Impacts of Government Subsidies on Green Supply Chain Based on Game Theory

Huang Ming[1], Hu Shuyu[2]

[1]College of Economics and Management, Hunan Radio and Television University, Changsha, 410004, China
[2]College of Network Education, Hunan Radio and Television University, Changsha, 410004, China

Corresponding author is Hu Shuyu

Abstract
In order to accelerate the market development of green products, the government will adopt fiscal subsidies to stimulate the enterprises and consumers. The game model of the manufacturer and retailer is established on the basis of considering the government subsidies from the perspective of green supply chain. In consideration of the green supply chain composed by the manufacturers and retailers and under the pattern that the government implements fiscal subsidies to the manufacturers and consumers respectively, the impact of the amount of subsidies on the decision behaviors of the manufacturers, retailers and consumers is analyzed. Through the numerical simulation, the impact of the amount of the government subsidies on the decision behaviors of manufacturers, retailers and consumers is analyzed, and the difference in the subsidy patterns of the manufacturers and consumers is further compared. The research conclusions reveal that (1) the manufacturers and retailers will select the pattern of consumer subsidies; (2) the subsidy pattern of the consumers is mainly influenced by the relative size of price sensitive coefficient and subsidy sensitive coefficient.
Keywords: GREEN SUPPLY CHAIN, GAME THEORY, SUPPLIER, GOVERNMENT SUBSIDIES, DECISION BEHAVIORS.

1. Introduction

Nowadays, the resources are reducing day by day and the environment continues to deteriorate, the demand in the green industry keeps increasing, and producing and purchasing green products have become the consensus of many enterprises and consumers. The manufacturing enterprise must strength the cooperation with the suppliers and retailers, carry out green supply chain management, so as to develop and produce green products and provide more green products to the society [1].. In order to encourage the enterprises and the consumers and accelerate the development of the green industry, the government subsidies have become an important means. In the field of green building, the central government and multiple local governments have introduced the corresponding policies and implemented fiscal subsidies. The Ministry of Finance and the Ministry of Housing and Urban-Rural Development joint issued the Implementation Opinions about Promoting the Development of Green Building in China in 2012, and rewarded the green building [2]. Till now the green building subsidies [3] have been implemented in over 10 provinces and cities including Shanghai, Xi'an and Beijing. In May 2011, the German government announced that it will additionally pay 1 billion euros (equivalent to 1.4

billion dollars) to assist the research and development of electric cars [4]. The energy-efficient products are promoted in construction, manufacturing and other fields by fiscal subsidies, and the central financial fund invested accumulatively is over 40 billion Yuan [5].

The domestic and overseas scholars have made several corresponding researches. The research of the green supply chain is mainly centered in the driving and obstacle factors of the management of green supply chain, performance evaluation of green supply chain, game between the government and the green product manufacturers, strategic decision-making pattern of the green supply chain management, design and structuring of green supply chain management, connotation of the green supply chain management and the risk management of green supply chain [1,6-7].

For the strategy research of government subsidies, Fang Haiyan and others have researched the influences of the government's implementation of the product research subsidy policies on the enterprises, and given the optimal research input strategies [8] of R&D enterprises under R&D competitions, R&D Cartel and other R&D alliance organizations. Dundas and Roper have concluded three special effects of the government subsidies to the enterprises' R&D, namely the government R&D subsidies will accelerate the enthusiasm of participating in R&D activities, meanwhile the progressive R&D activities aiming at improving the products will increase and the new product R&D activities aiming at complete innovation and R&D also will increase [9]. Meng Weidong and others have respectively analyzed the double oligarchies cooperative R&D game model for the government R&D investment subsidy policies and unit product subsidy policies, found that for the product R&D with relatively low input coefficient, the R&D investment subsidy policies shall be adopted, otherwise the unit product subsidy policies [10] shall be adopted. From the perspectives of resource dependence theory and social expectations, Rijnsoever et al.(2014)made the analysis from two levels of individual and alliance, and quantitatively analyzed the Dutch electric car subsidy program[11]. Li Youdong and Zhao Daozhi (2014) established the Nash game between the manufacturers and retailers and the Stackelberg game, analyzed the influences of low carbon research cost allocation coefficient and government low carbon subsidies on the low carbon R&D investment of the supply chain, and concluded the enterprise low carbon R&D cooperation and government subsidy strategies [12] under different forms of games. Holtsmark and Skonhoft (2014) analyzed the possible influences of Norwegian subsidy policies of electric cars and discussed the rationality of the subsidy policies [13].

