

Terrorist Incidents and Counter Terrorist Policies: A System Dynamics Model

M^a Mar Pajares de Mena¹

¹ *Departamento de Economía Aplicada, Universidad de Valladolid, Spain.*

Abstract According to the Global Terrorism Database, Asia was the continent that suffers the highest number of terrorist attacks and the highest number of casualties during the period 1998-2007. One of the numerous terrorist organizations operating on its territory is Lashkar e Taiba (LeT) that was created in 1999. From its inception to 2007, it has staged ninety attacks generating 1,945 casualties. This paper presents a system dynamics model to try to reproduce the number of monthly incidents of that organization. The construction is carried out adapting to the organization those feedback processes that explain the survival over time of a terrorist organization. Comparing the data series and the data obtained by simulation, the paper examines the degree in which the model reproduces the incidents of the organization. After checking the usefulness of the model, different counter terrorist measures are tested in order to assess their effectiveness.

Keywords Domestic Terrorism, Counter-Terror Policies, System Dynamics, Modelling and Simulation.

JEL Classification B49, C22.

Correspondence to: M^a Mar Pajares de Mena (e-mail: mar@eco.uva.es)

1. The Problem

According to Global Terrorism Database (GTD) from 1998 to 2007¹, Asia is the continent that suffers the highest number of terrorist attacks in the world. That outcome is a consequence of the great number of terrorist incidents that suffer countries such as Iraq, India, Afghanistan, Pakistan, Thailand or Philippines. During the period considered, Iraq, India and Afghanistan occupied the first, the second and the third position by incidents in the world with 2,828, 1,401 and 999 incidents, respectively; Pakistan is recorded by the database with 754 terrorist events, Thailand with 690 and Philippines with 548 incidents. Figure 1 shows the number of terrorist incidents in the period selected for the thirteen regions in which the world is divided by the GTD. That figure illustrates that Middle East and North Africa are the regions with the highest number of incidents followed by South Asia and Southeast Asia, which differs in only one incident.

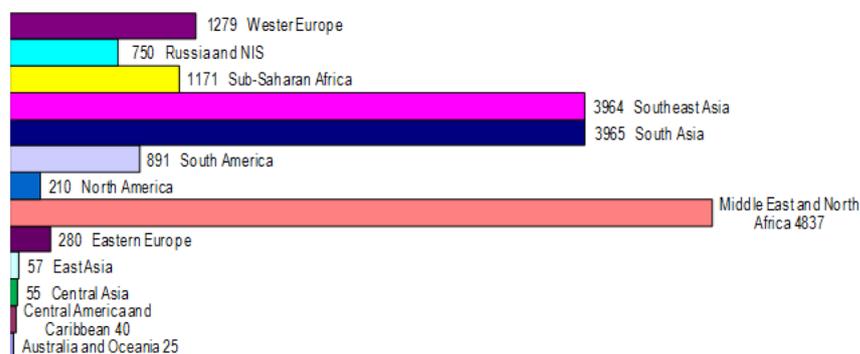


Figure 1: Terrorist attacks by regions, 1998-2007.

Moreover, Asia is the continent more punished by terrorism around the world when that aspect is measured by means of the number of victims. The GTD confirms that in 2007 and 2008 the six first positions in the world regarding the number of victims by terrorist events were occupied by countries in Asia. In par-

¹ The GTD has not published data since 2007, yet.

ticular, Iraq with 20,221 victims in 2007 and 12,957 in 2006 occupied the first position from 2003 to 2007; India with 2,845 in 2006 and 1,585 victims in 2007 attained the second position in those years.

Although most terrorist events are perpetrated by unknown people, 90% of the incidents in Iraq, 50% in India, 33% in Afghanistan, 88% in Thailand and 79% in Pakistan, numerous terrorist organizations of all types of tendencies, ethnic, religious, nationalist or of political nature, are settled in the Asian continent. In particular, India is the country where the higher number of terrorist organizations operated during the selected interval, over forty organizations though some of them are inactive, nowadays. Among the most active groups in the continent are the Taliban in Afghanistan with 605 incidents and 3,049 victims and in Pakistan with 44 attacks and 245 casualties; the Liberation Tigers of Tamil Eelam (LTTE), which was defeated by the Sri Lanka military in 2009, with 260 events and 4,541 victims; the Maoist Insurgents in Nepal with 197 attacks and 1,302 casualties; the United Liberation Front of Assam (ULFA) in India with 139 incidents and 1,196 victims; the group Abu Sayyaf in Philippines with 100 incidents and 1.034 casualties.

