

Research on 5S Site Management of Electric Power Infrastructure Projects Based on Game Theory

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Abstract—Activities of electric infrastructure projects are regarded as a system included production, plan, logistics and information flow. And the reasonable running of the system is very important to complete an engineering project. In all activities, site management is the most basic process, and there hide a lot of problems. In order to find the efficiency and low cost operation in the power infrastructure project, we play the game between the enterprise and the employees and analyze the payoff from the angle of game theory. Constantly optimize the management method, making the site management more effective, improve the quality of enterprise construction, improve efficiency and reduce the occurrence of accidents.

Keywords—game theory; electric infrastructure projects; 5S site management

I. INTRODUCTION

With the rapid development of economy in our country, the electric power resource has become one of the important conditions which restrict the economic development of our country. The scale of construction increase step by step. And the requirements of the infrastructure construction management become higher. 5S site management standard make the working system standardize, improve the poor working environment, and then improve the work efficiency, achieve the goal of improving the quality of the product. In this paper, the implementation of 5S site management has been discussed, considering the respective interests of enterprises and employees. And at last, find the final result that benefits both parties by the game theory method. Providing a new method and path for us to strengthen management, reduce costs, improve quality, and reduce the risk.

II. 5S SITE MANAGEMENT

Site management is an important part of enterprise management, and it is also the overall embodiment of enterprise management level. It is necessary for enterprises to strengthen site management. This can enhance the quality of the project.

A. The content of 5S site management

5S is the abbreviation of SEIRI, SEITON, SEISO, SEIKETSU and SHITSUKE. The object of 5S is environment. It makes a comprehensive consideration to the overall situation

of the site, and makes feasible plans and measures to achieve the standardization management.

SEIRI means distinguish between what is needed and not. There are only useful things leaved in the workplace. Clear unnecessary items.

SEITON means give everything a fixed position. Neatly arrange them and mark the quantity. We can easily find what we need. Reduce the search time.

SEISO means keep the working environment clean to prevent the occurrence of pollution. This can Reduce industrial damage, create a good working environment, keep a high quality of products and make employees a good mood.

SEIKETSU means make all of these be institutionalized. In order to keep all of the achievements that has already been achieved.

SHITSUKE means to develop good working habits. Eventually form a good corporate culture.

B. The advantages of 5S site management

5S management is the entry point to a quality assurance system. Start with environmental management to develop a good habit for every employee. Form corporate culture of the implementation of quality assurance.

The implement of 5S can give employees a clean construction site, which can make them feel comfortable. It also can influence the working atmosphere. Second, a lot of time is saved during looking for tools. Third, we can easily find the dangerous place and avoid it. And then, standardized operation makes quality more secure. The quality of electric project need to reaches a high level to ensure normal living of people and the steady development of economy. So 5S site management of electric infrastructure project is particularly important.

III. GAME BETWEEN MANAGEMENT AND EMPLOYEES

Discuss the implementation of 5S site management, based on the respective interests of enterprises and employees. Construct the model of game theory, and analysis the result of game theory.

A. Model of game theory

The complete information static game theory supposes that players have complete information. Each player has a complete understanding of the payoff of the other players. Players take action at the same time. Finally find out the Nash equilibrium between the players. Establish a complete information static game model between enterprise management and employees, with the common knowledge of all rational players. The paper makes the following assumptions:

Enterprise management chooses not to implement the 5S site management, employees to consciously implement the 5S site management. Cost C_1 , achieve W_1 . Enterprise management cost C_2 when choosing to implement the 5S site management. Employees implement the 5S site management which can make enterprise increase W_2 income and make themselves get the reward of W_3 . The penalty for employees which are not implementation is C_3 . $C_3 > C_1$, $W_1 > W_2 - C_2$, $W_2 > C_2$, $W_3 > C_1$.