Combing the aforesaid document analysis, we can see that the research of government subsidy policies is carried out mainly from the perspective of the general supply chain composed by the manufacturers and retailers, but rarely from the perspective of green supply chain. There are related documents [1] taking this point into consideration, however, such documents neither take the retailers into the research scope, nor research the government subsidy patterns. The conclusions of the documents reveal that there are two types available for the government to adopt, namely the subsidies to manufacturers to develop green products and the subsidies to consumers to purchase green products. For example, Xi'an city clearly indicated in the Notice about Promoting the Green Building Work in Our Province in 2012 that the citizens in Xi'an could select the products with the symbol of "green" when purchasing housing products, and simultaneously enjoy the subsidy policies [2] of "get fiscal subsidies if you purchase green house". Therefore, for the manufacturers, retailers and consumers in the supply chain, when implementing the fiscal subsidies, the government shall consider the problem that which subsidy pattern could bring the most profits and benefits and is more acceptable for them. Thus the game model of the manufacturers and retailers is established in this paper on the basis of considering government subsidies from the perspective of green supply chain. The influences of the government subsidy amount on the decision behaviors of manufacturers, retailers and consumers are analyzed through the numerical simulation and the differences between the manufacturer subsidy pattern and the consumer subsidy pattern are further compared.

2. Problem Description and Parameter Specification

The supply chain in this paper is the two-stage supply chain composed by the manufacturers and retailers. The manufacturers are the market leaders while the retailers are the market followers. The manufacturers wholesale the green products to the retailers, and then the retailers resell the products to the consumers. It establishes the linear demand model $D = a - bp + kg$ in this paper, namely the consumers determine whether to purchase the green product as per the market price and the green degree of the product. The higher the green degree, the more willing the consumers will be to purchase the product and the greater the market demand will be [5]. Hereby the

parameter symbols in this paper are explained as follows:

g : It is the green degree of the green product and it reflects the environmental protection and energy saving degree of the product;

p : It is the market price of the product and it is the decision variable of the retailers. Thereinto, p^i means the optimal retail price of the retailers under established pattern ($i=m$ means the pattern of the government subsidies to the manufacturers, and $i=c$ means the pattern of the government subsidies to the consumers);

w : It is the wholesale price of the green product negotiated by the manufacturers and the retailers and it is the decision variable of the manufacturers. Thereinto w^i means the optimal wholesale price of the manufacturers under established pattern ($i=m$ means the pattern of the government subsidies to the manufacturers, and $i=c$ means the pattern of the government subsidies to the consumers);

c_m : It means the unit cost of the manufacturer to produce the product;

c_r : It means the marketing cost of the retailer to sell the product;

b : It is the sensitivity coefficient of the demand to the price, and b means that the quantity demanded will decrease b units for each unit increased in the price;

a : It is the basic market demand of green product and unrelated with the product price and the green degree of the product;

k : It is the sensitivity coefficient of the consumers to the green degree of the product, and the bigger the green degree, the more willing the consumers will be to purchase;

u : It means the quantity of the fund subsidized by the government, and it is used to measure the strength of the government subsidies;

β : It is the sensitivity coefficient of the consumers to the government subsidies, and it means that the quantity demanded will decrease β units for each unit increased in the subsidy quantity of the government;

Π_r : It means the profits of the retailers and Π_m means the profits of the manufacturers;

