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Mode and Mechanism of Green Innovation Based on User Involvement Electronic Platform under Chinese Green Education Context

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ABSTRACT

By focusing on the Chinese green education context, this study analyzes the environment and the status quo of China's green innovation, presents a "4 Fundamental & 3 Supported Bodies" green innovation paradigm based on user involvement electronic platform under Chinese green education context, namely, enterprises, universities, research institutes and users as the four fundamental bodies, and government, intermediary and financial institutions as supported bodies involved in green innovation paradigm through electronic platform. By using game theory and system dynamics, the mechanisms of green innovation based on user involvement electronic platform under Chinese green education context are simulated. Moreover, this study puts forward three specific operational modes, including: (1) the operational mode of user proposal, which is to seek the views and suggestions of users dynamically in the entire process of green innovation decision-making phase, green innovation of pilot phase, and green innovation of try-out phase, and absorb into the optimization process of innovation decision and innovative products; (2) the operational mode of user experience, which involves users' product and service experience into the innovation activities, as well as users' R&D and production experience; and (3) the operational mode of user R&D, which invites the users' designs collection and users' involvement in R&D projects. Finally, the study takes NIU electric vehicle company in China as an example for case analysis.

Keywords: green innovation, user innovation, green education, incentive policy

INTRODUCTION

Nowadays, the environment protection and sustainable development related courses is gradually embedded in the whole process of education in China, which is named as "green education". It involves water sustainability education, waste reduction education, green energy education, and etc. During the green education, teachers should obey the natural rule of students to infuse the green concept to them smoothly.

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Contribution of this paper to the literature

- This research presents a "4 fundamental & 3 supported bodies" green innovation paradigm based on user involvement electronic platform under Chinese green education context.
- This research puts forward three specific implementation operational modes, and take NIU electric vehicle company in China as an example for case analysis.
- This research can help managers and scholars to recognize the importance of users involvement in green innovation.

Innovation exists consistently during the development of an individual or enterprise. Consequently, it is of vital importance to emphasis on green innovation in green education. Green innovation refers to the innovation during which energy and resource consuming, as well as waste, are reduced. While implementing the green innovation, the user involved electronic platform plays a pivotal role.

Currently, user innovation has become a significant way of open innovation. In China, many enterprises pay more attention to user innovation, and gradually carry out the practice of user experience and the user involvement in innovation. The government of China is strongly promoting the collaborative innovation among government-industry-university-research-user, making the user become an important choice for sustainable development. Nevertheless, green innovation in the process of practice encountered many difficulties in China, among which, the most important one is that the green innovation sometimes is not easy to get the user's understanding and support, making the lack of user's demand for the achievements and products of the green product innovation. Thereby producing propositions: In the Chinese green education context, whether the user innovation can be embedded with green innovation? What is the feasible operational modes of Chinese companies to accomplish the user involved green innovation?

As early as 1988, China put forward the policy of "science and technology as first productive force". In 1995, China initiated the "technology and education" strategy. In 2007, the Chinese government formally proposed that China should enter innovative country in 2020. In 2012, the Chinese government further pointed out that China's development mode to be driven by innovation instead of input and investment, and proposed the implementation of an innovation-driven strategy.

Chinese government attaches great importance to promote open innovation, and it has been promoting the construction of "technological innovation system with enterprises as the fundamental body, market-oriented, characterized by cooperation of industry-university-research." Moreover, Chinese government supports universities or research institutes to construct technological innovation platform to encourage enterprises carry out their R & D activities in technological innovation platform for universities or public research institutions. The public platforms for technological innovation including: national and provincial key laboratories, technical centers, testing centers; some local governments also geared to the needs of different industries to establish a regional integration of industry-university-research, an independent entity research institute of industrial technology. The Chinese government encourages the establishment of collaborative innovation research center, which relies on the strategic alliances of industrial Technological innovation, including enterprises, universities, research institutes, and even government departments involved.

Meanwhile, not only focusing on innovation, Chinese government takes measures to promote environmental protection and green innovation. For example, from 2016, Chinese government starts to implement the five-year plan of environmental protection technology to support green Technological innovation, then successively promulgated related specific technique policies, the key point of which is the technology research and development of the water environment and the atmospheric environment. Chinese Ministry of Science and technology and national environmental protection department are jointly launched the "Water Environmental Technology Project", invested heavily in research and development, and organized industry-university-research to carry out opening green innovation program.

Table 1. 2014 Open Innovation and User Innovation in China's Top Ten Green Innovative Companies

