Diffusion mechanism and models of green supply chain management

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Abstract
In order to analyze the diffusion mechanism of green supply chain management, diffusion mechanism problem was considered. In this paper we considering use Bass diffusion model, the research of innovation diffusion model had become a research focus of the attention of scholars. Thus the Bass diffusion model has a significant of milestone. With a study on this issue, we found that in the current Uzbekistan's economic background, the maximum number of potential Uzbekistan's implementation of green supply chain management enterprise is 3319 (m =3319). This paper first summarized the predecessors' research, and defined innovation and the green supply chain management, and analyzed the relationship between the two. In this paper we selected two typical green supply chain management practiced – ISO4001 environment certification and type I Uzbekistan's environment mark as enterprise implementation of green supply chain management. This paper analyzed the status quo of the spread of Uzbekistan's green supply chain management based on the diffusion innovation theory; and with a study on the internal and external factors, this paper established the systematic framework of Uzbekistan's green supply chain management and the green supply chain management diffusion model, which could provide the theoretical foundation for the subsequent articles research.
Key words: DIFFUSION MECHANISM, GREEN SUPPLY CHAIN, INNOVATION SPREAD

1. Introduction

Since 2000, with the global environment problem becoming increasingly serious, a series of relevant laws and regulations issued by the EU containing the waste electrical and electronic equipment directive ((WEEE) directive) and the restrictions on the use of certain hazardous substances in electrical and electronic equipment directive (RoHS directive), promoted the implementation of green supply chain management in enterprises; at the same time also affected the environmental behavior of Uzbekistan's export enterprises. By the same token, the Uzbekistan's government also began to realize the seriousness of environmental problems caused by the rapid development of the industry, and has issued the "cleaner production promotion law" and "circular economy promotion law" and the Uzbekistan's version of the WEEE and RoHS directive[1].

Under the background, the environmental protection consciousness of Uzbekistan's firms also gradually improve, especially some of the leading foreign investment enterprises and joint ventures (such as General Motors, MAN and Daewoo, etc.). They had first carried out actively the relevant practice of green supply chain management, and other companies also began to implement green supply chain management through the supply chain partnership and imitations of competitive enterprise learning. In 2009, GXG association of companies and the global supply chain carried out the research of "Uzbekistan green

supply chain". It showed that nearly a quarter (15%) of respondents said it would take force green supply chain management related measures in the next six months, and about 22% of the enterprises would enforce it in the future action within six months to two and a half years, but there were more than 21% of companies didn't have any plans. And the rest of enterprises were not sure whether to implement the green supply chain management. The survey also showed that nearly a third (32%) of companies were willing to actively explore how to promote environmental protection, and a third (33%) of companies were willing to share policy of sustainable development of the enterprise and actively to promote the suppliers corresponding environmental protection measures. The research results showed that the green supply chain management practices in the Uzbekistan's companies have in different ways (for example, on the initiative of enterprises and the supply chain enterprise cooperation) began to spread, but the present situation of the spread between the green supply chain management in Uzbekistan's enterprises and the effects of a variety of different spreading ways on the whole diffusion process were not clear[2].

With the continuous development of industrial civilization, human industrial activities have resulted in a growing number of environmental problems, such as a variety of large-scale climate change, environmental pollution, soil erosion, ecosystem damage and other ensued global environmental disasters. Green supply chain management (GSCM), as a systematic environmental management approach, has become an important corporate tactic and strategy to comprehensively enhance the enterprises' economic, environmental and social performances. Many leading international companies have brought the concept and measures of GSCM to build their GSCM system in order to promote upstream and downstream enterprises in a supply chain to carry out environmental practices. In the past two decades, the global industrial development and economic integration have contributed to the unprecedented development of the Uzbekistan's economy. A large number of manufacturing sectors in the supply chains have been transferred to Uzbekistan and other developing countries, which has provided a lot of opportunities to the development of local economy while causing more pollutions and destructions on the local ecological environment. Due to the high cost and the complexity of implementation, GSCM in Uzbekistan's enterprises is adopted at a low level, while the implementation rate is relatively poor[3].

To study the diffusion mechanism of GSCM in Uzbekistan, the first thing to understand is the basic status of GSCM in practice. At the same time, we should analyze the present situation and establish the basic framework of GSCM diffusion. And on this basis, do with the next research. Therefore, this article will firstly study the status quo of GSCM diffusion in Uzbekistan based on the diffusion of innovation theory; then combined with the connotation of GSCM diffusion and the influence factors of theory research and literature research, we would established the research framework of the spread of green supply chain management system and diffusion model.

2. The Status Quo of GSCM Diffusion in Uzbekistan

2.1Problem Description and Model Selection

Since 2000, with the global environment problem becoming increasingly serious, a series of relevant laws and regulations issued by the EU containing the waste electrical and electronic equipment directive ((WEEE) directive) and the restrictions on the use of certain hazardous substances in electrical and electronic equipment directive (RoHS directive), promoted the implementation of green supply chain management in enterprises; at the same time also affected the environmental behavior of Uzbekistan's export enterprises. By the same token, the Uzbekistan's government also began to realize the seriousness of environmental problems caused by the rapid development of the industry, and has issued the "cleaner production promotion law" and "circular economy promotion law" and the Uzbekistan's version of the WEEE and RoHS directive.

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According to the above theory research, this paper would defined the green supply chain management diffusion as the communication process of green supply chain management practices with the passage of time under the influence of some factors through certain channels in a social system (a particular industry or area). Therefore, we would explore the present spread situation of Uzbekistan's enterprise green supply chain management in Uzbekistan's enterprises or organizations between macro diffusion phenomenon, namely the implementation of green supply chain management in Uzbekistan (take all or part of the green supply chain management practice), or the number of the organization or enterprise change over time process and the influence factors of causing these changes.

2.1.1 The relevant theory

Although the relevant literatures specialized in the research of diffusion phenomenon of green supply chain management was less, but most literatures chosen the innovation diffusion theory as the theoretical research basis of green supply chain management diffusion.

