Pandora II

Improvements to a Scenario Model for Investigation of Terrorist Behavior

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Preface

When, somewhere halfway this academic year, the moment to choose a topic for the master thesis arrived, I was perplexed by the amount of topics we could choose from. There were over 90 different topics and for each of them I could easily come up with two or more variants by myself. However, it was not difficult to pick four favorites since I had a clear idea of what I wanted (although Pieter might not have agreed with me upon this after our first meeting, that was, probably because of me, quite chaotic). Several themes captured my interest and they all had something in common. They were researches that needed to be conducted in cooperation with a company or institution outside the university. What attracted me in this was the 'connaissance' that after completion my research would not just end up somewhere in a dusty corner of my own closet but that it could actually contribute to 'a bigger whole'.

For this reason I want to thank Pieter for considering alternative research possibilities within the Pandora project after the initial topic had already been given to Linda (who became, in a way, my 'partner in crime'). As Pandora was my first choice, I was really glad I got the chance to work on this project. I also want to thank Pieter for all the work he has done and advise he has given, especially in the early stages of my research. Furthermore, I want to thank Linda, with whom I have been working together to unravel the Pandora-model and to identify many of the points of improvements that are presented in this thesis. Then, last but certainly not least, I want to thank Peter for letting us work with his model, and for providing answers whenever there were questions about Pandora, technical terminology or criminal investigation in general. I hope I have been able to add some value to your project, just like I wanted to. For me it definitely was a challenging and interesting period which I enjoyed and in which I have learned a lot. Thank you all!

Sincerely,
Sophie

Abstract

The research into the origins of terrorism and terrorist countering practices may benefit from the automatic processing of information from the past in order to create scenarios for possible future events. The Dutch National Police Force (KLPD) developed Pandora, a scenario-model that enables the storage and comparison of data from terrorist incidents and provides insights in terrorist behavior. In this thesis we investigate the quality of the Pandora-model in order to highlight weaknesses and propose possible improvements. For this purpose we used three different approaches: (1) we described the components of the model, (2) we analyzed the components and their corresponding values to determine their suitability for statistical analysis, and (3) we subjected five components of the model to statistical analysis to determine the existence of relationships and dependencies.

The research resulted in the definition of a set of technical and conceptual improvements. Implementation of these improvements led to a new and improved version of Pandora that, in its foundations, is suited for statistical analysis: Pandora II. However, due to the design of the Pandora model only a limited number of statistical methods can be used on it. We found that there are significant relations between the components ´Target Type´, ´Type of Incident´, ´Weapon Type´, 'Sub-weapon Type' and 'Terrorist Group'. This allows us to derive the values of components on the basis of values of other components with reasonable to high certainty. However, terrorist groups differ in the extent to which the components of incidents connected to them can be predicted. We also found that relations between variables become stronger when the least occurring values for the variable are eliminated before the analysis.

Based upon these results we draw three main conclusions. First, to make sure all components of Pandora can be analyzed, more information needs to be added to the model or other techniques should be used for analysis such as text-data mining or machine learning. Second, the components that were analyzed should not be eliminated from the model as they have proven to be useful predictors of other variables. Third, the results of this research can be used by criminal investigators to quickly focus their attention on the most important elements within the model or to develop tools to support human decision making.

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1. Introduction

This chapter provides a description of the motivation for this study (1.1), a problem statement and research question (1.2) and the methodology that has been applied (1.3).

1.1 Motivation

In this research possible improvements to the Pandora-model are investigated. Pandora is the test version of a scenario model that is used for criminal investigation. The Pandora-model contains data about terrorist incidents and it is used to create scenarios on possible future incidents based on data about earlier scenarios. By creating scenarios of possible future incidents, governmental institutions such as the Dutch National Police Force (KLPD) can be able to anticipate criminal behavior, and more specifically; terrorist behavior.

As Rapoport reflects (1979, in: Kaplan, J. in: Rosenfeld, J.E., 2011, p.67), the concept of terrorism is not new. Parts of the Hebrew Bible already treated religiously inspired terrorism. A lot of research has been done on terrorism and strategies to defeat this phenomenon. According to Malkki and Toivanen (2010) the lack of a clear notion of terrorism is a significant problem in this research area. The exact notion of terrorism is highly debated; definitions of terrorism are often one sided and depending on the political purposes of those who define the concept. In addition to this problem, Malkki and Toivanen (2010) list six divergent deficits of research on terrorism. These deficits mainly concern the quantity of research done in this field. They state there are (1) too few source-based studies on terrorist movements, (2) too many researchers concentrate on terrorist movements which form a current threat, (3) there is too little research on the history of terrorism and (4) there are too few comparative studies. They also argue that (5) too much of the research done is politically-oriented and (6) there is a lack of research that critically assesses the states' role in the concept of terrorism.

In order to get a good grip on terrorism and to investigate the possibilities for countering terrorism, it is important to collect more information, knowledge and insights into this topic. In his oration for the University of Leiden in January 2008, De Graaff states the scientific world has an ethical duty to examine the future of terroristic violence as we need to protect ourselves from losing that what is beloved. In modern society there is a constant threat of terrorism and insurgent violence and the evolving nature of these threats increased the importance for finding new ways for analyzing the problem of terrorism and terrorist groups' behavior (Jackson, 2005, p. 1).

Although there has been a lot of research on terrorism, many researches did not provide us with new information or insights into this topic (Malkki & Toivanen, 2010). However, there are approaches that offer new and interesting viewpoints on terrorism and might be useful in countering

terrorism violence. A relatively new approach to the research on terrorism and crime is the use of scenario-based systems and forecasting methods to describe or predict possible future events (Go & Carroll, 2004: Gorr & Harries, 2003: Gorr, Olligschlaeger & Thompson, 2003: Khalsa, 2004).

Scenario-based systems are an aid for thinking, a good tool for brainstorming and allow the consideration of different alternatives in decision making (Go & Carrol, 2004). One of these scenario-based systems is the Pandora-model that has been developed for the Dutch National Police Force. Pandora is not the name of the actual scenario model but refers to the test version of this model and its corresponding dataset. The actual scenario model has no specific name. However, as we will work with the test version of the model for this paper and for the sake of convenience, we will continue calling the model 'Pandora'.

Scenarios as incorporated in the Pandora-model are not necessarily used to forecast criminal behavior; moreover a scenario model can serve as a helpful tool investigating the underlying forces of and the relevant constraints and changes in criminal behavior in order to enable institutions to anticipate on this behavior and to adapt the strategy used to counter it based upon different indicators (Ringland, 2006, in: Berenschot, 2010). One of the things one can investigate by using a scenario-based model is whether a change in one of the variables the model has been built upon might influence other variables. If, for example, the modus operandi of a terrorist attack strongly depends on the motive of the offender, this can offer significant insights in cases where the modus operandi of an offender is known but his or her motives remain unclear or the other way around. When a relationship between those variables is found, this information can be used to fill in 'blanks' of knowledge by institutions that try to counter terrorism. In the example described above this would mean one can anticipate on the modus operandi which is expected to be used once one is aware of the motive of the offender.

Seeing the current state of research on this topic, more research into the nature of terrorism and how combatting terrorism can be improved, needs to be conducted in order to increase the possibilities for countering terrorism. As scenario-based systems offer a relatively new approach to research on terrorism, research on this area still needs to be expanded in order to gain more insight in the way scenario-based modeling can be used for countering terrorism and how models of this type can be refined. As the Pandora-model also is relatively new and still subject to development, it makes sense to say there probably are considerable possibilities for improving the content or composition of the model. If there are possibilities for improvement of Pandora and to what extent, will therefore be investigated in this research. Since Pandora is a product of a scenario-model that can be used to investigate crimes other than terrorist events as well, it seems evident that results found in this paper can also be applied on other applications of the actual scenario-model.

1.2 Problem statement and research questions

The goal of this study is to investigate to what extent there are possibilities for improvement of the Pandora model. Therefore the following problem statement has been formulated:

To what extent can the quality of the content of the Pandora model be improved?

Several research questions are defined in order to provide an answer to the problem statement. In order to find out how the quality of the content of the Pandora-model can be improved, it was first of all important to find out how the model has been built up and what exactly it incorporates. The first research question therefore states:

RQ1: Which different components currently form the framework of the Pandora model?

