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Modeling and Predicting the Behavior of the Witnesses of an Incident Using Theory of Game

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ABSTRACT

In this study we look forward to use the theory of games and the Nash equilibrium, first to model the witnesses' responses to an incident, that is, whether they report the incident to the authorities or not, and then the witnesses' most reasonable response was predicted using the Nash equilibrium, so that none of the witnesses had no intention to do any other reaction. Finally the relationship between the number of witnesses and the probability of reporting the incident, when costs and benefits are fixed and the witnesses are symmetrical, is found and it will investigated through a real example.
KEYWORDS: Incident, witnesses, strategy, report, theory of games, Nash equilibrium.

1. INTRODUCTION

One of the major branches of human knowledge which is developed in the field of economics and mathematics, is the theory of games that is applied widely in various branches of the humanities, engineering and basic science; moreover its uses is developed so far as to describe and analyze many of the behaviours in philosophy and ethics.

Studies in this field are often based on a set of guidelines known as the balance in games. These guidelines, are mainly inferred from rational rules. The most famous equilibrium, is the Nash equilibrium. According to the theory of Nash equilibrium, given that in each game with compound strategies, players choose their guidelines reasonably and logically, seeking for the most profit in the game, there is at least one guideline for achieving the best results for each player and if players choose other guidelines, they will not get a better result.

In the theory of games, the strategy for a specific player, is the design that discriminates his action against other players. If the number of strategies for each player is limited, the game is called limited or else it is called unlimited [1].

2.Stating the topic:

Various incidents occur near us. Among the people witnessing them, some report them to the authorities and some do not. In this article, we'll see that if the cost (e.g. cost of a phone call) and profits (e.g. protecting the life of a person) is fixed, by applying the theory of games, if a relationship between the probability of reporting the incident and the number of witnesses could be found [2]?

For this purpose we assume that n people witness the incident and each of the witnesses decide to report (*R*) the incident or not to report (*N*) it at the same time. Each of the witnesses prefer the incident to be reported, so the desirability for the incident to be reported (or, for example, that the person not to be killed) (*V*) is higher than the cost of reporting the accident (or the call cost for each person and ...) (*C*), that is (*C*<*V*). The result or the payoff function is

$$u_i(s) = \begin{cases} 0 & \forall\, s_j \in S \qquad s_j = N \\ V - C & \qquad\qquad\qquad s_i = R \\ V & s_i = N \quad \exists\, s_j \in S_{-i} \;\; s.t \;\; s_j = R \end{cases} \quad (1)$$

where the set of all witnesses' strategies are in S, and s_i is the i-th witness strategy, and u_i is the desirability or the profit for the witness in choosing the s_i.

Now according to this modeling and the Nash equilibrium, we have got a pure strategy [3], in which we have only one witness who reports the incident and none of the rest does it ($\forall\, j \neq i a_j$= N $\& a_i$= R). So the profit of the person who has reported, would be $V - C$ or else the result will be null, so he has no motivation to violate and the result for the person who has not reported is V and if he report, the result would be $V - C$, so he has no motivation to violate, therefore it would be a pure strategy. Also, there is no pure strategy in which more than one person reports, because if for example two persons report, the result would be $V - C$ and one of them will have the motivation to violate and not to report and place V in place of $V - C$. There will also be no pure strategy in which no one reports, and in this way everyone obtains null and one would have the motivation and obtain $V - C > 0$. So this game will have n pure strategies in which one of the persons report and the rest do not.

But this does not lead us to the main goal (which is to know whether others have reported or not), hence it is better for us to enter the possibility area and investigate the changes in the possibility of reporting for a person in compound strategy, while the number of witnesses is increased [4]; since the number of the players is too much we assume that the

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space for the game and the players are symmetrical, in this way if the possibility to report for a person is p then the possibility of not to report for a person is *1 – p*, as the witnesses or the players are considered independent. Therefore, the possibility that *n - 1* persons do not report is $(1-p)^{n-1}$. Now two cases may occur for the desirability or the profit for each person:

1. the person will not report, so his desirability will be equal to [5]:

$$u\big(N(\text{picked strategy}), n(\text{the number of witnesses}), p(\text{the possibility report})\big) = p(\text{the possibility that at least one of the rest reports}) \times V + p(\text{the possibility that nobody reports}) \times 0 = \left(1-(1-p)^{n-1}\right)V \quad (2)$$

