



Explanation and Analysis of the Interaction between Environmental Health Officers and Directors of Food Preparation, Supply and Distribution Centers Based on Game Theory Model in Yazd

Mohsen Pakdaman¹, Mohammad Taghi Ghaneian², Mohammad Hassan Ehrampoush²,
Vahid Jafari Nodoshan³, Ebrahim Gholami Zarchi^{2*}, Mohamad Hasan Lotfi⁴

¹Health Policy and Management Research Center, Department of Health Care Management, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

²Environmental Science and Technology Research Center, Department of Environmental Health Engineering, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

³College of Environment and Energy Branch, Islamic Azad University, Tehran, Iran.

⁴Department of Statistics and Epidemiology, School of public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

ARTICLE INFO

ORIGINAL ARTICLE

Article History:

Received: 20 January 2019

Accepted: 20 April 2019

*Corresponding Author:

Ebrahim Gholami Zarchi

Email:

ebigholami.63@gmail.com

Tel:

+989133730079

Keywords:

Game Theory,

Environmental Health,

Interaction,

Game.

ABSTRACT

Introduction: Health monitoring and control of food preparation, supply and distribution centers are the responsibility of environmental health officers. Therefore, the present study was conducted to explain the interaction between environmental health officers and providers of food preparation based on the game theory model.

Materials and Methods: This research is a descriptive-analytical study in which after the determination of effective factors on the interaction between officers and directors, the so-called 22 games were designed and for each game four behavioral strategies determined and strategies identified as a two-choice I agree, I disagree questionnaire provided to environmental health officers and directors of food preparation, centers to select their desired strategy. In the quantitative phase, SPSS 22 was used to analyze the data collected by questionnaires in order to determine the percentage of response frequency to each question. Gambit software was used to analyze for determination Nash equilibrium of any Games.

Results: In the present study, the factors affecting the interaction between environmental health officers and directors were categorized to 24 subcategories assigned to six categories, and in the quantitative phase, finally, 22 dominant behavior strategies were identified and the final benefit percentage of each actor was determined.

Conclusion: Investigating selected strategies by directors suggests that there is a good fit between the rules and health behaviors among the directors. The emphasis on health inspection based on education and counseling and lack of acceptance of the activities of health self-reported companies by the directors and officers are the most important outcomes of this study.

Citation: Pakdaman M, Ghaneian MT, Ehrampoush MH, et al. *Explanation and analysis of the interaction between environmental health officers and directors of food preparation, supply and distribution centers based on game theory model in Yazd*. J Environ Health Sustain Dev. 2019; 4(2): 776-90.

Introduction

As defined by the World Health Organization, factors in the environment that can affect human health are identified and controlled by environmental health¹. One of the environmental

factors affecting the health of people in the community is the health status of food preparation, distribution and supply centers. The monitoring and control of food preparation and distribution centers in different countries are

varied². But environmental health professionals are always part of the advisory process in planning, implementing and managing health activities at all local, national and global levels³. In countries such as Australia, South Africa, Scotland, and the state of Queensland, Australia, the health officer is responsible for overseeing and inspecting centers for the distribution and sale of food and public places⁴. Monitoring and controlling health centers for preparing, distributing and supplying food and public places and assessing environmental health threats in Iran are the responsibilities of the health officers of the Ministry of Health⁵. According to the US Centers for Disease Control, about 77% of food poisoning is due to food supplied to public places and restaurants, 20% is from home foods and 3% is from commercial foods⁶. The US Centers for Disease Control estimates that 76 million people in the United States each year develop food-borne illnesses, 325,000 are admitted to the hospital, and 5,000 people die from the disease and 60% of food poisonings in the United States in 2006 were due to foods consumed in restaurants⁷. Environmental health officers aim to promote community health by enforcing health rules of water and food in public places and other environmental conditions⁸, but they always require the co-operation, collaboration and interaction of directors of food preparation, distribution and supply centers and public places. At times, the level of cooperation and interaction between environmental health inspectors and directors of food preparation, distribution and supply centers is low, which results in conflict between the benefits of the two groups in some cases. Logically, individuals always seek to maximize their own desirability and interests⁹. This behavioral characteristic is analyzed among various groups including the environmental health inspectors and the directors of food preparation, distribution and supply centers. We use the game theory when two or more individuals or organizations seek to make decisions with different goals⁹.

In Iran, there are few studies on the various professional issues of environmental health inspectors. These studies have not been as extensive as the history and diversity of the work and the duties of environmental health inspectors¹⁰. According to a study in the United States, the failure to comply with health regulations in the supply and distribution of food is the cause of about 97% of food-borne diseases in restaurants and homes¹¹. Therefore, the collaboration between the inspector and the director and the implementation of participatory behaviors in the implementation of health regulations and rules in restaurants play an effective role in reducing food-borne diseases and the resulting outbreaks. The study of Motavalian et al. regarding the collaborative effectiveness of the elimination of baking soda from traditional bread processing in 2008 indicated that the focus on legal tools was not able to eliminate 100% of baking soda in the program, and interorganizational collaboration, along with participatory training methods between the inspector and the director is an appropriate tool for changing the behavior of bakers in the elimination of baking soda from the processing of traditional bread¹². A study by Malhotra in India examined the role of game theory in public health, which suggested that the application of game theory to decision-making by health experts to address health issues can be effective in resolving health issues disputed by people and offers rational solutions¹³. In a study by Nadeau using game theory to analyze the relationship between health safety directors and workers. The results showed that there are contradictions between the goals and strategies of health safety directors and workers¹⁴. Salazar explained in a study to investigate the application of game theory to address the contradiction of groundwater withdrawal in Mexico, in areas where groundwater scarcity is observed, there are always conflicts and contradictions between the economic benefits of farming and the negative environmental effects of excessive withdrawal of groundwater, including reduced water table levels

and entry of contaminants and increased entry of nitrate to water. In fact, an optimal balance and interaction should be created between farmers and society (the environment) as the two main actors¹⁵.

