A System Dynamics Model for SMS Governance

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Abstract. Using System Dynamics method, this study analyzes the SMS governance. A System Dynamics Model is built and is simulated with VENSIM PLE 5.4C. The simulation result proves that carries should be the key entity to be governed. This study also uses the model to analyze SMS policies and finally gets the conclusion that real mobile identification and unification the service providers' access number could reduce harmful SMS.

Keywords: *Harmful short message, Telecommunication industry chain, System dynamics*

1   INTRODUCTION

In recent years the high-speed development of the SMS services in China effectively makes up the decline of the income from voice services, but it also causes a series of social problems. Only if the SMS is well managed and inducted, it can bring more profit and convenience to society.

Many domestic researchers have proposed some suggestions on harmful SMS. Cheng Zong et al. [1] figured out that government should perfect the laws and control mechanism. Silin Liu [2] presented the countermeasure from four aspects: carriers, government, mobile phone manufacturer and user. Zengyan Cheng [3] considered real mobile identification need the mutual effort from government and telecommunication carrier.

Current researches focus on the negative effects SMS brings to society and how to apply policy to eliminate these effects. But these viewpoints have lack of system research and are hard to implement. It is urgently needed to conduct deep and religious demonstration of the suggested policy which provides reliable decision-making foundation for government. This is what this paper tries to figure out.

After Forrester [4] presented the method of system dynamics, many researchers brought forward the research on analysis of industry with system dynamics. Zhong Ning et al. [5] researched the evolution of industry cluster. Yijun Huang [6] simulated a series of operation phenomena in telecommunication. H Chen and TS Jan [7] analyzed the development of semiconductor industry in Taiwan. With these approaches, system dynamics has been proved a mature tool for industry and system research.

The paper uses system dynamics as framework, firstly analyzes the industry chain, secondly builds a system dynamics model by drawing flow chart and archetype

analysis, thirdly simulates the model and empirically analyzes the key factors which should be supervised in the industry chain, and analyzes the influence which some policies will bring out. (Such as real mobile identification and unification the service providers' access number)

2   SMS SYSTEM DYNAMICS MODELING

2.1   Research Boundary and Hypothesis

Because SMS is the main factor this paper researches, the research boundary only refers to social entities related to SMS, including social influence, telecommunication users, telecommunication carrier(only China Mobile Communication Corporation), service providers, content providers, terminal manufacturers and government.

This paper supposes the system is running under the environment of 2G; there is only one company in the market: China Mobile Communication Corporation. But there are so many service providers, content providers and terminal manufacturers that they together form the situation of perfect competition. These hypotheses will ensure the system can satisfy the need of evolution.

The definition of harmful SMS in this paper is the SMS containing redundancy, eroticism, misdeed and destructive information communicated between individuals and groups. The definition uses related definitions of domestic researchers and Ministry of Public Security for reference [1-3]

2.2   Industry Chain Analysis

SMS industry chain is a system consisting of telecommunication carriers, content providers, service providers and users. Telecommunication carriers control a majority of income and profit in the industry chain as the center enterprise of the industry chain. The paper also considers the interaction between SMS industry, government, society, so the industry chain analysis is relevantly extended as figure 1.

Telecommunication carriers are operational company which provides communication services and information services. *Content providers (CP)* are the creators and providers of content of

Figure 1. Industry Chain Analysis

value-added services. *Service providers (SP)* are information service carriers who don't participate in the network operation, but provide SMS in virtue of network platform and service application platform. *Terminal manufacturers* provide terminal
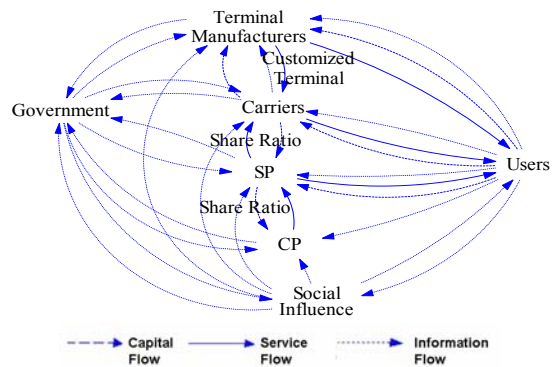
(mobile phone) to support SMS service for SMS users. *Users* are the final consumers of SMS service and the final service objects of the whole industry chain. Users can freely choose which terminals, which carriers, and which service providers, and so how to get more users is the important problem of the other entities of industry chain.