3. Government Subsidy Model

3.1. SM Model of Government Subsidies to Manufacturers

In order to encourage the manufacturers to produce green products with higher green degree, the government will offer fiscal subsidies for the R&D costs and manufacturing costs of the manufacturers. For example, The Ministry of Finance and the Ministry of Housing and Urban-Rural Development joint issued the Implementation Opinions about Promoting the Development of Green Building in China in 2012 and clearly indicated to give awards to the building developer to construct the green building; in the second half of 2011, United States Department of Energy proposed the medium and long term R&D policies of energy technologies in the Four-year Technology Evaluation Report and took the electric cars as the focus of recent investment in R&D of the energy technologies; the Japanese government plans to investment 21 billion yens on the accumulator project of the new energy automobiles within 7years and increase at least 3 times the one charge driving range of the Japanese electric cars before 2020. At the moment the market demand function is:

$$D = a - bp + kg \tag{1}$$

The profit function of the retailers is:

$$\prod_r = (p - w - c_r)D = (p - w - c_r)(a - bp + kg) \tag{2}$$

The profits of the manufacturers will be affected by government subsidies, and its function is:

$$\prod_m = (u + w - c_m)D = (u + w - c_m)(a - bp + kg) \tag{3}$$

Deduce the first-order derivative about p from the formula (3), make the derivative as zero and the product price confirmed by the retailers is:

$$p = \frac{a + kg + bw + bc_r}{2b} \tag{4}$$

Substitute the formula (4) into the formula (3) and the profit function of the manufacturers is:

$$\prod_m = \frac{(u + w - c_m)(a + kg - bw - bc_r)}{2} \tag{5}$$

Deduce the first-order derivative about w from the formula (3), make the derivative as zero and the optimal wholesale price of the manufacturers at the moment is:

$$w^m = \frac{a + kg - bc_r + bc_m - bu}{2b} \tag{6}$$

Substitute the formula (6) into the formula (4) and the optimal market price of the retailers under the pattern of the government subsidies to the manufacturers is:

$$p^m = \frac{3a + 3kg + bc_r + bc_m - bu}{4b} \tag{7}$$

Now the actual payment of the consumers is equal with the market price of the green products, namely:

$$p_r^m = p^m = \frac{3a + 3kg + bc_r + bc_m - bu}{4b}$$

Substitute the formula (7) into the formula (1) and the optimal quantity demanded under the pattern of government subsidies to the manufacturers is:

$$D = \frac{a - bc_m - bc_r + kg + bu}{4} \quad (8)$$

Substitute the formula (6) and formula (7) into the formula (2) and formula (3) and the profits of the retailers and the manufacturers under the pattern of government subsidies to the manufacturers are:

$$\Pi_r^m \frac{(7bc_r + bc_m + bu + kg - a)(3a - kg - bc_r + bc_m + bu)}{8b} \quad (9)$$

$$\Pi_m^m = \frac{(bu + a + kg - 3bc_m - bc_r)(3a - kg - bc_r + bc_m + bu)}{8b} \quad (10)$$

3.2. SC Model of Government Subsidies to Consumers

The market price of the green products is generally higher than general products due to their high R&D costs and marketing costs. The government subsidies to the consumers are to compensate them for the paid green costs and accelerate the consumers to purchase the green products in higher green degree with a relatively low price. For example, our government has begun to carry out the fiscal subsidies [1] to ten kinds of energy efficient and environmentally friendly products since 2009. In September 2013, the national relevant department issued the Notice about Carrying on the Popularization and Application for New Energy Automobiles for the new energy automobile industry and it made it clear that the government will offer fiscal subsidies to the consumers to purchase new energy automobiles from 2013 to 2015. The government provides subsidies to the consumers and the consumers will determine whether to purchaser the green product as per the amount of the subsidies. The greater the amount of the government subsidies, the more willing the consumers will be to purchase the green products but not the general products, and the market demand will increase consequently. Therefore the market demand function is:

$$D = a - bp + \beta u + kg \quad (11)$$

Now the profit function of the retailers is:

$$\Pi_r = (p - w - c_r)(a - bp + \beta u + kg) \quad (12)$$

The profit function of the manufacturers is:

$$\Pi_m = (w - c_m)(a - bp + \beta u + kg) \quad (13)$$

Similarly, if the backward induction is applied, the market price of the retailers is:

$$p = \frac{bw + bc_r + a + \beta u + kg}{2b} \quad (14)$$

Incorporate the formula (14) into the manufacturer profit function and it will get:

$$\Pi_m = (w - c_m)\left(\frac{a + kg + \beta u - bw - bc_r}{2}\right) \quad (15)$$

