Analysing Israel-Hamas Conflict Based on Game Theory Approach

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ABSTRACT

The Islamic Resistance Movement (AKA: Hamas) has taken control over Gaza Strip, Palestine, in 2007. Since then, the organization was in a continues hit-run conflict against the Israeli Defence Forces (IDF). The conflict is very resistant to any sort of resolution, and Hamas and Israel engage frequently in what it seems an endless cycle of resentment and violence. Despite numerous mediations by global and regional powers, this conflict appears to be further away than ever. This particular conflict can't be addressed according to the common negotiation theories that based on rationality and hard politics, which seems not that functional. Instead, a model based on the game theory approach is presented in this study to explain this phenomenon. In this work, some facts about Israel - Hamas regional concerns are explained. Moreover, the study analyses the reasons behind Hamas enforcing calm in Gaza, even though Hamas considers Israel as its arch enemy. The presented model shows that whenever Israel and Hamas reach an agreement, both sides can collaborate in maintaining a state of calm. Moreover, results show that the proposed model is applicable to analyse a conflict in terms of actions, duration and terms of settlement.

KEYWORDS: Israel; Israeli-Palestinian conflict; Hamas; Gaza strip; Game theory

1 INTRODUCTION

The Palestinian-Israeli conflict is indeed one of the longest conflicts in our world's modern history. It has been an intractable ongoing conflict for more than seventy years (since 1948). The conflict has entered another phase ever since Hamas's victory in the 2006 parliamentary election. Hamas is a Palestinian political organization, which is widely accepted in Palestinian society and attracts large support from the Palestinian public. Hamas's civilian wing offers many services for the Palestinian population, especially living in Gaza, and many Palestinians show appreciation to the organization. On the other hand, the military struggle against Israel had made Hamas's military wing highly popular, despite its heavy cost for Palestinian population. This popularity made Hamas's first won the parliamentary elections in 2006, presenting their first experience in politics and governance under the Palestinian Authority (PA). This experience compelled Hamas to change its behaviour and adapt to the new political environment to become later a dual-purposed faction that maintains its politics and governance role alongside its armed resistance. Since Hamas's election victory, the movement has shown it willingness to be open to discuss the solution of a Palestinian state. Hamas officials called for diplomatic efforts with different western organizations. Even though these calls were mostly denied due to the background of the organization, it shows the dramatic changes in Hamas's views towards having political backgrounds despite the isolation it lives in today.

Hamas has made some diplomatic changes dealing with international and regional organizations. However, it continued its refusal to abandon the armed struggle against Israel. The ongoing conflict is regarded as extreme and considered as an influential, deviant, as well as a critical case in the present literature [1]. Many studies have investigated the obstacles that restrain the Palestinian-Israeli peace process. Bar-Siman-Tov devoted an entire volume to define the "barriers to a peaceful resolution" addressing the Israeli-Palestinian conflict [2]. Landman was one of the contributors who argued that the basic issue between Palestinians and Israelis has originated from the parties' unwillingness to make compromises about values that are "sacred" rather than from their incapability to achieve a peaceful solution on aspects of realistic concern [3]. While There is no shortage of scholarly studies on ways and means to resolve the Palestinian-Israeli conflict [4]. There is a dearth of research on the possibility of a Hamas–Israel settlement, probably due to the conflict dynamics and negotiation model natures. Thus, new approaches and models are needed to deliver better understanding to the conflict nature and scenarios.

Game theory is a mathematical and analytical study of both cooperation and conflict. The main purpose of applying game theory in any case is to formulate, construct, analyse, and gain insight into strategic scenarios. Game theory was used and applied in problems of war and politics, driven a revolution in economics, sociology and psychology, and established links with evolution and biology, and more [5-9]. In political science, game theory has been adopted in many applications, such as: examining the importance of honour and symbols in international politics [10], applying the complexity theory in public policy [11], examining the institutional changes and various political strategies [12], analysing negotiation process for a potential agreement [13]. For example: De Mesquita presents an interesting game theoretic model explaining the increase in terrorism after government concessions, considering the concessions are only accepted by moderates and not extremist [14].