Sarkis et al.(2011) summarized the study on green supply chain management, and concluded the green supply chain management research at present content, theory and methods, and also put forward the green supply chain management in the future direction of the research question and research direction. Sarkis et al.(2011) argued that the innovation diffusion theory was one of the important theory and method for further the research of green supply chain management[4]. Hazen et al.(2011) thought the green supply chain management was a kind of innovation, based on the theory of innovation diffusion and the resource-based view, and using one-way ANOVA analysis of the statistical analysis analyzed the relationship between the enterprise green supply chain management practices (such as green reverse logistics) and the enterprise competitive advantage[5]. They found that the implementation of green supply chain management did not necessarily lead to an improvement in enterprise core competitiveness, and thus influenced the diffusion of green supply chain management. With combining innovation diffusion theory and ecological modernization theory and according to the Uzbekistan's manufacturing enterprise implementation level of green supply chain management, Zhu et al. (2005) divided the enterprises into the leading enterprises, the enterprises to follow and the backward enterprise. And through comparing the enterprise with different operation, economic and environmental performance level of implementation, they analyzed the spread of the green supply chain management practices. At the same time, using Bass approach and Probit MODEL, Liu (2009) adopt Japanese companies has environmental authentication data to study the diffusion process between the green supply chain management in the enterprise[6-7].

Therefore, this article also chose the theory of innovation diffusion as the research basic and based on summarizing predecessors' research results analyzed the rationality of its application.

2.1.2The innovation spread of green supply chain management

According to above review on the development of green supply chain management, the green supply chain management was put forward by the manufacturing research institute of Michigan state university in 1996 when studied the issue of "manufacturing in environmentally responsible" as a new concept(Song and Jia, 2009). They thought that the green supply chain management should integrate the ideas of environmental protection, the effective utilization of resources into each link of supply chain management, and its purpose was to reduce the impact on the environment, to improve the efficiency of resource utilization and then make the system benefit optimal. Although in the later, the definition of green supply chain management was becoming increasingly rich, but it had not much change in essence. Throughout the development of

environmental management practices, we can find that the environment management practice experienced a change from the mandatory practice to the competitive practice, and green supply chain management belonged to the latte. Namely it was a new kind of environmental management practices that grew out in the process of development of enterprise competition. The research on green supply chain management research is associated with life cycle analysis, extended producer responsibility and production stewardship, and developed continuously in-depth, but also formed three research phases of the green supply chain (Zhu, 2005). As for green supply chain management, it means that we should pay attention to and strengthen the environmental factors, at the same time mind the cooperation between the upstream enterprises (suppliers) and downstream (client). Green supply chain management practices included green procurement, environmentally friendly logistics (internal and external logistics), cleaner production practice, the environmental management system (IS014001) construction, green marketing practices (product of distribution and logistics) and old product recycling and management (reverse logistics)(Zhu, 2006)[8].

Most of the green supply chain management practices included the innovation both in the strategic and tactical. Based on the diffusion of innovation theory, the green supply chain management can be thought of as a kind of environmental management innovation. The concept of innovation was put forward by the Austrian American economist Schumpeter in 1939 in the “Business Cycles". It was proposed as a comprehensive innovation theory, and thought that the content of the concept of innovation includes technological change, but also the content of technical change (Kang, 2004; Schumpeter, 1939). And Innovation Diffusion theory was put forward by Professor Rogers of the University of New Mexico Everett - (Everett M. Rogers) in the book “Innovation of Diffusion” published in 1962. In this book, he examined the process of innovation Diffusion and various influence factors, and summed up the basic rule that how innovation things diffused in a social system, and put forward the famous theory of innovation Diffusion S – curve (Rogers, 1995). Rogers believed that innovation had five basic characteristics: relative advantage, compatibility, complexity, testable, observability, and pointed out that the innovation diffusion was actually that a kind of new ideas, thoughts, technology was introduced to a social system, and in this social system from a decision making unit to the next unit over time. He also pointed out that the innovation diffusion was always slow at the beginning, and then when the adopter reaches a certain number (i.e., "critical mass"), the diffusion process sped up (i.e., the stage of take - off). The process would continue until that the most likely to adopt innovation units in the system had adopted innovation, namely it reached its saturation point. At this time, the diffusion speed then slowed down gradually, and the calculation of the innovator number change with time and presented an s-shaped path (Rogers, 1995)[9].

By the analysis on the means of green supply chain management, we can see that green supply chain management could satisfy five basic characteristics of innovation. First of all, the green supply chain management is a kind of advanced ideas, and a kind of advanced management style, which add environmental protection concept into the green supply chain management to improve enterprise's environmental performance. Second, the green supply chain management can implement parallel with other environmental management measures such as cleaner production. It show that it has great compatibility; Third, compared with other environmental management means, the green supply chain management pay attention to the supply chain upstream and downstream enterprises and the environmental behavior of consumers, showing the characteristics of complexity; Fourth, with the success of the implementation of the green supply chain management in a field, the successful experience could be generalized to other fields in an experimental; finally, after the implementation of green supply chain management performance evaluation can be done, its implementation results are observed. To sum up, the green supply chain management could be considered as a kind of innovation, for which we can use innovation diffusion theory, model and method to study.

2.1.3The choice of model

After the 1960 s, the research of innovation diffusion model had become a research focus of attention of scholars. And within those researches, the Bass diffusion model has the significance of milestone. The core of Bass diffusion model is that innovation diffusion could spread through two channels, namely independent innovation and imitation innovation. It did not only determine the direction of study of diffusion theory, but also determined the basis of the study of diffusion theory.

Bass diffusion model was put forward by the famous management psychologist Frank Bass

(Frank M. Bass) in 1969, and was often used as market analysis tool to predict the demand for new products, new technologies. Many innovative experiences had shown that the new method, the new concept of market diffusion process can fully use the Bass model to express:

$$\frac{dN(t)}{dt} = \left[p + q\frac{N(t)}{m} \right]\left[m - N(t) \right] \quad (1)$$

Where *N(t)*indicates the innovative individual number in time *t*. The Bass model introduced three parameters to predict *N(t)*: *m*-market potential, namely the total number of potential demand; *p*-coefficient of innovation, namely the possibility of independent innovation; *q*-imitation coefficient, namely the possibility of the innovation by imitating adopters.

