A Policy Model for Logistics Based on Complex System Theory

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Abstract

Nowadays the logistics system has evolved into an open complex giant system along with the progress in global economics and technology and the era of network, so that more and more factors have to be considered in the constitution of logistics policy. In order to reach overall synthesis, dynamic evolution and self-adaptive movement of logistics system, we put forward a new policy model based on the complex system theory including Synthesization and Integration System Space Flight (Qian Xuesen), Adaptive Systems Theory(Santa Fe), Thinking of Complicated Method(Edgar Morin), several complex thoughts of Herbert·A·Simon, and Pansystems Theory(Wu xuemou). The concrete contents of the study include the description of the policy model for logistics, the submodels consisting of external synthesis model, internal dynamic equilibrium model, policy optimization model, and implement model. Consequently, this new policy model provides theoretical reference for the formulation of logistics policy in a country or region.

1. Introduction

After policy science was first proposed by Harold Lesswell (1951), several forerunners began to research on the constitution of policy and some famous policy theories are created. At the beginning of research on policy science, the pure rationalism model or rational-comprehensive model is the main academic trend. In order to improve the pure rationalism model for exploring expected but impracticable goals, Herbert·A·Simon (1947) put forward the limited rationality and subsequently the "The general Theory of Second Best" was published by Richard·Lipesy and K·Lancaster (1957). In addition to pure rationalism model and limited rationality, disjointed incrementalism (C·E·Lindblom), integrated analysis of policy constitution (Y·Dror) and constitution of political leaders (T·R·Dye, H·Zeiger) have come out gradually to contribute the progress of policy science(Figure 1).

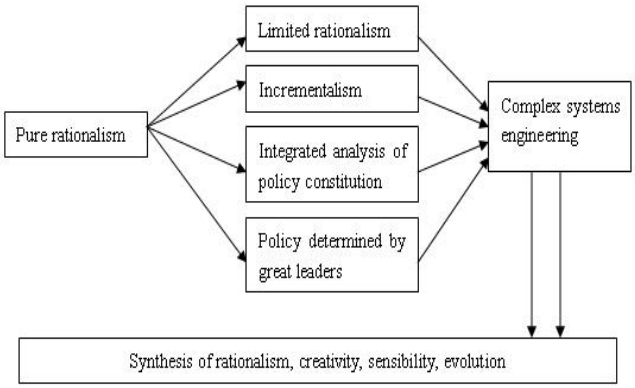

Figure 1. History of policy science

However, the above theories have not synthesized the rationalism, creativity sensibility and evolution that need to be simultaneously considered on the background of network. Moreover, there is little theory about this integration in logistics research. So in this paper, based on several important complex theories, we present a policy model for logistics system so as to synthesize those factors and improve the current formulation and implement of logistics policy.

In this policy model we put forward relative accurate framework of logistics policy system, macroscopic and concrete operations， as well as principle of value in logistics industry. Furthermore, Synthesization and Integration System Space Flight and other methods for complex adaptive system provide the tools for the combination of qualitative and quantitative analysis. Consequently, the further precise quantitative model of logistics policy could be raised according to this framework.

2. Logistics system

Logistics system can be defined as an organic combination composed of two or more different and related cells to accomplish the movement of entity and information. Logistics system, an important part of social economical system, closely connects other parts

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to develop the whole national economy. Without reducing the trading cost and avoiding resources waste of logistics system, the national economy can not be well developed. In addition to entirety, relationship, intention, and adaptation which are possessed by a general system, the logistics system constituted of complexity, opening, avalanche, initiative adaptation. Along with the globalization, advancement of high-technology and era of internet, the logistics system, has evolved into a super system.

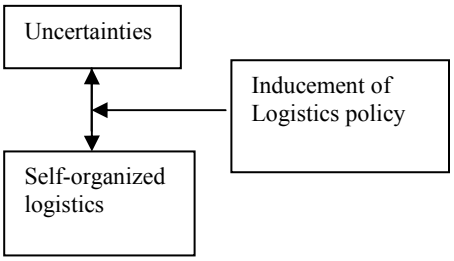

Figure 2. Function of logistics policy

3. Logistics policy

In this thesis, Logistics policies means that the government policy enacted the code of conduct and operation for implementing rational allocation of limited resources, resolving the problem in logistics industries and supporting the development of logistics industry. Confronted with opened environment, the interacting evolution happened between requirement of complex logistics system and the environment. At this time, function of logistics policies rest with the role of the self-induced evolution – considering the overall benefits of the government planning and the main benefits of system via a relatively fair distribution（ Figure 2）.

