

A SYSTEM DYNAMICS MODEL FOR AN ENTERPRISE'S SUSTAINABLE INNOVATION PROCESS*

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ABSTRACT

By using the System Dynamics approach, based upon the background of a real Enterprise's Sustainable Innovation process implemented in a famous Chinese enterprise, paper developed a System Dynamic Simulating Model.

1. INTRODUCTION

Technological Innovation (TI) has become the common behavior for most Chinese enterprises[1],[2]. However, only few enterprises have ability to sustain the TI process continually for a long period and get significant development.

Though the enterprises which have/had implemented an Enterprise's Sustainable Innovation (ESI) process are small in quantity, they usually are powerful and occupy very important position in their industries even in whole nation's economy. So, it is important to research on the sustainable innovation in an enterprise sector.

Here, the concept of the ESI is defined as following:

An Enterprise Sustainable(Sustained) Innovation process is such a process that has (had) continually implemented one or more projects of introducing new products/new process techniques/developing new markets/acquiring new materials sources/realizing new organization and/or their inside diffusions at the enterprise for a long period (normally, more than ten years) and made a continually significant economic development to the enterprise during the period.

Comparing with the normal sense of the enterprise's technological innovation, besides of making broader sense of "Technology", we add such an important condition as "Sustainable or Sustained" to it. Particularly, Enterprise's Sustainable Innovation has three basic characters: Time Sustainable, Benefits Growth Sustainable and Enterprise Development Sustainable.

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According to these "Sustainable" characters and the background of a real Enterprise's Sustainable Innovation process implemented in a famous Chinese enterprise-the Yuxi Cigarette Factory, by using the System Dynamics approach, paper developed a System Dynamic Simulating Model (SDSM).

2. MODELING THE EARLY PERIOD OF THE ESI PROCESS

2.1 Background

Under the leadership of the Excellent Chinese Entrepreneur, Mr. CHU Shijian, the Yuxi Cigarette Factory (located in Yuxi City, Yunnan Province, China) has successfully implemented an Enterprise's Sustainable Innovation since 1981. With the innovation, the Yuxi Cigarette Factory has achieved sustained and high-speed growth of the economic benefits and the sustained developing. In the period of 1981-1994, the annual average growth rates of the profits and the fixed assets were 41.1% and 34.7%. The enterprise had made 4.1 billion yuans profit and owned 0.79 billion yuans fixed assets in 1994. The Yuxi Cigarette Factory has become the largest manufacturer with the best economic benefits and the 1990's world-level advanced technical equipment in Chinese tobacco industry.

The Start-up-point of the ESI process was in 1981 when the Yuxi Cigarette Factory had implemented a project: importing a set of advanced cigarette making machine (MK9-5) from UK. Using the excellent tobacco leaf planted from the Yuxi area and this machine, it produced high quality filter-cigarettes such as the famous brand "Hongtashan" which is welcome by Chinese consumers, and returned the buying costs only by two months production. Since then, the Yuxi Cigarette Factory has continually imported the advanced equipment to renovate its backward production ability. Till 1985, the enterprise invested about US \$ 5 million in equipment importing and owned 280,000 cases/year advanced production ability .

However, the Yuxi Cigarette Factory faced a serious situation soon. The advanced machines could use high quality Tobacco leaf to produce higher class cigarettes and only higher class cigarettes could make higher profits. Unfortunately, the peasants in the Yuxi area, with the traditional planting experience and weak investment ability, could not produce enough high quality tobacco leaf to feed these machines, especially, the A class leaf which was the major material of the A class brands such as " Hongtashan". So, more and more advanced machines would be uneconomically used to make lower class cigarettes.

2.2 The Part I of the SDSM for the Early Period of the ESI Process

Above situation occurred in the early period (1981-1985) of the ESI process in the Yuxi Cigarette Factory could be described in following Flow Diagram 1 (Fig. 1) by using SD approach[3]:

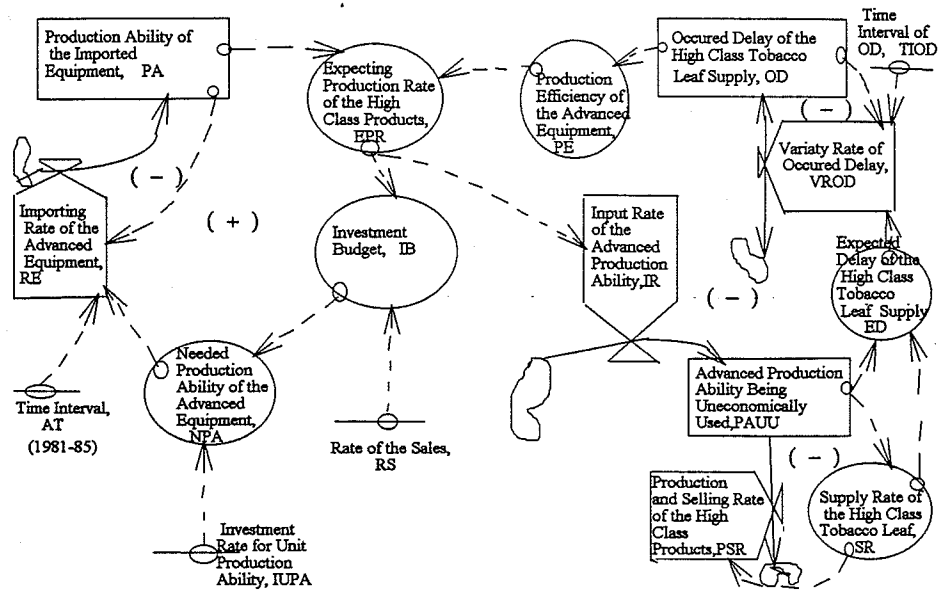


Fig. 1 Flow Diagram 1 for the Early Period (1981-1985) of the ESI Process in the Yuxi Cigarette Factory-Production and Selling Increasing with the Limitation of the High Class Materials Supply