The concepts of game theory provide a language to formulate, structure, analyse, and understand strategic scenarios. In addition, game theory has been used to study a wide variety

of human behaviours. Increasingly, political scientists apply game theory to analyse strategic scenarios across different settings including political economy, public choice, war bargaining, international relations, negotiations, positive political theory, and social choice theory. Focusing on negotiations, game theory considered as a guide since it may provide insights that can lead to practical results. Game theory does not only offer options and strategic decisions but also it provides explanations to most of political actions and interactions.

This study proposes a game theoretic approach to analyse the interaction between the Hamas-led government in Gaza and the Israeli government. The proposed approach shows the analytical views of different scenarios in both calm and conflict. The established model attempts to explain the decisions made by both parties considering a given situation. Furthermore, the model focuses on the interactions between the two parties on the instrumental or material values which are subject of rational thinking. Sacred values are not part of this study due to the complications they might entail.

2 MODEL AND ANALYSIS

The proposed game theoretic model captures the interaction between the Israeli government (I) and Hamas-led government (G) in Gaza. Hamas seeks to benefit from any situation to lift the ongoing siege over Gaza, while the Israeli government tries to avoid any conflict that might cause trouble, and to minimize concessions offered for calm in the area. The game starts by the assumption that the Israeli government making an offer to Hamas which will be deciding later whether to accept or reject it. The second move is for Hamas whether to accept the offer or reject it. Accepting the offer means that Hamas agrees to keep the area in calm and stop any militant activity against Israel. Hamas is also supposed to enforce any understanding reached by the negotiation process on other Palestinian organization, moderates or extremists, from engaging in actions against Israel. Rejecting the offer means Hamas and other organizations operating in Gaza Strip are in war with Israel and can choose a preferred level of responsive actions. The level of responsive actions on Hamas's side varies, depending on the Israeli aggregation in a given period of time. Furthermore, the assumption is when Hamas accept the offer, it is unable to violate the agreement due to pressure of international mediators and the amount of responsive actions Israel can use against the Gaza territory and the organization itself.

After describing the general outline, the detailed description of the underlying assumptions could be explained as follows: in round τ, the Israeli government I offers a number of concessions $k^{\tau} \geq 0$. These concessions include a determined part ($\beta \in (0,1)$) as public properties, such as easing the siege or allowing facilities, the benefits of which can be gained by Hamas whether they accept the concessions or not. Then the other portion (1 - β) of the concessions includes private properties that benefits Hamas exclusively if they accept the concessions. For simplicity, we will refer to the benefit Hamas gains after accepting an offer as k, even though not all concessions benefit Hamas exclusively. The Israeli government also attempts to take a planned respond to any militant attack from Gaza. Using these planned actions or strategies, the probability of successfully stopping the attacks is based on two variables: (1) the amount of efforts, planning and funding responsive actions, invested by the Israeli government in round τ ($a^{\tau} \in [0,\ a]$), and (2) whether Hamas is able to enforce an agreement on other factions to keep the area in calm ($c^{\tau} \in \{\ \underline{c}, \overline{c}\}$), where $\overline{c}$ and $\underline{c}$ represents whether or not Hamas is able to enforce control over Gaza, respectively. The probability of Israeli government defeating Hamas is $\sigma\ (a, c)$, where: $\sigma : [0,\ \bar{a}]\ .\{\underline{c}, \overline{c}\} \rightarrow\ [0,1]$, and the

probability of Hamas surviving the Israeli efforts is $1 - \sigma$. The assumption is that the probability of Israel's success to stop threats from Gaza increases as the planned countermeasures are advanced in response to any threat (i.e. $\partial\sigma/_{\partial a} > 0$), and it also increases knowing Hamas has a control to stop any other faction to attempt a security threat to Israel (i.e. $\sigma\ (a, \overline{c}) >\ \sigma\ (a, \underline{c}), for\ all\ a$). Following the given facts on the ground, Hamas has a powerful control over other factions operating in Gaza. A scenario in which Hamas reaches to an agreement with Israel, no other Palestinian faction will breach the agreement. Thus, we will refer to this variable in our model as *c*, without the upper and lower bounds, which also refer to the cost assigned to this control.