Information about dependencies and relationships between different components of the model can offer insights for the practice of countering terrorism. Also this information can be used to fine-tune the composition of the Pandora-model. If, for example, the modus operandi of a terrorist attack strongly depends on the motive of the offender, possible motives can be revealed in cases where the modus operandi of an offender is known but his or her motives remained unclear. When, at the contrary, one finds components which appear to be less important or which do not correlate with other components at all, it might also be considered to completely remove these components from the model. To analyze relationships and dependencies between different components, statistical analysis of these components needs to be performed. In order to find out if the model is suited for statistical analysis or if it needs some adaptations, the second research question has been formulated.

RQ2: To what extent is the current version of the Pandora model suited for statistical analysis?

Once we know if statistical methods can be applied on Pandora and eventual problems that hinder statistical analysis with the model have been resolved, we can proceed to the third research question;

RQ3: To what extent are there any relationships and dependencies between the different components of the Pandora model?

1.3 Methodology

In this research we started with a literature study on related work to find background information on what scenarios are and where they are used for. In addition to that we described a short history of scenarios, their advantages and drawbacks and the way they are used in (criminal investigation) practice (Chapter 2). Thereafter, conversations with the founder and former users of the Pandora model as well as examination of the model itself took place in order to provide an answer on the first and the second research question (Chapter 3 and 4, respectively). Furthermore, statistical analysis is applied to examine the different components of the model in order to answer the third research question (Chapter 5). Finally, the results of all research questions are summarized and discussed and a conclusion has been built upon these results to answer the problem statement (Chapter 6).

2. Related work

In this chapter several definitions of scenarios are provided in order to describe what scenarios are and where they are used for (2.1). Also a short history of scenarios is given (2.2). Furthermore, it is described how scenarios are used and what their advantages and drawbacks are (2.3).

2.1 What are scenarios?

Since multiple persons created their own definition, there is no single definition of scenarios. Schoemaker (1995) defines scenarios as "a disciplined method for imaging possible futures in which organizational decisions may be played out". Porter (1985) uses a more general description, which does not only cover business settings, when saying a scenario is "an internally consistent view of what the future might turn out to be". Both definitions show us that scenarios do not aim at precisely forecasting the future. Rather, scenarios help us finding a possible answer on questions such as: "What can happen in the future?" Or: "What can happen if …?" Bandhold and Lindgren (2009, p. 25) distinguish scenarios from forecasts and visions by saying that scenarios indicate possible, plausible futures while forecasts and visions respectively describe probable and desired futures. Also, they mention scenarios illustrate risks whereas forecasts and visions tend to hide risks.

Although the definitions from the paragraph above suggest scenarios are only used to say something about the future, scenarios can be used in two different ways. That is, reactively, to reconstruct historical events, or proactively, to provide insight into future events (Berenschot, 2010). However, since the scenario based model Pandora is created for anticipating criminal behavior, for the purpose of this research, the reactive use of scenarios is not as interesting as the proactive use. Section 2.2 will therefore give a short description of the history of the proactive use of scenarios. This enables us to comprehend its origin, purpose and possibilities.

2.2 History of proactive scenario usage

According to Bandhold and Lindgren (2009) every human being constantly uses scenarios. We need to learn from the past and combine this experience with information about the future in order to be able to choose which way to go in our lives. In 1985, Neurologist David Ingvar suggested we all are natural scenario planners. However, the usage of scenarios outside of our own thinking is not of all times. It is said Herman Kahn was the first person who used scenarios to describe possible future developments. Kahn worked for the RAND cooperation, a military-strategic policy institute that conducted research for the United States armed forces. In his book 'on thermonuclear war', which was presented in 1960, Kahn outlined how a conflict between the United States and the Soviet Union could escalate into a nuclear war. He used a technique called 'future-now-thinking' to reveal the patterns of action and reaction of both world powers that could lead to this nuclear war and he suggested possible effects of a nuclear war as well as possible strategic options to react upon it. After

'on thermonuclear war', Kahn wrote several other articles and books which influenced the United States' military strategy and strategic thinking in general (Hudson Institute, N.D.). In 'The year 2000', Kahn and Wiener (1967) provide a framework for speculation on the future. They created an image of how the world would look like in the year 2000 by using scenarios and the systematic context (or 'alternative future'). Kahn and Wiener describe scenarios as 'hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points' (Kahn & Wiener, 1967).

Kahn's work was the precursor of the use of scenarios within the commercial industry. Large enterprises such as Dutch Royal Shell and General Electric embraced scenario planning and used it to explore the future. Pierre Wack and a group of strategic planners at Royal Dutch Shell used information about the past to foresee future incidents such as the oil crisis of 1973 (Carrol and Go, 2004). Shell's successes, deriving from their scenario planning approach, inspired many other companies to start using scenarios during the 1970's (Bandhold and Lindgren, 2009, p. 38). Nowadays, Shell still uses scenarios to "explore possible developments in the future and to test our strategies against those potential developments" (Shell, N.D.).

2.3 Scenarios in practice

2.3.1 How scenarios can be used

Shell's corporate website outlines decision makers "can use scenarios to think about the uncertain aspects of the future that most worry them – or to discover the aspects about which they should be concerned – and to explore ways in which these might unfold". This corresponds to Kahn's consideration of scenarios as "an aid to thought in uncertainty" (Kahn, 1962 in: Carrol and Go, 2004). According to Melo and Varum (2010) the underlying assumption of scenarios is that the business world is unpredictable, but some events are predetermined. By taking these predetermined events and combining those with other possible occurrences, scenarios of the future can be created. These scenarios can offer a pessimistic, optimistic or more moderated view on the future of the subject the scenario is created for. However, "No scenario can provide an accurate description of the future" (Melo and Varum, 2009). Scenarios are not used to predict the future but the identification of trends and uncertainties helps managers to avoid errors which often occur in decision making situations such as overconfidence and tunnel vision (Schoemaker, 1995).

2.3.2 Advantages of scenarios

Kahn lists five advantages of the scenario as an aid to thinking of which two are of particular interest as they overlap with Ringland's (2006) conditions for a successful scenario model. First, scenarios can be used to make an analyst salient to important events, which need to be taken into account in the uncertain future (Kahn, 1962 in; Carroll and Go, 2004). Although described in a different way, this

advantage is more or less related to one of the conditions Ringland (2006) considers to be crucial for pro-active scenario models: “the ability to anticipate real world behavior –which may be unexpected- through exploring the constraints or changes in the external environment, or the relationship between forces”. Both Kahn and Ringland state scenario models enable the identification of occurrences that influence the future.

Second, scenarios can be used for reasoning about alternative possibilities for past or present crises (Kahn, 1962 in; Carroll and Go, 2004). This statement also correlates to Ringlands’ aforementioned condition for successful scenario-models. Reasoning about alternative possibilities for crises can be seen as an attempt to anticipating on crises and crises are real world behavior.

Finally, both aforementioned advantages together fit into another concept a successful scenario model offers to its user: adapting the chosen strategy on the basis of early confirming or disconfirming evidence, or indicators (Ringland, 2006, in: Berenschot, 2010). In the ideal situation, an analyst using a scenario-based model will discover important events which might influence the future. Then he or she will reason on alternative possibilities for how to act when these events happen and from that, the chosen strategy can be adapted based on the revealed indicators which show which scenario seems most likely to occur.

2.3.3 Why scenarios are not used more widely

Thus far it has become clear why scenarios are a useful tool for exploring the future of an organization, institution or even a whole society. Still, the use of scenario also has pitfalls. Bandhold and Lindgren (2009), list four reasons which explain why scenarios have not been used more widely. Firstly, they mention there is ‘uncertainty in conclusions’. This is the fact scenarios do not provide the security often required in decision making since they do not give an exact answer about the future. Secondly, scenarios are ‘counterintuitive to managerial simplicity’. This means that, in contrast to traditional methods for decision making, scenarios do not give one right answer to every question. Neither can it be used to divide a problem into three parts, of which each part can be solved separately; what managerial simplicity does promise to be able to. Thirdly, scenario techniques are often based on reasoning and intuitive pattern recognition. Analysis is regularly used as well, but scenarios leave much room for creativity and most of the time results are qualitative instead of quantitative. This means scenarios are and provide ‘soft methods and soft answers’. Finally, scenarios are ‘time consuming’ since it usually requires a large amount of time from the participants before a scenario is constructed and results can be presented.