4. A new policy model for logistics

In this paper, according to complex theory, we present a new policy model for logistics in order to reach overall synthesis, dynamic evolution and self-adaptive movement of logistics system in logistics network. The model can be divided into four submodels which are external synthesis model, internal dynamic equilibrium model, policy optimization model and implement model (Figure 3).

In the external synthesis model, the interests of customers, government, creativity, uncertainties and evolution can be integrated by a 'controller' which is like central processing unit in a computer. After the above-mentioned factors are inputted into this controller, the output as a reasonable structure of logistics policy is determined by the basic principles PRR'P'.

PRR'P' of logistics policy system can be explained as follows: In all situations the perfection representing the total satisfaction to all demands in the logistics system. However, it is more or less the regret including contradictions, restraints, boundaries, and etc that really exist. In this case, the universally satisfied solution and second-best policy should be flexibly formulated in order to accomplish a task or project effectively.

The functional modules of policy subsystems always complement and conflict with each other in the internal policy model. However, the stability of logistics policy as a representation of internal dynamic equilibrium should be achieved. So PRR'P' intrudes that every functional module sacrifices part of its benefit to obtain the overall synthesis in this organic-like system. Since every functional module varies for all time, a new internal dynamical equilibrium comes into being under the influence of the external factors such as the national economic direction, economic crisis, great innovation in logistics industry, etc.

The internal equilibrium embodies concrete structure and content of logistics policy. Then the logistics policy analyst should value and optimize the new specific logistics policy according to proper policy theories, the previous implement of other countries or districts. At the suggestion of logistics policy analyst, the government enacts the specific policy including macro policies, middle-scale policies and micro policies at last. The effect of promulgated policies can be feedback to the government and policy analysts. The unsatisfied effect calls for the improvement and evolution of this logistics policy which is also regarded as the initial stage of this policy model.

5. External synthesis model

Definition: g_i: various kinds of factors in the process of policy constitution such as interests of customers, government, creativity, uncertainties, evolution, etc; δ_i: the related policy subsystems concluding regulation system, scope system, product system and operating system which will be concretely explained in the internal dynamic equilibrium model. Policy function: $F= (\circ)-\prod(\delta_i \circ g_i)$. If F(s) =Const, then S is called F-gradual policy change, otherwise the F-catastrophe. If policy system S is of F-gradual policy change, then call the subsystems of S are F-synergy. If F-synergy with a certain environment S_e, then S is called to be F-adaptive (with S_e).