Company	Industry	Open Innovation	User innovation	Electronic Platform
Beijing Unisplendour Empvreal Environmental Engineering Technology Co..Ltd.	water treatment equipment and materials	joint innovation with Tsinghua University, Donghua University and Nanjing University; shared university innovation experimental platforms	company users involve in R&D projects	www.c-c.com
China Everbright International Limited	green energy, environmental protection water and new energy	cooperate with the user companies, local governments and overseas companies in innovation activities	the government users are involved in pilot innovation projects; local environmental agencies involved in test improvement	www.ebyunfu.com
Jiangsu Sunhome New Energy Co., Ltd.	development and manufacturing of energy storage, energy-saving technology	cooperate with Chinese Academy of Sciences, Qinghua University, Southeast University, Nanjing University of Technology, China Science and Technology, and the EU companies	the downstream of the power grid companies are involved in the R&D project of intelligent storage	www.c-c.com
Shandong Three Benefit Landscaping Co., Ltd.	landscaping, municipal, beach landscape design, construction and maintenance	cooperate and innovate with Shandong Forestry Science and Technology Research Institute to build experimental base	none	www.11467.com
Beijing Huasheng Hengye Technology Co,. Ltd.	R&D of Mechanical and electrical products	cooperate and innovate with German Lenze	the downstream of the machinery manufacturing companies involved in innovation activities	cn.made-in-china.com
Heilongjiang InterChina Water Treatment Co., Ltd	municipal water supply and drainage project and ecological environment management project	Joint innovation with Tsinghua University, Tianjin University, Harbin University, Beijing TIANDIREN Environmental Protection Technology Co., Ltd., Beijing China Sciences Environment Protection Co., Ltd	the water sector, as the downstream, involved in innovation activities	www.h2o-china.com
Société Générale de Surveillance Co., Ltd. (SGS)	testing, demonstration and technical services of agricultural, mining, petrochemical, industrial, consumer goods, automotive and life science inspection	cooperate with SGS(Switzerland) and many downstream companies	some downstream companies involved in standard-making	www.1024sj.com
Shenzhen Hyper Dot Technology Co., Ltd.	printing technology	cooperate with in-land companies and American companies	joint innovate with the downstream companies	cheung661.b2b.hc360.com
Tianjin Huatai Shenmiao Bio Engineering Technology Co., Ltd.	UHP biological treatment technology research and equipment manufacturing	cooperate with Qinghua University	none	www.caigou.com.cn
Beijing Air Energy Plants System Co., Ltd. (AEP)	environmental restoration, ecological building energy-saving	cooperate with overseas companies	the downstream companies in Vancouver, Canada, to carry out user experience plan in ecological counter and ecological oxygen bar	www.visacn.com

In terms of green innovation, for example, state and local governments provide all aspects of support for the research and development of new energy vehicles, for example, in terms of electric vehicles, China central government and local governments give consumers subsidies. Pure electric passenger cars, plug-in hybrid (with extended range) buses, pure electric vehicles and fuel-cell vehicles, the highest amount subsidies from China central government and municipal financial subsidies shall not exceed 80% of the vehicle sales price. In 2014, China adjusts its economic development strategy, and puts forward the "new normal" strategy, the strategic situation are: (1) By the high-speed economic growth (more than 7%) into the medium speed (less than 7%); (2) the industrial structure upgraded from extensive to intensive, saving resource and energy that will become an important part of the adjustment of industrial structure; (3) the Chinese economy transforms from the production investment-driven

model into an innovation-driven model, innovation and entrepreneurship become the main driving force for economy development; (4) the new normal state has some uncertainties and challenges, especially more emphases should be put on environmental protection. Obviously, under the "new normal", green innovation will absorb wide attention by the Chinese government and enterprises.

Implementing green innovation through open innovation, agglomeration, and integrated innovation resources, has become a trend of green innovation in China, which reflects the government's participation and support for this kind of opening green innovation. Taking "2014 China Top Ten Green Innovation Enterprises" as an example, we can see from **Table 1**, the ten representative of green innovation enterprises adopt an open innovation way, among them, the green innovation cooperation between enterprises and universities is of the most common, but there are also overseas enterprises, research institutes and even government departments involved in the green innovation activities. Nine of the top ten green innovation enterprises have the user involvement in green innovation, but eight of them involved only by enterprise users in the green innovation, only one of them involved both enterprise users and the terminal consumers in the green innovation, at the same time the user involvement in the 10 enterprises all have used the electronic platform. This shows that opening innovation has been very general in the mainstream of China green innovation enterprises, user involvement electronic platform in green innovation shows a significant start as well, but there is not enough for the end user involvement electronic platform in green innovation.

MODEL AND SIMULATION

This paper assumes that the government, enterprises and users are incomplete rational individuals. in the process of green innovation, those incomplete rational individuals play games with each other to maximize their own interests, which can be economic benefits or utility. This game can be divided into two sub-games, one is a company – consumer game, and another is a company-government game. For simplicity, this paper only considers the following situations: the game between companies and users on the issues of user involvement in innovation, and the game between companies and government enterprises on the issues of enterprises' achieving low-carbon and energy saving target by developing green innovation. To simplify the calculations, this paper assumes that, firstly, the user has two choices in terms of business innovation: high involvement, refers to user involvement in R&D development and user recommendations, and low involvement, refers to no participation or only participation in user experience. Secondly, enterprises have two options in terms of user innovation, one is giving high support, which includes building sound platforms and toolboxes for users to participate, carrying out institutional user training and giving rewards for user involvement, and the other is giving low support, in concrete, there is no support measures or merely the user experience and user recommendation system is provided. Thirdly, enterprises also have two choices towards green innovation: one is actively involved in green innovation to achieve low-carbon and emission reduction, and another is no development in green innovation. Fourthly, government has two actions towards green innovation: one is giving rewards or punishment, and another is no interfere. Based on these assumptions, this paper presents two payoff matrices as shown in **Table 2** and **Table 3**. Wherein, U is a high probability of innovative user involvement, EU is the probability of enterprises' high support for user innovation, G is the probability of the government's rewards and punishments for the enterprises involved in green innovation or not, EG is the probability of companies' carrying out green innovation.