Criticizers of scenario models often come up with the third pitfall mentioned here above. Berenschot (2010) mentions there is a discussion among critics about the truth value of scenarios created by ‘soft’ scenario methods, which rely upon creativity and imagination, in comparison with

'hard' scenario methods, which are based upon mathematical techniques. He states their critique is based on the lack of scientific footage for data used in soft scenarios, which, in the eyes of the criticizers, weakens the certainty value of proclamations about the future. In response to this critique, Berenschot (2010) postulates that when working with a scenario model, the objective of its use must determine to what extent there is room for 'insecurity' in the analysis of soft scenario data. One can imagine that when making a prognosis about the expected number of aids patients for the coming decade in a certain country, reliable results are more imperative than for an explorative brainstorming session about the future of a local library.

2.3.4 Scenarios in criminal investigation

Scenarios which are not used for predictions about the future and therefore are not evaluated on criteria such as reliability and accuracy to foresee future events, are those created for literature, movies and theater pieces. Berenschot (2012) lists twelve Elementary Scenario Components (ESC12), every possible story can be constructed of. Every scenario is composed by a combination of the following elements: (1) Protagonist, (2) Antagonist, (3) Arena, (4) Time (frame), (5) Context, (6) Motivation, (7) Primary Purpose, (8) Means, (9) Modus Operandi, (10) Resistance, (11) Symbolism and (12) Red Herring. Those elements partly overlap with the "golden W's", (who, what, where, when, why, how and with) which are used by coroners, police officials and military police in criminal investigation (Gross, 1904). Investigators need this information for a thorough investigation of a case and in order to write a decent report on it.

A specific form of criminal behavior is terrorism. Terrorism can be seen as a form of organized crime (Chibelushi, Sharp, & Shah, 2006). Chibelushi, Sharp and Shah (2006) define organized crime as *"… a (structured or not structured) group of two or more people existing for a period of time and acting in concert with the aim of committing one or more serious crimes that are motivated by politics, religion, race, or financial gain (...)."* Although terrorism and organized crime have a certain overlap, terrorism distinguishes itself from other forms of organized crime –such as fraud or gang robberies- since the direct target of a terrorism event is not always its main target. This is also referred to as 'the double victimization principle' (Van der Heide, 2010).This principle reveals the symbolic nature of terrorist events. It is for instance generally accepted that the 9/11 attacks were directed at the Twin Towers because these towers represent the economic and military power of the United States. As symbolism is one of the components of the ESC12, the differentiation between the direct and main target can be accurately captured in a scenario model that is built upon the ESC12.

Terrorist attacks can and have been described as scenarios or as a collection of scenario or story-elements (Sloan, 1981, De Graaff, 2007). However, descriptions of terrorist attacks in a scenario

format had never been put in a model before. Berenschot (2010) made a first attempt to gather and categorize information on terrorist events in a scenario model. He put information on terrorist events in his earlier created scenario-model to test the capabilities of the model. This test version was “Pandora”. Pandora was created “to enable comparison of large amounts of data and to provide insight in processes of radicalization and terrorist planning” (Van der Heide, 2011). In the next chapter the different components of the Pandora model will be outlined in order to provide an answer on the first research question of this paper.

3. Pandora explained

In this chapter an answer will be provided on the first research question:

RQ1: Which different components currently form the framework of the Pandora model?

Investigation of literature written on the Pandora model and the model itself as well as conversations with the founder of the model and persons who have been working with Pandora, enable us to analyze the model. First, we will take a closer look into the possibilities and limitations of a pro-active scenario model such as Pandora in the practice of criminal investigation (3.1). We do this because possibilities and limitations underlie the design of a model as they help clarify what the boundaries of a model are. Secondly, it is described how the founder and former users of Pandora tried to cope with these limitations (3.2). Finally, the actual design, and thus the different components, of Pandora will be analyzed (3.3). In Section 3.3 we will also preliminary describe the components that were added to Pandora as a result of the analysis in Chapter 4. This way we offer a complete description of the model both before and after the implementation of improvements.

3.1 Possibilities and limitations of pro-active scenario models in criminal investigation

With an extensive literature study and conversations with different experts within the field of criminal investigation, Berenschot (2010) supported the idea that scenario models could be of significant value for the investigation of criminal behavior. From his book we can conclude that the possibilities of proactive scenario models are twofold. Firstly, one of the largest advantages of a scenario model in comparison with the techniques used until now, is the possibility to compare multiple cases in order to explore correlations. By analyzing the similarities and differences between multiple cases instead of analyzing an individual case, the growth and group processes of terrorist organizations as well as changes in their modus operandi may be uncovered (Berenschot, 2010 p.34). Identifying behavioral patterns within criminal organizations increases the opportunities for anticipating on criminal behavior. One of Berenschot's interviewees emphasizes the importance of proactive investigation practices. The interviewee stresses that a terrorist attack starts months or even years before the actual attack takes place and therefore the investigation of an attack should start in an earlier stage as well, not just once the trigger has been pulled (Berenschot, 2010 p.34).

The second advantage of scenario models lies in an essential knowledge management notion: the storage of knowledge and experience. Organizations need to store tacit and explicit knowledge to prevent the loss of significant knowledge and experience when experienced employees retire or resign (Debowksi, 2006). In an institution such as the Dutch National Police Force where different organizations and departments cooperate, the storage of knowledge is even more vital because it enables a structured access to information across different sections (Berenschot, 2010).

While the use of a scenario model has clear advantages, within the scope of this research two limitations must be considered. Firstly, in criminal investigation practices, sensitive information must be protected from unauthorized use. Therefore, a model used within institutions for criminal investigation can only have restricted access possibilities. Secondly, in order for the model to be of consistent quality and to ensure validity, guidelines need to be set on how information is added to the model. As different persons will work with the model and they are all subject to their own interpretation, the process of adding information to the model should be as standardized as possible.

3.2 Coping with limitations

When designing Pandora, Berenschot has considered both of the limitations listed in Section 3.1. The first version of Pandora contains open source intelligence (OSINT) retrieved from mostly online sources. This enables persons from outside the Dutch National Police Force to work with the model as well since there is no risk of unauthorized use of sensitive information.

Concerning the second limitation, we need to explain how Pandora is constructed and how the data set has been built up. Pandora is based upon the twelve Elementary Scenario Components which were already mentioned in Subsection 2.3.4 of Chapter 2 and which will be explained into further detail in Section 3.3 of this chapter. Together with four additional categories (which can be found in table 1), the scenario components form the framework of Pandora. To add a terrorist event in Pandora, the scenario or storyline of the case needs to be deconstructed into the different components. This forces every person who adds information to the model to add specific and detailed information and eventually allows comparison of characteristics of different cases. Many of the fields within Pandora are text fields and can be filled out by one's own interpretation of an event. However, to further increase consistency within the model, for some of the fields the user has to choose between a restricted amount of terms or definitions.

Until the start of this research, three persons have been adding information to Pandora. They did this in close consultation to ensure internal consistency. While the KLPD does not employ a specific definition of terrorism, to guarantee the internal validity of Pandora it was chosen to adopt one. Van der Heide (2011) used the following definition of terrorism as proposed by Alex Schmid (2011) to select cases for Pandora.

"(…) An anxiety-inspiring method of repeated violent action, employed by (semi-) clandestine individual, group or state actors, for idiosyncratic, criminal or political reasons, whereby – in contrast to assassination – the direct targets of violence are not the main targets. The immediate human victims of violence are generally chosen randomly (targets of opportunity) or selectively (representative or symbolic targets) from a target population, and serve as message generators.

Threat- and violence-based communication processes between terrorist (organization), (imperiled) victims, and main targets are used to manipulate the main target (audience(s)), turning it into a target of terror, a target of demands, or a target of attention, depending on whether intimidation, coercion or propaganda is primarily sought."

Besides the employment of a clear definition, Van der Heide (2011) set three other principles to ensure the trustworthiness and validity of the information she added to the model. Firstly, as different sources do not always tell the same story, she opted to accept the facts supported by the majority of the sources as the truth. Second, for fields such as 'motivation' which are subjective, and thus open for interpretation, it was sometimes chosen to accept multiple alternative explanations by using the term 'miscellaneous'. Thirdly, when no agreement was found on a specific component of a case or there was no information at all, the field was left blank or listed 'unknown'. Although other principles or rules might have been used as well during the process of filling out the model, there is no formal description or guidebook with this information.

During this research, minutes of the changes have been kept in order for future users of Pandora to trace these changes and to use this information to explore or improve the model. The changes that have been made are described in Sections 4.1 and 4.2 of Chapter 4.