2. The Aim and the Rationale for our Modelling Choices

The data about the terrorist events reflect some of the consequences of that type of activities. Without trying to be exhaustive about the direct and collateral effects of the terrorism, there are human effects such as the immediate suffering produced to the victims and their relatives, the generation or the increase of the fear felt by the population, especially when it coexists with terrorism. There are also economic effects. The GTD confirms that private citizens and their properties are the most hit by terrorist events, even more than militaries, polices or government, in general, that actually represent the human face of the counter-terrorism measures.

These negative effects for the population are actually objectives to reach for any domestic terrorist organization because the creation of fear is considered a

necessary step to achieve its constitutional objectives. It is a way of harassing to the corresponding authority in order that it accepts the pretensions of the organization. But, the activities of a terrorist organization entail that the government adopts a set of measures to fight against it. However, the governmental strategy, in some occasions, has a high economic and human cost and, in addition, is not often sufficiently effective. Then, could a model be constructed to test policies against a terrorist organization? The aim of this paper is to construct a model that explains the number of monthly incidents of a specific domestic terrorist organization. The System Dynamics methodology is selected to construct the model taking into account that the number of incidents could arise from the actions and reactions of both the terrorist organization and the government of the territory where the organization carries out its attacks.

The causal structure of the model is based on the interrelationships arising in a generic terrorist organization described in Soto et al. (2009, a, b). Firstly, the structure considers the influence of the fear felt by the population that coexist with the organization and then, the influx on the organization of the personality of the leader is incorporated. The fear plays an important role in the causal structure being the key to explain the increase of resources in hands of the organization, which guarantee its survival over time, and moreover, the counter-terror measures adopted by the government.

The dynamic model for the organization Lashkar e Taiba (LeT) is completed considering its own features, which are picked up from different publications. A simulation exercise finds the number of monthly incidents of the organization. Comparing the results obtained by simulation with the data series allow us to assess, using different test, if the model reproduces the behaviour of the system. When the model is accepted, it can be used as a tool for testing different counter terrorist policies in order to defeat the selected organisation. The simulation model is very versatility, which is an important reason to use the methodology.

3. Previous Literature

Different approaches have been used to study the patterns of behaviour over time shown by events attributed to terrorist organizations. Some authors use statistics and econometrics methods. That approach is used by Enders and Sandler (2000) and Clauzet et al. (2007). Nevertheless, other studies construct models perceiving the cause-effect relationships between a terrorist organization and a government. This approach was selected by Fleichtinger (2001) et al. who integrates the interactions between both actors in a problem of dynamic optimisation; Das (2008), basing his study on a previous analysis carried out by Faria (2003), constructs a predator-prey model considering the solution of two problems of static optimisation, one for the government and the other one for an organization. Likewise, it could also be mentioned Rosendorff et al. (2005) who point out different researches in which the interactions between a terrorist organization and a government are used to seek an equilibrium strategy according to game theory.

There are various precedents in System Dynamics literature about the usefulness of the methodology to study topics related to the terrorism. A first analysis was carried out by Rulof (1975) who pointed out the importance of System Dynamics to approach conflict situations. A causal structure was constructed by Coyle (1985) to make clear the feedback processes between a government and an insurgence. More recently, many studies have appeared analysing different aspects about the topic. Akcam et al. (2005) showed the advantages of the methodology to study the ethnic terrorism. Grynkewich et al. (2006) examined the financial operations and the organizational behaviour of Salafist Group for Preaching and Fighting. Richmond (2009) analysed the governmental counter- terrorism measures to fight against an insurgency.

In 2009, additionally, at least, other eight studies can be counted. Soto et al. constructed two system dynamics models to analyse the number of incidents of the organizations Tierra Vasca y Libertad (ETA) and the Fuerzas Armadas Revolucionarias de Colombia (FARC) from 1998 to 2005; Anderson constructed a system dynamics model as a basis that must be supplemented by additional

theory from outside sources to enable calibration to a historical data set. Weaver developed a system dynamics model to measure the popular support to insurgency and the desertions as consequence of the success of the governmental counter-terrorism policies. Schoenwald et al., based on a previous analysis of Merari (1993), illustrated how the insurgent groups will pursue the resources necessities to keep on with the operations, regardless of the aims pursued. Arango et al. used the methodology to evaluate public policies to reduce crime in the city of Medellin.