According to the above assumptions, establish a complete information static game model between enterprise management and employees. Regard enterprise management and the employees as the two players. The strategy of employee is to obey or disobey. The strategy of enterprise management is to implement or ignore. Payment matrix is as follows:

TABLE I. THE PAYOFF BETWEEN ENTERPRISE MANAGEMENT AND EMPLOYEES

		employees	
		obey	disobey
enterprise management	implement	$W_2 - C_2, -C_1 + W_3$	$-C_2, -C_3$
	ignore	$W_1, -C_1$	0, 0

B. The analysis of result

1) One time game

According to the streak method, we can reach out the payoff of Nash equilibrium between enterprise management and employees is (ignore, disobey). In the one-time game theory, both the enterprise and the employees are seeking maximal benefits based on the rational assumption. But this choice does not achieve the Pareto optimal. At this time, players have not reached the maximum benefits. The Pareto optimal payoff between enterprise management and employees is (implement, obey). This is the best combination of the players. Therefore, in this game Nash equilibrium does not lead to Pareto optimal.

2) Finitely repeated games

Finitely repeated games usually use the reverse push to analyze the process of game. If the players clearly cooperate to the last time, the future will not repeat the game. There is no difference between the last period of the game and one time game. The deception and breach of the players are not likely to be retaliation, so the final period of the dominant strategy of a single player is not to cooperate. Push back to the previous period, the result is the same to one time game.

3) Infinitely repeated games

There is not exist a last stage of the game can be used as the last game in infinite repeated game. Reverse push method is invalid. There is always the chance of revenge in the infinite repeated game. One can avow that he never cooperate with other players again. They will suffer long-term heavy losses. So, each player will not take the act of breach or fraud. Game can reach the Pareto optimal.

IV. GAME BETWEEN SPECIAL TEAM AND EMPLOYEES

Because of the inexistence of the infinite repeated game, we try to realize the maximum benefit by cooperation and the punishment of noncooperation.

A. Model of game theory

The paper makes the following assumptions:

It may cost C_0 and achieve L_1 to the enterprise if employees implement the 5S site management or they do not implement but correct. Employees themselves may get the reward of L_0 . Employees are not implement the 5S site management may cost C , punish X when they are checked. Special team need K to check. $C_0 > C$, $K > X$, $L_1 > K$, $L_0 > C_0$.

The probability of special team to inspect implementation is P . The probability of mistaken obey the rule for not obey the rule is U . The probability of employees implement the 5S site management is V . The probability of employees being found not to obey the rules and do not correct is W .

According to the above assumptions, establish a complete information static game model between special team and employees. Regard special team and the employees as the two players. Then come to the Nash equilibrium.

The pure strategy space of special team is:

A1: Active supervisions and get the correct conclusion

A2: Active supervisions but get the wrong conclusion

A3: Not supervise

The probability of each strategy is:

$$S_1 = \{P(1-U), PU, (1-P)\}$$

The pure strategy space of employees is:

B1: implement the 5S site management

B2: do not implement but correct

B3: do not implement and not correct

The probability of each strategy is:

$$S_2 = \{V, (1-V)(1-W), (1-V)W\}$$

Payment matrix is as follows:

TABLE II. THE PAYOFF BETWEEN SPECIAL TEAM AND EMPLOYEES

			employees		
			B1	B2	B3
			V	(1-V)(1-W)	(1-V)W
special team	A1	P(1-U)	-K+L1,-C0+L0	X-K+L1,-C0-X	-K+X,-C-X
	A2	PU	-K+L1,-C0+L0	-K,-C+L0	-K,-C+L0
	A3	1-P	L1,-C0	0,-C	0,-C

B. The analysis of result

1) Pure Strategy Nash Equilibrium:

According to the streak method, we can reach out the payoff of Nash equilibrium between special team and employees is (A3, B3). If the special team does not supervise, employees will not implement the 5S site management. In a limited time game, the result will not change. But in the long run, the company is expected to run indefinitely. So find the right measures to reward employees and implement 5S site management is the right way.