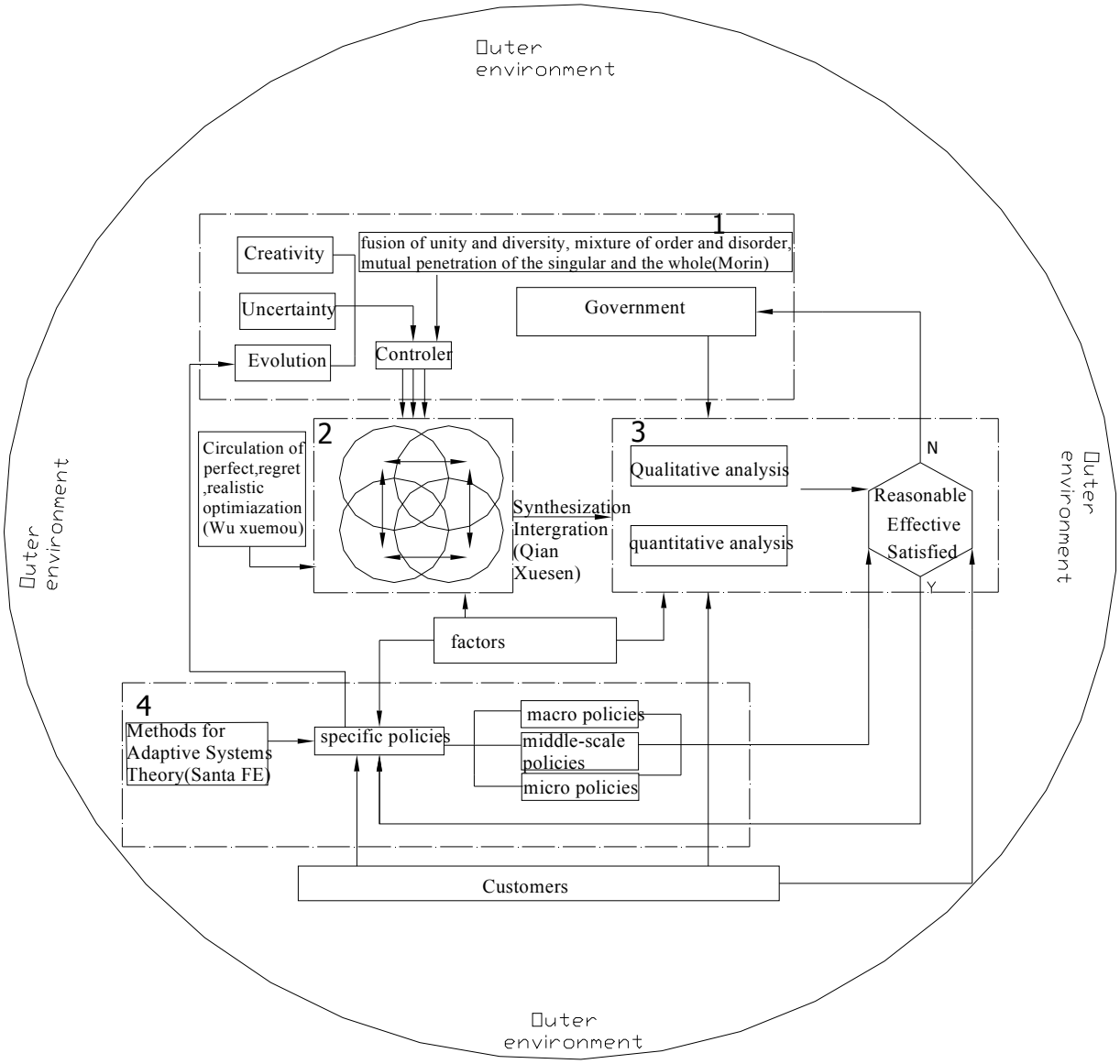

Figure 3. Pansystems policy model for logistics

The F-gradual policy change can be considered as a system model of concepts of stability and homeostasis which is essential for the development of national economy. Confronted with economic crisis or economic revolution, F-catastrophe can be generated. At this time, a new state of F-gradual policy change will gradually be formed with the guidance of PRR'P', a hiding leader for systematic evolution.

6. Internal dynamic equilibrium model

6.1. Regulation System——Pan-zeros, Pan-extreme, Pan-Boundary.

The regulation system of logistics policy refers to the sum of regulation, law and management of logistics systems. The layer of law means guidelines with legal effect within logistics policies which were enacted by the government; The layer of regulation means the behaviors of regulated activities, the constraints and limitations to main logistics system directly implemented by the government in accordance with