When using the Bass model to study other issues, the researchers usually used the existing data to regress and get the parameter values, and then predicted the spread in the future. In the decades after this, a large number of scholars on the basis of the Bass model, by changing some assumptions of diffusion model for further research. So someone viewed the Bass model and its extended models collectively as "the Bass model".

As a kind of innovation model, green supply chain management can make use of innovation diffusion model for research. Enterprises in the implementation of green supply chain management was not only affected by internal autonomy (enterprise environmental vision, internal environmental policy (and the external pressure corresponding) as well as the environmental awareness of corporate leaders and employees), but also by external pressures (environmental laws and regulations, consumer market, competition, suppliers and the mass media industry). So when we research the spread of the green supply chain management research in Uzbekistan, we should consider both inside and outside the enterprise factors at the same time (Zhu et al., 2010; Zhu et al., 2008). As for the research of innovation diffusion, Bass model and its derivative model was not only the main model at the macro level, and at the same time also considered the influence of internal and external factors. Therefore this paper will use the Bass model to describe the green supply chain management innovation diffusion.

Although the diffusion of innovation theory and Bass model for the study of green supply chain management innovation diffusion provides the theoretical basis, but while using the Bass model to research the innovation diffusion of green supply chain management should consider three aspects: first, how to determine whether the enterprise to adopt green supply chain management innovation, namely whether can choose the right indicator to evaluate the enterprise implementation of green supply chain management. Secondly, we should use the real data to fit the Bass model, and then test whether the coefficient is significant. That is to say that whether the innovation diffusion of the green supply chain management will meet the Bass model. Finally, when fitting regression parameters of the model, we should pay attention to its practical significance, namely whether reasonable explanation to the actual situation of green supply chain management innovation diffusion in Uzbekistan.

2.2Model Building and Basic Assumptions

2.2.1The assumptions

In this paper, we will give the meaning of green supply chain management innovation diffusion the coefficient of original Bass model, and built an innovation diffusion model of green supply chain management. We suppose that *N(t)*indicates the innovative individual number in time *t*, *m* means market potential, namely the total number of potential demand; *p* indicates the coefficient of innovation, namely the possibility of independent innovation; *q* means the imitation coefficient, namely the possibility of the innovation by imitating adopters.

The bigger of the coefficient of innovation *p* means that the greater possibility of enterprise implementing green supply chain management, which will be affected by the main factors including enterprise vision, leader support, and the costs of environmental activities(Zhu and Gen, 2009; Zhu, 2009). The bigger of the imitation coefficient *q* means that the greater possibility of Uzbekistan's enterprises imitating green supply chain management, and it was mainly affected by the pressure of the green supply chain, the government department in charge of environmental protection laws and regulations, environmental pressure, green industry association activities and the current and potential green business opportunities, etc (Zhu et al., 2010; Zhu et al., 2008). In this paper, the basic assumption of the assumptions was the same as the assumptions in Bass model basically, as follows:

(i)The innovation diffusion is independent of the other;

(ii)The geographical boundary of the social system does not change according to the diffusion process;

(iii) The green supply chain management practice of companies is divided into two states: not implement or implementation;

(iv)Once companies has adopted green supply chain management, and will continue implement it, namely the implementation process is reversible;

(v) There are no supply constraints;

(vi) All enterprises are homogeneous without any difference.

(2)The set-up of the model

Based on the original analytical of Bass model, we could establish enterprise implementation of green supply chain management innovation diffusion model in the framework of Bass model as bellow:

$$N(t)=\mathrm{m}\left[1-e^{-(p+q)t}\right]\left[1+\frac{q}{p}e^{-(p+q)t}\right]^{-1} \quad (2)$$

Where p means the innovation indicator; $p\left[m-N(t)\right]$ means the number of firms that adopt green supply chain management by the independent innovation; q means the imitation coefficients; $q\frac{N(t)}{m}\left[m-N(t)\right]$ indicates that the number of firms that adopt green supply chain management by imitation.

The accumulation diffusion curve of Bass model is commonly a s-shaped curve, and the shape of the curve depends on the parameters p and q. And the curve will reach a turning point in t^* time at when the curve becomes convex form concave, and the diffusion speed changed from up to down.

If $p \geq q$, namely enterprises implement green supply chain management mainly through the enterprise own innovation, diffusion model at this time will appear similar to the logarithmic function of convex curve, and the diffusion rate will falling with a biggest value at the initial moments, which shows that diffusion failure. If $p<q$, that is, most of the enterprises to implement green supply chain management is affected by other enterprises, and imitate other enterprises successful management practice. In this situation, now the spread curve presents the s-shaped Logistic curve, and the diffusion speed increased first and then fall, which means that the spread is success.

2.3Data Fitting and Result Analysis

Based on the innovation diffusion model of green supply chain management in the framework of Bass model, this paper first analyzes two typical green supply chain management practices as the indicators concerning whether the enterprise implement green supply chain management, and then collect data based on these indexes. Next, using Matlab software, this paper will fit the model with the data collected. At the final, we will analyze the diffusion phenomenon of green supply chain management in Uzbekistan's enterprises.

2.3.1Sample Selection

This article selects two typical green supply chain management practices-IS014001 environment system certification and type I Uzbekistan's environment mark as enterprise implementation of green supply chain management. IS014000 standard is international organization for standardization (ISO) to organize the formulation of environmental management system standards, officially issued in September 1996, and its standard number was from 14001 to 14100 with a total number of 100, known collectively as IS014000 series standard. From the perspective of the environmental factors and for the purpose of making the enterprise achieve compliance law-abiding, preventing pollution and continuous improvement, it minimize the environmental impact of enterprise every link of the activities, products or services by making a series of systematic, rigorous and documented standard system, and make continuous improvement on the basis of their own. Green supply chain has a close relation with IS014001 environmental management system certification. And its core idea is consistent with the idea of building environment oriented system of supply chain management in essence. It is a platform for building a green supply chain management system (Kong and Gao, 2007) and can promote the enterprises to implement green supply chain management (Arimura et al., 2011).