4. Aspects of the Domestic Organization

The characteristics of Lashkar e Taiba (LeT), with the meaning of Army of the Pure, are collected from the South Asia Terrorism Portal (www.satp.org), the GTD and the Terrorist Organization Profiles data set (www.start.umd.edu). The information obtained is synthesized by the following aspects:

- Islamic nature. Its objective is to introduce an Islamic state in South Asia.
- The organization is banned as a terrorist organization by India, Pakistan, the United States, the United Kingdom, the European Union, Russia and Australia.
- Formed in 1990 in Afghanistan, it is thought that it is based in Muridke near Lahore in Pakistan. Hafiz Muhammad Saeed is considered as a founder though his current role within LeT is unclear. Different publications assert that Maulana Abdul Wahid Kashmiri is currently its official leader.
- The main area of operations is Jammu and Kashmir. Nevertheless, it has carried out attacks in other parts of India: New Delhi, Mumbai, Bangalore, Hyderabad, Varanasi, Kolkata, Gujarat, etc.
- Its cadres are organised at district levels with 'district commanders' in charge. It is considered that within Pakistan, it has a network of training camps and branch offices, which undertake recruitment and collection of finances. It reportedly has cells in many cities/towns outside Jammu and Kashmir.

- It is considered that it collects donations from institutions located in different places of the world. Likewise, it receives financial support, material and other forms of assistance from diverse organizations.
- The organization is considered closely linked to the Taliban and Al Qaeda. According the GTD it has staged attacks with certain organizations: Jamiat ul-Mujahedin (JuM), Jaish-e-Mohammad (JeM), nine times by each one; Hizbul Mujahideen (HM), four times; Al-Mansoorian and Harkatul Jihad-e-Islami, twice; Al-Badr, Al Barq, Al-Arifeen and Students Islamic Movement of India (SIMI), once.
- Mainly, they use the armed assault followed by bombing/explosion for the attacks.
- The organization has carried out ninety attacks. The first attack (1999-04-01) occurred in an army camp at Tehsil Goal in the Udhampur district of Jammu and Kashmir state. Thirty-one Indian soldiers were killed.
- The number of casualties that the GTD assigns to the organization is 1,945; the annual distribution is collected in Figure 2, where it is possible to stand out the number of victims in 2006. In part, this result is due to the bloodiest attack (December, 7) carried out by the group in Mumbai, India. In this attack, the group killed at least 187 civilians and injured another 817. The event went due to a series of train bombings and a string of seven blasts that spanned 56 kms, from Churchgate to Mira Road.
- A monthly series is constructed (see Figure 3) for one hundred and five months using the daily information about terrorist attacks provided by the GTD, in which are included armed assault, assassination, bombing/explosion, facility/infrastructure attack, hijacking, hostage taking (barricade incident and kidnapping), unarmed assault and unknown. This series allows to observe the following characteristics:
 - The monthly average of incidents is 0.85 with a standard deviation equals to 1.22.

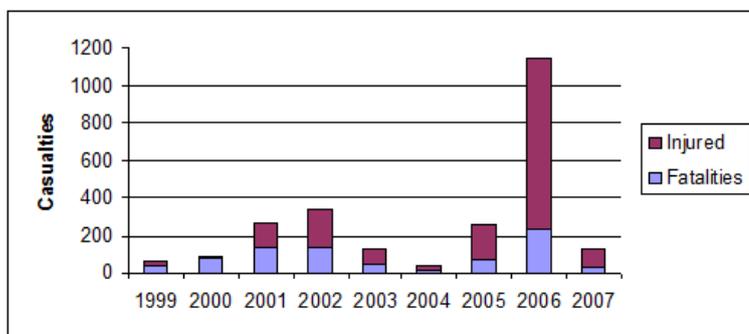


Figure 2: Casualties attributed to LeT.