In the system of monitoring and control of the health of preparation, distribution and supply centers of food and public places, in some cases, the interests of inspectors are in contradiction with those of the directors and a low level of interaction and cooperation between the two groups is created. Given the importance of interaction in the present study, conducted in 2018-2019 in Yazd province, between the environmental health inspectors and the directors of food preparation, distribution and supply centers and their impact on the implementation of health regulations and instructions, the game theory was used in order to analyze the interactive behaviors (interactions) between environmental health inspectors and directors of food preparation, distribution and supply centers. Using the game theory, one can analyze the relationship between the inspector and director, and find the balance point between the interests of two groups, which is agreed upon and satisfies both groups.

Materials and Methods

This research is a descriptive-analytical study in which the interaction model between environmental health inspectors and directors of food supply, distribution and supply centers was explained by using the game theory in two qualitative and quantitative phases. In the qualitative phase, the data collection method was interview. The participants included eight environmental health experts and inspectors and six directors of food preparation, distribution and supply centers that were selected by purposive sampling. The criterion for the determination of the number of samples in this research was theoretical saturation of the researcher. Theoretical saturation occurs when interviews do not contain new information or viewpoints. After each interview, the analysis and coding of the

interview were done by the MAXQDA10 software. Finally, the themes, categories, and subcategories of the interviews were formed, with education, the focus of the monitoring system, the enforcement of law in health violations, the method of inspection, acceptance of health regulations and instructions by the director and the need for the inspector to pay attention to the conditions of the director and the region drawn as categories. Finally, 22 interactive behavior strategies of environmental health inspectors and directors of food preparation, distribution and supply centers were determined. Using the game theory model, in the first step, each of the 22 interactive behavior strategies between the inspector and the director, in terms of the game theory, were separately designed, and for each factor, four strategies were determined that were designed as a questionnaire and provided to actors, i.e., inspectors and directors, to choose their strategies. The target population in this study consisted of two groups. A 46-individual group of environmental health inspectors in Yazd, which due to the limited number of this study population; all were selected as sample and enrolled in the project. The other study population of the study consisted of the directors of food preparation, distribution, and supply centers. The size of this study population is 6990 people, 365 of whom were selected using the Cochran's formula. Sampling method was stratified random sampling conducted in food preparation, distribution and supply centers of Yazd. The directors of centers were selected from the centers covered by the holistic health services centers in a proportional manner. That is, at each holistic health center, according to the division formula and proportionately to the number of centers covered by the comprehensive health center, the sample size was determined in each region. By dividing the number of centers covered by the holistic health center into the total number of centers covered by Yazd County Health Center, the result is multiplied by the sample size and the sample size in each region is obtained (Table 1). The questionnaire designed in the present study

was a researcher-developed questionnaire and its questions were closed-ended with the two choices I agree and I disagree. At the beginning of the questionnaire, instructions and guidelines to complete the questionnaire appeared. At the beginning of this guideline, the purpose of the design of the questionnaire and the title of the research appeared, and a brief explanation about the efficacy of the research in the field of environmental health inspection and the relationship of the inspector with the director was provided. Then, some explanations about some words and terms and titles in the text of the questions were provided in order for the respondent to better understand the questions. In the second section, the demographic characteristics were addressed without the respondent's name and the main questions were included in the third section. After the designing of the initial version of the questionnaire, in several sessions, the questions in the presence of the supervisor, were examined to match the intended purpose, i.e., the design of the game in the game theory model, and each of the questions, which in fact indicates the behavioral strategies of inspectors and directors, were examined for proper writing and in terms of the structure and design of the game, which requires determination of four strategies (four questions). After final confirmation of the questions by advisors, the validity and reliability of the questionnaire were determined. In this research, qualitative content, face validity was used to determine the validity of the questionnaire. In the qualitative study of face validity, a questionnaire was given to eight directors to study it and answer questions.

Certain issues including difficulty level, comprehensibility of words and items, suitability and desirable relation of expressions to questionnaire dimensions and ambiguity regarding misinterpretations were also taken into account. To determine the content validity, a questionnaire was provided to ten inspectors and senior experts in environmental health affairs of Yazd University of Medical Sciences. They were asked to review the

questionnaire for grammatical criteria, appropriate wording, item necessity, and appropriate order of items and to give proper scoring and feedback. At this stage, the phrases were understandable, the questions were fully reviewed by the directors and, using the viewpoints of experts and directors, changes were made to the form of questions to make them simpler and more understandable. In the next step, in order to verify the reliability of the questionnaire, its internal consistency was evaluated using Cronbach's alpha coefficient. This coefficient was calculated at 0.8.