2.3   Flow Chart Analysis

Flow chart of the whole system consists of three level variables, three rate variables and other variables. There are totally 34 variables. Three subsystems are built up with three level variables as their centers: SMS Income subsystem with income of *SMS industry* as its centre, harmful SMS subsystem with *the number of harmful SMS* as its center, User subsystem with *the number of users* as its centre, and assistant variable group with government governance index as its center. Each variable within subsystems interacts with each other, and there are association relationships between subsystems. It is shown as Figure 2.
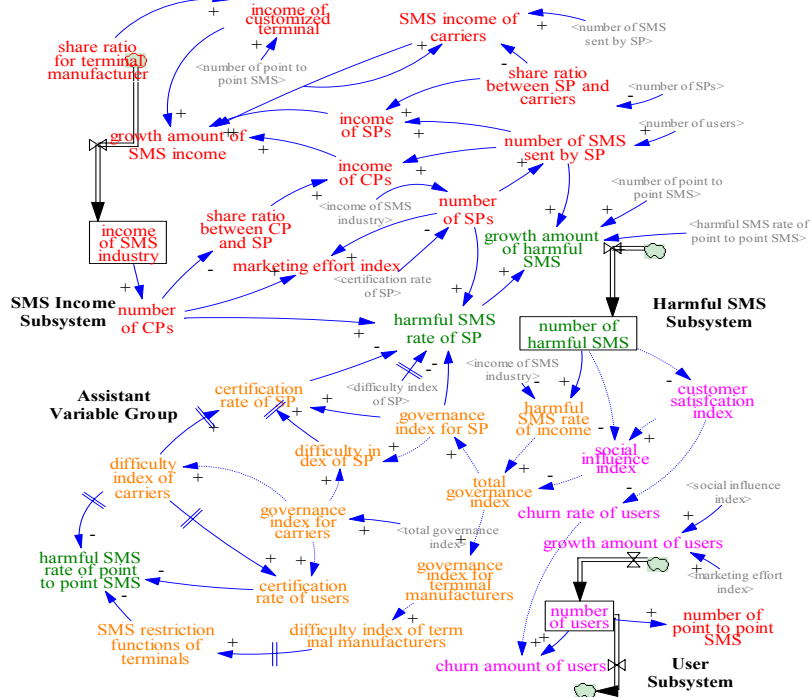

Figure 2. Flow Chart

Between the SMS income subsystem and the harmful SMS subsystem, it can increase the SMS industry income to attract more SPs and CPs to enter industry chain. But their entry causes the increase of the rate of sending harmful SMS, and then the increase of harmful SMS brings the increase of the degree of government governance. It will reduce the quantity of SPs, and then the growth of SMS income will be slowed down.

Between the SMS income subsystem and the user subsystem, the increase of the SMS industry income attracts more SPs and CPs entering industry chain. The competition makes they increase the degree of devotion in marketing, these marketing will attract more SMS users, and the quantity of SMS sent will together increase, and it causes the increase of SMS industry income.

Between the harmful SMS subsystem and the user subsystem, the increase of harmful SMS will corrupt the social affection, and also will reduce the satisfaction of customer. The decrease of customer satisfaction will cause the churn of customers, and these both influences will affect the total number of customers.

Between user subsystem and harmful SMS subsystem, the increase of user amount will bring more and more SMS, both point to point and sent by SP, and then will cause the increase of harmful SMS, and finally the total amount of harmful SMS will rise up.

2.4   Archetype Analysis

Archetype is the efficient language for explaining system thinking. Archetype analysis will explain complex phenomena, and resolve the root problem of dividing the work in excess and separately thinking by finding hidden lever result [8]. The qualitative conclusion of archetype analysis will guide the quantitative analysis.

2.4.1   Increase and Undercapitalize Archetype for SMS Income

The archetype consists of 3 level variables, 3 rate variables as well as some assistant variables. As shown in Figure 3.

In the archetype, the income of carrier will increase, because the growth of the number of SPs makes SMS industry greater. On the other hand, the increase of the quantity of SPs will bring the increase of harmful SMS and reduce the appraisement which users make, and then the income of carrier

Figure 3. Increase and Undercapitalize Archetype for SMS Income

will decrease; it is the bottleneck of carrier's development. Only when the percentage

of harmful SMS reaches a certain proportion, government will realize the importance of governance. But there is delay from realizing the importance to reaching the goal of the decrease of the percentage of harmful SMS. So carrier will face the risk of the decline of performance caused by this delayed governance. The lever result of the system is the carrier and government should induct the timely feedback mechanism, and these will early reduce the decrease of income because of the overabundance of harmful SMS and eliminate the upper limit of income increase.