For this model, we assume that since Hamas has a control over other factions in Gaza, it will be held responsible for any attempts against Israel once they have reached to an agreement. This would help Israel in the planning process of their responsive actions, since targeting Hamas will be a priority in case of a conflict. That explains the fact that when some breaches occur from Gaza, the Israeli government targets Hamas known places even if the breaches are not made by Hamas. Thus, knowing Hamas is in control would focus the Israeli government efforts. It is also important to know that the Israeli responsive efforts are costly. Israel can accept a cost $\Upsilon(a)$, which is a function increases and convex based on a, where a has an effect of $\omega(a)$ on weaken and limiting the militant capabilities of Hamas.

For setting the model, if Israeli government succeed in defeating Hamas, it gets a payoff of (*W*), otherwise it gets a payoff of 0. Similarly, if Hamas succeed in defeating Israel, it gets a payoff of (*P*), otherwise it gets a 0. Denote that Israeli government can bear a cost *G* of attacks from Gaza and a cost *k* of concessions. Finally, at each round, the Israeli government gets a benefit (*x*) for not being defeated, and Hamas gets a benefit (*y*) for surviving. On the other hand, assume that the total amount of attacks attempted from Gaza in round τ by G^{τ}. The probability of Hamas's success to survive the Israel responsive efforts in round τ, is given by π (G^{τ}) where $\pi : R^{+} \rightarrow [0,\ 1]$ is a function increases and concaves. For each round τ, there are three potential results with different outcomes: (1) The Israeli government gains success on the conflict with probability *σ*, leading to ending the game with a resulting payoff of *W* for Israel and a payoff of 0 for Hamas; (2) Hamas gains success on the conflict with probability $(1\ -\ \sigma) \times \pi$, leading to ending the game with a resulting payoff of 0 for Israel and a payoff of *P* for Hamas; and (3) Neither Israel nor Hamas concludes the conflict with probability $(1\ -\ \sigma) \times (1\ -\ \pi)$, leading to continuing the game to next round with a payoff of $x - \Upsilon - G - k$ for Israel and $y\ +\ k - \omega(a) - \eta$ for Hamas, where η is the resources devoted by Hamas to maintain *G*. In case the game continues as neither side concludes the conflict, the history in round τ can sum up to H^{τ}, denoting $V_I(H^{\tau})$ and $V_G(H^{\tau})$ are the continuation value of Israeli government and Hamas in round τ, respectively. Two more assumptions should be emphasized. First, denote $W \geq x + V_I(H^{\tau})$ and $P \geq y + V_G(H^{\tau})$ for all $H^{\tau}$and all τ, which means that both the Israeli government and Hamas would always favour wining the conflict instead of having it continued. Second, denote $x + V_I(H^{\tau}) - \Upsilon(a) - \hat{G} - \hat{k} > 0$ and $y + V_G(H^{\tau}) -\ \eta - \omega(a) > 0$ for all H^{τ}, where $\hat{G}$ is the maximum tolerable number of attacks from Gaza and $\hat{k}$ is the total amount of concessions to be offered by Israel in an equilibrium (to be described later). The second assumption indicates that both the Israeli government and Hamas prefer continuing the game instead of losing the conflict. The expected outcome represented in the continuation value of the Israeli government can be given as follows:

$$V_I(H^{\tau-1}) = \sigma(a^{\tau}).W +\ \left(1 - \sigma(a^{\tau})\right).\left(1 - \pi(G^{\tau})\right).(x - \Upsilon(a^{\tau}) - G^{\tau} - k^{\tau} + V_I(H^{\tau})) \quad (1)$$