The questionnaires were delivered to the respondents in person and collected after completion. Due to completion of the questionnaire by the inspectors and the directors, all the questionnaires were gathered in the presence of the researcher. Data were analyzed using SPSS software version 22 and descriptive statistics (frequency distribution and frequency) were used. After determining the percentage of the frequency of response to each question, strategies and frequency of response to that strategy were entered into Gambit version 14.1.0 and Nash equilibrium of each strategy was introduced by the software (statistical analysis) the Nash equilibrium point is the point that all actors choose maps with respect to the roles of their opponents so that they can gain the most benefit.⁹ In fact, a behavioral strategy is considered to be a superior behavior when the two main game actors have the most tendency to it. In fact, for the 22 games, superior strategy and behavior, with the highest percentage of response rates among directors and inspectors, was introduced by Gambit software as the superior and agreed upon behavior of two groups. In the last stage, these behaviors were introduced and analyzed as superior and agreed upon behaviors of both groups of inspectors and practitioners. In addition, the percentage of each player's end benefit was also determined by the Gambit, which in fact indicates that what percentage of the inspectors and operators have chosen the dominant strategy.

Table 1: The status of selecting samples in holistic health centers

Name of holistic health center	The number of covered food preparation, distribution, and supply centers	The number of selected samples
Emamshahr	520	27
Azadshahr	830	43
Eskan	180	9
Akbari(1)	560	29
Akbari (2)	750	39
Shahidnasiri	240	13
Joyhorhor	210	11
Ahmadiyah	350	18
Hakimzadeh	330	17
Rahmatabad	356	19
Shahediyh	296	15
Zarch	260	14
Shikhdad	290	15
Qalahasedan	280	15
Kasnaviye	300	16
Naaimabad	280	15
Nikopour	534	28
Maskan	424	22
Total	18	6990
		365

Ethical issues

This study was conducted with the approval of Shahid Sadoughi University of Medical Sciences and Health Services, Medical Ethics Committee. Code: IR.SSU.SPH.REC.1396.74

Results

In the qualitative section, after the analysis of the data, 338 primary codes were drawn, and after analyzing the drawn codes, the codes were assigned to 24 subcategories and 6 categories. The categories are the factors related to education, the focus of the monitoring system, legal measures, the inspection method, the acceptance of the rules by

the director, inspector's paying attention to the conditions of the director and the region (Table 2). Two groups of participants participated in this study: Environmental health inspectors and directors of food preparation, distribution and supply centers. The number of inspectors who completed the questionnaire was 46, and the number of instructors who completed the questionnaire was 365. The demographic information of the environmental health inspectors and the directors of food preparation, distribution and supply centers are as follow (Table 3).

Table 2: Interactive categories and subcategories between environmental health inspectors and directors of food preparation, distribution and supply centers.

Theme	Categories	Subcategories
Interaction between health inspectors and directors	1. Education	1. The agreement of university courses with the discussion of food inspection.
		2. Modification of the method of training in the Guilds Health Center.
		3. Empowerment of environmental health inspectors
		4. Intervention of the health center in education and training-based inspection.
	2.The focus of the monitoring system	1. Integrating monitor system of foods
		2. Interference of the tasks of environmental health organization and food and drug administration.
3.Legal measures	1.The long process of dealing with health violations in the judicial system	
	2.Assigning special branches for dealing with violations of health and interaction with judges	
	3. Non-deterrence of sentences	
	4. Considering the alternative instead of the financial penalty	

Theme	Categories	Subcategories
	4. Inspection method	5. Fining by the inspector at the site.
		1. The role of self-report companies in overseeing food supply centers
		2. Lack of progress of the environmental health inspectors and the inspection method along with the progress and variety of guilds
		3. Specialized inspections for guilds with similar activities
		4. Deficiencies in checklists and lack of transparency of issued alerts for a director
		5. Quantification of inspections and reduced quality of inspections
		6. Coordination with trade unions and tradesmen
	5. Acceptance of the rules by the director	7. Lack of proper access to portable equipment.
		1. Incentive system
		2. Feeling of profit and gain by the director
		3. Correct training and detailed explanation of the cause of the health instruction
	6. Inspector's paying attention to the conditions of the director and the region	4. Trust and confidence in the Inspector.
1. The inspector should consider the conditions of the director		
2. Compliance with local and regional regulations for directors		

Table 3: Demographic data of directors of food preparation, distribution and supply centers, and environmental

Type	directors of food preparation	environmental health officers
Education level	Under diploma level	39%
	Diploma level	43%
	Associate's degree	4%
	Bachelor's degree	12%
	Master's degree and PhD	2%
Age (Year)	20-30	20%
	30-40	44%
	40-50	22%
	50-60	10%
	Older than 60 years	4%
Work experience	0-10	47%
	10-20	38%
	20-30	10%
	Older than 30 years	5%
Gender	Man	92%
	Female	8%

Optimal behavioral strategies in the interaction between health inspectors and the directors of food preparation, distribution, and supply centers were provided in the form of 22 optimal interactive behavior strategies in order to cover the vacuum of the inspection system and improve the interaction between inspectors and operators to provide an

inspection mechanism to the two groups of environmental health inspectors (17 strategies) and directors of food supply, distribution and supply centers (5 strategies) (Figure1). The results of determining the best behavioral strategy for each game determined by Gambit software are presented below (Table 4-9).