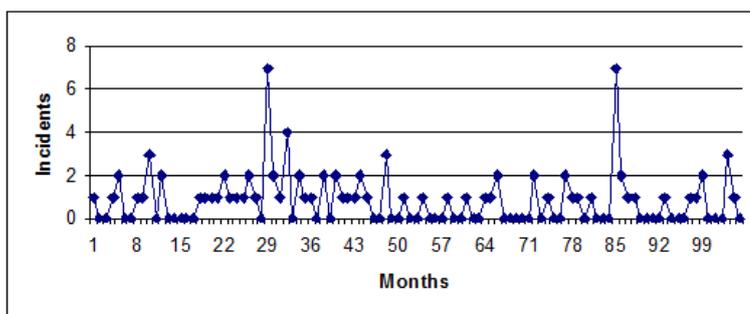


Figure 3: Attacks attribute to LeT, 1999-2007.

- The organization did not carry out attacks for fifty months (55%); for thirty-five times (38%), the organization only staged one attack; two attacks a month occurred for fourteen months (15%); for two months it carried out seven attacks; for one month, four incidents and finally, for three months, three attacks².
- Five months is the longest period without attacks. That fact occurred two times.
- For twenty-seven months, a month without attacks went followed by a month without attacks.

² These data allow us to accept the null hypothesis, 95% signification level, about the number monthly of incidents follows a Poisson distribution with an average equal to the average of the sample.

- When the organization performs two or more incidents on the same month, then that number of attacks is not repeated on the next month. Nevertheless, that fact is not observed when the organization carries out less than two incidents.
- Except in two cases, if the ninety months are arranged consecutively into groups of four months, we can find at least a month without attacks inside each group.

5. The Dynamic System

The decisions made by a domestic terrorist organization in order to attain its objectives together with those adopted by the government of the territory where the organization operates, can be linked by several causal relationships in a way that it is possible to construct a dynamic system.

The formation of the model structure requires, in first place, to study some primary relationships between a government and a domestic terrorist organization.

Any domestic terrorist organization expects some radical change in some aspects, such as political, social, cultural, religious, ethnic, ideological, etc., related to a specific geographical territory. In addition, it expects to get these changes soon. However, its outlooks come into conflict with the ideas defended by the government of the territory. The denial to its pretensions by the government leads the terrorist organization to create an atmosphere of fear on the citizens living in the territory to put pressure on the government. But, the fear felt by the population forces to the government to adopt a set of measures to fight against the domestic organization. In this way, government and terrorist organization are involved in several feedback processes that would constitute the base of a system dynamics model.

The first feedback processes arises taking into account that any terrorist organization needs certain resources to survive. Three different types of resources can be considered necessary for the survival of an organization: human, economic and

material resources. In fact, the organization needs people building your hopes up, that adopt the ideas defending by the organization unselfishly and capable of developing different tasks. In this regard, the organization will require to proselytise to increase the number of adepts, indoctrinate for integrating new members, teach to use and manipulate arms, carry out the attacks, guard possible targets, look for financing, etc. Usually, the members of a terrorist organization are divided into groups, the commands, formed by few persons by security, so every group is in charge of a special task. Of all those groups, the operative commands would take charge of the attacks. In addition to human resources, the organization also needs economic resources to finance its activities and to proportionate means of living to its members. In this instance, it has to provide clothes, food, shelter, journeys, etc. Moreover, the organization needs material resources, such as ammunition, explosives, bombs, arms, etc. to carry out the attacks.

It could be distinguished two types of activities performed by a terrorist organization related to the obtaining of economic and material resources. On the one hand, the organization would obtain economic resources from the population as a result of the fear felt by them. The fear would increase as a consequence of both the number of attacks and the damage produced by each attack and would decrease taking into account that the population forget. On the other hand, the organization could get both types of resources using the same means that any another organization outside of the law. These incidents do not pursue fear creation, just obtaining resources, and consequently, they are not considered as terrorist incidents. Because of this, such type of activities will be named irregular activities in which can be included: traffic of drugs, traffic of arms, etc.

In addition to the resources, the survival of the organization requires an individual leader, or a group leader, for managing the organization, encouraging its members to carry out certain tasks and mark the guidelines of behaviour in order to achieve the success of the ideals defended by it. In particular, the leader will determine a strategic plan and all tactical aspects tied to it. For example, the leader will make decisions about the responsibility of each command, targets to reach,

number of attacks, where and how they will be undertaken or the opportunity of each activity. This last aspect means that the leader assesses the advisability of every attack according to the current objectives of the organization. For example, the leader assesses if the attack entails too risk for the executors or even, for the own organization.

