Complete Information Multi-players Dynamic Game of Visitor Education Intervention in Tourism Destination

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Abstract—The three stages complete information multi-players dynamic game between visitors, local governments and parks managers is proposed in this paper to solve the significant problem about the investment on the visitor education. The game reveals that the government should set up induction fund to lead the parks and tourism companies invest money on visitor education before the Nash Equilibrium state of the game is reached. The win-win-win situation of the government, parks and visitors can be obtained when the positive interaction mechanism of government leading, tourism enterprise implementing and tourist participating is established.

Keywords—visitor education; multi-players dynamic games; complete information game.

I. INTRODUCTION

The number of domestic tourists reaches 2.9 billion in China in 2012. The negative impacts to the natural ecological environment is introduced by the enormous tourists quickly [1]. The tourism education activities are originated in America. In 1979, the wilderness specialist Jim Bradley proposed a tourism education programme to reduce the negative impacts to Nature Reserve areas [2]. In the 1990s, the related department of the United States and Non-Profit Organization designed and promoted a Leave No Trace [3] programme together. China also attaches importance to visitor education in fact. The contents, patterns and routes of visitor education has been studied and practiced fruitfully, but the complete theoretical system, practice pattern, dynamic mechanism, and share responsibility for the education cost are the bottleneck problems. In fact, visitor education intervention is a complex system, Wei,D. and Wen,S. proposed an ordinary differential equation and stochastic Dynamics to study the efficacy of the visitor education intervention [4,5]. No all of the stakeholders are willing to input resources to visitor education because of their own benefit, because some tourism resources are not pure public goods. It is the three stages complete information multi-players dynamic game between visitors, local governments and parks managers [6].

II. NOTATIONS

\[ e_1 : \text{The unit cost of behavior intervening} \]
\[ e_2 : \text{The unit cost of knowledge services} \]
\[ x_1 : \text{The visitors participation level of behaviors} \]
\[ x_2 : \text{The visitors’ participation level} \]
\[ u_i (x_i e_i) : \text{The utility function of visitor satisfaction} \]
\[ u_j (x_j e_j) : \text{The visitors’ satisfaction increment due to knowledge services} \]
\[ g(x_i e_i) : \text{The negative utility function} \]
\[ c : \text{The cost of basic services providing by parks} \]
\[ u(c) : \text{The visitors’ satisfaction of the basic services} \]
\[ a : \text{The ticket price of park} \]

III. MULTI-PLAYERS DYNAMIC GAME OF VISITOR EDUCATION

The first primary missions of visitor education is intervening the visitors’ behaviors base on the aims of parks’ management, hereinafter referred to as ‘behaviors intervening’. The second primary missions is spreading or sharing knowledge of parks, hereinafter referred to as ‘knowledge services’. The total cost of visitor education is defined as \[ u_i (x_i e_i). \] Visitors can choose the participation level according their own need. However, there is negative utility for minority visitors when they reduce uncivilized behaviours. Hence, the utility function of visitors can be denoted as following

\[ U(x_1, x_2) = u(c) + \sum_{i=1}^{3} u_i (x_i e_i) - g(x_i e_i) - f(a) \]  

(1)
where \( a \) is the ticket price of park. The visitors’ satisfaction does not decrease when the ticket is priced at reasonable range, otherwise the satisfaction decreases. The tourist quantity increases when visitors’ satisfaction increases. The function of tourist quantity can be described as following

\[
N = N(U(x_1^*, x_2))
\]  

(2)

Government collects \( t \) taxes on each ticket. Government pays \( \alpha \) percentages of the total cost of visitor education. Then the earnings of government is

\[
R_G = (t - a)N(U(x_1^*, x_2))
\]  

(3)

Parks can save a part of resource maintenance and clean-keeping cost by the behaviour intervention. The cost saving can be denoted as \( \phi(x, e_1) \). The knowledge services can save a part of market promotion cost. The part of cost saving is denoted as \( \phi(x, e_2) \). So the total incomes of park with \( N \) tourists in a certain accounting cycle can be calculated as following

\[
R = (a - c - (a - e)0\sum e) + \phi(x, e_1) + \phi(x, e_2) + e - t)N(a(x_1, x_2))
\]  

(4)

where \( 1 - a \) is the ratio of visitor education cost invested by the park.