Table 4: Optimal Interactive Behavioral Strategies (Nash Equilibrium) Between Inspectors and Directors in the Education Subcategory

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit	The percentage of directors' marginal benefit
The disparity of the university course with food control and inspection	The agreement of the courses and practical training offered at the university will increase the inspector's control over the inspection	96%	90%
Modifying the methods of training in the guilds health education center	Holding an educational class at the Guild Health Education Center for similar businesses will increase the efficiency of the training course.	80%	93%
Empowering inspectors and increasing their knowledge	Teaching the inspectors and their familiarization with the behavior of the directors will increase their cooperation in the implementation of health rules.	95%	90%
Empowering inspectors and increasing their knowledge	The familiarity and mastery of health inspectors over the method and type of work of supply and distribution centers, for example, the food production method, makes it possible for directors to pay attention to the health points focused by the inspector.	98%	95%
Further engagement of the health center in education	Practical training of directors by inspectors will make the directors of food preparation, distribution and supply centers better observe health points better.	92%	95%

Table 5: Optimal Interactive Behavioral Strategies (Nash Equilibrium) Between Inspectors and Directors in the Subcategory of Monitoring System's Focus

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit	The percentage of directors' marginal benefit
Monitoring System's Focus	If organizations such as the Health Center, the Food and Drug Administration, the Veterinary Medicine and the Standards Office, take on the role of an integrated health inspection and health monitoring organization, the level of health monitoring and quality will increase.	86%	84%

Table 6: Optimal interactive behavioral strategies (Nash equilibrium) between inspectors and directors in the subcategory of inspection method

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit	The percentage of directors' marginal benefit
Education-based inspection	Health monitoring based on education and counseling by health inspectors will increase the health level of food preparation, distribution and supply centers.	95%	92%
The role of self-report companies in controlling and monitoring food supply centers	By conduction of inspections by self-report companies, the levels of quality and health monitoring will not increase in food preparation, distribution and supply centers.	54%	44%
The role of self-report companies in controlling and monitoring food supply centers	By conduction of inspections by self-report companies, the levels of quality and health monitoring will increase in food preparation, distribution and supply centers.	85%	83%
Specialized inspections for guilds with similar activities	If for the guilds and centers with similar activities, the joint inspector be assigned, the level of health monitoring and inspection of these centers will increase.	85%	83%

Table 7: Optimal Interactive Behavioral Strategies (Nash Equilibrium) Between Inspectors and Directors in the Subcategory of Inspector's paying attention to the conditions of the director and the region

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit	The percentage of directors' marginal benefit
The inspector should consider the conditions of the officer	If health inspectors consider and apply the conditions of a director, such as economic, financial, and educational level, the director's cooperation with implementation of health instructions and regulations will increase.	84%	87%
Agreement between laws and local and regional regulations	If the health inspectors consider the conditions and type of district and city of the business, the collaboration of the director in implementation of the health instructions and regulations will increase.	93%	86%

Table 8: Optimal interactive behavioral strategies (Nash equilibrium) between inspectors and directors in the legal dealing with directors having committed health violations subcategory

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit	The percentage of directors' marginal benefit
Considering special branches to deal with health violations and more interaction with judges	If special branches are assigned to health violations, the issuance of health sentences will be more appropriate	92%	77%
Considering special branches to deal with health violations and more interaction with judges	In the event of the establishment of a health dispute resolution council with the presence of representatives of the health center, the Chamber of Guilds and the Court, the status of the hearing and issuing health sentences will be more appropriate.	84%	84%
Considering the alternative instead of financial penalties	If directors who have committed health violations sometimes participate in training courses instead of paying a financial penalty, the health breach will be less frequent.	74%	85%
Imposing fine by the inspector at the workplace	The fine imposed by an environmental health inspector at the director's workplace will not reduce the health misconduct by the director.	50%	70%

Table 9: Optimal Interactive Behavioral Strategies (Nash Equilibrium) Between Inspectors and Directors in the Acceptance of Health Rules and Instructions by Directors Subcategory

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit
Appropriately training and precisely explaining the health instructions	In the event that health inspectors explain a health instruction to the director, the engagement and cooperation of the director will increase.	91%
Establishing an incentive system	Establishing an incentive system, such as a health center grading system, will increase the health level of food preparation, distribution and supply centers.	95%
Establishing an incentive system	Reducing taxes levied on centers with appropriate health level will encourage the directors and, in general, will increase the health level of the centers.	84%

Subcategory	Optimal interactive behavioral strategy (Nash equilibrium)	The percentage of inspectors' marginal benefit
Directors' feeling of benefit and gain	If the directors of food preparation, distribution and supply centers feel to profit from health inspection and feel that their interests are being provided by the inspection, their interaction and cooperation in the implementation of health sentences will increase.	89%

Practical training of health personnel by inspectors will make the health care providers better positioned by providers of food supply, distribution and distribution centers
 Holding an educational class at the Health School for similar businesses, such as restaurants, pizza, sandwiches, will increase the productivity of the course
 Teaching the inspectors and their familiarity with the behavior of the operators will increase the co-operation of the providers in the implementation of health rules
 The familiarity and dominance of health inspectors by the method and type of work of supply and distribution centers, for example, the food production method, makes it possible for health inspectors to be considered better by the inspector.
 The adaptation of the courses and practical training provided at the university will increase the inspector's control over the inspection