Figure 4 illustrate feedback loops influencing the number of incidents of the organization LeT. The human resources have been divided into two levels: the beginners, individuals in formation that do not carry out tasks for the organization and the active members that are distributed by cells. The figure shows that the economic resources in hands of the organization increase with the fear, due to the contributions of population and foreigners, and decreases with the spending necessary to maintain its human resources. Additionally, a fraction of the economic resources is dedicated to acquire material resources. The diagram shows that the organization obtains not only material resources by purchases, but also from irregular activities. For this organization, it is assumed that if the fear increases, the success of the irregular activities diminishes. Likewise, the model considers that the increase of material resources due to irregular activities is affected by a random number obtaining from a normal distribution. Finally, it is possible to observe that the material resources decrease with its use as a consequence of the consumption in the attacks.

The operative commands, which always stand by to carry out the attacks, are a percentage of all squads, though its number could be limited depending on the material resources in hands of the organization because both persons and material resources are necessary for the attacks.

The assumption about the influence of the fear on the success of the irregular activities is made taking into account the characteristics of the organization with regarding to the distribution of the number of attacks. Likewise, that distribution is also attributed by the model to a strategic behaviour adopted by the leader. In this way, it is assumed that the organization limits the number of attacks and the opportunity not only obeys to reasons of caution, but also depends on the

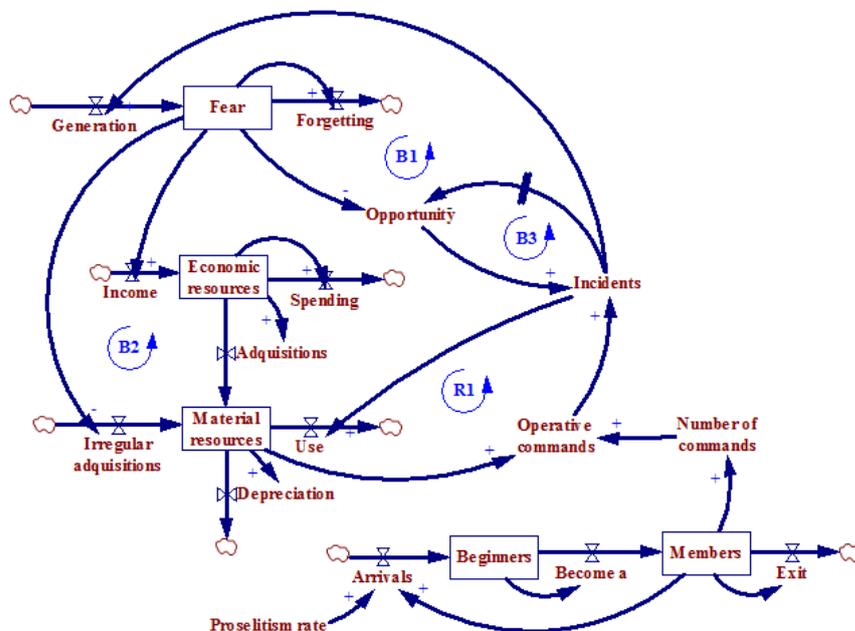


Figure 4: Casual structure associated to LeT.

number of attacks carried out by the organization in the short term. In addition, the opportunity of carrying out the attacks must consider the counter-terror policies adopted by the government. Consequently, all the incidents planned by the organization cannot be successful. In order to take into account this fact, the model considers that the success of the attacks is basically controlled by a random number obtained from a Poisson distribution. The mean of the distribution, which is the only parameter to obtain the random number, is function of the fear: more fear, less average. All these assumptions are picked up in the causal diagram where the opportunity depends on the fear and on the number of incidents carried out by the organization in previous months.

Figure 5 shows the number of incidents that the simulated organization developed for one hundred and five months. A simple analysis, about the simulated data, finds that the monthly average is 0.73 and the standard deviation is 0.8. The simulated data also show that three times the organization fulfils three attacks

though now, the maximum number of attacks per month is three. Likewise, two times during the period of simulation, for four consecutive months, the organization does not carry out attacks opposite five consecutive months of the data series. The inactivity is similar for both organizations: 48 months in front of 50 for data series.

Though the simulated data differ from the data series, above all, if they are compared point by point, the monthly averages and the standard deviations are closer and as a result, the decomposition of the mean square error (MSE) (Sterman, p. 875) determines the following result: which guarantees that the majority of error is unsystematic.