Similarly, the expected outcome represented in the continuation value of Hamas can be given as follows:

$$V_G(H^{\tau-1}) = \left(\left(1 - \sigma(a^\tau)\right)\pi(G^\tau)\right).P + \left(1 - \sigma(a^\tau)\right).\left(1 - \pi(G^\tau)\right).\left(y - \omega(a) - \eta + k + V_G(H^\tau)\right) \quad (2)$$

When Hamas accepts an offer, it plays a commitment game with the Israeli government, in which Hamas chooses whether or not to enforce calm and control over the territory using their influence power (at cost *c*, which could be political efforts or a force on the ground). On the other hand, the Israeli government chooses whether or not to honour the offered concessions. full stage game beside this commitment subgame is better described in Fig. 1.

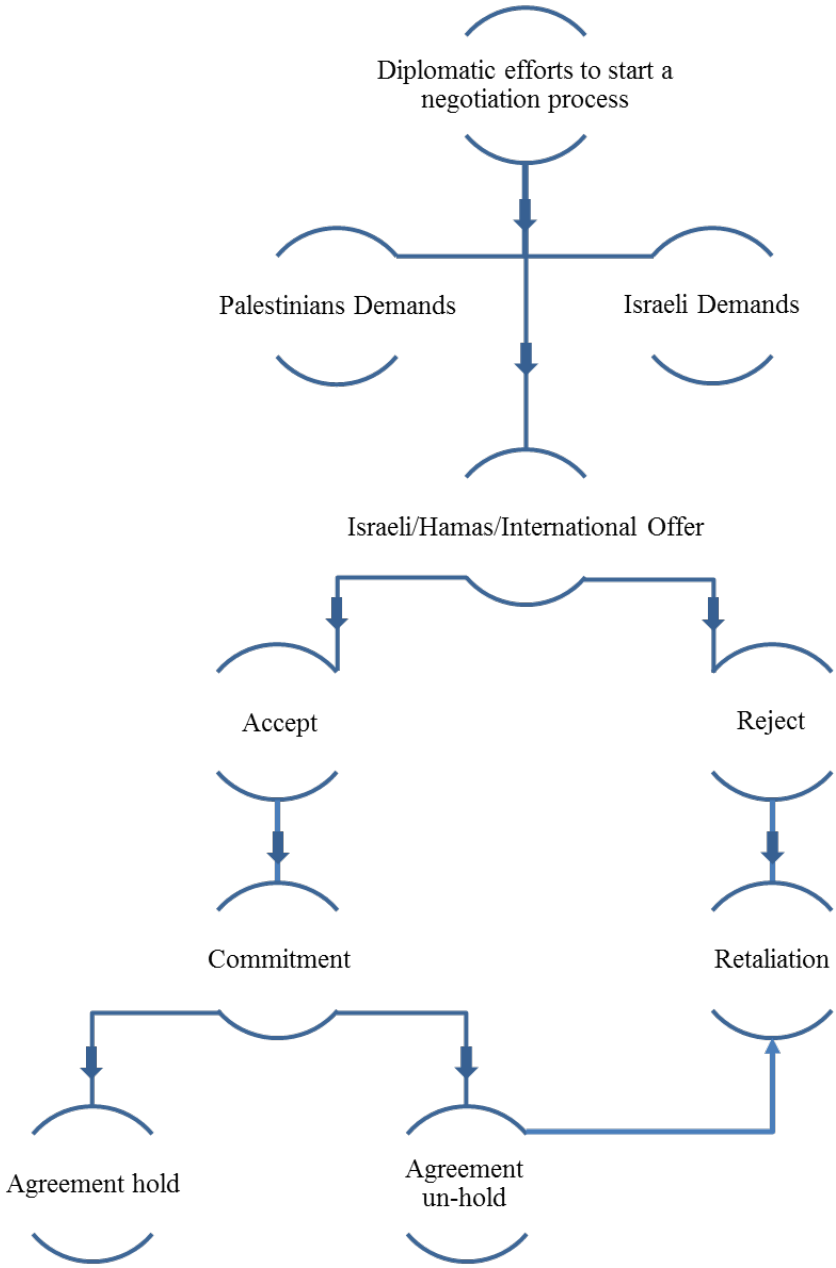

Fig.1 Interaction stage game

In this game, the Israeli responsive actions (offensive or defensive) could be analysed using the following equation:

$$\frac{\partial\sigma(a)}{\partial a}\left[W-\left(1-\pi(G)\right)(x-\Upsilon(a)-k-G+V_I)\right]=\left(1-\sigma(a)\right)\left(1-\pi(G)\Upsilon(a)\right) \quad (3)$$

Equation (3) implies a definition of optimal level of responsive actions (a^*). The left-side of the equation characterizes the marginal benefit in terms of increasing the Israeli government probability of winning the conflict as the efforts increases. On the right-side, however, there are the marginal costs of these efforts in terms of resources devoted to this purpose. On the other hand, Hamas responsive actions (offensive or defensive) could be analysed using the following equation:

$$\frac{d\pi}{dg}(1-\sigma)(P-\varepsilon)-\frac{\partial\sigma}{\partial a^*}\frac{\partial a^*}{\partial g^*}(\pi P+(1-\pi)\varepsilon)=v' \quad (4)$$