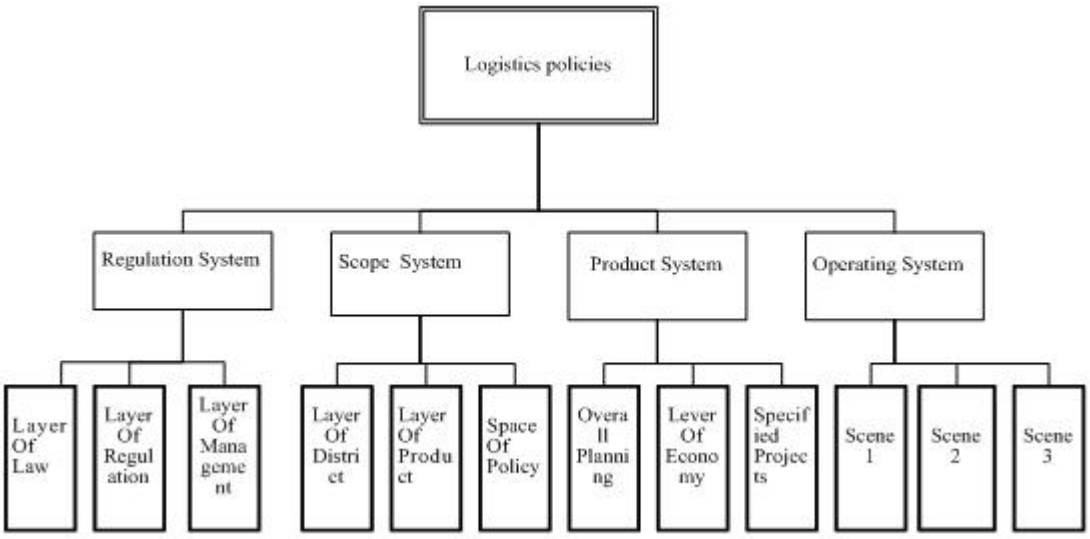

Figure 4. The internal structure of logistics system

relevant laws and regulations; The layer of management means the behaviors of regulated activities, the constraints and limitations to main logistics system implemented directly by the government in utilization of privilege to take administrative measures.

6.2. Scope system——Relativity and fuzzy boundary of policies

The scope system of the logistics policies refers to geographical and crowd borders affected by logistics policies. In the view of geographical scope, according to administrative districts, geographic regions and economic sphere etc., each region should have suited and specified logistics policy to suit their regional characteristics.

6.3. Product system——common product of policies in all levels of system.

Product system of logistics policies is the sum of content covered by current logistics policies, which includes overall planning, the economic lever and specific projects. Overall planning is the comprehensive plan for achieving the overall goal of the logistics industry by government. Economic levers is an economic measure to intervene in logistics industry by government, specific projects is the specific policies in order to achieve a specific goal in logistics industry by government.

6.4. Operating system——Formulating the logistics policy with the PRR'P' principles.

PRR'P'—perfection regret and realistic pan optimization with myriad interderivatives of the good, the evil, the evil, the paradoxes and the regrets! The PRR'P' directs kaleidoscopic vivid dramas of multifarious social systems, subsystem and supersystems.

In this logistics policy system, the PRR'P' can be specified as follows: Perfection-the ideal and potential lever that the logistic industry could reach. Regret-the Pan-boundaries such as resource limitation, regulation etc. Realistic pan optimization-the satisfied level that logistics industry can achieve considering Pan-boundaries.

Operating system of logistics policies refers to the sum of general or specific policies aimed at the problems that arose in the development of the logistics industry.

6.5. Dynamical synthetic division model.

Let $G \subset S \times T$ be given space-time domain, and g_i: $G \to W_i$ (or $g_p \subset G \times W_i$) be the division of policy system, put $W=\prod W_i$, the synthesis of various g_i can be described as $g \subset G \times W$. Generally speaking, only certain organization-matching of various W_i may be rational, which may embody in the form $D \subset W$ or $W \to L$, where L is certain order structure representing some optimized levels. D can be also considered as a description of certain shengke relations or synergy-conflict relations. And now $h=g \circ D \subset G \times L$, if $\delta \in Es\,[G \circ h]$, $f=h^{-1}$, then $f \in Es\,[G]$ is a division of policy

system. Consider the projections g_t: $S\times T\to S$, then $g_t'(f'(\delta))\in Es[G\circ T]$ embody a dynamical division into policy subsystems with the parameter $(D, \delta,f):S\supset Q=\cup Q_i(t)(dg_t'(f'(\delta)))$.

Let $\iota\in L$, we have $D\circ\iota\subset G$, and the policy subsystems g_t $(g\circ (D\circ\iota))$ is of effect level of ι. If D, g_t are given in advance, the procedure described above embodies a constraint $pd\subset P\ (G^2\times W)\times L\times\uparrow W\times S\uparrow(S\times T)$ which describes the correlation variation of division g and effect of efficiency ι. One can select g to make $\iota\in L$ sufficiently high, this process is called pansystems policy programming based on pansystems division into policy subsystems. For sufficiently high $\iota\in L$, the $g\in pd\circ(\iota, D, g_t)$ is the just the solution.