Type 1 environment mark is a kind of Uzbekistan's official proof of symbol. Ministry of environmental protection in Uzbekistan environmental certification center and its predecessor in Uzbekistan had carried out the plan of Uzbekistan's environment mark in 1994. Environment mark certification can not only promote enterprise to follow the environmental protection rules in the process of production, use and disposal, but also promote the products improved with low toxicity and less pollution compared with other similar products, contributing the formation of saving resources and

environmental advantages. Thus, it can promote the formation of the green consumption (Chen, 2009).

To sum up, the enterprise which has obtained the IS014001 environmental system certification will pay attention to the environmental protection measures within the enterprises and can affect the implementation of green supply chain management of upstream suppliers, while the enterprise which has obtained I type Uzbekistan's environment mark will pay attention to the environmental protection measures within the enterprises and can affect the implementation of green supply chain management of downstream suppliers and customers. This two kinds of indexes can be basically on behalf of the enterprise on the supply chain of green supply chain management practices. Therefore, the number of enterprises which has obtained IS014001 environmental system certification and type I of Uzbekistan's environment mark could be used to analyze Uzbekistan's green supply chain management. It is reasonable.

2.3.2Data Collection

Published by Uzbekistan's ministry of environmental protection certification center, we can get the number of enterprises which obtained the IS014001 environmental system certification and type I Uzbekistan's environment mark, showing a table 1 and table 2.

Table 1. The number of ISO 14001 certified enterprises from 1998-2009

year	1998	1999	2000	2001	2002	2003	2004
number	9	11	35	78	103	114	142
Year	2005	2006	2007	2008	2009	2010	2011
number	203	241	316	331	338	409	442

Note: the number in table 1 means the number of enterprise certified in this year.

Table 2. The number of enterprise with Uzbekistan's Environmental Label I from 1998-2011

year	1998	1999	2000	2001	2002	2003	2004
number	1	3	10	14	18	22	25
Year	2005	2006	2007	2008	2009	2010	2011
number	33	47	51	66	88	102	133

Note: the number in table 2 means the number of enterprise certified in this year.

2.3.3Data Analysis

Based on diffusion model of green supply chain management with a constant m values, this paper will use cftool curve fitting industrial box provided by Matlab7.8 computing platform to fit (Shi et al., 2007). Through Matlab simulation of IS014001 environment system certification and type I of Uzbekistan's environment mark for enterprise data, the fitting effect are shown in table 3.

Table 3. Fitted results from the number of enterprises

	Coefficients				Goodness of Fit			
	p	q	m	t^*	SSE	R-square	Adjusted R-square	RMSE
ISO 14001	0.0003872	0.6683	3319	11.00	6647000	0.9969	0.9964	777.3
Type I	0.001336	0.4210	1088	12.47	49660	0.9939	0.993	61.81

With fitting the data, both of the estimates of R-square and the R-square with correction are 0.99 above, which indicates that the fitting effect is very good. According to the results of Sultan et al.(138) who summed up 213 Bass model in15 papers, the fitting coefficient of diffusion of innovation coefficient (p) was 0.03 on average, and the average of imitation coefficient (q) was 0.38 on average. By comparison, both of these two indicators of fitting coefficient of innovation are smaller than the average value, while the imitation

coefficients are greater than the average value. It indicates that the spread practices of Uzbekistan's green supply chain management are mainly the imitation. The other two indicators of the fitting results are $p < q$, meaning that the diffusion type is an s-shaped curve. $t^* = (p+q)^{-1} \ln\left(\frac{p}{q}\right)$ means the time when the curve reached the inflection point. And the t^* value of fitting data for IS014001 environmental management certification enterprise is 11.00, namely in January 2008 or so; and the t^* value of fitting data for Type I attestation of Uzbekistan's environment mark is 118, which in February 2008. Thus it can be inferred in the present Uzbekistan's economic and policy background, the Uzbekistan's enterprise green supply chain management should spread with a turning point in 2008 between January and February. Before that, the diffusion rate was increasing year by year; after that, the diffusion rate was decreasing year by year, fitting a curve as shown in Figure 1 and Figure 2.

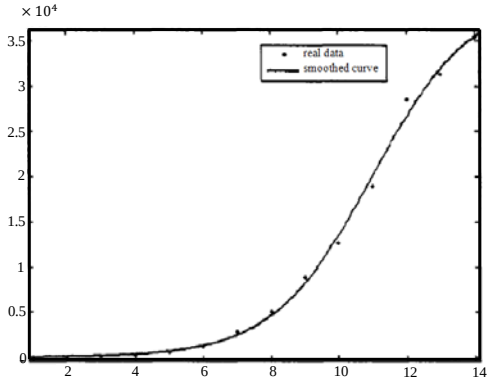

Figure 1. ISO14001 smoothed curve from the fitted results

It could be easily seen from the fitting curves that the overall trend of this two curves is the same. Thus, we can divide the process of enterprise's green supply chain management at present in Uzbekistan into three stages: (a) slow start stage (1996-2003), the thought of the green supply chain management had just arisen in this stage, with a relatively low and a relatively stable state of enterprise diffusion rate maintained; (b) the rapid growth phase (2004-2001). In this stage, green supply chain management has become popularized, with a large number of enterprises carrying out the green supply chain management practice. In this stage, the whole diffusion was characterized by a rapid growth; (3) the slow growth stage (after 2011). In this stage, the spread of the green supply chain management in Uzbekistan's enterprises gradually matured, and the diffusion rate began to fall.