Assume that, in the organization of user involvement in green innovation, when company gives high support to user involvement in green innovation, the company's cost is Ech, when company gives low support to user involvement in green innovation, the company's cost is Ecl; in addition, in terms of user involvement in company green innovation, when the users involve in green innovation to a great extent, the users' cost of high involvement is Uch, when the users involve in green innovation to a little extent, the users' cost of low involvement is Ucl. Suppose that, when the company is in high support and the user is highly involved in green innovation, the number of innovation achievements is N11; When the company is in low support but user is highly involved in green innovation, the number of innovation achievements is N12; When the company is in high support but user is lowly involved in green innovation, the number of innovation achievements is N21; When the company is in low support and user is lowly involved in green innovation, the number of innovation achievements is N22. Obviously,

Table 2. Game Payoff Matrix of Company and User

		Company	
		High Support (EU)	**Low Support (1-EU)**
User	High Involvement (U)	U_{11}, EU_{11}	U_{12}, EU_{12}
	Low Involvement (1-U)	U_{21}, EU_{21}	U_{22}, EU_{22}

Table 3. Game Payoff Matrix of Company and Government

		Company	
		Active in Green Innovation (EG)	**No Activity in Green Innovation (1-EG)**
Government	Incentive Policy (G)	G_{11}, EG_{11}	G_{12}, EG_{12}
	No Interfere (1-G)	G_{21}, EG_{21}	G_{22}, EG_{22}

we can get N11> N12> N22, N11> N21> N22. Furthermore, let the coefficient of user's earnings transferred from innovation achievements is K1 and the coefficient of company's revenue transferred from innovation achievements is K2. Additionally, the development degree of electronic market has a significant impact "L" on the efficiency K1 and K2. Based on the above-mentioned illustrations, it can be expressed as the follows:

$$U_{11} = N_{11} \times K_1 \times L - U_{ch}$$

$$U_{12} = N_{12} \times K_1 \times L - U_{ch}$$

$$U_{21} = N_{21} \times K_1 \times L - U_{cl}$$

$$U_{22} = N_{22} \times K_1 \times L - U_{cl}$$

$$EU_{11} = N_{11} \times K_2 \times L - E_{ch}$$

$$EU_{12} = N_{12} \times K_2 \times L - E_{ch}$$

$$EU_{21} = N_{21} \times K_2 \times L - E_{cl}$$

$$EU_{22} = N_{22} \times K_2 \times L - E_{cl}$$

Suppose Gc is the funds paid by the government when it implements real-time incentives for company's green innovation behavior, EGc is the company's cost of green innovation, and Ed is the company's emission reduction; moreover, the emission reduction produced from the company's green innovation can be regarded as government revenue, its conversion coefficient is set K3. Clearly, when the government does not interfere the company in innovation, companies generally do not take the initiative in developing green innovation. Based on the above assumptions, we can get:

$$G_{11} = E_d \times K_3 - G_C$$

$$G_{12} = -G_C$$

$$G_{21} = 0$$

$$G_{22} = 0$$

$$EG_{11} = G_C - EG_C$$

$$EG_{12} = G_C$$

$$EG_{21} = -EG_C$$

$$EG_{22} = 0$$

In terms of industry-university-research collaboration innovation, assume the impact coefficients of universities and research institutes' cost to the company's technological innovation are Un and Re. In addition, the impact coefficient of intermediaries and financial institutions' cost to the company's technological innovation are Ia and Fa. Moreover, the development degree of electronic market also influences on the variables, which is represented as M, N, and P. Then we can get:

$$E_{ch} = EG \times F_a \times I_a \times R_e \times U_n \times M$$

$$E_{cl} = EG \times F_a \times I_a \times R_e \times U_n \times N$$

$$EG_c = EU \times F_a \times I_a \times R_e \times U_n \times P$$

According to evolutionary game theory, duplicated dynamic equations on U are:

$$dU/dt = U(1-U)[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] \quad (1)$$

Duplicated dynamic equations on EU are:

$$dEU/dt = EU(1-EU)[(EU_{11} - EU_{12} - EU_{21} + EU_{22})U + (EU_{12} - EU_{22})] \quad (2)$$

Duplicated dynamic equations on G are:

$$dG/dt = G(1-G)[(G_{11} - G_{12} - G_{21} + G_{22})EG + (G_{12} - G_{22})] \quad (3)$$