3.3 The Pandora-model

As stated in Section 3.2, Pandora is based upon the ESC12, the twelve Elementary Scenario Components. These elements are (1) *the protagonist,* (2) the *antagonist,* (3) the *arena,* (4) the *time* (frame), (5) the *context,* (6) the *motivation,* (7) the *primary purpose,* (8) the *means,* (9) the *modus operandi,* (10) *resistance,* (11) *symbolism* and (12) the *red herring*. Table 1 presents a short description of all elements.

Table 1 - ESC12-elements

	Component	Description
1.	**Protagonist**	The offender of an incident
2.	**Antagonist**	The victim of an incident (which is not necessarily a person but can also be a building or object).
3.	**Context**	The circumstances under which the incident took place.
4.	**Arena**	The location where the incident took place.
5.	**Time**	The moment at which the incident took place.
6.	**Modus Operandi**	The actions that happened before, during and after the incident.
7.	**Means**	The sources that have been used for the incident.

8.	**Motivation**	The reason why the protagonist has offended the antagonist.
9.	**Primary Purpose**	Where the protagonist was striving for with the incident.
10.	**Resistance**	The obstacles the protagonist had to overcome to be able to perform his act.
11.	**Red Herring**	A misleading occurrence or indicator, often used to lead someone in the wrong direction or to make someone believe an untruth.
12	**Symbolism**	Occurs when a specific act is of symbolic value for the offender, the victim, an audience or another specific individual or group of persons.

Pandora consists of multiple broad main categories based upon the aforementioned scenario elements and a place for additional remarks on features that cannot be placed in one of the categories. Taken together, the main categories form the storyline or scenario of an event. Each main category has several subcategories or variables and these variables together form a specific scenario element within the storyline. Each main category and its corresponding subcategories or variables will be described below by the use of multiple tables. The tables are partially adopted from Van der Heide (2011) but they differ at three points: (1) in the tables below, every single column that appears in the actual model is described (also those that occur more than once, such as 'pre-incident actions') in order to provide a complete and accurate description of all components of Pandora. (2) Additional information on e.g. the textual or categorical nature of the variables is provided since this is useful information with regard to the statistical analysis for this research, possible points of improvement of Pandora and the comparison of Pandora with the GTD (why and how this was done will be described in the Section 4.2). (3) In addition to the initial components of Pandora, we also preliminary describe the components that were modified or added to the model as a result of the analyses in Chapter 4. The modifications and additions can be recognized by their bold typeface. This way we provide an accurate description of the model both before and after the implementation of the points of improvements that were found in that chapter.

Each table consists of three columns. The first column lists the name of the category and the corresponding subcategories. In two cases multiple categories are mentioned in one table. This is because these categories are the umbrella categories for different sub-categories but still belong to the same main category. The second column lists what the type of the variables is. Variables can be either textual, numerical or categorical (nominal or binary). The third column offers a description of the variable and lists the possible values this variable can take. If the list of values is considered too long to be placed in the table, it can be found in an appendix.

3.3.1 General information

Table 2 presents general information on the terrorist event that can be used to identify individual cases.

Table 2 - ***Pandora-model: general information***

Category : Subcategory	**Type of variable**	**Description**
Case ID: Name	Text	Label of terrorist act
Case ID: Category	Nominal	What type of terrorist act? *Possible values: Hezbollah special operations, Al Qaida inspired, Lone Wolf.*
Background: Description	Text	Short summary of terrorist attack
Succesful attack: Attack/attempt	Binary	Was it an attempt or an attack (and thus a succeeded attempt)? *Possible values: attack, attempt.*
Peripeteia (change of circumstance): Description	Text	What changed at the moment the attack started?
Peripeteia (change of circumstance): Red Herring	Text	Was there a false indicator (another moment that indicated an attack or a diversion during the change of circumstance)
Peripeteia (change of circumstance): Symbolism	Text	Was the moment symbolic?

3.3.2 The Protagonist

Table 3 lists the different subcategories related to the protagonist. The information in this category varies from demographic information about the protagonist to the description of ties of the protagonist with third parties.

In Chapter 4 four points of improvement for the category protagonist are described. First, it is noticed that the variables ‘Age group’ and ‘Number of Assailants’ are measured by multiple scales at the same time. One could add information in the form of an exact number or choose from ratio scaled categories. Secondly, the different scales between which one can choose for the variable ‘Number of Assailants’ showed an overlap. To resolve these two problems it was decided to only use exact numbers for this variable. For the purpose of this research, the values of the variable ‘Age group’ have not been modified. Nevertheless, this should be taken into consideration for future use of the model.

Then, Pandora describes whether an incident is preceded or followed by other incidents. However, it does not directly answer the question whether an incident is part of multiple incidents or not. Therefore, we decided that it was useful to add the category ‘Part of multiple incidents’.

Table 3 - *Pandora-model: the protagonist*

Category : Subcategory	**Type of variable**	**Description**
Protagonist: Protagonist known	Binary	Is the protagonist known? *Possible values: yes, no*
Protagonist: Incident attributed to	Text	Name of protagonist
Protagonist: Incident claimed by	Text	Who claimed the incident? It can be the protagonist or someone else or a terrorist group or no-one at all
Protagonist: Claimed by means of	Text	How was the responsibility claimed?
Protagonist: Leakage	Binary	Was there a leakage before the terrorist act? *Possible values: yes, no*
Protagonist: Leakage	Text	Description of the leakage
Protagonist: Red Herring	Text	Were there any false indicators as to who was the protagonist?
Protagonist: Symbolism	Text	Was the protagonist a symbolic figure?
Protagonist: Number of assailants	Numerical	How many protagonists? ***Initial possible values: exact number or ratio scaled category (e.g. 1-5 or 5-10)*** ***Current possible values: exact number***
Protagonist: Male / Female	Binary	Was the protagonist feminine or masculine? *Possible values: male, female*
Protagonist: Age group	Numerical	What specific age has the protagonist or to what age group does he or she belong? *Possible values: numbers 1 up to 100, 20-30, 30-40 or 'miscellaneous'.*
Protagonist: Terrorist group	Nominal	Member of terrorist group known by the Global Terrorism Database (GTD). *Possible values: see GTD Codebook on http://www.start.umd.edu/gtd/*
Protagonist: Terrorist group	Text	Further description or details of the Terrorist Group
Protagonist: Red Herring	Text	See Table 2 – Pandora-model: general information
Protagonist: Symbolism	Text	See Table 2 – Pandora-model: general information
Protagonist: Category	Nominal	What is the nature of the terrorist act? *Possible values: nationalistic, religious, ideological, lone wolf, miscellaneous or unknown*
Protagonist: Category	Text	Further description or details of the nature of the terrorist act.
Protagonist: Background/history	Text	Significant information about the background/history of the protagonist
Protagonist: Known previous incidents	Binary	Is there any known previous incident in which either the protagonist or the group to which he/she belongs to was affiliated with? *Possible values: yes, no*
Protagonist: Known previous incidents	Text	Further description or details of known previous incidents.
Protagonist: Known	Text	Further description or details of known previous incidents.

previous incidents		
Protagonist: Known subsequent incidents	Binary	Is there any known subsequent incident in which either the protagonist or the group to which he/she belongs to was affiliated with? *Possible values: yes, no*
Protagonist: Known subsequent incidents	Text	Further description or details of known subsequent incidents.
Protagonist: Known subsequent incidents	Text	Further description or details of known subsequent incidents.
Protagonist: Ties with third parties	Binary	Are there ties between the protagonist and third parties? *Possible values: yes, no*
Protagonist: Ties with third parties	Nominal	With which parties did the protagonist have any ties? *Possible values: see variable Protagonist: Terrorist group*
Protagonist: Ties with third parties	Text	Further description or details about the protagonist's ties with third parties.
Protagonist: Part of Multiple Incident	**Binary**	**Was the incident part of a sequence of incidents?** ***Possible values: yes, no***

3.3.3 Primary purpose of incident

Table 4 presents the variable 'Primary purpose of incident'. This variable indicates what the protagonist tried to obtain with his action(s).

Table 4 - ***Pandora-model: Primary purpose of incident***

Category	Type of variable	Description
Primary purpose of incident	Nominal	What did the protagonist try to obtain with his action? *Possible values: applying pressure, media attention, oppression, emphasizing cause, extending influence, eliminating opponent(s), training, miscellaneous, unknown*

3.3.4 The Antagonist

Table 5 describes the antagonist; the target of the terrorist event. Tis category also contains the variables that are used to define the number of casualties caused by the event.