Use the first order condition on the formula (15) and the optimal wholesale price of the manufacturers is:

$$w^c = \frac{bc_m + \beta u + a + kg - bc_r}{2b} \quad (16)$$

Accordingly the optimal market price of the retailers under the pattern of the government subsidies to the consumers is:

$$p^c = \frac{bc_r + 3a + 3\beta u + 3kg + bc_m}{4b} \quad (17)$$

Similarly, the actual payment of the consumers is:

$$p_r^c = \frac{bc_r + 3a + 3\beta u + 3kg + bc_m}{4b} - u = \frac{bc_r + 3a + 3\beta u + 3kg + bc_m - 4bu}{4b} \quad (18)$$

Incorporate the formula (16) and formula (17) into the profit function and the retailer's profit and the manufacturer's profit under the pattern of the government subsidies to the consumers are:

$$\Pi_r^c = \frac{(a + kg + \beta u - bc_r - bc_m)^2}{16b} \quad (19)$$

$$\Pi_m^c = \frac{1}{8b}(\beta u + a + kg - bc_r - bc_m)^2 \quad (20)$$

3.3. Theoretical Proposition and Proof

We can get the following theoretical propositions after comparing and comprehensively analyzing the aforesaid two models.

Proposition 1. Regardless of how the subsidy amount changes, the $w^m < w^c$ will constantly stand up and the $p^m < p^c$ also will constantly stand up.

$$w^m - w^c = \frac{a + kg - bc_r + bc_m - bu}{2b} - \frac{bc_m + \beta u + a + kg - bc_r}{2b} = \frac{-bu - \beta u}{2b} < 0$$

$$p^m - p^c = \frac{3a + 3kg + bc_r + bc_m - bu}{4b} - \frac{bc_r + 3a + 3\beta u + 3kg + bc_m}{4b} = \frac{-bu - 3\beta u}{4b} < 0$$

This proposition reveals that the government subsidies to the manufacturers will function obviously, namely the manufacturers will endeavor to adopt various measures to reduce the wholesale price of the

green products. However, the effect of the reduction in the wholesale price is not obviously if implementing subsidies to the consumers. Similarly the changes in the market prices could be analyzed.

Proposition 2 $\frac{\partial w^c}{\partial u}=\frac{\beta}{2b}>0$ and $\frac{\partial w^m}{\partial u}=-\frac{1}{2}<0$. It reveals that in the SC model, the wholesale price will increase with the increase of the subsidy amount. However, in the SM model, the wholesale price will decrease with the increase of the subsidy amount.

Proposition 3 $\frac{\partial p^c}{\partial u}=\frac{3\beta}{4b}>0$ and $\frac{\partial p^m}{\partial u}=-\frac{1}{4}<0$. It reveals that in the SC model, the market price of the green products will increase with the increase of the subsidy amount. However, in the SM model, the market price of the green products will decrease with the increase of the subsidy amount.

Proposition 4. When $b>\beta, p_r^m>p_r^c$, $b<\beta, p_r^m<p_r^c$:

$$p_r^m-p_r^c=\frac{3a+3kg+bc_r+bc_m-bu}{4b}-\frac{bc_r+3a+3\beta u+3kg+bc_m-4bu}{4b}=\frac{3bu}{4b}-\frac{3\beta u}{4b}=\frac{3u(b-\beta)}{4b}$$

Obviously when $b>\beta, p_r^m>p_r^c$, $b<\beta, p_r^m<p_r^c$.

