

According to the principle of system dynamics, the establishment of causal relationship between equipment development in Figure 1:

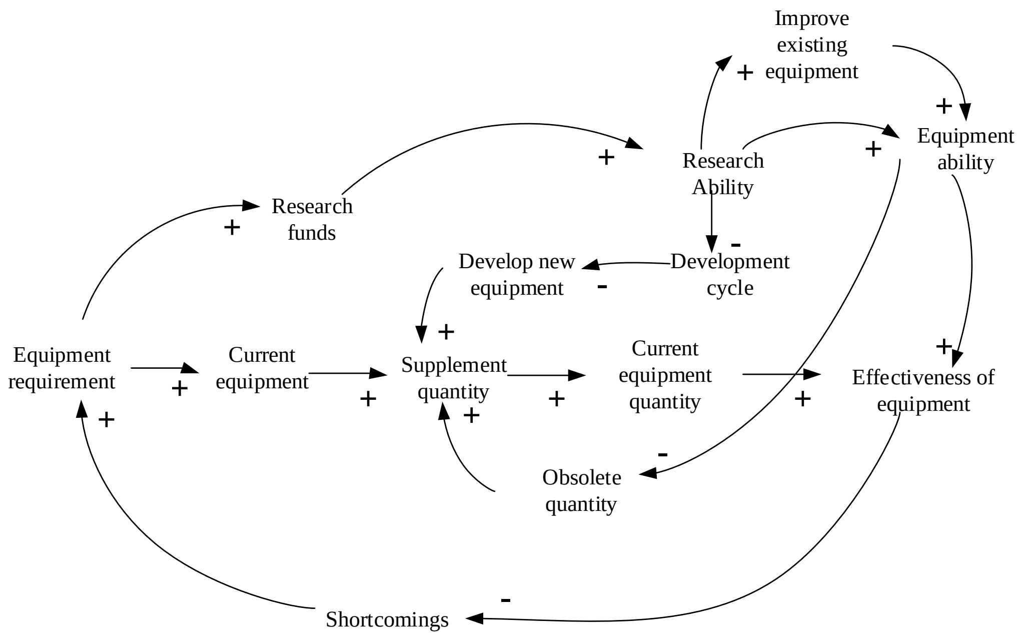


Fig. 1 Equipment development causal map

There are 5 feedback loops in Fig. 1.

Existing equipment production and the actual number of equipment circuit, that is, according to the gap between the two sides of the equipment, analysis of needs, production of existing equipment, make up for the number of equipment, increase the actual number of equipment, improve equipment capabilities, thereby reducing the gap with the other equipment. This loop is a negative feedback loop.

The new equipment development and production and the actual quantity of equipment circuit, that is, according to the gap between the two sides of equipment, analysis of needs, increase research funding, improve the level of scientific research, new equipment development, replenishment of equipment, increase the number of actual equipment, improve equipment capabilities , And then narrow the gap with the other equipment. This loop is a negative feedback loop.

Existing equipment improvement and equipment combat capability loop, that is, according to the gap between the enemy and our equipment, analysis of enemy threats, increase investment in scientific research, improve the level of scientific research, improve existing equipment, optimize equipment performance and improve equipment combat capability, And then narrow the gap with the enemy's equipment. This loop is a negative feedback loop.

The number of outdated equipment and the actual number of equipment circuit, that is, according to the gap between the two sides of equipment, analysis of needs, increase investment in scientific research, improve the level of scientific research, optimize equipment performance, reduce equipment out, add equipment, increase the number of actual equipment, improve Equipment capabilities, thereby reducing the gap with the other equipment. This loop is a positive feedback loop.

The level of scientific research and equipment combat capability circuit, that is, according to the gap between the two sides of equipment, analysis of needs, increase investment in scientific research, improve the level of scientific research, optimize equipment performance, improve equipment capabilities, and thus narrow the gap with the other equipment. This loop is a positive feedback loop.

4. Equipment Development Model Flow Chart

According to the principle of system dynamics, the establishment of equipment development flow chart is as in Fig. 2.