In Chapter 4 two problems were noticed within the category 'Casualties'. First, the variable 'Antagonist dies from attack' describes whether the antagonist died from the attack or whether he or she survived. As one can only choose between the options 'yes' or 'no' to answer the question 'Did the antagonist die from the attack?', this variable is not well suited for a description of an event in which multiple antagonist played a role and during which some of them died and others did not. For this reason it was decided to add the variable 'antagonist dies from attack exact' in which the total number of antagonists that have died can be described.

Second, multiple scales are used to measure the numerical variables 'Total fatalities' and 'Total injured'. The values of these variables are filled out as an exact number or as an ordinal scaled category. To enable the inclusion of information as precise as possible and to perform statistical

analysis, it is decided to add the variables 'Total fatalities exact' and 'Total injured exact'. As the names of the variables suggest, these variables allow for an exact description of the number of total fatalities and injured.

Table 5 - *Pandora-model: the antagonist*

Category : Subcategory	**Type of variable**	**Description**
Antagonist: Primary target	Binary	Was the primary target a person or an object? *Possible values: person, object.*
Antagonist: Specific/generic	Binary	Is the target specific or generic? *Possible values: specific, generic*
Antagonist: Target Type	Nominal	What was the type of target? *Possible values: see Appendix 1.*
Antagonist: Name	Text	Name of antagonist
Antagonist: Description	Text	Description of antagonist
Antagonist: Red Herring	Text	Was there a false indicator as to who was the antagonist
Antagonist: Symbolism	Text	Is the antagonist of symbolic value?
Casualties: Antagonist dies from attack	Binary	Did antagonist die from attack? *Possible values: yes, no*
Casualties: Other fatalities	Binary	Were there any other fatalities? *Possible values: yes, no*
Casualties: Total fatalities	Numerical	What is the total number of fatalities? *Possible values: 0, 1, 2, 3 – 4, 5 – 6, 7 – 8, 9 – 10, 10 – 12, 13 – 15, 16 – 18, 19 – 21, 22 – 25, 26 – 30, 31 – 35, 36 – 40, 41 – 45, 45 – 50, 51 – 100, 101 – 150, 151 – 200, 201 – 250, 251 – 300, 300 – 500, or 'unknown'.*
Casualties: Total injured	Numerical	What is the total number of injured?

		Possible values: see total fatalities + values 501-1000 and 1001-2000.
Casualties: Antagonist dies from attack exact	**Numerical**	**How many of the antagonist died?** ***Possible value: the exact number of antagonist that died***
Casualties: Total Fatalities exact	**Numerical**	**What is the total number of fatalities?** ***Possible values: the exact number of fatalities***
Casualties: Total Injured exact	**Numerical**	**What is the total number of injured?** ***Possible values: the exact number of injured***

3.3.5 The Arena

Table 6 explains the different variables which describe the arena of the event. Besides variables describing the geographic location of the event, this category contains other variables which give a more detailed description of where the event took place. For instance, it is described whether the location was an urban or rural zone and if the event took place while the antagonist was en route.

Table 6 - *Pandora-model: arena*

Name of subcategory	Type of variable	Explanation
Arena: Region	Nominal	In what region did the event take place? *Possible values: see Appendix 1.*
Arena: Country	Nominal	In which country did the event take place? *Possible values: see GTD Codebook on http://www.start.umd.edu/gtd/*
Arena: City	Text	In what city did the event take place?
Arena: Kill zone	Binary	Was the kill zone urban or rural? *Possible values: urban, rural*
Arena: Static location	Nominal	What was the static location of the incident? *Possible values: home address, workplace, social location, hotel, other, not applicable or unknown?*
Arena: En route	Nominal	Did the event take place en route? *Possible values: Home - Work (or vice versa), Home - Social (or vice versa), Work - Social (or vice versa), Work – Work, Social – Social, Unknown.*
Arena: Public route / location	Binary	Was the route public? *Possible values: yes, no*
Arena:	Text	Further details on the location

Description		
Arena: Red Herring	Text	Was there any false indicator as to what location would be used?
Arena: Symbolism	Text	Was the location/arena symbolic?

3.3.6 Time

Table 7 presents the variables that can be found in the category 'time'. Together these variables construct a detailed time line of the terrorist.

Table 7 - *Pandora-model: time*

Category : Subcategory	**Type of variable**	**Description**
Time: Day of the week	Nominal	On which day of the week did the event take place? *Possible values: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.*
Time: Day	Numerical	Day of the month *Possible values: number 1 up to 31*
Time: Month	Nominal	Month *Possible values: January, February, March, April, May, June, July, August, September, October, November, December.*
Time: Year	Numerical	Year
Time: Hour (local time)	Nominal	At what hour (local time) did the event take place? Hour. *Possible values: numbers 0 up to 12 or 'unknown'*
Time: Minutes	Nominal	At what hour (local time) did the event take place? Minutes. *Possible values: numbers 0 up to 59 or 'unknown'*
Time: AM/PM	Binary	Did the event take place in the morning (AM) or evening (PM)? *Possible values: AM, PM.*
Time: Red Herring	Text	Was there a false indicator as to on which day the event would take place?
Time: Symbolism	Text	Is the day, date or time symbolic?

3.3.7 Context

Table 8 describes the category 'context' that contains only one variable and describes whether the act was committed for political, economic or other reasons.

Table 8 - *Pandora-model: context*

Category : Subcategory	**Type of variable**	**Description**
Context: Type	Nominal	What was the context of the event? *Possible values: political, economic, religious, personal, miscellaneous, unknown.*

3.3.8 (possible) Motive

Table 9 presents the category (possible) Motive that outlines the reason why the Protagonist committed the act.

Table 9 - *Pandora-model: (possible) motive*

Category : Subcategory	**Type of variable**	**Description**
(Possible) Motive: Motivation	Nominal	What was the motivation of the protagonist? *Possible values: significance of target, target vulnerability, level of grievance, level of exposure, significant date event, iconic value of target, miscellaneous, unknown.*
(Possible) Motive: Motivation	Text	Further explanation of motivation

3.3.9 Means

Table 10 summarizes the variables that describe the means that were used during the event. In Chapter 4 we notice there was a problem with the values of variable 'Weapon type'. This variable contained values that can be used interchangeably. The value 'knife' for instance, is a sub-weapon type that belongs to the umbrella-category 'Melee'. To distinguish between weapon types and sub-weapon types it was decided to add a variable 'Sub-weapon type' and to modify the values of the variable 'Weapon type' so that this variable only contains 'main' weapon types.

Table 10 - *Pandora-model: Means*

Category : Subcategory	**Type of variable**	**Description**
Means: Type of Incident	Nominal	What was kind of incident was it? *Possible values: Assassination/liquidation, armed assault, bombing, hijacking, hostage taking/kidnapping, vehicle attack, computer network attack/electronic warfare, CBRN, other miscellaneous, unknown.*
Means: Weapon type	Nominal	What weapon type has been used? ***Initial Possible values: Biological, nuclear, radiological, chemical, conventional explosive(s), self-made explosive(s), firearms (handguns, rifles, automatic weapons, sniper rifles, unknown), RPG(s), knife/blade/sword, fake weapons, incendiary, sabotage equipment, vehicle (not vehicle born), melee, other, miscellaneous, unknown.*** ***Current Possible values:*** ***Biological, Chemical, Radiological, Nuclear, Firearms, Explosives/Bombs/Dynamite, Fake Weapons, Incendiary, Melee, Vehicle (not vehicle born), Sabotage Equipment, Other, Unknown, Miscellaneous.***
Means: Weapon	Text	What specific weapon was used?
Means: Type of primary explosive	Nominal	If explosives were used, what type? *Possible values:* *See Appendix 2*
Means: Amount of primary explosive	Nominal	How much was used? *Possible values:*

		See Appendix 3
Means: Detonation	Nominal	In what way was the explosive detonated? *Possible values: timer, radio frequency, pressure, manually, motion or trip-wire controlled, Miscellaneous, other, unknown.*
Means: Suicide mission	Binary	Was it a suicide mission or not? *Possible values: yes, no*
Means: Delivery method	Nominal	In what way was the explosive delivered? *Possible values: Ground based Vehicle, Water, vessel, Sub aquatic / scuba, Aircraft, Missile, Surface to surface, Missile, Surface to air, Missile, Air to surface, Missile, Air to air, Missile, unknown type, Suicide terrorist, Human host, Mail / post, Food / beverages, Water supply, Gaseous, Miscellaneous, Unknown.*
Means: Description of explosives	Text	Further details on explosives
Means: Description transportation	Text	Was there any transport and if so; what kind of?
Means: Red Herring	Text	Was there any false indicator as to what weapon(s) would be used?
Means: Symbolism	Text	Were the weapons used of symbolic value?
Means: Sub-weapon type	**Nominal**	**What was the exact type of weapon that was used?** ***Possible values: see Appendix 1***

3.3.10 Modus Operandi

Table 11 contains the variables that describe how the event happened. This allows the users of Pandora to create a precise storyline of what has happened and in what order.