Thus, the actual payment of the consumers is comprehensively influenced by the sensitivity coefficient b of price and the sensitivity coefficient β of subsidies. In case that the consumers are very sensitive to the price, namely, the changes in the price of the green products will generate great influence on the consumer purchase behaviors, the retailers will consider this psychic reaction of the consumers if the subsidies are offered to the consumers at that time. Then the market price of the green products will be greatly reduced and more consumers are urged to purchase the green products.

Proposition 5 (1) $\frac{\partial p_r^m}{\partial u}=-\frac{1}{4}<0$. With the increase of the fiscal subsidies to the manufacturers, the consumers' actual payment is continuously reducing. It reveals that the government subsidies make the manufacturers continuously reduce the costs and the consumers benefit from it.

(2) $\frac{\partial p_r^c}{\partial u}=\frac{3\beta-4b}{4b}$, when $3\beta>4b$, $\frac{\partial p_r^c}{\partial u}>0$; when $3\beta<4b$, $\frac{\partial p_r^c}{\partial u}<0$. In case of government subsidies to the consumers, whether the consumers can benefit from it mainly depends on the relative size of β and b.

Proposition 6. (1) $\frac{\partial^2\Pi_r^m}{\partial u^2}=\frac{b}{4}>0$, $\frac{\partial^2\Pi_m^m}{\partial u^2}=\frac{b}{4}>0$, $\frac{\partial^2\Pi_r^c}{\partial u^2}=\frac{\beta}{16b}>0$ and $\frac{\partial^2\Pi_m^c}{\partial u^2}=\frac{\beta}{4b}>0$. Thus, it can be seen that whether in the SC model or in the SM model, the profits of the manufacturer and retailers both increase with the increase of the subsidy amount. It reveals that the government subsidies are favorable to the manufacturers and retailers.

(2) $\Pi_r^c>\Pi_r^m$ and $\Pi_m^c>\Pi_m^m$. It can be seen that for the manufacturer's profit, the value in SC model is always bigger than the value in SM model. For the retailer's profit, the value in SC model is also always bigger than the value in SM model. Therefore, it can be believed that under the same amount of the government subsidies, the pattern of subsidies to consumers could make the manufacturers and retailers obtain more profits compared with the pattern of subsides to the manufacturers. The manufacturers and retailers are more willing to accept the pattern of subsidies to the consumers, but not the pattern of subsidies to the manufacturers.

4. Numerical Experiment

In order to better analyze the mutual effects of the parameters, the numerical experiment is hereby made. The main parameter assignments are $a=500$, $\beta=13$, $b=11$, $k=17$, $c_r=22$ and $c_m=31$.

4.1. Impact of the Amount of Government Subsidies on the Wholesale Price of Green Products

It can be seen from Fig.1 that the wholesale price will improve with the increase of the subsidy amount if applying subsidies to the consumers, while applying subsidies to the manufacturers, the wholesale price will reduce. In case of further comparison, it will find that regardless of the subsidy amount, the wholesale price in the SC model is always higher than the wholesale price in the SM model. Thus, it can be believed that after the manufacturers have received the government subsidies, they will endeavor to adopt various means, such as reinforcing the R&D and technical innovations and purchasing environmental materials, to reduce the wholesale price and encourage the retailers to wholesale more green products. Thus, the conclusions in proposition 1 and proposition 2 are correct.

4.2. Impact of the Amount of Government Subsidies on the Market Price of Green Products

Fig. 2 reveals that in the SM model, the product market price will continuously decrease with the increase of the subsidy amount. In the SC model, the market price of the green products will increase with the increase of the subsidy amount. It is completely consistent with the conclusions in proposition 3.