7. Policy optimization model

Definition: Let the panweighted network of policy: $g\subset G^2\times W$ or g: $G^2\to W$, θ_1: $P(W)\to W$, θ_2: $W_2\to W$. Define θ_1^+:$P(W\uparrow G^2)$ as $\theta_1^+\{g_\delta\}(x,y)=\theta_1\{g_\delta(x,y)\}$, and$\theta_2^+$:$P(W\uparrow G^2)^2\to W\uparrow G^2$ as$\theta_2^+\{g_1, g_2\}(x,y)=\theta_2\{g_1(x,y), g_2(x,y)\}$, or$(g_1\theta_2^+g_2)(x,y)= g_1(x,y)\ \theta_2\ g_2(x,y)$. Define the θ-composition$\theta=(\theta_1, \theta_2)$: $(W\uparrow G^2)^2\to W\uparrow G^2$ as $g_1\theta g_2(x,y)=\theta_1\{ g_1(x,t)\ \theta_2\ g_2(t,y) \mid t\in G\}$. We will adopt notation $(\theta)-\prod g_\delta$ to represent $g_1\theta\ g_2\theta\ g_3\theta$, provided the associativity is satisfied.

Theorem: If θ_1, θ_2 satisfy associativity and distributivity, then θ satisfies associativity. Namely, $(w_1\theta_2w_2)\ \theta_2\ w_3= w_1\theta_2(w_2\theta_2w_3)$, $\theta_1\{\theta_1\{w_{\lambda\sigma}\mid\lambda\in\wedge\}\mid\sigma\in\Sigma\}=\theta_1\{\theta_1\{w_{\lambda\sigma}\mid\sigma\in\Sigma\}\mid\lambda\in\wedge\}$, $(w\theta_2)\ \theta_1\{w_\sigma\}=\theta_1\{w\theta_2w_\sigma\}$, $(\theta_1\{w_\sigma\})\theta_2\ w=\theta_1\{w_\sigma\theta_2w\}$ imply $(g_1\theta g_2)\theta\ g_3$.

Some n-order optimization of policy model and its concrete process can be denoted by certain panweight w, then the above theorem, which may be called as associativity principle of pansystems network, presents a sort of algorithm principle to analyze various multistage decision process and dynamic programming in this policy model, and includes following principles and related algorithms as some special eases: Bellman principle, suboptimization principle, Qin Yuyuan's jar-metric principle, Chapman-Kolmogoroff equation. Consequently, the quantitative analysis based on pansystems optimization theory provides the government with reasonable evaluation for a new policy, as well as the previous policies.

8. Implement model

8.1. Forecast of total demand of targeting logistic system.

Logistics system and its subsystems' goals in coordination with the national economic growth should be the satisfied solution to multi-objective optimization of socio-economic system, resulting in the overall synthesis, dynamic evolution and self-adaptive movement.

8.2. Long-term strategic planning.

After determining the aggregate balance of the logistic system and its sub-systems, the government then has to draft the strategic planning which includes the expected level of industrialization, the promising direction of logistics industry, as well as the aimed productive capacity.

8.3. Medium-term plan for implementation.

The medium-term plan includes the static layout planning and the dynamic operational procedure planning. This plan must be drafted in the strategic framework, and developed following the same decision-making method.

8.4. Short-term plan for specific projects.

Project planning aims to clarify the details, such as budget and conduction, about a certain project. It requires the contractor to undertake feasibility assessment, with consideration of land utility, geological conditions and other worth factors. The method of "Unit Comparison" or "Cost-Benefit analysis" could be employed.

8.5. Supportive system.

No rules, nothing can be accomplished. Integrated and efficient system, which could be established following the mentioned "decision-making method", is a must to assure proper implementation of the plan.

9. Conclusion

Complex theory grants us to research on formulation and implement of logistics policy from the systemic angle. Concerned with the unsatisfied development of national logistics, we present a policy logistics model to improve the former process that the logistics policies have been enacted. The self-organized logistics system in the era of network should reach overall synthesis, internal equilibrium and stably

progress under the guidance of logistics policy. In a conclusion, the research on the formulation of logistics policy is not only the government's responsibility but also the scientific attitude, philosophic, and academic foundation.

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