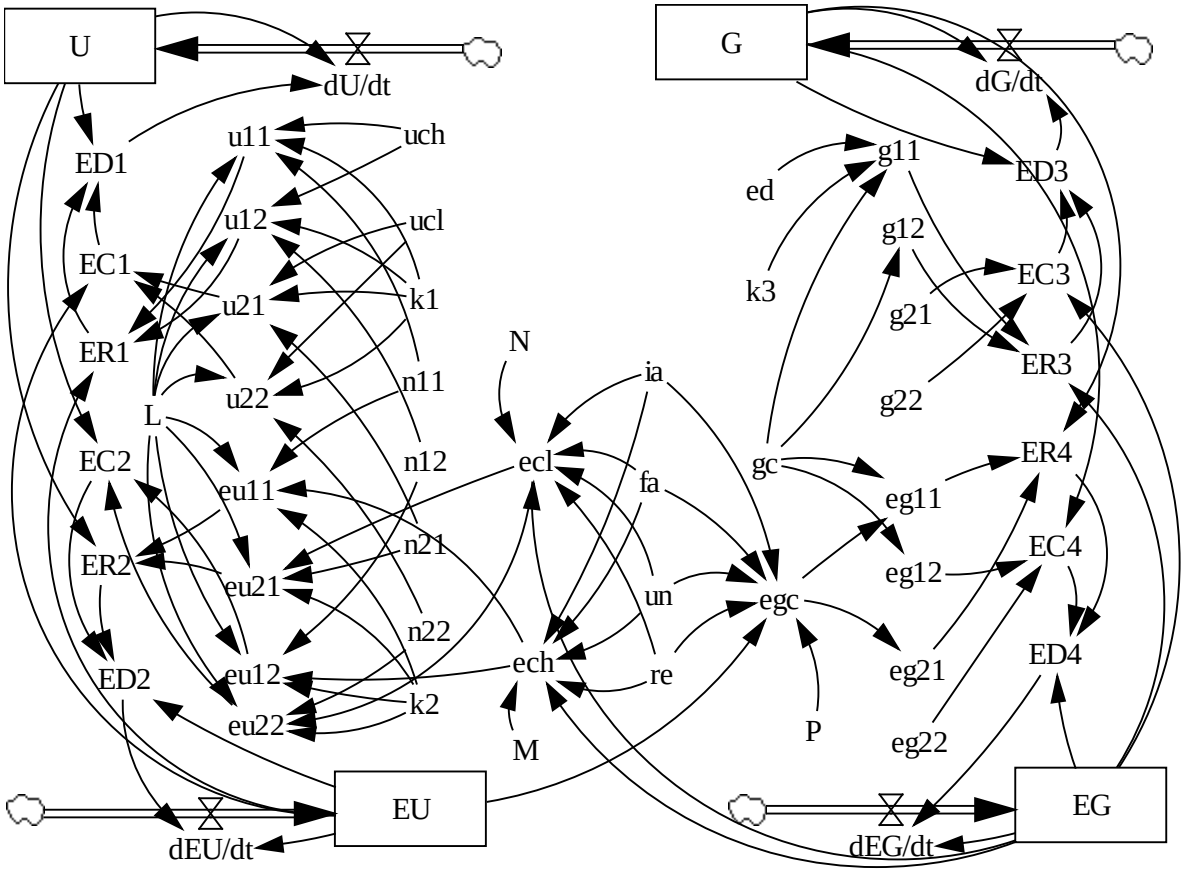


Figure 1. System flow diagram of Industry-University-Research-User game of users involvement in green innovation and electronic market

Duplicated dynamic equations on EG are:

$$dEG/_{dt} = EG(1-EG)[(EG_{11} - EG_{12} - EG_{21} + EG_{22})G + (EG_{12} - EG_{22})] \quad (4)$$

In order to carefully depict the decision evolution of all parties in the game, this paper simulates the above game evolution model by using the method of system dynamics. The system flow diagram is shown as in **Figure 1**.

The main equations are:

$$dU/_{dt} = ED_1 \times U$$

$$dEU/_{dt} = ED_2 \times EU$$

$$ER_1 = U_{11} \times EU + U_{12} \times (1-EU)$$

$$ER_2 = EU_{11} \times U + EU_{21} \times (1-U)$$

$$EC_1 = U_{21} \times EU + U_{22} \times (1-EU)$$

$$EC_2 = EU_{12} \times EU + EU_{22} \times (1-U)$$

$$ED_1 = ER_1 - U \times ER_1 - (1-U) \times EC_1$$

$$ED_2 = ER_2 - EU \times ER_2 - (1-EU) \times EC_2$$

$$dG/_{dt} = ED_3 \times G$$

$$dEG/_{dt} = ED_4 \times EG$$

$$ER_3 = G_{11} \times EG + G_{12} \times (1-EG)$$

$$ER_4 = EG_{11} \times G + EG_{21} \times (1-G)$$

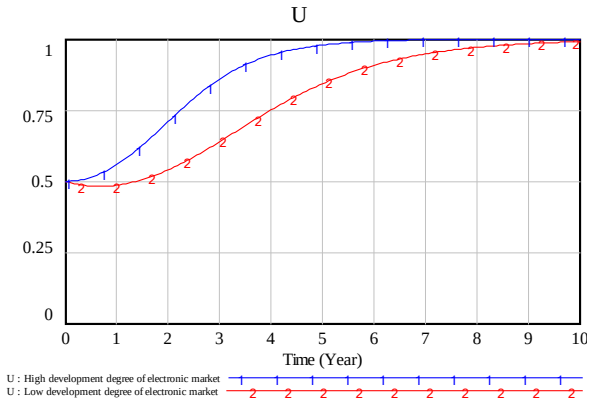
$$EC_3 = G_{21} \times EG - G_{22} \times EG + G_{22}$$