2. The person will report, so his desirability will be:

$$u(R, n, p) = V - C$$

In pure strategy the player must be indifferent between *N* and R so we have

$$p(\text{the possibility that at least one of the rest reports}) = (V-C)/V \quad (3)$$

And

$$p\ (\text{the possibility that the incident is not reported}) = p\ (\text{the possibility that the other } n-1 \text{ do not report}) + p\ (\text{the possibility that I do not report}) = (1-p)^n \quad (4)$$

Now, if p decreases with increasing n, the possibility that no one reports also decreases and considering (3) we have:

$$1 - (1-p)^{(n-1)} = (V-C)/V \Rightarrow 1 - (1-p)^{(n-1)}\, V = V - C \quad (5)$$

Then

$$p\ (\text{the possibility that everyone reports}) = 1 - \left(\frac{C}{V}\right)^{\frac{1}{n-1}} \quad (6)$$

3. An intuitive example:

Reporting a crime (based on a true story)[6]

A 28 years old woman lived in New York in 1960s. While she was walking in one of New York districts at night she was attacked 3 times within 30 minutes by an unidentified man, within this 30 minutes 38 different persons witnessed the crime in different sites. Of these 38 witnesses, 37 did not report anything to the police and the 38th person reported to the police reluctantly. Police were present at the scene within 2 minutes while the woman had died [7, 8]. If in a specific mode *C = V / 3*, then valueing of n (the number of witnesses) we will have

$$\begin{cases} n = 2 \\ (6) formula \end{cases} \Rightarrow p = 1 - \left(\frac{\frac{V}{3}}{V}\right)^{\frac{1}{2-1}} = 1 - \left(\frac{V}{3} \times \frac{1}{V}\right)^{1} = 1 - \frac{1}{3} = \frac{2}{3} (7)$$

As a result, the percentage will be p (the possibility that each one reports) $= \frac{2}{3} \times 100 = 66.7\%$

On the other hand by placing the obtained nand pin equation (7) and assuming *C = V / 3*, we have:

$$p\ (\text{the possibility that the crime is not reported}) = (1-p)^n = \left(1 - \frac{2}{3}\right)^2 = \left(\frac{1}{3}\right)^2 = \frac{1}{9} \quad (8)$$

As a result, the percentage will be p (the possibility that the crime is not reported) $= \frac{1}{9} \times 100 = 11.1\%$.

Keeping on this process and valueing n the table below is obtained.

Table 1. Investigating the effect of increased witnesses on reporting a crime

***n* (the number of witnesses)**	***p* (the possibility that each person reports)**	***p* (the possibility that the crime is not reported)**
2	66.7%	11.1%
3	42.3%	19.2%
5	24.0%	25.3%
10	11.5%	29.5%
38	2.9%	32.4%

4. CONCLUSION

Regarding (6) and the first column in Table 1 we conclude that with increased number of witnesses (*n*), p (the possibility that everyone reports) decreases. And regarding (4) and the second column of table (1) we conclude that with increased number of witnesses (*n*), p (the possibility that the crime is not reported at all) increases. In general, when the number of witnesses increases, the possibility that a person reports the crime is decreased.

REFERENCES

1. DarisaviBahmanshir, R and DarisaviBahmanshir, H, The Analysis of The Application of The Theory of Games In International Negotiation and Contracts.
2. Ahmadi, A. and Memariani, A.A, The Theory of Games, JahanJaam Jam Publication (2004).
3. Abdoli, Gh, Theory of Games and its applications, Research and Gethering Academic Human Science books Organization (SAMT) Center of Research and Development of The Human Sciences (2012).
4. AkhvanNiaki, S.T, The Theory of Possibility and Its Application, Sharif University Press (2000).
5. Freund, F, Statistics, NashreDaneshgahi publications, translators: Ali Amidi, Mohammad QasimWahidiAsl (2008).
6. Rosenthal, A.M, Thirty-Eight witnesses: The Kitty Genovese case; MC Grow Hill (1964).
7. Rosenthal, A. M, Thirty-eight witnesses. Berkeley: University of California Press (1999). (Original work published 1924).
8. Darley, J.M. and Latane, B, Bystander Intervention in Emergencies: Diffusion of Responsibility. Journal of Personality and Social Psychology, Vol. 8, No. 4, 377-38, (1968).