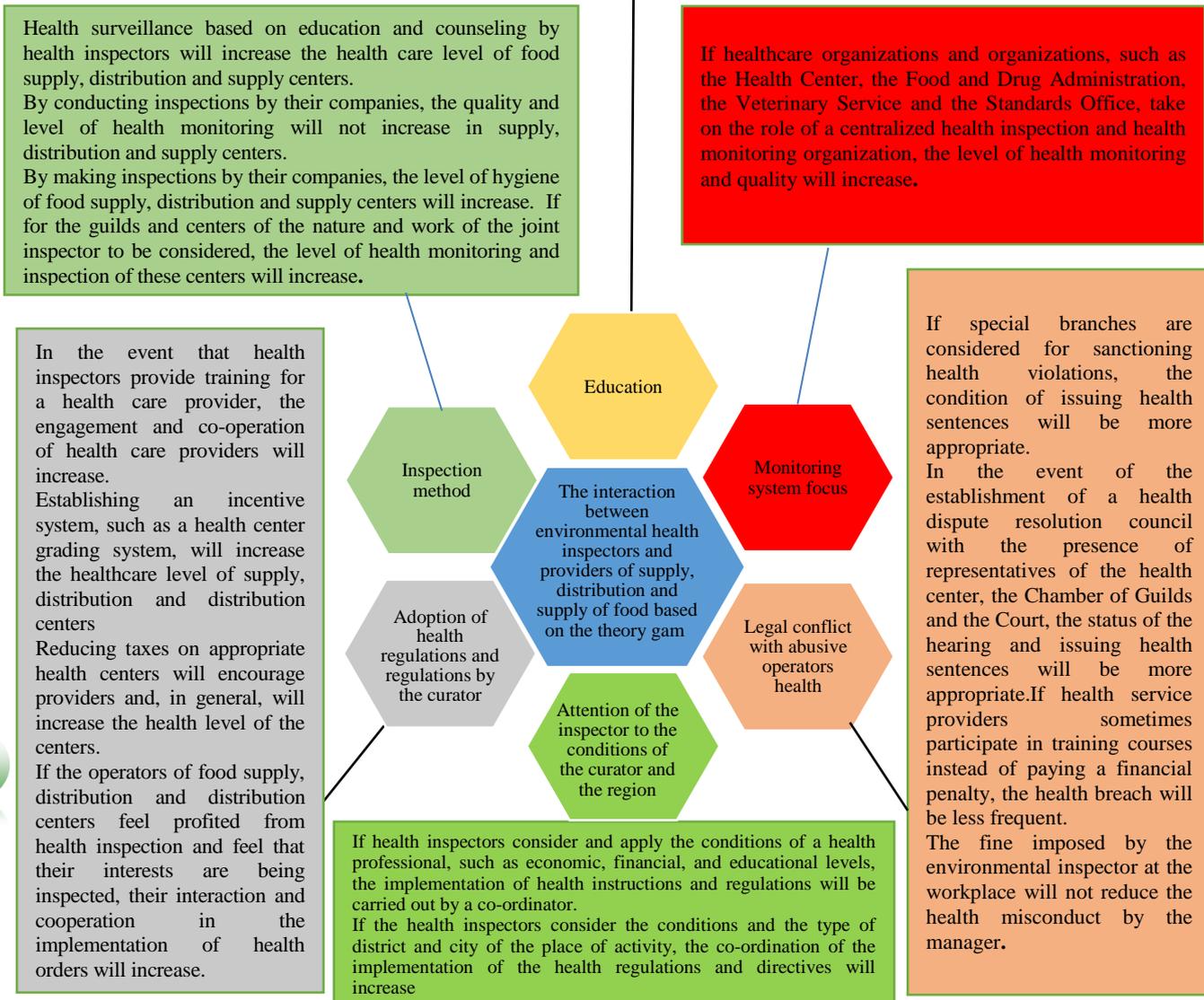


Figure 1: The mechanism of interactive inspection based on the game theory

Discussion

The findings of this research in the quantitative phase to determine the best behavioral strategy (Nash equilibrium) for 22 games designed were reported in the results section. Twenty two optimal behavioral strategies were defined as the superior behavior for each game, which was ultimately agreed upon by the two groups of inspectors and directors.

The review and observation of the best behavioral strategy in game no. 1, which is related to the practical training of health items at the workplace by the inspector, suggests that, by practical training of health points by the inspector to the directors at the workplace and during the inspection, the director better observes relevant health points and the director's behavior in the functional area improves. In fact, directors tend to receive practical training in health points during inspection, and they do not merely expect inspecting and revealing deficiencies without training. Carrying out certain works, such as washing and disinfecting vegetables or hand washing at the site by the director under the supervision of an inspector, can help the director appropriately and better health behaviors. A study on the level of awareness of the Bardsir confectionery guild regarding the use of synthetic colors in the provision of food shows that the awareness of the confectionery guilds about edible and non-edible, and standard colors as well as the use of authorized colors was low and they required training¹⁶, which is consistent with the results of the current study on the importance of training during inspection. The study by Hedberg on the causes of outbreaks in restaurants shows that the exposure of restaurant staff hands with food was the cause of outbreak among consumers and the outbreak of the disease in 35% of cases, which indicates the important role of teaching practical points such as hand washing to staff by the inspector at the site¹⁷. The best behavioral strategy in game no. 2 suggests that, from the perspective of inspectors and directors, holding courses at the Guilds Health Education Center need to be modified and reformed. At present, due to the