The expected outcome of Hamas can be influenced by the amount of resources utilized in the actions in three dimensions. The first dimension, ($\frac{d\pi}{dg}(1-\sigma)(P-\varepsilon)>0$), means there is a direct impact of increasing the resources on the probability of defeating the Israeli government. The second dimension, ($-\frac{\partial\sigma}{\partial a^*}\frac{\partial a^*}{\partial g^*}(\pi P+(1-\pi)\varepsilon)<0$), means that as the resources of Hamas increases, the level of countermeasure efforts of Israeli government also increases, which could mean an increase in the probability of Hamas being defeated. The third dimension $-v'<0$ denotes the occasional costs of utilising scarce resources in actions. Equation (2) can explain how Hamas could behave based on different resources and levels of attacks. Consequently, at an interior solution, g^* is growing in P and R. This formulation will enable us to determine the level of responsive actions Hamas choose.

The expected outcome of Hamas when engaging in violence (responsive actions) is:

$$out_G(\,actions)=\sum_{j=0}^{\infty}[(1-\sigma)(1-\pi)]^j[(1-\sigma)\pi P+v(R-G)]=\frac{(1-\sigma)\pi P+v(R-G)}{\sigma+(1-\sigma)\pi} \quad (5)$$

If $k<out_G(\,actions)$, then Hamas will not accept the offer. In this case, the total level of violence would be G, which indicates that the Israeli government's expected outcome as follows:

$$Out_I(k)=\sum_{j=0}^{\infty}[(1-\sigma)(1-\pi)]^j\,[(1-\sigma)(1-\pi)(x-\gamma-G)+\sigma W]=\frac{(1-\sigma)(1-\pi)(x-\gamma-G)+\sigma W}{\sigma+(1-\sigma)\pi} \quad (6)$$

The Israeli government's expected outcome is given as follows:

$$Out_I(\hat{k})=\frac{(1-\sigma)(1-\pi)(x-\gamma-\hat{k})+\sigma\,W}{\sigma+(1-\sigma)\pi} \quad (7)$$

Based on parameter values, both resulting utilities can arise in equilibrium. The main characteristics of the equilibria in this game are presented in the following proposition. To summarize this result, there are two different equilibrium paths that can be realized for this game considering the two players have a cooperation during in the commitment subgame. These two paths are shown as follows:

1. No Deal: when concessions are offered, leading to a level of responsive actions
2. Making a deal: when concessions is offered, leading to a state of calm in the area.