In fact, Government-Park-Visitor three Stage Multi-players Dynamic Game \( G(S^m_1, S^n_2, S^k_3, R_G, R, U) \) can be expressed as the following optimization problem:

\[
\max \{R_G(\alpha, t, e_1, x_1, x_2), R(\alpha, t, e_1, x_1, x_2, U(\alpha, t, e_1, x_1, x_2))\}
\]

S.t.

\[
\begin{align*}
S^m_1 &= \{\alpha \in R^m, m = 2\} \\
S^n_2 &= \{e \in R^n, n = 2\} \\
S^k_3 &= \{x \in R^k, k = 2, 0 \leq x_i \leq 1\}
\end{align*}
\]  

(5)

IV. SOLUTIONS

The Backwards Induction is the best method to solve the problem [6]. In the third stage of Government-Park-Visitor three Stage Multi-players Dynamic Game, visitors choose the optimal participation level as following

\[
\frac{\partial U(\alpha, t, e_1, e_2, x_2, x_1^*)}{\partial x_1} = u_1(x_1^*, e_1^*) = 0
\]  

(6)

\[
\frac{\partial U(\alpha, t, e_1, e_2, x_2, x_1^*)}{\partial x_2} = u_2(x_2, e_2^*) = 0
\]  

(7)

It can be seen from Eq.(6) that visitors choose the optimal participation level \( x_1^* \) in the condition that marginal positive and negative utility of the behaviour intervention are equal. Eq.(7) indicates that visitors choose the optimal knowledge services participation level \( x_2^* \) to gain the maximum satisfaction level \( u_2(x_2^*, e_2^*) \).

In the second stage of Government-Park-Visitor three Stage Multi-players Dynamic Game \( G(S^m_1, S^n_2, S^k_3, R_G, R, U) \), park managers should choose the optimal visitor education investment \( (e_1^*, e_2^*) \) in order to gain the maximum earnings. It can obtain the optimal visitors’ participation strategy as following

\[
\frac{\partial \phi(x_1^*, e_1^*)}{\partial e_1} = \frac{\partial \phi(x_2^*, e_2^*)}{\partial e_2} = (1 - \alpha)
\]  

(8)

The park’s optimal investment strategy on visitor education should satisfy that the marginal return of investment on the behaviour intervention equal to the marginal return of investment on the knowledge services.

Backward to the first stage of the game, the government should choose an optimal strategy as following

\[
\frac{\partial \phi(x_1^*, e_1^*)}{\partial e_1} = \frac{\partial \phi(x_2^*, e_2^*)}{\partial e_2} = (1 - \alpha)
\]  

(9)

And it can derive from

\[
\frac{\partial \phi(x_1^*, e_1^*)}{\partial e_1} = \frac{\partial \phi(x_2^*, e_2^*)}{\partial e_2} = (1 - \alpha)
\]

\( \alpha \neq 0 \) and \( \alpha > 0 \) when Government-Park-Visitor three Stage Multi-players Dynamic Game \( G(S^m_1, S^n_2, S^k_3, R_G, R, U) \) does not achieve the Nash Equilibrium state. The government should invest a lot of fund to induce or support the park to develop visitor education. The Nash Equilibrium solution of the game can be obtained by the Eq.(6),(7),(8) and (9). And the win-win-win situation of the government, parks and visitors appears on the Nash Equilibrium state of the game. The triple sides gain the maximum benefit simultaneously.

V. CONCLUSIONS

When the visitor education system in the tourism market does not established and there are no other external factors to push the establishment, visitor education can only gain the equilibrium in lower level. In that case, the government should set up induction fund to lead the parks and tourism companies invest money on visitor education, because financial fund has the leverage and amplification effect. When visitor education develops to a certain stage with the help of government induction fund, it can run autonomously without the external factors. And the Game \( G(S^m_1, S^n_2, S^k_3, R_G, R, U) \) can reach Nash Equilibrium state in the autonomous running stage.

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REFERENCES