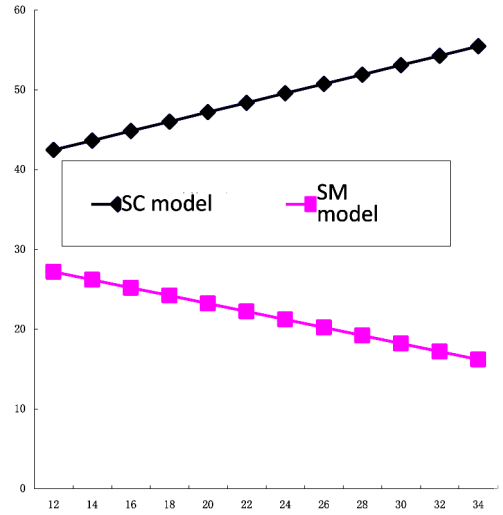

Figure 1. Influences of Government Subsidy Amount on Wholesale Price of Green Products

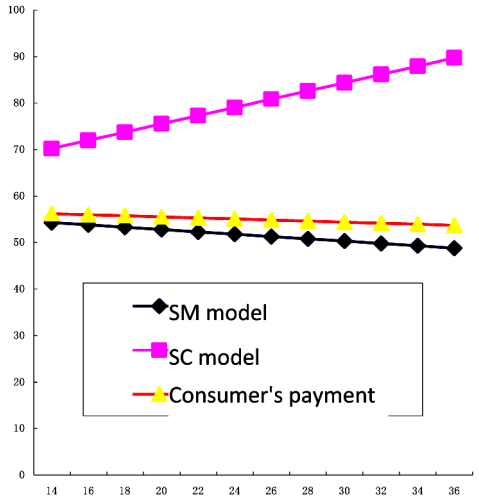

Figure 2. Influences of Government Subsidy Amount on Market Price of Green Products

In addition, if we compare the SC model and SM model after observation, we will find that the actual payment of the consumers in the former is higher than the one in the later. This is because according to proposition 2, when $b < \beta, p_r^m < p_r^c$, the assignment in this payer is $b = 11 < \beta = 13$, so such condition occurs and it just verifies the proposition 4. As the actual payment of the consumers is higher in the SC model, the consumers are more willing to accept the pattern of government subsidies to the manufacturers.

What's more, it can be seen from the figures that the actual payment of the consumers gradually decreases with the increase of the subsidy amount in the SC model. Because the assignment in this time is $3\beta = 39 < 4b = 44$, the conclusions in the second part in proposition 5 are verified. In the SM model, the actual payment of the consumers is equivalent to the market price of the green products, and we can see the Fig. 2 that the actual payment of the consumers also gradually decreases with the increase of the government subsidy amount and the first part of proposition 5 are verified. In general, it can be believed that the government subsidies to the manufacturers or consumers both could play the role of regulation to a certain extent and make the consumers satisfied.

4.3 Impact of the Amount of Government Subsidies on the Profits of Manufacturers and Retailers

Let's observe the Fig.3 and it will find that in the SM model, the profits of the manufacturers and retailers both gradually increase with the increase of the government subsidy amount, and their difference value is relatively small. In the SC model, the profits of the manufacturers and retailers also both gradually increase with the increase of the government subsidy amount, but their difference value is relatively large, and the difference value in the in the trend of expanding. Therefore, the conclusions in the first part of proposition 6 are correct.

In addition, it also can be seen that for the profits of the manufacturers, the value in the SC model is always bigger than the value in the SM model; for the profits of the retailers, the value in the SC model is always bigger than the value in the SM model; Therefore, the conclusions in the second part of proposition 6 are correct, namely, the manufacturers and retailers are more willing to accept the pattern of subsidies to the consumers.