Therefore, the results can be considered acceptable because the model tries to explain the dynamics observed in the data series more than to replicate its accurate behaviour. Moreover, it is possible to check that the model endures extreme conditions and it does not show any special sensitivity under light modifications of parameters and initial conditions of the levels. As a result, the model could be used to test the usefulness of certain policies to fight against the organization.

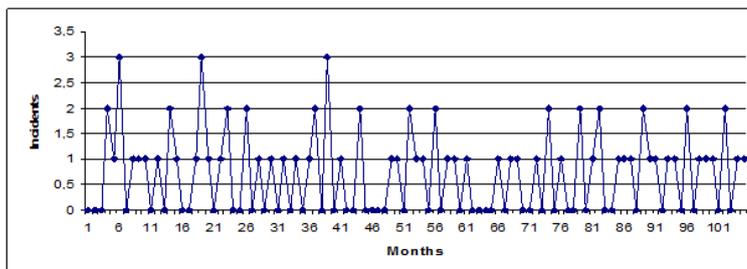


Figure 5: Simulated incidents.

6. Counter-terrorism Policies

This section explores the possibilities of implementing new measures in order to suppress the attacks of the organization. Four different types of policies are implemented in the model of simulation. These policies are held for twenty months,

which are assessed after 105 months, in order to determine the best one to attain the aim.

The first policy focuses on the human resources. It supposes that the government is able to arrest 5% of active members each month. The second policy focuses on the flow of irregular acquisitions of material resources: the governmental policies against the organization prevent of that possibility for twenty months. The third policy acts on the flow of economic resources: the organization is unable to get that type of resource, and finally, the fourth policy is aimed at the stock of material resources: the counter-terror policy achieves a monthly decrease next to 25% of materials resources in the hands of the organization.

Assuming the success of these policies, Figure 6 shows the evolution of the number of operative commands of the simulated organization. The figure contains five paths corresponding to the scenarios in consecutive order though the first path shows the evolution of the number of operative commands when none policy is adopted. It simply extends for twenty months the path followed by the simulated organization.

Observing Figure 6 it is possible to check that the best policy, among the selected ones, for fighting against the organization is whether act against the human resources or try to decrease the material resources. Notice that the operative commands decreases more quickly with the fourth policy that with the first policy; although in both cases, the decrease is step by step. The other two policies analysed do not achieve a diminishing of the number of operative commands, maintaining to the organization with the same potential of damage.

7. Conclusions

According with Calduch (1993, p. 330), the terrorist violence has the characteristic of being unforeseeable as consequence of two aspects: the vulnerability of the modern societies and the impossibility of forecasting the moment, the place, the target and the modality in which each terrorist action will present itself. This author

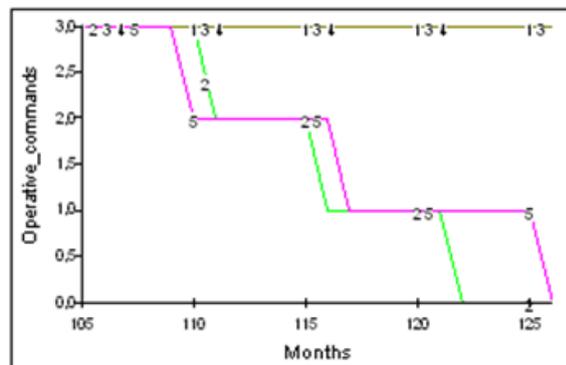


Figure 6: Responses to counter-terror policies.

asserts that the terrorist strategy has to be totally random and it cannot follow established guidelines of behaviour. These characteristics make difficult to forecast the evolution over time of any variable associated to a terrorist organization, even in the short term. He concludes that it might be possible to estimate the number of members or operative cells at each moment of time as well as its economic resources or even its material resources. Nevertheless, the estimations can change daily as a result of the random behaviour associated to terrorist strategy.

In agreement with Caldach about the difficulties to know the future behaviour over time of a terrorist organization, the understanding of the interactions between the actions of an organization and a government helps to explain the procedures used by an organization. But the formation of a causal structure explaining the operative way of an organization is not the only contribution of System Dynamics methodologies to the analysis of terrorism. In fact, taking into account that each terrorist organization has its own peculiarities the methodology would enable to capture those specific characteristics. In this way it would be possible to contrast real data with simulated data in order to assess the capacity of the model to reproduce the behaviour shown by the organization. Moreover, the simulation model offers the possibility of testing governmental policies to determine the best counter-terror policy.