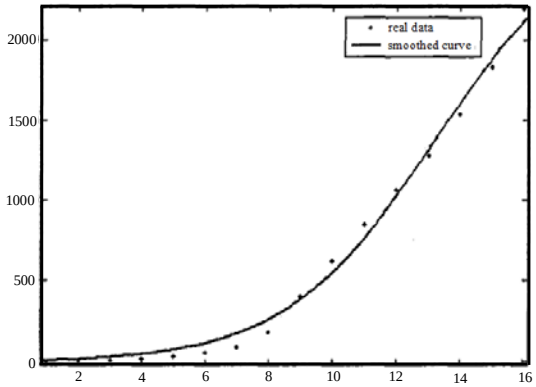

Figure 2. Eco-label I smoothed curve from the fitted results

2.3.4Trend Analysis

With a study on this issue, we found that in the current Uzbekistan's economic background, the maximum number of potential Uzbekistan's implementation of green supply chain management enterprise is 3319 (m=3319). But as Uzbekistan's environment problem became increasingly serious, and consumer environmental protection consciousness gradually strengthened, as well as the state environmental protection policy became constantly improved, Uzbekistan enterprises own environmental protection consciousness and enterprise external environmental pressure increased. Thus, the green supply chain management also will continue to spread. So we will take different values for m in Bass model to analyze the change of innovation implementation of coefficient (p) and imitation coefficient (q). Based on the second national economic census of Uzbekistan in 2008, we set m value as 5%, 10%, 20%, 30%, 50% of the total number of industrial enterprises in Uzbekistan, while m means the potential implementation of green supply chain management of Uzbekistan's biggest companies. The goodness of fit and estimated results was shown in table 3-4. Compared with different indicators of 5 sets of data, we found that with the increase of m value, innovation factor (p), imitation coefficient (q) and R-square reduced gradually. But innovation coefficient decreased faster. Therefore, with the increase of the number of potential implementation of green supply chain management enterprise, the influence of the implementation of imitation became greater.

Table 4. Estimation results and goodness of fit with different values of m

	value	p	q	R-square
ISO 14001	5%	0.001574	0.3608	0.9745
	10%	0.001091	0.3061	0.9685
	20%	0.000618	0.2841	0.965
	30%	0.000427	0.2774	0.964
	50%	0.000264	0.2722	0.9631
Type I	5%	0.000168	0.2189	0.9787
	10%	8.48E-05	0.2172	0.9785
	20%	4.26E-05	0.2163	0.9784
	30%	2.85E-05	0.2161	0.9783
	50%	1.7096-005	0.2158	0.9783

2.3.5Results Analysis

From the above analysis, we may draw the four main results about the spread of green supply chain management for Uzbekistan's enterprises:

(a) The implementation of independent innovation performance is not obvious, and the imitate implementation dominant

As for the two different indicators, two innovation coefficients are within the scope of (0.0003, 0.002), 2 imitation coefficients are within the scope of the (0.4, 0.7). It indicates that in the implementation of green supply chain management for Uzbekistan's enterprises, innovation (independent) implementations is not obvious, but imitate implementation dominants. This is due to the corporate pursuit of profit maximization in the process of operation, while implementation of the green supply chain management independently will increase the operating costs of enterprises, and imitating the implementation by absorbing the experience from the enterprises that has been implemented green supply chain management will greatly reduce the cost of the enterprise. In addition, due to the weak consciousness of environmental protection for Uzbekistan's enterprise, most of the implementation of green supply chain management of enterprises is the external pressure of the supply chain and the government's environmental regulations, only a small amount of enterprise has the environmental vision and could get help support from the leadership, then can implement the green supply chain management independently. Finally, the independent innovation is a road only with a few people walked off, thus there must be a lot of uncertainty and risk. Most enterprises are of the type of risk aversion, and therefore they are willing to imitate implementation rather than to implement independently.

(b) The value of the real value minus the fitting value for this two indicators were changing from negative to positive

In 2004 (IS014001 environmental system, r = 7; type I of Uzbekistan's environment mark, t = 9), the diffusion velocity of Uzbekistan's enterprise green supply chain management increased suddenly, making the actual accumulative number of companies implementing green supply chain management was greater than the number of fitting, and this period of time continued until around 2007 to 2008. Through the analysis of macro events, we found that in 2003, the external factors of the enterprise groups gave positive stimulus spread to the spread of the green supply chain management. On the one hand, with the opening up to the world economy, Uzbekistan's enterprises would be formally compete with foreign companies on the same platform, and Uzbekistan's commodity also should be recognized by the foreign customers and consumers who had a strong environmental protection consciousness. Therefore, in the case of multiple pressures, Uzbekistan's market transition period from 2004 to 2008, the government would actively promote environment mark certification within the enterprises and products with good condition and wish improve the quality of manufactured goods by environment mark as dance. On the other hand, the "green barrier" has prompted Uzbekistan's export enterprises to carry out the green supply chain management practices. For example, the European parliament and the European commission published "about limit use of certain harmful Substances in electrical and electronic equipment directive (Restriction of Hazardous Substances) (hereinafter referred to as RoHS directive) on February13th in 2003, which formally began to put into implement on July 1st 2006. In this restriction, it enshrined in eliminating motor electronic products in the a total of 6 kinds harmful substances including lead, cadmium, hexavalent chromium, polybrominated biphenyls (PCBS) and polybrominated diphenyl acid. In addition, the ISO 14001 environmental system certification was updated in 2004, and some enterprises which had adjusted its own environmental management strategy got the new version of the environment system certification again. As a result, the pressure of the supply chain, the government's policy dance and potential green business opportunities are important external

motivation factors for promoting the spread of green supply chain management.