diversity of guilds, there is a need for more specialized training courses for the centers of food preparation, distribution and supply with similar activity. A study on the effect of training courses for guilds to change the knowledge and performance of staff and directors of food preparation, distribution and supply centers shows that despite the fact that training courses will improve these indicators, the rate of the changes were low and less than expected so that there was a need for changes and modifications in the content of the training course and its implementation method, and the holding of a training course specifically for guilds and their grouping would improve the performance indicators of the directors and employees¹⁸. The results are also consistent with the results regarding determination of the best behavioral strategy in this study, so that specialized training sessions and grouping of directors with similar activities was drawn as the best behavioral strategy. The study of the best behavioral strategy in game no. 3 shows that if inspectors carry out inspection based on education and counseling, the health level of food preparation, distribution and supply centers will increase as directors and staff receives advice from law enforcement inspectors and better observe health behaviors, leading to improved level of health of the centers. A study by Soon et al. at the University of British Columbia shows, by decreasing inspection intervals to less than one year and educational intervention and counseling by inspectors, health indices increases¹⁹, which is consistent with the behavioral strategy outlined in this game. The study of the best behavioral strategies in games number 4 and 5 shows that generally training and empowering inspectors is necessary and, in general, by increasing the information of and empowering inspectors, the cooperation of directors in implementing health laws will increase. A review of the Healthcare Guidance Guide for food preparation, distribution and supply centers has highlighted the importance of training in the field of basic, field, and in-service training for inspectors, and the US Food and Drug Administration has identified five phases of health

inspection, the second phase of which is the training of inspectors⁶. A study in this field showed that the level of awareness of 50% of environmental health inspectors in the field of familiarization with the implementation of Article 13 of the law on food, drinking, cosmetics and hygiene was low and poor². Another study in this regard suggests that from the perspective of inspectors, in-service training plays an essential role in empowering them¹⁰. Another study shows that the level of knowledge and skills of 50% of environmental health inspectors regarding the use of pesticides and disinfectants is not desirable²⁰, which is consistent with our results regarding the best behavior strategies identified in games no. 4 and no. 5 stating that the training and empowerment of inspectors in a variety of areas, including how to deal with directors and law enforcement, will further enhance the cooperation of directors. The best behavioral strategy in game no. 6 confirms that, if the courses and the training provided at the university are consistent with health and food health inspection, the mastery of health inspectors in inspection will increase. The results of this study indicate that the educational activities of the environmental health professionals are currently not in line with the training program for human resources at universities, and there is a need for more adaptation of the courses and training to executive activities of inspectors⁵. Another study in this field suggests that the training courses and lessons offered by the university are not fully responsive to the needs of the inspectors, while 72% of the inspectors believe that the food health lesson is important and applied, yet the number of its credits is low²¹. The study of the best behavioral strategy in game no. 7 shows that the collaboration and interaction of the director in the implementation of an instruction improves if the environmental health inspector explains the implementation of that instruction to the director. In fact, in many cases, the reason for the failure of directors to follow health laws is their low level of attitude towards the importance of the implementation of health regulations and the extent

of their impact, and when the inspectors are well aware of the implementation of health guidelines and their importance, they became aware of the implementation of the health point. A study by Khosravi Mashizi et al. shows that the second reason for the use of synthetic colors in the provision of food from the viewpoint of staff and inspectors is the lack of awareness of the food industry staff about the dangers of using these colors, and that the inspectors' lack of knowledge about effective training methods that change staff attitudes has also had an impact on the use of synthetic colors by staff¹⁶. The best behavioral strategy in the game no. 8 shows the implementation of incentive systems for operators such as the establishment of restaurant health grading, which is currently being incompletely implemented, be extended to cover all centers of preparation, distribution and supply of foods, and in general, the health level of the centers will increase. At present, one of the shortcomings of the environmental health inspection system is the lack of incentive mechanisms for operators and centers, which seems to be one of the priorities of the Ministry of Health to complete this protocol. Besides, the study of the best behavioral strategy in the games no. 9 and no. 10, also shows that the implementation of incentive policies such as tax reductions for food preparation, distribution and supply centers or their exemption from paying membership fees in unions, as incentive policies, increases the cooperation of operators, and in general, the health level of the centers. The best behavioral strategy in games no. 8-10 confirms the agreement of the results and the need to establish an incentive system for operators. In this regard, studying the results of the study by Hamzah Kalaknari et al. shows that the main barrier to accepting the HACCP system in the food industry is from the point of view of the managers of the government's lack of financial support, and suggests that low-interest loans to the industry be paid by the government and the possibility of partial increase in product prices in industries with the HACCP system certificate be implemented as policy incentives by policy makers and planners²².

The study of the best behavioral strategy in game no. 11 shows that if the inspector sees the profits and benefits and feels that his/her interests are being provided, his engagement and cooperation in the implementation of health and safety regulations will increase. In fact, this strategy emphasizes that the inspector must have the principles to remind the director of the benefits of implementing health instructions. For example, the receipt of a health certificate grade 1 by the restaurant from the inspector will increase the profitability of the business. The study of Hamzah Kalaknari et al. in this regard shows that the most important benefits of HACCP system implementation in the food industry from the managers' perspective is the possibility of increasing the price of the product, the possibility of export, reducing waste, increasing income, and increasing the safety of food products, so taking into account the benefits persuades the operators and directors will to implement the HACCP system²². The study of best behavioral strategy in games no. 12 and 13 indicates that if the inspector considers the economic conditions, the level of education, and the problems of the director as well as his/her regional and local conditions, then his/her cooperation with law enforcement and collaboration will increase. Indeed, at some point, it is necessary for the inspector to adapt the existing rules to the specific conditions of the director, such as economic problems, or, for example, the type of city or village of business, using the expert opinions. In this context, one study shows that economic criteria are effective on the use of using synthetic drugs in food production¹⁶. However, given the importance of the issue and the dangers of color consumption, the economic problems of the director should not be the basis for the decision made by the inspector in deal with him/her. In this regard, Tahkapaa studied the challenges facing enforcement of control laws in Finland, and observed that there is a significant difference between the implementation of laws in terms of geographic regions, taking into account the time of implementation, the method and content of control plans²³.