5. Conclusions

In order to guide the market development of green products, the government will offer fiscal subsidies

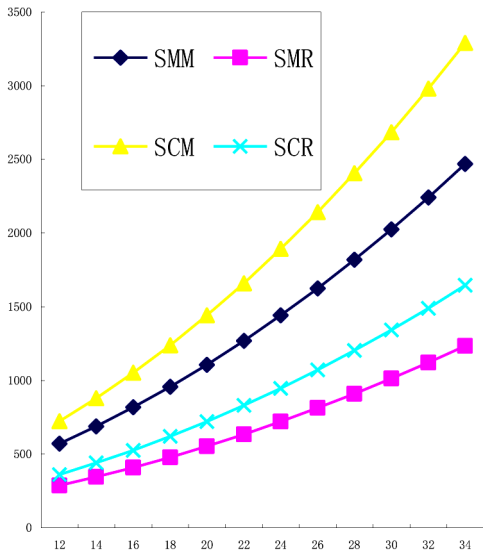

Figure 3. Nfluences of Government Subsidy Amount on Manufacturers and Retailers

to stimulate the enterprises and consumers. The influences of changes of the subsidy amount on the decision behaviors of the manufacturers and retailers are studied in this paper under the condition that the government respectively implements fiscal subsidies to the manufacturers and consumers. The research results reveal that (1) the manufacturers will strengthen the R&D and technical innovations and make the wholesale price reduce after receiving the government subsidies; (2) the actual payment of the consumers are comprehensively affected by the price sensitivity coefficient b and subsidy sensitivity coefficient β. When $b < \beta, p_r^m < p_r^c$, the consumers are inclined to the pattern of government subsidies to the manufacturers, while when $b > \beta, p_r^m > p_r^c$, the consumers are inclined to the pattern of government subsidies to the consumers; (3) no matter it is under the pattern of subsidies to the manufacturers or subsidies to the consumers, the profits of the manufacturers and retailers both gradually increase with the increase of the subsidy amount as well as the green degree of the product, and it reveals that the government subsidies are favorable to the manufacturers and retailers; (4) the manufacturers and retailers are more willing to accept the pattern of subsidies to the consumers. The game problem under complete information is analyzed in this paper, in the future, the game problem under incomplete information could be researched and the situation of the application of R&D investment subsidy pattern by the government could be further probed into. The game problem under complete information is analyzed in this paper, in the future, the game problem under incomplete information could be researched and the situation of the application of R&D investment subsidy pattern by the government could be further probed into.

Acknowledgements

The research is supported by Hunan province soft science research plan Key projects (2014ZK2041)

Reference

1. CARLOS ANDRES, SEBASTIAN LOZANOB, B. ADENSO-DIAZ. Disassembly sequence planning in a disassembly cell context. Robotics and Computer-Integrated Manufacturing, 2007, 23(6), pp. 690-695.
2. D. E. GROCHOWSKI, Y. TANG. A machine learning approach for optimal disassembly planning. International Journal of Computer Integrated Manufacturing, 2009, 22(4), pp. 374-383.
3. Yishuang Geng, Kaveh Pahlavan, On the Accuracy of RF and Image Processing Based Hybrid Localization for Wireless Capsule Endoscopy, IEEE Wireless Communications and Networking Conference (WCNC), 2015.
4. Jie He, Yishuang Geng and Kaveh Pahlavan, Toward Accurate Human Tracking: Modelling Time-of-Arrival for Wireless Wearable Sensors in Multipath Environment, IEEE Sensor Journal, 2014, 14(11), pp. 3996-4006.
5. G Piatetsky-Shapiro, B Masand. Estimating campaign benefits and modeling lift. Proceedings of the Fifth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining.ACM Press,1999, 185-193 p.
6. G. TIAN etc. Probability Evaluation Models of Product Disassembly Cost Subject to Random Removal Time and Different Removal Labor Cost. Transactions of Automation Science and Engineering, 2012, 9(2), pp. 288-294.
7. G. TIAN, Y. LIU, Q. TIAN, J. Chu. Evaluation model and algorithm of product disassembly process with stochastic feature. CLEAN TECHNOLOGIES AND ENVIRONMENTAL POLICY, 2012, 14, pp. 345-356.
8. Il-Horn Hann, Kai-Lung Hui, Sang-Yong T.Lee. Consumer Privacy and Marketing Avoidance: A Static Model. Management Science,2008,54(6), pp. 1094-1103.
9. J L Herlocker, J A Konstan, L G Terveen. Evaluating collaborative filtering recommender systems.ACM Transactions on Information System , 2004, 22(1), pp. 5 - 53.
10. Jiang, Dingde, Zhengzheng Xu, Peng Zhang, and Ting Zhu. A transform domain-based anomaly detection approach to network-wide traffic. Journal of Network and Computer Applications 40, 2014, pp. 292-306.
11. Jie He, Yishuang Geng and Kaveh Pahlavan, Toward Accurate Human Tracking: Modelling Time-of-Arrival for Wireless Wearable Sensors in Multipath Environment, IEEE Sensor Journal, 2014, 14(11), pp. 3996-4006.
12. Jonathan Gemmell, Thomas Schimoler.et Personalized Recommen- dation By Example in Social Annotation Systems, 2011.
13. LAMBERT AJD. Optimizing disassembly processes subjected to sequence dependent cost. Computers and Operations Research, 2007, 34(2), pp. 536–551.
14. Ling C X, Li C. Data mining for direct marketing: problems and solutions. Proceedings