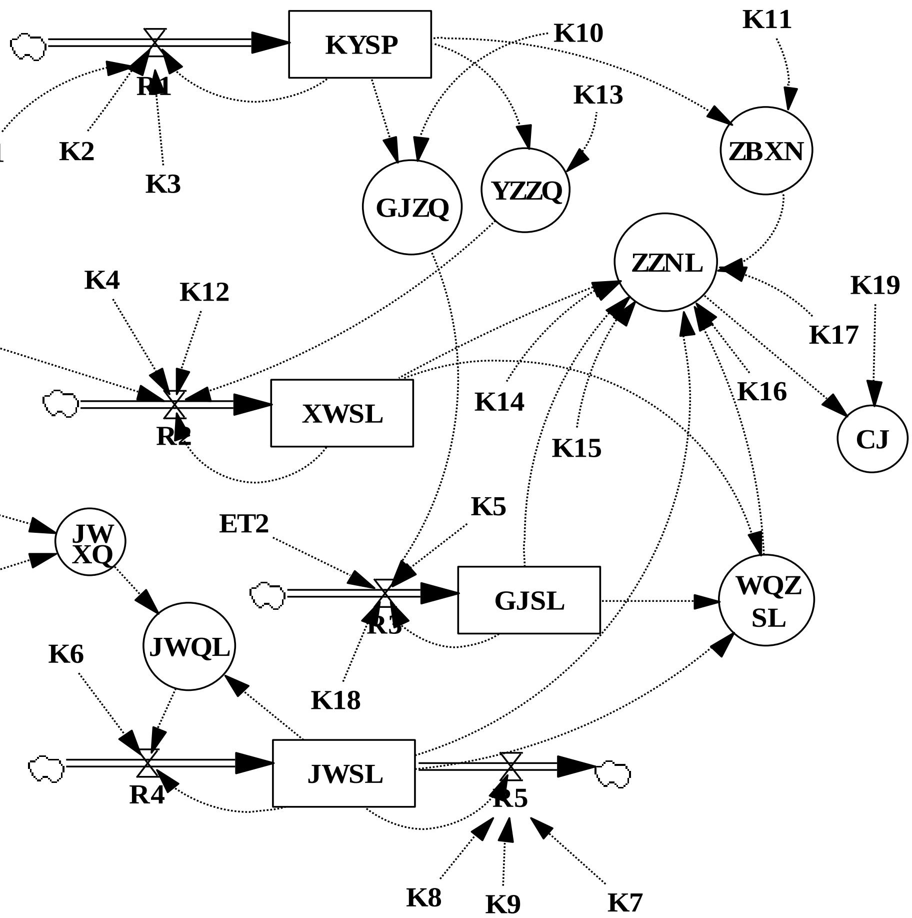


Fig. 2 Equipment development of the flow chart

The meaning of each parameter in the picture is as follows:

KYSP said the level of scientific research; XWSL said the number of new equipment R & D and production; GJSL said the number of original equipment to improve the update; JWSL said the original number of production equipment.

R1 represents the completion rate of annual planning and scientific research projects; R2 represents the new equipment R & D productivity; R3 represents the original equipment to improve and update the productivity; R4 represents the original equipment productivity; R5 represents the out-of-date equipment outage rate.

GZZQ said that the improvement of production cycle; YZZQ said the development and production cycle; ZBXN that equipment performance; ZZNL equipment combat capability; JWXQ original equipment demand reserve; JWQL original equipment shortage; WQZSL equipment total.

K1 represents the tactical technical performance requirements of the equipment impact factor on the completion rate; K2 represents the impact of researchers on the completion rate of the annual plan, including the quality of scientific research personnel, the number of personnel; K3 that research funding impact on the completion rate of the planning K4 represents the new equipment productivity factor; K5 represents the improvement of equipment productivity factor; K6 represents the original equipment productivity factor; K7 represents the equipment renewal elimination rate; K8 represents the equipment life loss rate; K9 represents the equipment training consumption rate; K10 represents the scientific research level K11 represents the impact of research level on equipment performance; K12 represents the demand for new equipment; K13 represents the impact of the research level of the development cycle; K14 represents the impact of the number of new equipment on the combat capability of equipment; K15 K16 represents the impact of the number of old equipment on the combat capability of the equipment; K17 represents the impact of the total number of equipment on the combat capability of the equipment; K18 represents the demand for improved equipment; K19 that is expected to reach The target value of capability; ET1 means required Seeking for the impact of the production of the old equipment factor; ET2 indicates that the demand for improving the equipment production impact factor; ET3 indicates the demand for new equipment production impact factor.

5. Simulation Analysis

5.1 Simulation conditions

Vensim simulation software was used to simulate the development of equipment during the 10 years from 2010 to 2020. The simulation step was 1 year. The parameters are set as follows: ET1 = 1.1 ET2 = 1.3, ET3 = 1.5, K1 = 1.5, K2 = 0.8, K3 = 0.4, K4 = 0.02, K5 = 0.05, K6 = 0.1, K7 = 0.05, K8 = 0.01, K9 = 0.01, K10 = 0.4, K11 = 0.3, K12 = 100, K13 = 0.6, K14 = 0.3, K15 = 0.4, K16 = 0.3, K17 = 0.1, K18 = 200, K19 = 1000, INITIAL JWSL = 1000, INITIAL GJSL = 0, INITIAL XWSL = 0, INITIAL KYSP = 1.