$$EC_4 = EG_{12} \times G + EG_{22} \times (1-G)$$

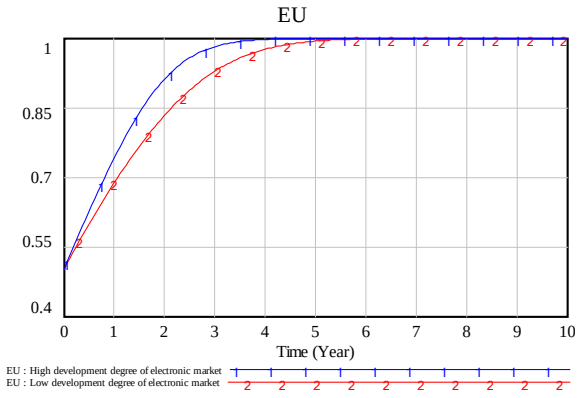
$$ED_3 = ER_3 - G \times ER_3 - (1-G) \times EC_3$$

$$ED_4 = ER_4 - EG \times ER_4 - (1-EG) \times EC_4$$

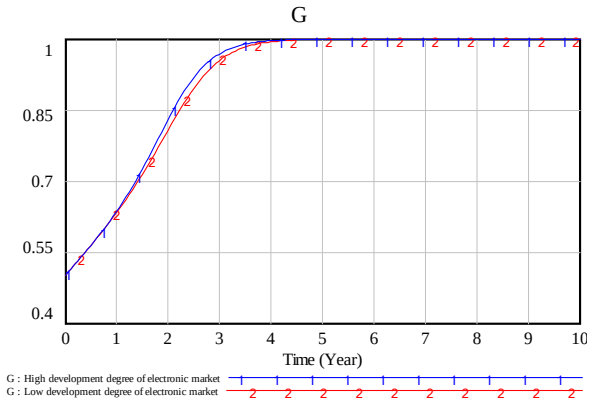
Vensim software is used to simulate the system dynamics model as shown in **Figure 1**. Theoretically, in equation (1), when , $[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] = 0$, any point in U ∈ [0,1] is equilibrium point. When $[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] \neq 0$, the equilibrium point is U = 0 and U = 1. In the same way, equation (2), (3), (4) have similar properties. As for equation (1), when $[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] > 0$, U = 0 is stable equilibrium point. When $[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] < 0$, U=1 is stable equilibrium point. Here, we only consider when equilibrium point is 1. In general, at this time, U starts from arbitrary initial conditions will eventually come to the equilibrium point U = 1. We consider the configuration parameters in the following conditions:



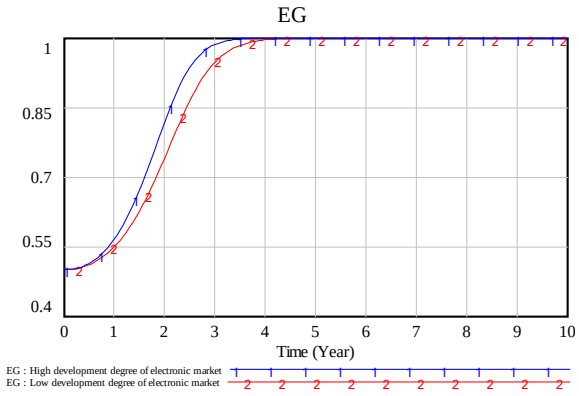
Changes in the decision-making process of user involvement in company's innovation



Changes in the companies' decision-making in user involvement in innovation



Changes in the decision-making process of government incentives for company's green innovation



Changes in the companies' decision-making process in green innovation

Figure 2. Decision-making simulation results of Industry-University-Research-User in user involvement in green innovation and electronic market: A typical case when the stable equilibrium point is 1

$$[(U_{11} - U_{12} - U_{21} + U_{22})EU + (U_{12} - U_{22})] < 0$$

$$EU(1 - EU)[(EU_{11} - EU_{12} - EU_{21} + EU_{22})U + (EU_{21} - EU_{22})] < 0$$

$$dG/dt = G(1 - G)[(G_{11} - G_{12} - G_{21} + G_{22})EG + (G_{12} - G_{22})] < 0$$

$$EG(1 - EG)[(EG_{11} - EG_{12} - EG_{21} + EG_{22})G + (EG_{21} - EG_{22})] < 0$$

$$N_{11} > N_{12} > N_{22}, N_{11} > N_{21} > N_{22}, K_1, K_2 > 0$$

Using various combinations of parameters satisfying the above conditions, and assuming that the parties in the initial phase of the game do not have any decision-making preferences, that is, U = 0.5; EU = 0.5; G = 0.5; EG = 0.5, we find the trends of simulated U, EU, G, EG are similar under different parameter combinations. Wherein **Figure 2** is a typical case. As we can see, in the stable equilibrium point U = 1, EU = 1, G = case 1, EG = 1, the company is more positive and fast in supporting user involvement in green innovation. And once the company

gains performance in supporting users involved in innovation, there tends to be more companies to follow suit rapidly, so that user innovation is promoted in companies. Government's attitude towards company's green innovation is relatively positive and firm. However, in contrast, the initiative of users' involvement in company innovation is lagging behind, presenting an S curve. It reflects that there are pending phenomenon in user involvement in innovation in the early stage. But once users participate in innovation through a certain period of time, it exhibits rapid growth. Whereas, the company is relatively slow in developing green innovation, the pending period is longer, and the time to reach the peak is longer too. Additionally, we compare the two situations in which the development degree of electronic market is high or low by setting the parameters L, M, N, P as 1 or o.5 respectively. The result shows that the intension of the users' involvement in company's innovation and the support of user involvement in innovation by companies represent a positive relationship with the development degree of electronic market. Moreover, the government is more willing to implement incentive policy, while the companies are more likely to active in green innovation in high development degree of electronic market.