The best behavioral strategy in game no. 14 indicates that if health food monitoring organizations such as veterinary medicine, agriculture, the standard organization, food and medicine, and environmental health organizations take on the role of food inspection and control agencies in the framework of one single organization, the level of monitoring and quality of inspection and food control will be improved at different stages.

In this context, other countries' successful experience in integrating food safety control organizations include the Food and Drug Administration (FDA) in the USA, the Food Safety Authority in Ireland (FSAI) (Institute of Environmental and Health Services, Tehran University of Medical S dignity, 2013). and Health Services, Tehran University of Medical Sciences. Currently, in Iran, due to the lack of integration of these organizations, there are gaps and in some cases parallel activities in control activities, for example, the health quality of agricultural products are not controlled for residual pesticides by any organization, while sometimes there are parallel tasks between environmental health organization, food and drug administration, and veterinary medicine. The study of best behavioral behavior in game no. 15 shows that with the introduction of self-report companies into the environment health inspection, the level of health monitoring on the centers will not increase, and directors and inspectors do not have a good view of the entry of these companies to the inspection area. As for the results of the activities of self-report companies, there are still no scientific sources available because of it is one of the novel new plans of the Ministry of Health that has not yet been fully implemented. But the best behavioral strategy in game no. 16 suggests that with the entry of these companies, the level of health inspection in the centers will increase, because anyway, the counseling and training of these companies to the operators will increase the health level of the food preparation, distribution and supply centers. Examining the best behavioral strategy in game no. 17 suggests that considering a specialized inspector

for centers with similar activities will increase the level of health monitoring of the centers. Currently, due to the growing diversity of food preparation, distribution and supply centers, as well as a variety of environmental health inspections, for example, an inspector will visit a barber shop, restaurant, swimming pool and hotel within one day, while the health issues that should be given attention in inspecting these centers are totally different. Therefore, it is necessary in big cities, special inspectors are assigned to, for example, restaurants, pools, etc. However, this is being somehow implemented, and special inspectors have been assigned to offices. The study of the best behavioral strategy in game no. 18 indicates that the collaboration between the environmental health inspectors, the union and the guild and their presence in inspections and joint inspections will increase the cooperation of directors with law enforcement. A study by Nezakaty Olfaty et al. in this field shows that the directors holding business licenses have a satisfactory level of performance in terms of health issues, indicating that legal and unionized operators have better performance, and introducing directors to obtain licenses by union officials to health centers is effective in promoting the health conditions of the centers²⁴. Examining the best behavioral behavior in games no. 19 and 20 suggests that consideration of special branches for dealing with health violations and the formation of dispute resolution councils will result in better sentences, and the process of proceeding violations will be more appropriate. One of the problems with dealing with health violations is the prolongation of the process of investigating violations in the judiciary and the non-compliance of the crimes with the amount of health violations that seems to be solved by forming the health dispute resolution councils. Examining the best behavioral strategy in game No. 21 suggests that sometimes compelling a competitor to attend training courses for health violations rather than paying a financial penalty will result in less repetition of that violation. Several studies have shown that training for the curator and changing his attitude and knowledge

on the performance of the curator will be affected. And the results of this study also show that the failure to observe health care by the curator at some point due to lack of knowledge of the curator. The study of the best behavioral strategy in game no. 22 indicates that the on-site penalty is not appropriate for the health-related violation of the director and will not reduce his/her health misconduct, and lack of fining will reduce violations. This plan is not currently a policy of the Ministry of Health, and specifically the analysis of the best behavioral strategy drawn from game no. 22 was not agreed upon by inspectors and operators.

Conclusion

Optimal behavioral strategies in the interaction between health inspectors and directors of food preparation, distribution and supply centers to cover the vacuum of the inspection system and improve the interaction between them were presented in the form of 22 optimal interactive behavioral strategies for providing an inspection mechanism. The most important behavioral strategies emphasized and approved by inspectors and directors were: paying attention to the interaction between inspectors and directors, and the inspection based on training and counseling, the establishment of incentive mechanisms for the directors, and the full implementation of the health rating system of the centers, the centralization of the health monitoring system, the transparency of work self-reported companies and adaptation of the training provided at the university to the professional issues of the inspectors and the reform of the structure of the guilds health training center. Investigating selected strategies by directors suggests that there is a good fit between the rules and health behaviors among the directors, and their chosen strategies are fully in line with the strategies selected by the inspectors, indicating that there is an appropriate field of cooperation and interaction between the inspectors and the directors. Also, the results of this study indicate that the lack of transparency in the work of the self-reported health companies and the directors'

reluctance to accept them will be the most important challenge between the directors and the health inspection system in the future.

Acknowledgements

This is an extracted part of a graduate student's thesis in Environmental Health Engineering, Yazd University of Medical Sciences. Thanks and gratitude to our dear colleagues and health inspectors from the health department of Yazd University of Medical Sciences who helped us with this study.