2.4.2   Limits to Growth Archetype for SPs

The archetype consists of level variable "SMS industry income", rate variable "the growth of SMS income" and some assistant variables. The archetype describes the following fact: on one hand, the upper limit of the number of SPs: the increase of the number of SPs will bring the increase of the total income in the SP industry, and many SPs will enter the market under the encouragement of the future of market so that the number of SPs will increase. But with the increase of number, the competition of SP industry is more intense. It leads that some low competitive SPs exiting market, and the number of SPs declines. It makes a dynamic balance of the number of SP.
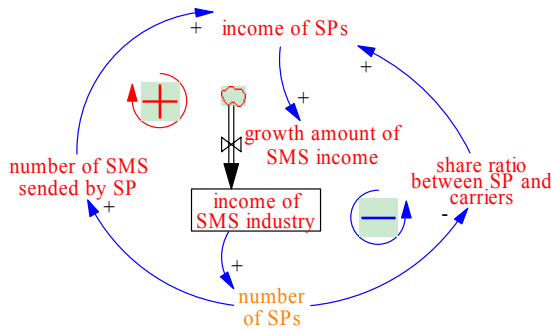
Figure 4. Limits to Growth Archetype for SPs

On the other hand the income of SPs is another upper limit of growth. SPs locate between the carrier and CPs in the industry chain. Carrier will drive the SP back forward to pursue profit maximization, but CPs will block SPs in the back forward position. The advantages of SPs comparing with CPs are the information of users, and comparing with carrier is segmentation of customers. It is the upper limit of the growth of SPs. The lever result of the upper limit is that SPs strengthen the reflection to market and higher the marketing effort index, and conduct the distinctive service.

3   SIMULATION

Based on the detail analysis and the acquired qualitative conclusions to the system, we input the data into models, and use VENSIM PLE 5.4C software for simulation and analysis.

3.1   Source of Data

We use open data; the majority can be downloaded on the Internet. Among them, the country's data mainly come from the Ministry of Information Industry's website

(http://www.mii.gov.cn), some data from [9] which is opened by iResearch Consulting Company. There are also references to many comments of senior experts and teachers in telecommunication industry, and estimate some index with their help.

3.2   Linear Regression Equation and Its Fitting

SP sending SMS = total number of users*0.00227891+ Total number of SP *286714-133.095   (1)

This formula is based on [9]. Residual table is as below which deviation is smaller than basic requirements. Figure 5 is the fitting chart which shows a good fitting result.

Figure 5. Fitting Chart

Table 1. The Number of SMS sent by SP

Observations	predicted Number of SMS sent by SP (100 million)	Actual Number of SMS sent by SP (100 million)	Residuals	Standard error
1	52.4510603	50	-2.45106	-0.11048
2	159.0128165	150	-9.01282	-0.40625
3	307.1786806	340	32.82132	1.479409
4	417.9232632	420	2.076737	0.093608
5	480.4850446	460	-20.485	-0.92336
6	531.4898308	520	-11.4898	-0.5179
7	604.7850869	580	-24.7851	-1.11718
8	646.6742171	680	33.32578	1.502148

3.3   Establishment of Table Functions

There is certain amount of subjectivity in the Establishment of table function. So we refer to the basic discipline of business, and focus on listening to the views of a number of telecommunications industry experts and teachers. For example the table function, "number of CPs" determines "share ratio between CP and SP", either SP or CP, the dividend between enterprises has no definite standard for it. But considering the macro trend, as the increase of the number of CP, SP is bound to have more power to choose CP, So as a result, the SP that control advantage resources will be more comparative in the game, and make "share ratio between CP and SP" decline. There are also some other cases in the design of table functions.

4   SIMULATION RESULTS AND ANALYSIS

4.1   Analysis of the Key Factors for Regulation

The purpose of supervision is to reduce the harmful SMS, so the evaluation of the effectiveness of supervision should focus on the variable "growth amount of Harmful SMS (unit: 100 million)", It reflects the harmful SMS number within a unit time.

First, we compare the results of the existing regulatory efforts (original), and then enhance the governance to carriers, SPs and terminal manufacturers. We infer the key regulatory factor according to the results. By constantly adjusting the parameters of the model, we finally find the optimal supervision policy.