ANALYTICAL RESULTS

In the development of open innovation, the Chinese government's guidance is very important. The Chinese government's support for industry-university-research can be divided into three stages. The first stage is to support industry-university-research cooperation, including the support in the system, policy and funding, to assist universities, research institutes and enterprises in doing joint scientific researches and personnel training, building research centers, research institutes and laboratories, establishing science and technology parks, implementing scientific research and achievements hatching, setting up a special fund for "industry-university-research" cooperation, establishing high-tech enterprises.

China has its particular situation, in which the government has a major advantage in terms of strength and speed of innovation resource scheduling. In the enterprise's green innovation activities, the enterprise is absolutely a main body and even a dominant body in green innovation activities. Because China's science and technology human resources mainly distributed in universities and research institutes, therefore, they should be regarded as the main body of the green innovation. Green innovation requires user involvement, therefore, in the near future, it needs to actively promote the user to become the main body of green innovation with using electronic platform. Here, the basic paradigm of green innovation in the Chinese green education context is proposed as "4 Fundamental & 3 Supported Bodies" paradigm, as demonstrated in **Figure 3**. That is, the collaborative industry-university-research-user green innovation through electronic platform is simplified as four fundamental bodies

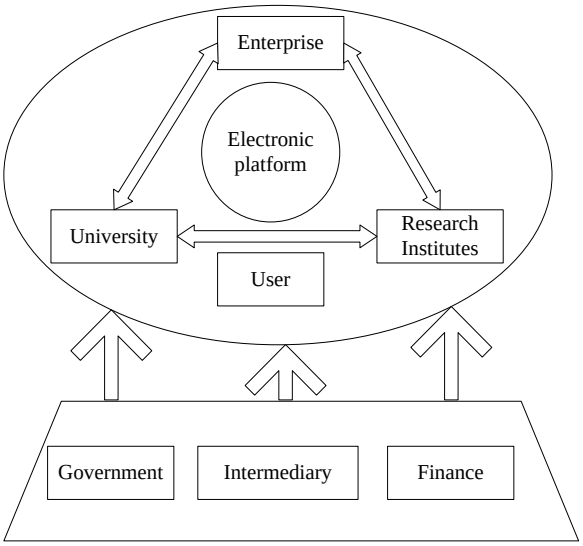


Figure 3. The mode of green innovation by collaborative electronic platform

and three supported bodies, in concrete, the four fundamental bodies refer to the organizations, like industries, universities, research institutes and users, who take the risks and returns, participate substantively in the process of collaborative green innovation through electronic platform, and take part in operation activities, such as participation in the creative development, research and development, production, marketing and other activities. And the supported bodies refer to the organizations, like governments or government service providers, financial institutions or financial services providers, and intermediaries or intermediary services providers, who participate un-substantively in the process of collaborative green innovation, but provide elements and services for green Technological innovation.

In China, the role of government played in user involvement electronic platform in the process of green innovation is very significant. The government acts in three areas: (1) the role of guidance, namely to guide users to participate in green innovation activities through the government publicity and demonstration, or to guide enterprises to attract users to participate in green innovation activities; (2) the role of support for constructing enterprise-oriented and user-involved green innovation electronic platform; (3) the role of risk protection, that is, the government supports and give subsidies for enterprises to buy science and technology insurance for green innovation projects, and the government provides the guarantee for the user to participate in the green innovation activities. For example, Wuhan and Shenzhen municipal governments give science and technology insurance subsidies to enterprises to participate in green innovation, and Zhejiang province gives compensations to failure green innovation projects according to 20 percent risk of losses in subsidies. Universities and research institutes provide the elements, outcomes, and knowledge support for the users involved in enterprises' green innovation projects, then users are deeply involved into green innovation activities of enterprises, through the user experience, DIY, user proposals, user innovation community, users involved in R&D or marketing and other ways, to achieve the users' personalization preferences and green demand for products and services. In the four-helix model, the real main bodies involved in the helix movement are enterprises, users, universities, research institutes and users, to achieve helix development under the supporting and protecting of governments in the base, and the feeding and nurturing of intermediaries and financial institutes. Intermediaries and financial institutions' main functions are: (1) the patent agency, provide advisory services intellectual property rights and interests divisions for users involved in green innovation; (2) enterprise incubator and maker space. When users involved in the enterprise green innovation with the strong willingness to innovate and start an undertaking, they can be supported by the enterprise incubators or maker spaces; (3) crowd funding and angel capital service platform, to attract investors for companies and to provide information and financial services for innovation participants.

IMPLICATIONS

In the context of China, the operational modes of user involvement electronic platform in green innovation can be roughly classified into three types: the operational mode of user proposal, the operational mode of user experience and the operational mode of user R&D. These three operational modes can also be combined to form new operational modes.