(c) The value of the real value minus the fitting value for this two indicators were changing from positive to negative from 2009 to 2011

From 2009 to 2011(ISO14001, $T=13$; Type I, $t=14,15$) , the accumulative number of Uzbekistan's enterprise which had implemented green supply chain management was lower than the fitting value. This is because that, on the one hand, the Uzbekistan's enterprises which had the conditions of implementing green supply chain had conducted green supply chain management measures of IS014001 and Type I from 2004 to 2006 under the influence of external factors. Thus, from 2009 to 2011, the speed of green supply chain management diffusion gradually slowed down. On the other hand, the global economic crisis happened in 2008, some companies under the economic pressure were unable to continue to carry out the green supply chain management. Thus, the economic costs were also the important factors that affect enterprise implementation of green supply chain management. But by 2011, the difference of the real value and fitting value changed from negative to positive, due to the reason that the effect of 2008 economic crisis on the enterprise in Uzbekistan had started to fade. In addition, some entrepreneurs and scholars found that the impact on the enterprises with good implementation of green supply chain management was small in the face of economic crisis. Those enterprises had a better ability to resist economic crisis (Yang and Chen, 2009). That was why many enterprises began to implement green supply chain management in 2011.

(d) With the increase of *m* value, the value of *p* and *q* changed at different levels

Under the background of the current Uzbekistan's consumers, the government's environmental protection consciousness of laws, regulations and other factors, the fitting results showed that the maximum number of potential Uzbekistan's implementation of green supply chain management (m) was small (less than 2.5% of the total number of industrial enterprises in Uzbekistan). But with the increase of environmental pressure from the Uzbekistan's government and the increase of consumer environmental awareness, more and more companies would tend to implement green supply chain management, thus the number of potential implementation of green supply chain management would also increase. Increase with the *m* value selected, the corresponding innovation coefficient (*p*) and the imitation coefficient (*q*) would constantly decrease, but the speed of *p* decreased was bigger than the speed of *q* reduced.

Since *p* reflected the spread of the independent innovation implementation of green supply chain management and *q* reflected the effects of imitation implementation of diffusion, so as Uzbekistan's implementation of green supply chain management, the number of potential enterprises would increase and the influence on the implementation of imitation would gradually increase. Therefore, the government should not only make the enterprise gradually realize the importance of environmental protection, but improve the ability of enterprises to implement green supply chain management, even if the value of innovation implementation coefficient increase. This could further promote the spread of green supply chain management in Uzbekistan's enterprises.

2.4 Model Conclusions and Limitations

This article first summarized the predecessors' research, and defined innovation and the green supply chain management, and analyzed the relationship between the two. We thought that green supply chain management is a kind of management innovation in essence; on this basis, we analyzed the innovation spread of green supply chain management using the theory of diffusion spread theory. And then this paper built a green supply chain management diffusion model based on Bass model, and adopted the number of enterprises which got the IS014001 environmental system certification and type I of Uzbekistan's environment mark in each year as fitting samples to analyze the current situation of enterprise green supply chain management spread and influence factors. This paper got the following conclusions:

(i)The implementation of green supply chain management of Uzbekistan's enterprises was mainly the style of imitation implementation, and the independent innovation implementation only accounted for a small proportion.

From the fact that the coefficient of innovation implementation was far less than that of imitation implementation from the fitted curve coefficient, we could know that the proportion of Uzbekistan's enterprises which implemented green supply chain management was very small, indicating that at present the initiative of our country enterprise to implementing green supply chain management was not strong, mainly promoted by external pressure from business groups (government and consumers, etc.) and the

influence of the interaction between enterprise group (competition and supply chain) to imitate.
Therefore, the government should promote the spread of the green supply chain management by encouraging and supporting some demonstration project or enterprise, then via the interaction between enterprises. For example, the government could promote the core enterprise in the supply chain first implementation of green supply chain management, thus promote the implementation of the entire supply chain or promote the influential or large state-owned enterprises, and through its great influence to promote more enterprises to implement green supply chain management.

(ii) The implementation of green supply chain management for Uzbekistan's enterprises was affected by both of internal and external factors.

From the change of the difference of data fitting value and real value, we can see that the implementation behavior of green supply chain management for Uzbekistan's enterprises was not only affected by the pressure of the green supply chain, the government's environmental policy and the influence of potential green business opportunities, but also affected by the environmental protection measures of any economic cost and the influence of its own internal factors such as environmental awareness. Within these factors, the government's environmental policies, such as the external environmental pressure will usually lead to the spread of the green supply chain management, while the economic costs of environmental protection measures will always prevent the spread of the green supply chain management.

(iii) At present Uzbekistan's enterprises were lack of stress and power to implement green supply chain management
From the fact that the value of fitting data m was small, we can see that under the background of Uzbekistan at present, the number enterprises of potential implementation of green supply chain management enterprise were rare. Therefore, the government should, on the one hand, strengthen environmental protection and other relevant policies and regulations to develop and improve law enforcement and increase the number enterprises of potential implementation of green supply chain management enterprise; and on the other hand, the government should promote or encourage measures to improve their environmental protection consciousness constantly.
In this paper, there are some shortages in the process of research. For example, this article only selected the IS014001 environmental system certification (attention to enterprise itself and the supply chain upstream of the environmental behavior) and type I Uzbekistan environment mark (pay attention to environmental protection behavior of consumers and the downstream supply chain) as the research indicators for the enterprise implementation of green supply chain management practices. In future studies, we should select a more comprehensive evaluation index of enterprise implementation to study this issue.

In addition, this article only chose the original Bass model for data analysis, not gave further correction to the Bass model according to the characteristics of green supply chain management. In the future study, we should select the most suitable model based on the comparison of different innovation diffusion model and by the correction of the original model to study the enterprises' behavior of green supply chain management in Uzbekistan.

3. The System Framework of GSCM Diffusion Mechanism

3.1The System Framework of GSCM Diffusion

Through the literature review of analyzing the current situation of Uzbekistan's green supply chain management spread and diffusion of green supply chain management factors, we presents the green supply chain management system framework in this section, as shown in figure 5. According to the situation of Uzbekistan's green supply chain management diffusion, the diffusion of green supply chain management mainly included two ways: one was that the enterprises within the enterprise groups carried out the imitation implementation through the interaction between enterprises(such as supply chain upstream and downstream enterprise relations of cooperation and competition of the same kind of enterprise relationship) to imitate the enterprises which had started to implement green supply chain management; another way was that the enterprises within the enterprise groups carried out the independent innovation implementation when they were affected by external factors (government, consumers, the media and non-profit organizations, etc.).