of the 4th International Conference on Knowledge Discovery and Data Mining, AAAI Press, 1998, pp. 73-79.
15. M. A. ILGIN, S. M. GUPTA. Recovery of sensor embedded washing machines using a multi-kanban controlled disassembly line. Robotics and Computer-Integrated Manufacturing, 2011, 27(2), pp. 318-334.
16. Raghuram Yengar, Christophe Van den Bulte, Thomas W. Valente. Opinion Leadership and Social Contagion in New Product Diffusion, Marketing Science, 2011,30 (2), pp. 195-212.
17. SARA BEHDAD, DEBORAH THURSTON. Disassembly and Reassembly Sequence Planning Tradeoffs Under Uncertainty for Product Maintenance. Journal of Mechanical Design, 2012, 134(4), pp. 1-9.
18. SHANA SMITH, GREG SMITH, WEI-HAN CHEN. Disassembly sequence structure graphs: An optimal approach for multiple-target selective disassembly sequence planning. Advanced Engineering Informatics, 2012, 26(2), pp. 306-316.
19. SHU-EN ZHAO, YULING LI. Disassembly Sequence Decision Making for Products Recycling and Remanufacturing Systems. 2010 International Symposium on Computational Intelligence and Design, 2010, 19(1), pp. 44-48.
20. Su, Tianyun, Zhihan Lv, Shan Gao, Xiaolong Li, and Haibin Lv. 3D seabed: 3D modeling and visualization platform for the seabed. In Multimedia and Expo Workshops (ICMEW), 2014 IEEE International Conference on, 2014, pp. 1-6.
21. TSAI C. KUO. Waste electronics and electrical equipment disassembly and recycling using Petri net analysis: Considering the economic value and environmental impacts. Computers and Industrial Engineering, 2011, 29(12), pp. 1-11.
22. Yishuang Geng, Kaveh Pahlavan, On the Accuracy of RF and Image Processing Based Hybrid Localization for Wireless Capsule Endoscopy, IEEE Wireless Communications and Networking Conference (WCNC), 2015.
23. Zhang, Mengxin, Zhihan Lv, Xiaolei Zhang, Ge Chen, and Ke Zhang. Research and Application of the 3D Virtual Community Based on WEBVR and RIA. Computer and Information Science 2, no. 1, 2009, 84 p.
24. Zhou T, Jiang L L, Su R Q, et. Effect of initial configuration on network-based recommendation. Europhys Lett,2008,81, pp. 580-584.
25. Lv, Zhihan, Alex Tek, Franck Da Silva, Charly Empereur-Mot, Matthieu Chavent, and Marc Baaden. «Game on, science-how video game technology may help biologists tackle visualization challenges.» PloS one 8, no. 3, 2013.
26. Lv, Zhihan, Alaa Halawani, Shengzhong Feng, Haibo Li, and Shafiq Ur Réhman. Multimodal Hand and Foot Gesture Interaction for Handheld Devices. ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM) 11, no. 1, 2014, 10 p.