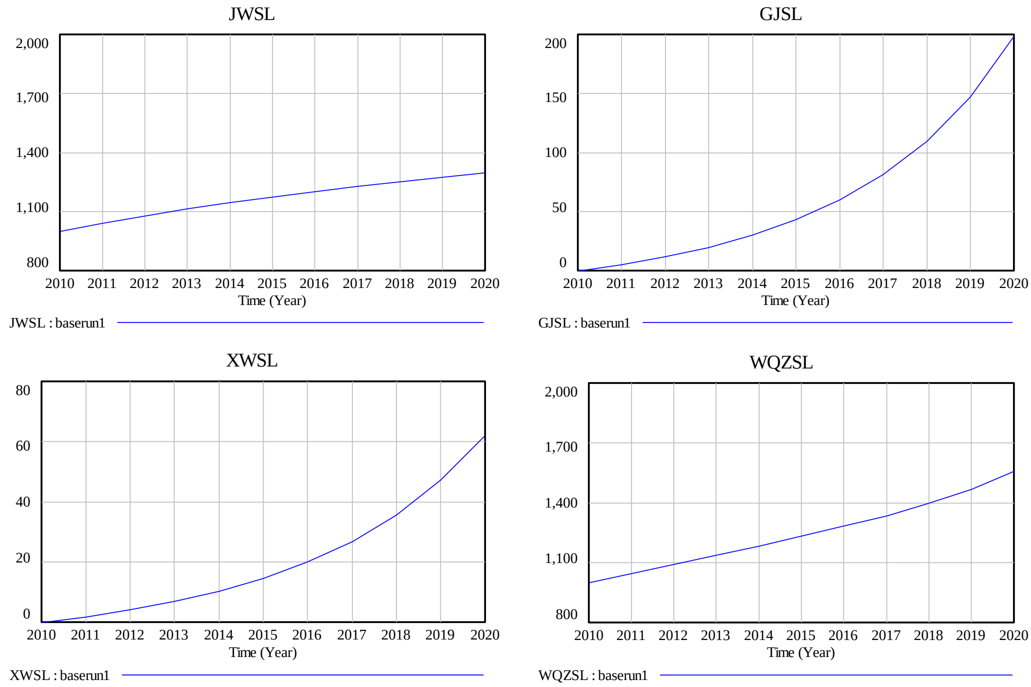
5.2 Simulation analysis

Run Vensim simulation software, extract part of the simulation results in Table 1.

Table 1 Test results of years

Equipment development	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
JWSL	1040	1077	1112	1144	1174	1202	1228	1253	1274	1295
GJSL	5	12	20	30	43	60	81	109	147	199
XWSL	2	4	7	10	15	20	27	36	47	62
WQZSL	1047	1093	1139	1184	1232	1282	1336	1398	1468	1556
KYSP	1.2	1.5	1.8	2.2	2.6	3.2	3.9	4.7	5.7	6.9
CJ	885	853	814	764	700	618	512	373	188	-63

Changes in the parameters over time shown in Fig.3.



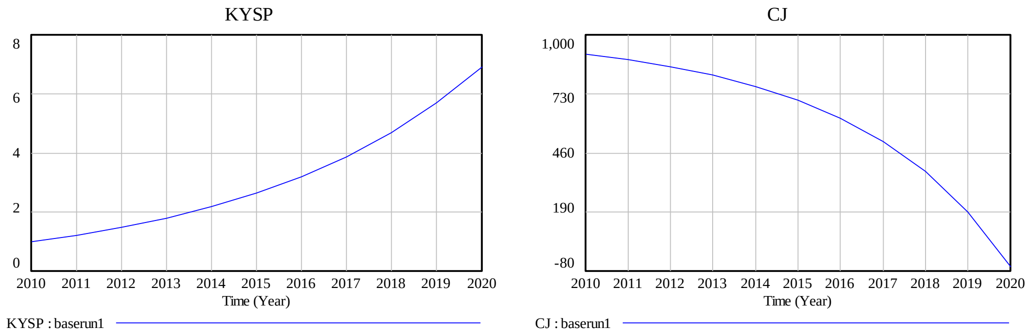


Fig. 3 Changes in the parameters over time

From the simulation results and the changes of the parameters can be seen:

The results of the simulation show the number of original equipment produced, the number of original equipment improved, the number of newly developed equipment, the level of scientific research, and the linear relationship between the changes over time. As can be seen from the causation diagram 1, the level of science and technology is related to the quantity of improved equipment and the quantity of newly developed equipment, which is independent of the quantity of original equipment. As can be seen from Figure 3, the quantity of original equipment changes slowly with time , The number of equipment to be improved and the number of newly developed equipment changed rapidly over time, indicating that science and technology will play an increasingly important role in the future development of equipment. The gap will decrease as time goes by. As a result, the gap will be negative by 2020, That our equipment has exceeded each other.

6. Conclusion

In this paper, the system dynamics method is applied to the equipment development, and the system dynamics model is established. Taking the development of equipment as an example, a simulation experiment was carried out. Through experiments, the feasibility of the model is verified. The simulation experiment platform provides the technical support for the macroscopic development of the equipment and provides the auxiliary decision-making tools for the planning and construction of the equipment construction plan. At the same time, it provides the necessary basis for the policy-makers to make policy analysis and has a strong promotion and application value.

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