2) Mixed Strategy Nash Equilibrium:

The expected utility function of the special team is:

$$\begin{aligned}
 U1 &= P(1-U)[V(-K+L1)+(1-V)(1-W)(X-K+L1) \\
 &\quad + (1-V)W(-K+X)] + PU[V(-K+L1)+(1-V) \\
 &\quad (1-W)(-K)+(1-V)W(-K)] + (1-P)[VL1+0+0] \\
 &= P(1-U)[-K+(1-W+WW)L1+(1-V)X] + PU \\
 &\quad (-K+VL1)+(1-P)VL1
 \end{aligned}$$

The first partial derivatives:

$$\frac{\partial U1}{\partial P} = 0, V^* = 1 + \frac{K}{(U-1)[(1-W)L1+X]}$$

The expected utility function of employees is:

$$\begin{aligned}
 U2 &= V[P(1-U)(-C0+L0)+PU(-C0+L0)+ \\
 &\quad (1-P)(-C0)] + (1-V)(1-W)[P(1-U)(-C0-X) \\
 &\quad +PU(-C+L0)+(1-P)(-C)] + (1-V)W[P(1-U) \\
 &\quad (-C-X)+PU(-C+L0)+(1-P)(-C)] \\
 &= V(PL0-C0)+(1-V)W[P(U-1)(C-C0)] + \\
 &\quad (1-V)[P(U-1)(C0+X)+PU(L0-C)+(P-1)C]
 \end{aligned}$$

The first partial derivatives:

$$\frac{\partial U2}{\partial V} = 0, P^* = \frac{C0-C}{(1-U)[L0+X+(W-1)(C-C0)]}$$

$$\frac{\partial V^*}{\partial K} = \frac{1}{(U-1)[(1-W)L1+X]} < 0 \text{ It indicates that in the}$$

background of high cost, employees are not willing to implement the 5S site management.

$$\frac{\partial V^*}{\partial U} = \frac{-K}{(U-1)^2[(1-W)L1+X]} < 0 \text{ It indicates that}$$

reduce the probability of mistaken obey the rule for not obey the rule may make employees to better implement the 5S site management.

$$\frac{\partial V^*}{\partial X} = \frac{-K}{(U-1)[(1-W)L1+X]^2} > 0 \text{ It indicates that the}$$

increase of punishment may make employees to better implement the 5S site management.

$$\frac{\partial P^*}{\partial W} = \frac{(C0-C)^2}{[L0+X+(W-1)(C-C0)]^2(1-U)} > 0 \text{ It indicates}$$

that the special team should strengthen the probability of active inspection especially employees refused to rectification.

$$\frac{\partial P^*}{\partial U} = \frac{C0-C}{[L0+X+(W-1)(C-C0)](1-U)^2} > 0 \text{ It indicates}$$

that the high probability of mistaken obey the rule for not obey the rule need frequent inspection to make up.

V. SUMMARY

The implementation of 5S site management is a continuous process. If we only implement once, we may cost more and reduce the benefits. The way of thinking is very important. The habit need to be formed to implement the 5S site management. Leading should play the leading role. Frequent educational activities are needed. Corporate culture may form step by step. Continuous improvement is the way to promote the process of 5S site management. Enterprises should not blindly criticize employees. Incentive mechanism should be improved. Then employees may have the power to implement the 5S standard. There is no ending in 5S site management. Only in this way can we reach Pareto optimal.

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REFERENCES

- [1] Li Pengxiang, The application of 5S management in a building construction site, Shenyang University of Technology, 2013, In Chinese.
- [2] Xing Lei, Application of 5S site management in A Boiler Company, Shandong University, 2013, In Chinese.
- [3] Han Lijiao, Research on communication management of engineering project construction process based on Game Theory, North China Electric Power University, 2014, In Chinese.
- [4] Yuan Taiping, Yuan Jianwen, Zhang Huaigang, "Discussion on the application of 5S management in construction site of infrastructure project," China Power Enterprise Management, pp.1002-1003, 2014, In Chinese.

- [5] Guo Jianming, "Application of 5S Management in Power Grid Construction," *Distribution & Utilization*, pp. 70-72, June 2015, In Chinese.
- [6] Liu Wantao, "The application of game theory in the management of safety production," *Inner Mongolia Coal Economy*, pp. 19-20, August 2016, In Chinese.