Enterprise green supply chain management included supply chain such as suppliers, manufacturers and distributors in each link; by the same token, the spread of green supply chain management within enterprises was also involved in composed of suppliers, manufacturers and distributors such as enterprise groups. Under the

influence of factors both inside and outside the enterprise, the green supply chain management began to spread between enterprise groups, and enterprise groups (including supply chain competitive companies and enterprise groups) with external groups (government and market, etc.), and finally achieved a balanced state under the influence of various factors. Based on the status quo of green supply chain management in Uzbekistan's enterprises and based on the spread of green supply chain management in different speed, we can divide the spread diffusion process into three stages. It is initial stage, the initial stage, diffusion phase and stable phase respectively. In the initial stage, the environmental protection consciousness of the government and market was not strong, and the enterprises were not familiar with green supply chain management innovation. Only some of the leading companies dare to do with the practice of the new management mode. Thus, the speed of spread was slow. In the stage of diffusion, along with the increasing pressure of environmental protection at home and abroad, consumers' environmental protection consciousness gradually got strengthened, and good benefit of implementation in some leading enterprises, the enterprises were aware of that the implementation of green supply chain management innovation can produce good economic and environmental benefits, and thus began to imitated. Then the rate of diffusion accelerated. In stable stage, the enterprise of the group members had completed the implementation of green supply chain management, and had established a good green supply chain management system, and had achieved the equilibrium of diffusion.

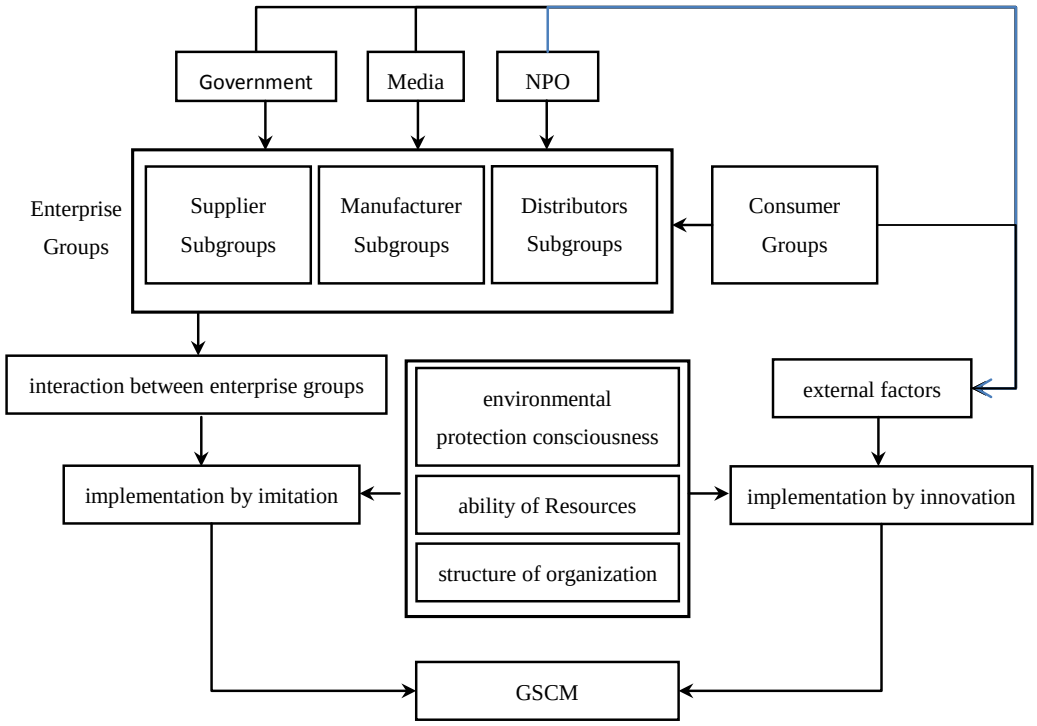

Figure 3. The System Framework of GSCM Diffusion

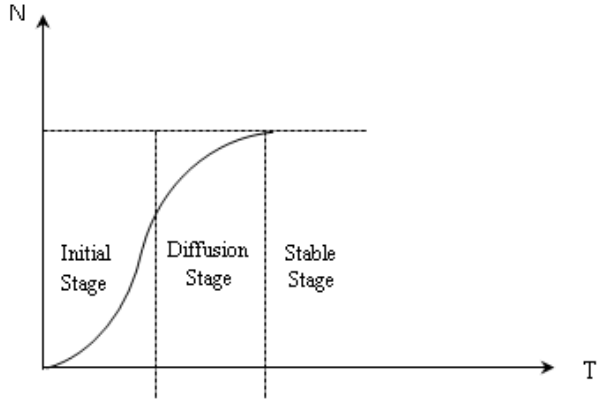

Figure 4. The Process and Phases of GSCM diffusion

3.2The Research Framework of GSCM Diffusion Mechanism

According to the system frame of diffusion of green supply chain management, we will design the green supply chain management diffusion research model framework (as shown in figure 7), working as the foundation for the following research. This paper will build green supply chain management diffusion model of enterprise based on the two main ways of the spread of green supply chain management within enterprises; and on the basis of the analysis enterprise individual implementation decision-making mechanism, we would analyze the diffusion rules of green supply chain management within enterprises, and then study the effect of government on the spread of green supply chain management.