Table 11 - *Pandora-model: modus operandi*

Category : Subcategory	Type of variable	Description
Modus Operandi: Level of intelligence	Nominal	How much intelligence did the protagonists need/attain for their actions? *Possible values: low, medium, high*
Modus Operandi: Modus operandi	Text	Explanation of what happened exactly
Modus Operandi: Pre-incident actions	Nominal	What happened right before the terrorist act? *Possible values: weapons/material movement, terrorist travel, terrorist training, surveillance, infiltration, test of security, illicitation, other, miscellaneous, unknown.*
Modus Operandi: Pre-incident actions	Text	Further description or detail of the pre-incident actions.

Modus Operandi: Pre-incident actions	Nominal	"…"
Modus Operandi: Pre-incident actions	Text	"…"
Modus Operandi: Pre-incident actions	Nominal	"…"
Modus Operandi: Pre-incident actions description	Text	"…"
Modus Operandi: Post-incident actions	Nominal	What happened right after the terrorist act? *Possible values: subsequent attack(s), subsequent action(s), incident claimed, successful exfiltration, other, miscellaneous, unknown.*
Modus Operandi: Post-incident actions	Text	Further description or detail of the post-incident actions.
Modus Operandi: Post-incident actions	Nominal	"…"
Modus Operandi: Post-incident actions description	Text	"…"
Modus Operandi: Communication	Text	Was there any form of communication during, before or after the attack?
Modus Operandi: Red Herring	Text	Was there any false indicator as to what the modus operandi would be?
Modus Operandi: Symbolism	Text	Was the modus operandi applied of symbolic value?

3.3.11 Resistance

Table 12 lists the variables that describe if and to what extend there was any protection for the antagonist.

Table 12 - *Pandora-model: resistance*

Category : Subcategory	**Type of variable**	**Description**
Resistance: Protection	Binary	Was there any form of protection? *Possible values: yes, no*
Resistance: Driver	Binary	Was there any driver? *Possible values: yes, no*
Resistance: Number of protectors	Numerical	How many protectors were there?
Resistance: Armed protectors	Binary	Were there any armed protectors? *Possible values: yes, no*
Resistance: Number of Armed protectors	Numerical	If yes, what number?
Resistance: Procedure	Text	What procedure did the protectors follow?
Resistance: Protection	Nominal	What kind of protection was there? *Possible values: Armored car, travelling in convoy, advanced protection team, counter surveillance team, guarded compound, body armor, RF jammers, unknown.*

Resistance: Protection	Nominal	".."
Resistance: Protection	Nominal	"…"
Resistance: Previous security breach	Text	Was there an earlier breach in security?
Resistance: Security intervention	Text	Has there been an intervention during or preceding the attack?

3.3.12 'Opmerkelijkheden'

Table 13 refers to the final category within Pandora that is called 'opmerkelijkheden' ('remarkabilities' or 'further comments'). Four text fields are reserved for a description of characteristics related to the terrorist event that do not fit within one of the other categories.

Table 13 - *Pandora-model: further comments*

Category : Subcategory	**Type of variable**	**Description**
Opmerkelijkheden: 'Extra veld'	text	For all further information that could not be placed within one of the other categories.
Opmerkelijkheden: 'Extra veld'	text	"…"
Opmerkelijkheden: 'Extra veld'	text	"…"
Opmerkelijkheden: 'Extra veld'	text	"…"

4. Pandora vs. statistical analysis

This chapter provides an answer on the second research question:

> RQ2: "To what extent is the current version of the Pandora model suited for statistical analysis?"

In Chapter 3 we have seen the different components the initial version of Pandora is made up of. This information enabled us to analyze the components in order to see if some of them can be improved. This analysis will already partially provide an answer on the problem statement. However, knowledge obtained from the third research question is needed to answer the problem statement as well and especially for this research question an early analysis of Pandora's components is crucial. Since statistical methods are used to answer the third research question, we need to revise whether Pandora in its current form can even be used for statistical analysis. The following sections will clarify if Pandora is ready for statistical analysis, and if not, what needs to be improved before we can proceed to analyzing the dependencies and relationships between the different components of Pandora. Some points of improvements were already briefly explained in Chapter 3. In the following sections and subsections we will provide a more extensive description of these points of improvement and propose other improvements that could not be captured in the tables of Chapter 3.

First, five conceptual and technical points of improvement to the variables and values of Pandora's current data set are given (4.1). Hereafter, a sixth crucial point of improvement will be explained together with a clarification of why this improvement is so important and a detailed description of the approach that was chosen to implement this improvement (4.2).The chapter will be concluded by a short description of what we consider as a new and improved version of Pandora (4.3).

4.1 Identification of points of improvements for statistical analysis

The analysis of Pandora in the preceding chapter showed us what components (or variables) can be found in the model and how the values of these variables are defined. Unraveling Pandora allowed us to find out to what extent we could apply statistical techniques to the model. Six technical and/or conceptual improvements were found that needed to be implemented or changed in the data set before Pandora could be used for statistical analysis. The last point of improvement will be discussed in Sections 4.2 and 4.3 as this improvement requires a more extensive explanation.

Two points of improvement were mainly technical. To begin with, an overall returning fact is that, although Pandora contains categorical variables, none of these variables are numerical. However, many statistical programs are better in processing numerical data than textual data. To

enable statistical analysis, as is needed to answer the third research question, the values of the categorical variables therefore need to be made numerical.

Depending on the kind of component, the numerical variables can be of nominal, ordinal, interval or ratio scale. For instance, the variable 'Region (GTD)' of category 'Arena' can be classified as a nominal variable and variable 'Number of armed protectors' of category 'security' is an ordinal variable.

All variables which contained categorical values (see table 1 up to table 11) and which would be used for analysis have been made numerical. Therefore we simply replaced each category or value within a variable for a corresponding number. For the variable 'category' of category 'Protagonist' for instance, the value 'nationalistic' now corresponds with the number '1', the value 'religious' corresponds with the number '2', the value 'ideological' with number '3', and so on. Pandora contained a few variables (such as 'claimed by means of') of which the values actually needed to be filled out as a text but which lend their selves to be picked from a range of alternative options. Consequently the textual values of these variables have first been changed into categorical values and were made numerical afterwards.

The second technical improvement is related to the values of the variable 'Number of assailants' of the category 'Protagonist'. The values within this variable could not only be an exact number as well as a ratio scaled number, also the different scales between which one could choose showed an overlap. To define the total number of assailants one could for instance choose for a category '1-5' or a category '5-10'. Since the number 5 occurred in both categories, one would not know which category to pick when there are 5 assailants. To resolve this problem and to offer a more precise image of the number of assailants it is chosen to only use exact numbers for this variable. For those records which had a categorical value, the exact number of assailants had been looked up again and was filled out manually.

The third point of improvement has both technical and conceptual foundations. In four cases Pandora uses multiple scales to classify a variable. Besides the variable 'Number of assailants' that has already been mentioned in the preceding section, for the variables 'Total injuries', 'Total fatalities' and 'Age group', ordinal scales have been used which contain both exact numbers as well as ratio scaled categories. This is a technical problem as we cannot perform a statistical test with a variable that uses two different kinds of scales at the same time. Therefore, one needs to choose which scale provides us with the most important information. This decision forces us to look at the conceptual part of the problem; what do we want to measure and what data do we want to preserve? Regarding the variable 'Age group' for instance, one can suggest it is easier to find patterns for an age group (a ratio scaled variable) than for a specific age (an exact value). One very trivial reason for this is that there is more data for a group that is clustered together from different values

than there is for one single value. However, we thought it would be a shame to loose data by clustering the exact values into categories without maintaining the initial exact values.

For the variables 'Total fatalities' and 'Total injuries' , this issue has been resolved by adding new columns in which the exact number of total fatalities and injuries is mentioned. For the initial columns of these variables, it is chosen to change the values of all records that contained an exact number into a ratio scaled value. So for some variables we now have two different columns; one of these describes the exact value whereas the other places the value in a distinct category. Analysis of the variables in chapter five will show if our idea that it is easier to find patterns with ratio scaled variables than with exact values is correct. Results of this analysis should indicate whether it should be considered to use the categorical variable in the model instead of the variable with exact values or the other way around.