In Figure 6, the original is the simulation curve when the governance index for carriers, the governance index for SP, the governance index for terminal manufacturers are all 0; the other three curves are the simulation curve respectively of raising these indexes by 0.2.
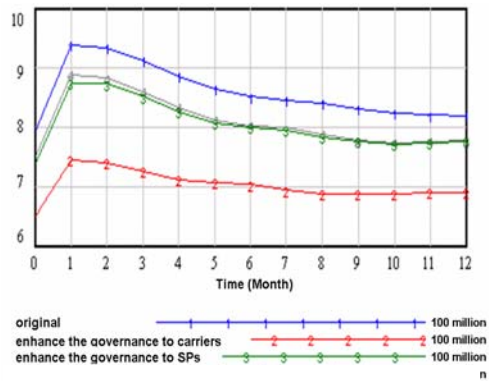

Figure 6. Growth Amount of Harmful SMS: Enhance Governance to Different Entities

It is obvious that with the same increasing extent, three ways could make harmful SMS decline. But more can be seen that strengthen supervision of carriers is the best, next by SP, the last by terminal manufacturers. Evidently, carrier should be a key factor of supervision. Next, we have adjusted several times to find the optimal regulatory scheme. That is, the governance index for carriers 0.3, the governance index for SP 0.15, the governance index for terminal manufacturers 0.08, and the supervision effect is the best.

This package makes harmful SMS being kept at a relatively low level, although have some fluctuations, but relatively stable. In the various schemes, this scheme reduces the harmful SMS not only the most effective, but also the most stable. This package also shows that need for supervising carrier, SP, Terminal manufacturers in different degrees, can achieve optimal supervision effect.
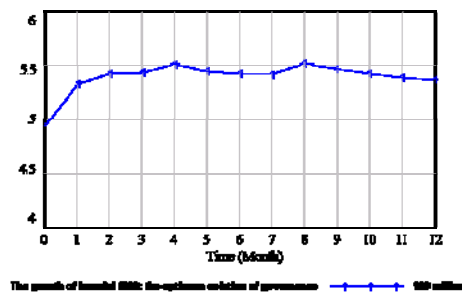

Figure 7. Optimal Solution of Governance

4.2   Forecast Analysis for Real Mobile Identification

We make "governance index for carriers" grow to 1 in a very short period which requires carriers in a short period to vigorously promote the real mobile identification, to observe the simulation results of real mobile identification. Figure 8 to Figure 10 reflect the simulation results.
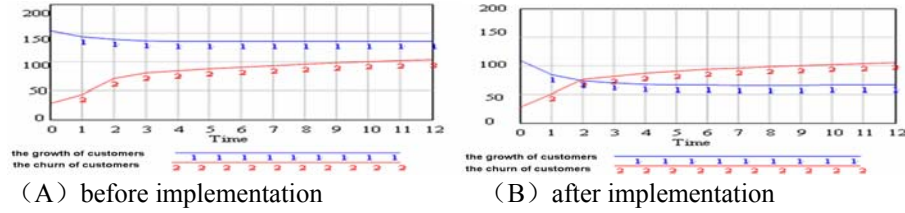

（A）before implementation   （B）after implementation

Figure 8. Comparison between growth and churn amount of users

This shows that as the implementation of the real mobile identification the growth rate of users tends to decline. The growth amount of users becomes less than the churn amount of users, thus leading to the total number of users decreases. It will be reduced accumulatively by 23.26% of all users by the end of the simulation.
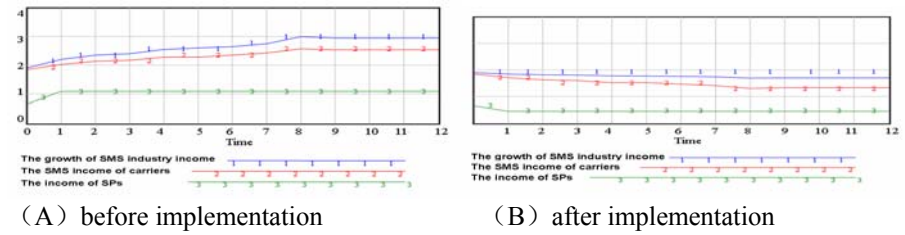

（A）before implementation   （B）after implementation

Figure 9. Comparison with Income

At least in the short term, the carrier revenue which accounts for a very large proportion in total income shifts from the increased steadily to decline gradually, The SPs which take SMS as a major source of income also have to face the crisis, the growth amount of SMS income is declined by an average of 40.59%.
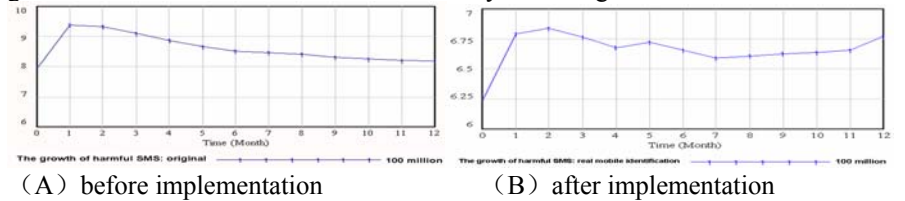

（A）before implementation   （B）after implementation

Figure 10. Comparison with Growth Amount of Harmful SMS

The growth amount of harmful SMS dropped sharply in simulation, the growth amount of harmful SMS curve is totally on the low level, besides, the trend of harmful SMS growth has changed, from gradually stable to a lower level to fluctuation on the even lower level. The growth amount of harmful SMS drops by 28.70% by average.