The operational mode of user proposal, which is to seek the views and suggestions of users dynamically in the entire process of green innovation decision-making phase, and the good ideas are adopted into the optimization process of innovation decision-making and innovative products manufacturing for enterprises. Enterprises can also take the views of consumers' solicitation way, giving prize or rewards for users raising good ideas and valuable suggestions in different ways and different grades, such as, bonuses, a reward after the successful development of green innovation products. Because most of the enterprises green innovation projects can get a grant from the government and recognition from the environmental protection department, there still exist the need to consulate from the government finance sectors, the environmental protection sectors, and experts in other fields, as shown in **Figure 4**.

The operational mode of user experience, refers to the enterprises invite users to experience the green innovation activities and achievements. In addition, green innovation experience is to invite users to the R&D and production sites of green innovation, experience the idea and technology of green innovation, the process and

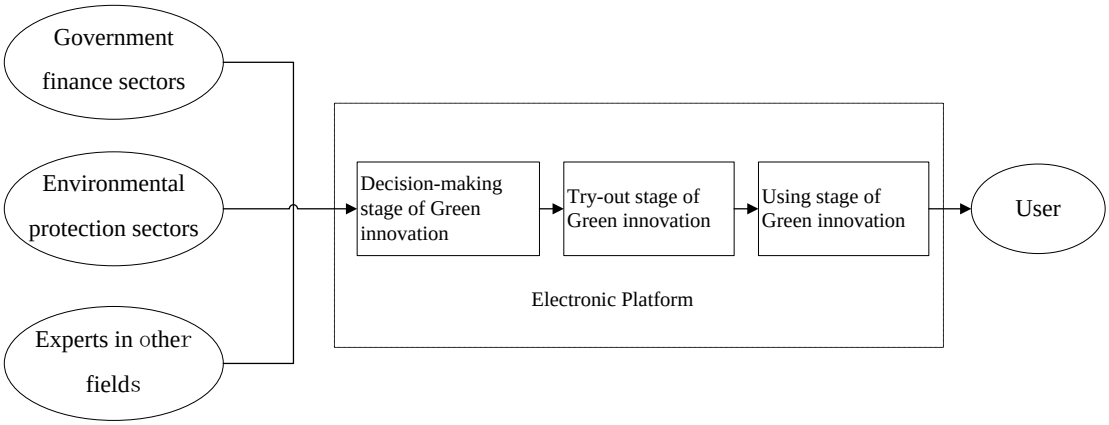


Figure 4. The operational mode of user proposal for user involvement electronic platform in green innovation

environment of green production. Furthermore, green innovation fruits experience means to invite customers' try-out before putting the green innovation products in batches to the market. This try-out can be divided into two types, one is a separate try-out, and the other is a group try-out. The group try-out is usually a specialized experience center set up by the enterprise or its agents, consumers can interact with the manufacturers of technology, production and marketing personnel, moreover, they can also exchange experience with each other. Through the operational mode of user experience, enterprises can, on one hand, collect the views of users to further improve their products, on the other hand, launch an experience marketing for green innovation products. These experiences can be achieved through the electronic platform, more convenient and economical.

The operational mode of user R&D refers to the user directly participate in the research and development activities, which includes two kinds of circumstances, one situation is the enterprise users is not the end product user, but the intermediate product user or subsistence users, that is, the downstream enterprises participate in the upstream enterprises' R&D activities, in concrete, downstream enterprises may choose the way of supervision or participation in manage R&D activities of upstream suppliers, joint research projects are carried out among upstream and downstream enterprises, and R&D companies or supply chain alliances are established among upstream and downstream enterprises to conduct collaborative green innovation activities. The second situation is the user is the end user, that is, subsistence users, at this time, the users can participate in the product design, or join into the enterprises' R&D projects directly. For example, many enterprises provide users with electronic platform for R & D design through the development of mobile phone APP.

A few Chinese enterprises start to explore the various operational modes of user involvement electronic platform in green innovation, for example, Hubei Provincial Huang mailing Phosphate Chemical Co., Ltd. invites farmers to do experiments in their rice fields, in order to develop green phosphate fertilizer, letting farmers to participate in collecting data after using the green phosphate fertilizer, which help the company to get useful result from the experiment and improve the product. Chinese Academy of Agricultural Sciences establishes joint company with farmers to develop the application of new varieties of green agriculture. Chengdu Blu-ray group is a real estate development enterprise, in the development of ecological, healthy, environmental protection, energy saving green villa project, the company undertakes energy-saving design tasks, and hand ecological and out-looking design tasks to the user, the user presents various design styles based on local climate, natural resources and cultural characteristics of the region, moreover, the user can also make recommendations on localization of building materials, and participate in research and development of materials localization. Among these user involvement practices, some are the operational modes of user proposal, some are the operational modes of user R&D, and some are the combination.