Some variables, including the variable 'age group', will not be taken into account for the statistical analysis as we do not have enough records that contain information on these variables. Therefore, conflicting scales used within these variables will not be changed or decomposed into two columns/variables for this research.

The fourth point of improvement that we have implemented is a small conceptual improvement as it simply extends the number of variables within the dataset with two variables. First, Pandora only mentions whether the antagonist died from the attack or not but does not mention how many of the antagonists died. Therefore, this variable is not suited for a description of incidents in which some of the antagonists died and others did not. Since we merged Pandora with another database to increase the number of records (see Section 4.2) and this database did contain a variable 'number of protagonists died', we decided to add this category to Pandora too. Second, we added the variable 'Part of Multiple incident' that was also found in the other database and that complements Pandora's variables 'Known previous incidents' and 'Known subsequent incidents' by directly answering the question whether an incident is part of multiple incidents or not.

The fifth point of improvement is both technical and conceptual and is related to one more variable that caused confusion. The variable 'Weapon type' within the category 'Means' contained values that could be used interchangeably. One could for instance choose the value 'Knife(s) Blade(s), Sword(s) etc.', or the value 'Melee'. Yet, the concept 'melee' refers to every object or technique that can be used to harm someone in a close combat. Therefore, the value 'Knife(s) Blade(s), Sword(s) etc.' belongs to the umbrella category 'melee'. To distinguish between weapon types and sub-weapon types it was decided to add a variable 'sub-weapon types' and to manually correct all records that actually described a sub-weapon type in the category 'Weapon type'. To fill out the sub-weapon types for the existing records, each individual case was analyzed again either by using the information that was already in Pandora or by searching for reliable references on the internet.

When the sub-weapon type was not clear, the founder of Pandora was consulted to discuss the different possibilities. A few times, it turned out multiple sub-weapon types were used during an incident. In this case it was chosen to fill out the most salient sub-weapon type or to choose for the value 'miscellaneous'.

Adding the variable 'sub-weapon types' was a pragmatic decision. It enables us to distinguish between two different kinds of variables that were used interchangeably and obscured the dataset because of that. Furthermore, by adding the variable a loss of information was avoided and it enabled us to incorporate even more details in the dataset. However, an analysis of the relationships between the two variables should point out whether the variables actually complement each other and whether or not it is useful to incorporate both variables in the model. Results of the analysis in chapter 5 will clarify these questions.

4.2 Expanding Pandora

The sixth point of improvement is related to the number of records in Pandora and is, just like the second and fifth improvement, of a both conceptual and technical nature as it improves the quality and the quantity of the model. Pandora contains 124 unique terrorist incidents ranging from the assassination of Czar Alexander II in 1881 to the attack of Nordine Amrani on a number of civilians in the center of Liège in 2011. 124 different records might contain enough information for qualitative research. For quantitative analysis however, this number of records is not large enough to guarantee the reliability of the results. In principle, there were two different options to resolve this problem. The first one was to manually add new incidents to the model. Then we would need to look up information on at least 377 different incidents (the required sample size for a 95% confidence interval when the entire population -number of terrorist incidents- is larger than 20,000) in open sources and create storylines upon these incidents by filling out the variables in Pandora. Clearly, this would require a significant amount of time. The second option was to search for comparable databases to see if it was possible to add information from these databases to the Pandora-model. As the first option seemed to require more time than the second option, we choose to start with the latter.

4.2.1 The Global Terrorism Database

The founder of Pandora was asked to verify if he or any other person in his working environment new about the existence of a database comparable to Pandora. The outcome of this query was that there does not seem to be a database that takes the same approach as Pandora does, namely, using classical scenario elements to create story lines. However, there is a large database that contains records on terrorist incidents; the Global Terrorism Database.

The Global Terrorism Database (hereafter called "GTD") is an open-source database including more than 98,000 records on terrorist events throughout the world. It includes cases from 1970 through 2010 and each individual case can be retrieved via an online interface. The National Consortium for the Study of Terrorism and Responses to Terrorism (START) enables online access to the database *"to increase understanding of terrorist violence so that it can be more readily studied and defeated".* According to START, the GTD currently is the most comprehensive unclassified database on terrorist events in the world (START, 2012).

4.2.2 Plan of approach

In order to see if data from the GTD could be added to Pandora, and thus if the two databases could be merged, the different variables of both databases and their corresponding values needed to be compared. For this purpose, a table was set up in which the different categories of Pandora and their corresponding variables were listed (Column 1 and 2). Information about the nature of the variables (whether they were text variables, yes/no or male/female (dichotomous) variables or variables that contained multiple categories (categorical)) was also given (Column 3). This information was compared with the information of the GTD code-book. In the GTD code-book all variables included in the GTD are described and the range of possible values for each variable is given. For each variable in Pandora it was verified whether this variable also appeared in the GTD, whether it did not appear in the GTD or whether it did appear in the GTD but in a different form (Column 4). An example for the latter is that Pandora and the GTD both provide a summary on each incident but where Pandora lists the 'what, where, against and whom', GTD describes the 'when, where, who, what, how and why'. Subsequently, the name and number of the GTD variable that partly or completely corresponded with the Pandora variable were listed in the table (Column 5). In case a GTD variable partly corresponded with a Pandora variable, a short description of the differences between the variables was given (Column 6) and a method to deal with this difference was proposed (Column 7). Table 13 shows how the comparison table looked like for four of the variables of the category 'Protagonist'. The complete table can be found in Appendix 4.

Tabel 13 - Example of comparison variables Pandora with variables GTD

Component Pandora			**Does the Pandora-component occur in the GTD?**			**Possible improvements of cells Pandora**
Category	*Name*	*Kind of variable*	*No = not in GTD Yes = exactly the same in GTD Different = in GTD but in a different*	*Name and number of (partly) corresponding GTD category*	*What is different?*	

			form			
Protagonist	Protagonist known	Y/N	No			
	Incident attributed to	Text	No			
	Incident claimed by	Text	Different	IX. Perpetrator Claim of Responsibility – A. Claim of Responsibility?	Pandora names the one who claimed incident, GTD leaves that behind but answers Q whether incident is claimed or not	Adding extra variable: Incident claimed? → Y/N
	Claimed by means of	Text	Different	IX. Perpetrator Claim of Responsibility – B. Mode for claim of Responsibility	Pandora uses text variable, GTD uses categorical variable	Using a categorical variable

After comparing all variables of Pandora with those of the GTD, it appeared that the two databases had four fundamental differences. Firstly, Pandora is based on the classical scenario elements of the creative industry and therefore incorporates very specific variables such as 'symbolism' and 'red herring'. These variables were not found in the GTD, neither were other more straightforward variables such as the variable 'leakage' that describes whether there was a leakage before, during or after the incident or not. Secondly, the comparison of the databases showed that the GTD contains more variables than Pandora as it allows for distinguishing multiple victims, perpetrators, weapon types etc. Thirdly, although the GTD contains more variables, the variables of Pandora cover a broader range of incident characteristics (such as 'level of security') and therefore allow for a more detailed description of the incidents. Then, in contrast to Pandora, GTD allows for a detailed description of the specific attack types 'hostage taking' and 'kidnapping'.

Despite these differences there were enough similarities between the two databases to bring all their records together in a new and expanded Pandora database. The resembling variables of the records of the GTD were loaded into Pandora. 79 variables of Pandora did not occur in the records of the GTD. Therefore these fields were automatically left blank. Variables that did occur in the GTD but not in Pandora, such as 'value of property damage', were not incorporated in the final database as they did not fit within the scenario concept or were too specific. However, there were two exceptions on this rule. As described in Section 4.1, weapon types and sub-weapon types were used interchangeably in Pandora. Therefore we decided to add the GTD category 'sub-weapon types' to Pandora and to manually correct all records in which a sub-weapon type was described in the column were actually the main weapon type needed to be described. Also, to prevent a loss of information from the GTD, we added the GTD variable 'part of multiple incidents'. Pandora contained the variables 'Known previous incidents' and 'Known subsequent incidents' that already indirectly answer the question whether an incident is part of multiple incidents. Therefore, it was relatively easy to fill out the variable 'part of multiple incidents' for all existing records in Pandora.

Pandora and the GTD have been merged into an Open Office file. As Open Office files are restricted to a maximum of 65,000 records, it was not possible to use all cases of the GTD. Therefore,

the cases from the year 1991 until the year 2010 have been used. Together with the 124 cases of Pandora, this brings the total number of records in Pandora II at 53288.