In order to widen this study, the model could be used in different ways. For example, it could focus on the number of fatalities, casualties or big damages with regard to the same organization. Nevertheless, the model could be adapted to study another terrorist organization. In particular, it could be checked with a terrorist organization presenting a different pace of activity.

References

1. Akcam, B. K. and V. Asal. (2005): The Dynamics of ethnic Terrorism. Proceedings of the 23rd International System Dynamics Conference. Boston.
2. Anderson, E. (2009): Modeling Insurgencies and Counterinsurgencies. Proceedings of the 27th International System Dynamics Conference. Albuquerque.
3. Arango, S., J. Prado and I. Dyer. (2009): Evaluación de políticas públicas para la reducción de la criminalidad en Medellín: Una aproximación con Dinámica de Sistemas. *Ensayos sobre Política Económica*, 60.
4. Calduch Cervera, R. (1993): *Dinámica de la Sociedad Internacional*. Ed. Ramón Árces. Madrid.
5. Clauset, A., Young, M. and K. S. Gleditsch. (2007): On the Frequency of Severe Terrorism Events. *The Journal of Conflict Resolution*, 51, 58-87.
6. Coyle, R. G. (1985): A System Description of Counter Insurgency Warfare, *Policy Sciences*, 18, 55-78.
7. Das, S. P. (2008): Some mechanism of terror cycles. *Journal of Economic Behavior and Organization*, 67, 644-656.
8. Enders, W. and T. Sandler. (2000): Is Transnational Terrorism Becoming More Threatening? *The Journal of Conflict Resolution*, 44, 307-332.
9. Faria, J. R. (2003): Terror cycles. *Studies in Nonlinear Dynamics and Econometrics*, 7, n^o3, article 1.
10. Feitchinger, J., Hartl, G., Kort, P. M. and A. J. Novak. (2001): Terrorism control in the tourism industry. *Journal of Optimisation Theory and Applications*, 108, 283-296.
11. Grynkewich, A. y C. Reifel. (2006): Modeling Jihad: A System Dynamics Model of the Salafist Group for Preaching and Combat Financial Subsystem. *Strategic*

- Insights* (electronic journal of the Center for Contemporary Conflict at the Naval Postgraduate School, Monterrey, CA), 5.
12. Merari, A. (1993): Terrorism as a Strategy of Insurgency. *Terrorism and Political Violence*, 5, 213-251.
 13. Prado, J. J. y I. Dyner. (2005): Evaluación de políticas públicas para el control de la carrera criminal en la ciudad de Medellín con apoyo de simulación. Actas del 3º Congreso Latinoamericano y Encuentro Colombiano de Dinámica de Sistemas. Cartagena de Indias. Colombia.
 14. Richmond, B. (2009): Systems Thinking Look at Terrorism. <http://www.iseesystems.com/community/SOTM/default.aspx>.
 15. Rosendorff, B. P. and T. Sandler. (2005): The political Economy of Transnational terrorism. *The Journal of Conflict Resolution*, 49, 171-182.
 16. Ruloff, D. (1975): The Dynamics of Conflict and Cooperation between Nations. A Computer Simulation and Some Results. *Journal of Peace Research*, 12, 2, Special Issue: Peace Research in Switzerland, 109-121.
 17. Schoenwald, D., C. Johnson, L. Malczynski y G. Backus. (2009): A System Dynamics Perspective on Insurgency as a Business Enterprise. Proceedings of the 27th International System Dynamics Conference. Albuquerque.
 18. Soto-Torres, M. D., R. Fernández Lechón y P. Fernández Soto. (2009a): Dynamics in domestic terrorist organizations. Proceedings of the 27th International System Dynamics Conference. Albuquerque.
 19. Soto-Torres, M. D., M. Pajares de Mena, R. Fernández Lechón y P. Fernández Soto. (2009b): Ciclos en terrorismo doméstico: un modelo para las FARC. Proceedings of the 7th International System Dynamics Conference Latinoamericana. Santa Marta. Colombia.
 20. Sterman, J. D. (2000): *Business Dynamics. System Thinking and Modeling for a Complex World*. McGraw-Hill.
 21. Weaver, E. (2009): The Role of Influence Operations in a Counterinsurgency Battle. Proceedings of the 27th International System Dynamics Conference. Albuquerque.