A typical example of Chinese enterprise's user involvement electronic platform in green innovation is China NIU electric vehicle company. China NIU electric vehicle company (NIU) is a new start-up company, the

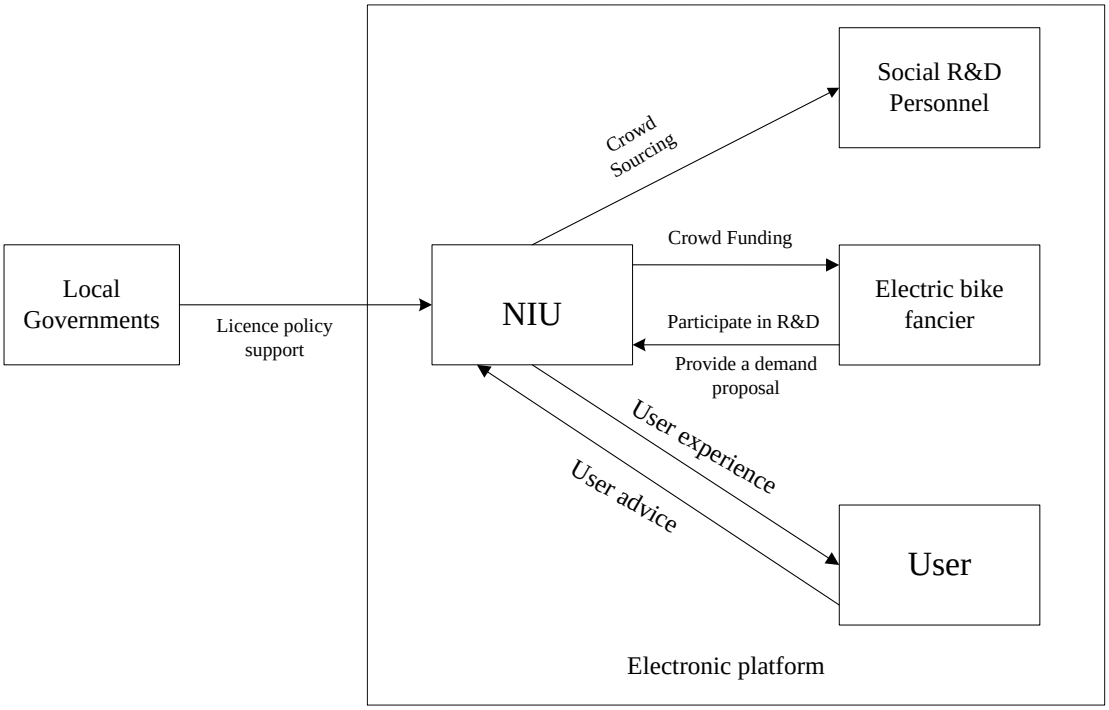


Figure 5. The integrated operational mode of user involvement electric platform in green innovation at China NIU electric vehicle company

main products of which is electric bicycles, and its target of 2014-2015 green products are: (1) lightweight, low-pollution batteries, no transfer and recyclable interior design for electric core, that is, the batteries can only be used for NIU electric vehicles, cannot removable to other brands of electric vehicles. The purpose is to guard against theft and avoid battery drain, and it is easy to trace the whereabouts of the battery, but the batteries can be recycled and secondary manufactured internally within NIU electric vehicles. (2) shortened frame arm, aimed at saving materials. (3) LED design for the whole car, aimed at increasing life span of lamps, such as, the LED headlights, for example, less heat and power saving.

The main characteristics of user involvement electronic platform in green innovation at China NIU electric vehicle company can be concluded as shown in **Figure 5**: (1) adopting crowd sourcing to attract R&D personnel including the user to participate in R&D activities of electric bicycles. (2) emphasizing on user experience, such as inviting users to take a test drive and to put forward opinions and suggestions. (3) collecting users' modifications, many users can modify their new electric bicycles according to their individual needs after the purchase. When NIU collects comments and ideas from the users, there are questions to be asked what are the potential aspects of new products to be improved. Finally, NIU's future products can meet users' satisfaction without any modification. (4) financing by crowd funding, in the first half of 2014-2015, NIU raised 76 million Chinese Yuan by Jingdong crowd funding platform to be input to produce 16,000 sets of electric bicycles, not only absorbing the suggests from the crowd, but also return a part of products to the funders, while another part of products be put on sale. (5) getting government support. China NIU electric vehicle company takes the lead to communicate with some city government to solving successfully on the licensing issue of electric bicycles for new users. Visibly, NIU has integrated user three operational modes of user involvement in green innovation, adopted crowd funding, and obtained government support. (6) establishing NIU mall, through the electronic platform, NIU starts from the understanding of products, service and support network, such as search, NIU arrived, NIU CARE, NIU APP and other customer service policies, to provide users with a better experience.

CONCLUSIONS

Green innovation mainly reflects the open innovation of user innovation, which is the trends in the field of innovation, and the integration of green innovation user innovation is a much bigger trend. User involvement electronic platform in green innovation can enhance the production of green innovation, while green innovation can attract more users to participate in the innovation activities. Since China launched the strategy of invigorating the country through science, technology and education, green innovation has been attached great importance to, and the implementation of current innovation-driven strategy that supplemented by carrying out the public entrepreneurship and innovation strategy, can greatly promote China's future green innovation involved by users. In this paper, based on the practice of China's green innovation, user innovation, the development of electronic platform and relevant cases, the paradigm and operational modes of user involvement electronic platform in green innovation are discussed.

As a consequence, during the process of green education, the explanation of green innovation should include the user involvement and electronic platform. But there are still many issues need to be further in-depth studied, such as the statistics analysis of user innovation's positive effect on promoting green innovation, and government policies designed to encourage users to be involved electronic platform in green innovation.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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