3 MODEL APPLICATION

The model has shown high applicability in resembling the ongoing conflict between Hamas and Israel. Many examples could be drawn starting from the Gaza war in 2008-2009, also known as operation cast lead, Gaza war of 2012 (operation pillar of defence), and Gaza war of 2014 (operation protective edge). A recent example is presented in this study, in which the Gaza war of May, 2021 also known as Operation Guardian of the Walls is analysed.

3.1 Confrontation Background

The fighting that began on May 10th was sparked by a rocket attack on Jerusalem by Hamas in response to clashes earlier in the holy city and other tensions in the area, most notably the Sheikh Jarrah crisis. Hamas called the ensuing conflict the "Sword of Jerusalem Battle". Whereas, the IDF responded by lunching Operation "Guardian of the Walls", which ended 11 days later, on May 21, with a unilateral ceasefire. Israel stopped launching airstrikes and Hamas stopped firing rockets and mortar shells.

3.2 Analysis using game theoretic approach

The Gaza war 2021 had witnessed massive diplomatic efforts to put an end to the conflict. The efforts resulted in several attempts to ceasefire. a game theoretic approach to analyse the negotiation process to ceasefire during Gaza war 2021 between Hamas and Israel is demonstrated. the options that both sides had and the strategies they chose to maximise their outcome were explored. The analysis addresses the level of violence in which each side engaged, the duration of the conflict and the terms of settlement.

3.3 Response levels

Israel and Hamas agreed to cease hostilities from 20 May [15-16]. A ceasefire deal ending 11 days of fighting. Both sides claimed victory in the conflict [17-18]. The truce tentatively concluded the fourth war between Israel and the Islamist militant group since 2008 [19]. Israeli Reports indicated Thirteen people were killed, 114 injuries directly related to rocket attacks, and another 198 indirectly related to rocket attacks [20-22]. The UN and Human Rights Watch reported that 260 Palestinians had been killed, half of them (129) civilians including 66 children and 40 women [23-25]. The deaths of some 243 were reportedly killed by Israeli Defence Forces. The Gazan Health Ministry stated 1,948 individuals were wounded, of whom 610 were children, and 400 women [23][25]. According to a report by the Intelligence and Terrorism Information Centre, which has ties to the IDF, 48% of the Palestinians killed in Gaza were militants. The report noted varying figures of Palestinians killed in Gaza ranging between 240 and 260 and analysed the deaths of 234 Palestinians in the Gaza Strip [26].

As it could be concluded, both sides choose to play the commitment subgame entailing accepting a level of concessions by a Palestinian faction knowing that Israel are committed to deliver the offered concessions. Based on equation (3), the Israeli government intensified its actions as the probability of wining the round increases, choosing a level of action = $\left(1-\sigma(a)\right)\left(1-\pi(G)\Upsilon(a)\right)$. On the other side, Hamas's choses a level of responsive action based on equation (4) using its maximum capacity of actions against Israel. Hamas used a variety of rockets and mortars indicating an increase of their resources. Maintaining such level of responsive actions comes with high cost on both sides. Costs include resources for

maintaining these actions, and the effect of these actions on the ground and the number of casualties.

3.4 Conflict Duration

The probability of a conflict to be continued for next round is given by $(1-\sigma)(1-\pi)$. Thus, the estimated duration of a conflict can be given as follows:

$$Duration = \sum_{j=0}^{\infty}[(1-\sigma)(1-\pi)]^j = \frac{1}{\sigma+(1-\sigma)\pi} \quad (8)$$

Even though both σ and π were relatively large during the beginning of this war, the duration was shorter than any other before. This is because both parties were not expecting this continuation of the war since there were early indication of diplomatic effort to stop it. In fact, there were ceasefire proposals since the first day of the conflict, in which it had Israel rejection and Hamas's acceptance. Given the previous history of Hamas $V_g(H)$, they are not in favour of continuing the conflict, but rather reaching a level of outcome as reached before, and therefore they chose to continue using a level of actions as in equation (4). Israel in return upgraded their responsive actions to it maximum to target everything that could influence Hamas's decision to accept an immediate ceasefire. For 11 days, both parties used a maximum level of responsive actions causing an unprecedented magnitude of the destruction in area.