According to the real data of the enterprise and the Flow Diagram 1, we built the Part I of the SDSM by using DYNAMO. Then, simulated it on PC-486 and got following results:

Table 1 Some Selected Data of the Simulation Results (Part I of the SDSM,1981-1986)

Time (Year)	1981	1982	1983	1984	1985	1986
OD (Year)	0.001	0.001	0.62216	1.2243	2.0414	4.9013
ED (Year)	1.	0.80133	0.63168	0.62977	0.74867	1.0072
PSR (10,000 cases/year)	1.5	1.5	2.2589	4.4031	6.8809	7.
PA (10,000 cases/year)	1.5	3.1	6.4477	13.484	28.199	58.75

This simulation showed that the production ability of the imported equipment would increase to 280,000 cases by the end of 1985. However, limited by high class tobacco leaf supply, the production and the selling amounts (supposing no inventory) of the high class cigarettes would be limited in about 70,000 cases in 1986. So, the using efficiency of the imported equipment would be very poor (only 25%) in 1986. These results provided important information: the enterprise must improve its high class tobacco leaf supply as soon as possible.

3. MODELING THE SUCCEEDING PERIOD OF THE ESI PROCESS

In fact, Mr. Chu and his colleagues launched an important strategy in 1985: Treating the Tobacco Leaf Growing Fields as the First Workshop of the Cigarettes Making. After then, the Yuxi Cigarette Factory has continually invested huge amount of money (Till 1995, the sum was 1.4 billion yuans.) to support the peasants producing high quality tobacco leaf by using advanced technology. This strategy has been effectively implemented for more than ten years

and got brilliant success. The A class tobacco leaf supply amounts from 6,000 tons in 1985 increased to 30,000 tons in 1994. This has ensured the sustainable increasing of the A class products. This situation also could be described in following Flow Diagram 2 (Fig. 2).

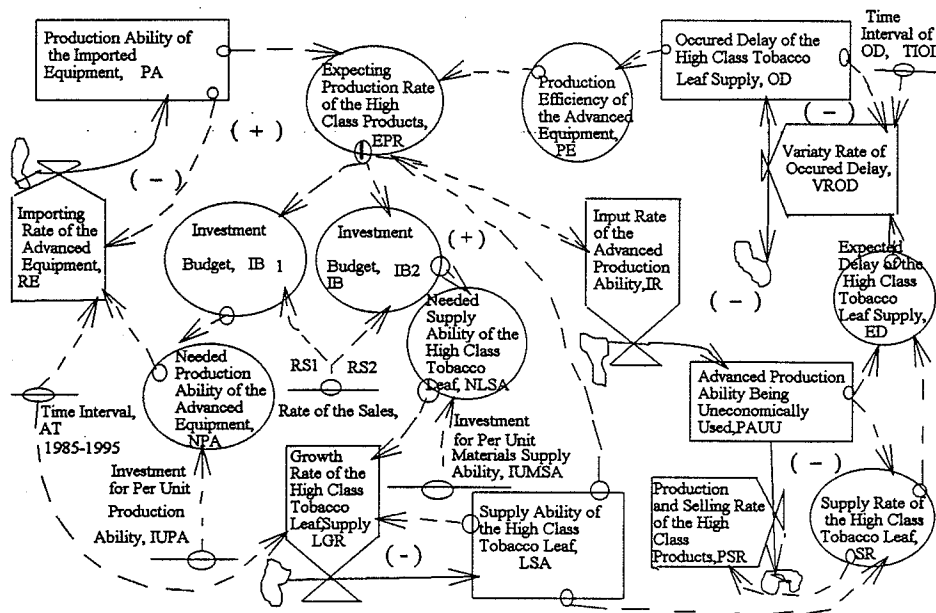


Fig. 2 Flow Diagram 2 for the Succeeding Period (1985-1995) of the ESI Process in the Yuxi Cigarette Factory-Production and Sales Increasing with the Materials Innovation

Also, we built the Part II of the SDSM and simulated it . The results showed that the Supply Ability of the A Class Tobacco Leaf (LSA, 1.09 million cases by 1993) and the Production Ability of the Advanced Equipment (PA, 1.05 million cases by 1993) could be optimally matched and realize 0.95 million cases of the A class cigarettes production in 1994. These results tallied with the actual situation.

Combining the Part I and II, we obtained the whole System Dynamics Simulating Model for the total ESI process(1981-1995) of the Yuxi Cigarette Factory.

4. CONCLUSIONS

System Dynamics could be very useful approaches to describe and analyze the ESI process. The application introduced here only a start. We will further the work later.

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