4.3   Forecast Analysis for Unification the Service Providers' Access Number

In the simulation, we continuously improve the governance index for carriers and the governance index for SP to make "Certification Rate of SP" achieves 1 in a short time which means all the SP numbers will be verified. The analysis of the impact of unification the service providers' access number is based on comparing the change between the two results. From Figure 11 to Figure 13 reflect the simulation result.
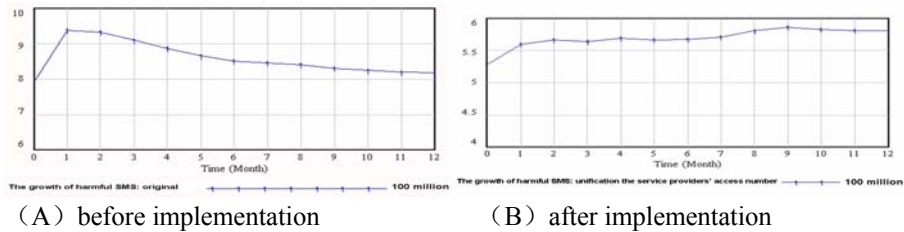
（A）before implementation   （B）after implementation

Figure 11. Comparison with Growth Amount of Harmful SMS

With the SP certification standards upgraded, the ratio of harmful SMS sent by SP drops significantly, this leads to substantially reduce harmful SMS; the average reduction rate is 34.14%.
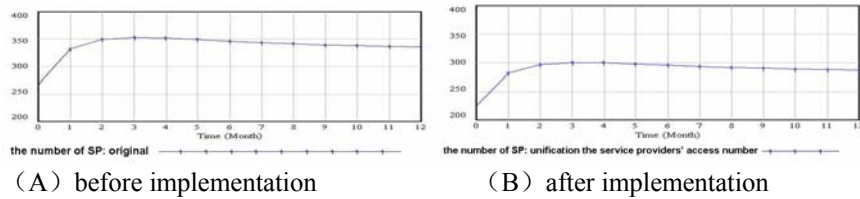
（A）before implementation   （B）after implementation

Figure 12. Comparison with Number of SPs

A large number of unqualified SPs will be forced to withdraw from the market, which leads to a decline in the number of SP. An average drop rate is 18.16%.
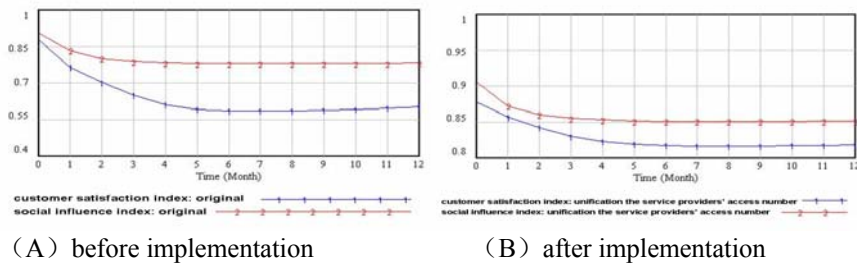
（A）before implementation   （B）after implementation

Figure 13. Comparison with Customer Satisfaction Index and Social Influence Index

After implementation, the social influence index has increased, the overall curve is greater than 0.85, compared to the original raise nearly by 0.1.Also, customer

satisfaction has also improved, and the entire curve is greater than 0.8, compared to before, rise approximately by 0.25.

5   DISCUSSION

This paper uses system dynamics to analyze SMS industry. It firstly analyzes the industry chain with flow chart, secondly analyzes industry with archetypes in a macro view, thirdly proves carriers should be the key factor for regulation, and fourthly predicts the possible affects of the implementation of real mobile identification and unification the service providers' access number. The conclusions are as follows:

(1) Carriers should be regulated with emphasis and policies must be pushed into industry chain mainly through carriers. The optimal supervision ratio of about 4:2:1 will have the best results.

(2) Real mobile identification will decline the number of customer in short-term (decrease of approximately 23.26%) and harmful SMS substantially reduced (down rate about 28.70%). It will facilitate the standardization of SMS industry.

(3) Unification the service providers' access number will reduce the harmful SMS (decrease off approximately 34.14%), standardize the SP market and improve customer satisfaction.

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