3.5 Settlement Terms

The model also provides insights into the terms of settlements between the Israeli government and Hamas. As explained earlier, Hamas will consider striking a deal if $k \geq out_G(\,actions)$. Knowing Hamas preferences, the negotiation process is very difficult since the level of concessions Israel is willing to offer is lower than acceptable for Hamas. Assume that Israeli government is willing to offer the minimal level of concessions that could enable solving the commitment subgame, then this level would be worth:

$$Out_I(\hat{k}) = \frac{(1-\sigma)(1-\pi)(x-\gamma-\hat{k})+\sigma\, W}{\sigma+(1-\sigma)\pi} \quad (9)$$

The level of concessions can be influenced by probability of one side winning the conflict. As when the probability of Israeli government to win the conflict increases, Hamas can be more flexible to accept this level of concessions. This implies that the more likely for Hamas to lose a conflict, the more appealing it is to make a deal an accept an offer. This explains the fact that by the end of the conflict Hamas accepted somehow the same level of concessions made by the first week of the conflict. Studying the conditions of both sides for a ceasefire, we can briefly show some of what they demand. Israel made small list of demands included no violence against Israel neither by firing rockets nor any other activities from Gaza guaranteed by Egypt (the mediator for the ceasefire agreement). While Hamas required the permit to transfer food and medical supplies furnished by the United Nations and Physicians for Human Rights, aid workers, and journalists into the Gaza Strip. Furthermore, Hamas insisted in ending the Sheikh Jarrah crisis, which shown the Israeli high court suspends its rule in its case. Obviously, this time Hamas received a higher level of concessions since the Israeli government can tolerate some level of G and γ. The continuation of the conflict would decrease the outcome $(x-\gamma-G)$ of the Israeli government. It is worth mentioning that this level of concessions required Hamas a higher cost considering the effects of the escalation on the area and the high number actualities.

4 CONCLUSION

This work presents a game theoretic approach to analyse a negotiation process between Hamas and the Israeli government. Ever since Hamas took control over Gaza Strip in 2007, the area has been witnessing frequent violent events affecting people living in and around Gaza Strip. During the recent years with some diplomatic efforts, Hamas and Israel came to realize a better way of dealing with each other through a negotiation process. Even though the two parties are not directly communicating, they were able to find a solution. We explained a game theoretic approach that models the scenarios of alternative choices they both can adopt to maximize their outcome. Considering the responsive actions from both sides and the cost of these actions, parties can choose different strategies to handle the situation. The model explains the phenomena that even though Israel considers Hamas as terrorist organization, yet it allows some facilitations that enable Hamas to control Gaza Strip. Moreover, even though Hamas considers Israel as an occupier and an enemy, it does not allow any militant activates against Israel from Gaza when an agreement is reached. The presented study describes a stage game that include a commitment subgame in which players can rely on history-dependent information to reach communicatively efficient equilibrium. The model shows that solving the commitment game leads to two paths: violent path when (No deal) is made, and calm path when a (deal) is made. Based on the history of the conflict, both Israel and Hamas have adopted different strategies lead to those different paths. Recently, it could be easily noticed that Israel and Hamas are tending to establish an understanding about keeping the area in calm. It is unfortunate that this understanding has come with expensive cost since it is realized after putting the area through four wars caused the area a massive amount of destruction. Studying the proposed model and adopting different strategies could lead to different results, yet one of the results include a peaceful path that could benefit both sides.

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Authors declare no conflict of interest.

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