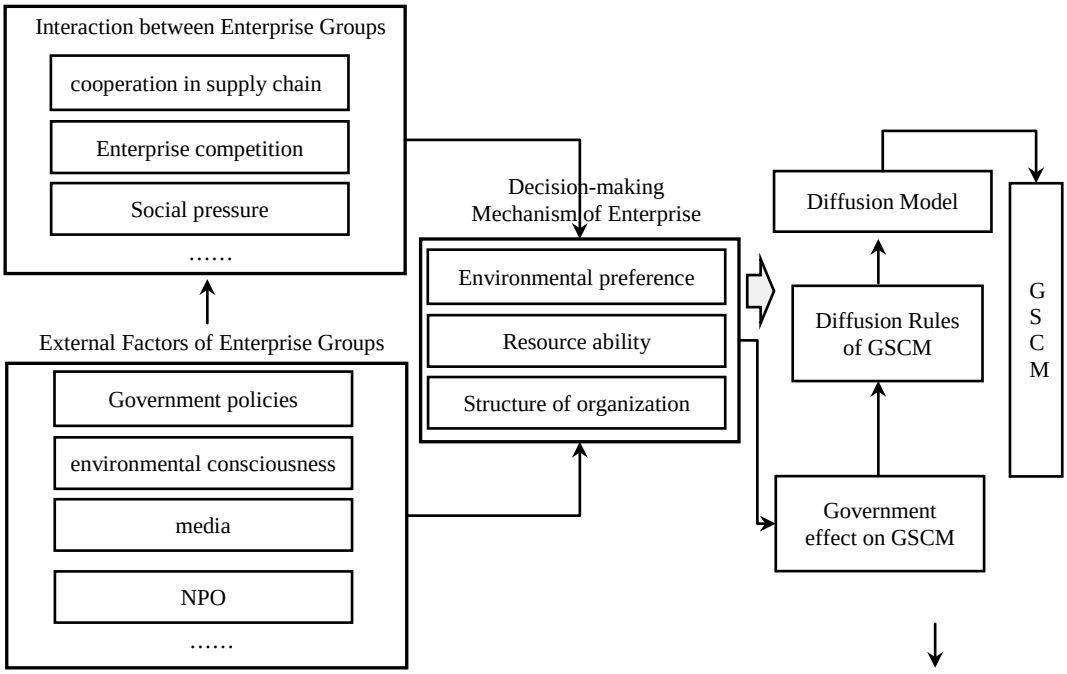

Figure 5. The Research Framework of GSCM Diffusion Model

The implementation of green supply chain management decision-making mechanism of individual enterprise is the foundation of the spread the green supply chain management in enterprise groups. It mainly discusses how the enterprises decided whether to implement green supply chain management according to their own internal factors under the interaction of enterprise groups and the external factors of enterprise groups.

As for the internal factors, it could be mainly divided into three main parts: (a) Environmental consciousness. Leadership's environmental protection consciousness, the enterprise's environmental vision, strategic environment, the enterprise and middle managers and staff's attitude to environmental protection. (b) Resources. Enterprises with the implementation of green supply chain management of capital, talent and technology resources and enterprise capacity on the implementation of green supply chain management. (3) Organization. Within the enterprise environment management system and implementation process of the establishment of enterprise internal collaboration capabilities of each related department.

The spread mechanism of green supply chain management is to discuss the spread rules of green supply chain management within enterprises under the influence of internal and external factors. The

external factors influencing the spread of green supply chain could be divided into the interaction factors within enterprise groups and external factors in enterprise groups. The interaction among enterprise groups mainly includes the relationship between the upstream and downstream enterprises of supply chain and the competition relationship between enterprises of the same type. Enterprises can select and support suppliers by purchasing the upstream parts and raw materials, and set specifications and requirements when sell products to the downstream enterprises. With these behaviors, the enterprises could spread the green supply chain management practices and measures to the whole supply chain. The enterprise of the same type product compete with each other in consumer market of different environmental preferences, and take green supply chain management strategies such as harmless products, green products and energy saving products, etc. In addition, when enterprise implemented green supply chain management, it would also specify the social norms role of other enterprises in the same industry or area, and thus promote the spread of the green supply chain management. Enterprise groups of external factors mainly include government, consumers, media and non-profit organizations, etc. Through different laws and regulations, the government has different effects on the enterprises which have implemented green supply chain management, for example, by making environmental regulations forced enterprises to implement, promoting policies to popularize environmental protection knowledge or subsidy policies to de and encourage enterprises to implement. Consumers with environmental preferences will buy green products. It will promote the enterprises to implement green supply chain management. At the same time, the media and non-profit organizations, the disclosure of environmental pollution on the popularization of knowledge of environmental protection, the supervision of government and enterprises and the publicity of green supply chain management to a certain extent, also affect the spread of the green supply chain management.

As discussed above, the goal of the spread of green supply chain management is to discuss how to promote green supply chain management in enterprise groups from the perspectives of government, and thus promote the sustainable development of a particular industry or a certain area of part or all of the of the enterprise. Therefore, the study on the drive effect of the spread of green supply chain management from the perspectives of government is to study how to apply the theory into the process of solving practical problems, and it is also the important content of green supply chain management diffusion mechanism. To study the drive effect on the spread of green supply chain management, government could know how to effectively and scientifically promote diffusion between the green supply chain management in the enterprise.

4. Conclusions

This article analyzed the status quo of the spread of Uzbekistan's green supply chain management based on the diffusion innovation theory; and with a study on the internal and external factors, this paper established the systematic framework of Uzbekistan's green supply chain management and the green supply chain management diffusion model, which could provide the theoretical foundation for the subsequent articles research.

(i) Green supply chain management is a kind of innovation. We can study the diffusion mechanism of green supply chain management research based on the innovation diffusion theory and model.

(ii) The carrying out of the green supply chain management of Uzbekistan’s enterprises was mainly influenced by imitation, so the government should promote the core enterprise of supply chain to implement green supply chain management, and promote the implementation of the entire supply chain.

(iii) Under the present background, the green supply chain management of Uzbekistan’s enterprise has entered the stage of slow continuous development; thus the government should make policy to improve enterprise's ability of implementation of green supply chain management motivation, and increased the spread speed of green supply chain management again.

(iv)Based on the status quo of the spread of Uzbekistan's green supply chain management and the relevant literature, this article established the research framework of the spread of green supply chain management, and identified the two aspects of the main research content of diffusion model, namely the impact rule of internal and external factors on the green supply chain management and the government effect on the spread of green supply chain management.

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