Funding

This study is a part of thesis which was funded by Shahid Sadoughi University of Medical Sciences Yazd.

Conflict of interest

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

This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work for commercial use.

References

1. Kumwenda S, Samanyika Y, Chingaibe E, et al. The emerging environmental health risks and challenges for tomorrow: Prospects for Malawi. *Am Int J Res Form Appl Nat Sci*. 2014; 1(1): 21-6.
2. Peiravi R, Vahedian Shahroodi M, Alidadi HA. Survey on the knowledge of environmental health officers in regard to the executive process of the legal item 13. *Iranian Journal of Research in Environmental Health*. 2015; 1(2): 112-8.
3. Musoke D, Ndejjo R, Atusingwize E, et al. The role of environmental health in one health: A Uganda perspective. *One Health*. 2016; 1(2): 157-60.
4. Thomas EP, Seager JR, Mathee A. Environmental health challenges in South Africa: Policy lessons from case studies. *Health & Place*. 2002; 8(4): 251-61.
5. Hamdi MR, Parvaresh A, Amin M. Description of job tasks and educational needs of graduates of different degrees in environmental health. *Iranian Journal of Medical Education*. 2006; 2(5): 63-71.
6. Institute of environmental and health services, Tehran University of Medical Sciences. Guidelines for preparation and distribution of food health inspection centers and public places. Autumn 2013; Available from: <http://www.markazsalamat.behdasht.gov.ir> [Cited August 20, 2012].
7. Kwon J, Roberts K, Shanklin C, et al. Food safety training needs assessment for independent ethnic restaurants: Review of health inspection data in Kansas. *Food Prot Trends*. 2010; 30(7): 412-21.
8. Tehrani H, Taghdisi MH. [Editorial] Community action: A strategy for health promotion. *Iranian Journal of Health Education and Health Promotion*. 2015; 2(4): 255-9.
9. Sepasy S, Eatemadi H, Sirghani S. Application of game theory in the strategic game analysis of the budget manager managing director in participatory budgeting and budget failure. *Journal of Research Financial Knowledge Analysis of Securities*. 2016; 9(31): 1-20.
10. JonidiJafari A, Elahi T, Ahmadi S. Competency achievement methods of environmental health inspectors based on their own perspectives in Iranian Medical Sciences Universities. *Iranian Journal of Medical Education*. 2014; 14(6): 550-7.
11. Howes M, McEwen S, Griffiths M, et al. Food handler certification by home study: Measuring changes in knowledge and behavior. *Dairy, Food and Environmental Sanitation*. 1996; 16(11): 737-44.
12. Ahmadi N, Taqdisi M, Motavalian S, et al. Efficacy of a participatory intervention to remove the soda bread, from traditional bread processing in a city at 2008. *Iran Occupational Health*. 2009; 6(1): 37-43.
13. Malhotra VM. Role of game theory in public health. *Online J Health Allied Sci*. 2012; 11(2): 28-35
14. Nadeau S. Co-operation in health and safety:

- A game theory analysis. *University of New Hampshire Law Review*. 2002; 1(3): 219–27.
15. Salazar R, Szidarovszky F, Coppola E, et al. Application of game theory for a groundwater conflict in Mexico. *Journal of Environmental Management*. 2006; 7(11): 1–12.
 16. Mashizi RK, Yunesian M, Borna MO, et al. Evaluation of knowledge and attitude of confectionery workers towards usage of artificial food dyes in Bardsir. *Journal of Health*. 2012; 3(2):32-41.
 17. Hedberg C, Smith J, Kirkland E, et al. Systematic environmental evaluations to identify food safety differences between outbreak and nonoutbreak restaurants. *Journal of Food Protection*. 2006; 69(11): 2697–702.
 18. Almasi A, Pirsahab M, Rezaee M. The special health education course effects on knowledge, attitude and practice of preparation, distribution and sale centers food staff in Kermanshah. *Iranian Journal of Health and Environment*. 2010; 3(3): 299-308.
 19. Soon JM, Baines R, Seaman P. Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *Journal of Food Protection*. 2012; 75(4):793-804.
 20. Farshad AA, Sanati B, Farzan HA. Survey on the knowledge and practice of experts and health care professionals in the application of toxins and disinfectants and its effective factors. *Journal of Yazd University of Medical Sciences*. 2001; 9(4): 107-12.
 21. Fadaei A, Ghafari M, Amiri M, et al. Investigating environmental health engineering graduates' viewpoints about the conformity rate of the curriculum with their professional needs in Chaharmahal and Bakhtiari province. *Iranian Journal of Medical Education*. 2014; 14(9): 787-95.
 22. Hamzahkalaknari H, Ghorbani M, Varidi MM, et al. Advancing the benefits and obstacles to fault analysis system at the points of the bazzan in the food industry of Mashhad. *J Agric Econ Res*. 2015;7(2):27-61.
 23. Tähkää S, Kallioniemi M, Korkeala H, et al. Food control officers perception of the challenges in implementing new food control requirements in Finland. *Food Control*. 2009; 20(7): 664-70.
 24. Rafeemanesh E, Nezakati Olfati L. The effect of educational courses on the health knowledge and practice of managers and staff in food preparation and distribution centers in 2012. *Iranian Journal of Health and Environment*. 2015; 8(2): 153-62.