4.3 Pandora II

Concluding this chapter we can say a new version of Pandora has been created that in its foundations still resembles the initial version of Pandora but that differs in two facets. First of all, the number of records has significantly increased from 124 incidents to over 50,000 different incidents. Secondly, improvements to the existing variables and their corresponding values have been carried through which enables us to conduct statistical analysis with the information in Pandora. From that we can investigate to what extent there are any dependencies or relationships between the different components of Pandora (Research Question three). It is expected that this points out which variables are crucial for anticipating criminal behavior and helps us fine-tuning, and thus again improving, the composition of the database.

What methods of analysis will be used for the purpose of suggesting improvements for Pandora and what the results of this analyses are, will be described in the next chapter. This is preceded by a description of which components of Pandora are most important for the usage of the model in the practice of criminal investigation. This enables us to identify which components require the most attention during the statistical analysis of the model.

5. Relationships and dependencies between different components

In the following chapter the results from the statistical analyses of Pandora II are presented. First, it is described what variables from the entire data set were found to be suitable for statistical analyses and how we came to this selection (5.1). Then, the results of four analyses are reported. The first test analyzes the relationships and dependencies between the variables 'Target type, 'Type of incident', 'Weapon type' and 'Sub-weapon type' (5.2). For the second test, one extra variable was taken into consideration; the variable 'Terrorist group' (5.3). A third test was conducted in which we modified two of the variables to see if this would give a better result than the first and second test (5.4). Finally, in addition to the three tests that reveal relationships between variables, one test was performed to see whether the way information is presented has an influence on the strength of the relationships that are found (5.5). Results of the different tests will provide an answer on the following research question:

> *RQ3: To what extent are there any relationships and dependencies between the different components of the Pandora model?*

5.1 Selection of variables for analysis

When selecting the variables that could be analyzed for the purpose of this research, two criteria were of importance. First, the data we wanted to use needed to be numerical. The reason for this is that programs such as SPSS (the program that will be used for this research) are not well suited for non-numerical variables (Weegen, van der, 2006). The tables that outlined the different components of Pandora in Chapter 3 already showed for each variable whether it was a text, numerical or a categorical (nominal) variable. The text variables of Pandora could not be used for the analysis of relationships and dependencies with SPSS. The reason for this is that these variables contain highly divergent values and therefore cannot be made numerical. The values of most of the categorical variables could, on the other hand, be expressed as or translated to a number.

Secondly, the variables we wanted to analyze needed to contain enough data. This criterion is related to the merging of the initial version of Pandora with the Global Terrorism Database. As there were some fundamental differences between the composition of Pandora and the GTD, for 79 variables within Pandora II there is no corresponding variable in the GTD. Since those variables do not contain enough data to guarantee reliable results, this automatically implies they cannot be used for analysis. An example of such a variable is the variable 'leakage' from the category 'Protagonist'. This variable did not appear in the GTD and therefore Pandora II contains only 124 records for this specific variable, equal to the number of records in the initial version of Pandora.

The total number of variables in Pandora II is 125. After testing these variables on the criteria mentioned above, it was found that 23 of the variables can be used for analysis in SPSS. Appendix 5 provides a table that shows for each variable whether it can be used for analysis with SPSS or not, and if not; which of the criteria is not met by the variable. The variables that can be used are summarized in table 14. Also, it is described whether the variables are continuous or discrete and when a variable is discrete, it is given whether the variable is binary, nominal or ordinal. We need this information for the selection of the right analysis methods to measure the relationships and dependencies between the different variables.

Tabel 14 - Summary of variables that can be used for analysis with description of their type

	Variable	*Type of variable*
1.	Succesful attack or attempt	Discrete – binary
2.	Protagonist - Incident claimed by means of	Discrete - ordinal
3.	Protagonist - Number of assailants	Discrete- rational
4.	Protagonist - Terrorist group	Discrete- nominal
5.	Protagonist - Ties with third parties	Discrete- nominal
6.	Antagonist - Target Type	Discrete- nominal
7.	Arena - Region	Discrete- nominal
8.	Arena - Country	Discrete- nominal
9.	Time - day	Discrete- nominal
10.	Time - month	Discrete- nominal
11.	Time - Year	Discrete- nominal
12.	Means – Type of Incident	Discrete- nominal
13.	Means – Weapon type	Discrete- nominal
14.	Means – Sub-weapon type	Discrete – nominal
15.	Means – Suicide mission	Discrete – binary
16.	Modus Operandi – Part of multiple incident	Discrete – binary
17.	Casualtities – Antagonist dies from attack (yes/no)	Discrete – binary
18.	Casualtities – Other fatalities (yes/no)	Discrete – binary
19.	Casualtities – Total fatalities (in categories)	Discrete - ordinal
20.	Casualtities – Total injured (in categories)	Discrete - ordinal
21.	Casualtities – Antagonist dies from attack (exact number)	Discrete - rational
22.	Casualtities – Total fatalities (exact number)	Discrete - rational
23.	Casualtities – Total injured (exact number)	Discrete - rational

5.2 Test 1

As testing relationships between 23 variables is not possible within the time reserved for this research, it was first decided to analyze relationships and dependencies between four of the variables. The variables ‘target type’, ‘Type of Incident’, ‘Weapon type’ and ‘Sub-weapon type’, were

selected since experts in the field of criminal investigation expected these variables to correlate with each other[1].

5.2.1 Selection of method for analysis

Each selected variable is measured on a nominal scale. Therefore the Chi Square is used to measure the existence or non-existence of relationships. The following 0-hypotheses were formulated for the Chi Square tests:

1. The target type does not correlate with the type of incident
2. The target type does not correlate with the weapon type used
3. The target type does not correlate with the sub weapon type
4. The type of incident does not correlate with the weapon type used
5. The type of incident does not correlate with the sub weapon type
6. The weapon type used do not correlate with the sub weapon type

Results showed that none of the hypotheses could be tested with the Chi Square. The Chi Square test has two assumptions; (1) all expected cell frequencies should be equal to or bigger than 1, and (2) at the very most 20% of the expected cell frequencies may be between 1 and 5. Unfortunately, each combination of the four variables led to a violation of one or both of these assumptions.

Besides the Chi Square, there are few statistical tests to analyze relationships or dependencies between nominal variables. Logistic regression with dummy variables is sometimes used. However, it is discouraged to use this technique when a variable has many values. Applying logistic regression to our variable 'Type of Incident' for instance, implies the creation of 13 dummy variables (N=14, number of dummy variables is N-1). To explain the logits (logarithms of a chance ratio) of these variables, one needs to perform 13 distinctive tests. According to Lammers, Pelzer, Hendrickx and Eisinga (2007, p. 163), such an approach will generally lead to inconsistencies in the results, such as different predicted changes for a specific category and predicted chances for all categories which, all taken together, do not count up to 1.

Other tests, such as the association measures Phi or Cramér's V could not be used either since they are based upon the Chi Square. One remaining option was to use an association measure based on the proportional reduction of errors such as the Lambda or Goodman & Kruskal's Tau. These measures show the proportional reduction of wrong predictions of a dependent variable when we know the independent variable, in opposite to a situation in which we do not know the independent variable. Lambda has a value between 0 and 1. Finding a Lambda of 0 means one is not capable to predict the dependent variable by using the independent variable. When, on the contrary, Lambda has the value 1, there is a proportional error reduction of 100% which implicates a perfect

[1] Personal correspondance with Peter Berenschot (KLPD)

prediction of the dependent variable (De Vocht, 2010, p. 161). As the Chi Square could not be used to test our hypotheses, and other methods are limited and less usable, we decided to perform a Lambda analysis. The advantage of the Lambda is that is has no constraints on the distribution of variables but this also makes it less accurate than the Chi Square. Therefore, the results presented below should be interpreted with a certain reticence.

5.2.2 Results Test 1

Lambda analyses were performed for six combinations of four variables (see hypotheses 1 to 6 in Subsection 5.2.1). Each of the two variables within a combination acted once as a dependent and once as an independent variable so in total there are twelve different relations. Table 15 gives five parts of information about the six Lambda analyses and their corresponding results. The first column describes what combination of variables was tested. The second column describes which of the two variables is the dependent variable. The third column gives the Lambda value that was found for each relation. The fourth column lists the proportional error reduction percentage (PRE) that corresponds to the Lambda value and the fifth column gives the P-value (approximate significance) of the relation that was tested. We adopt the guidelines for interpreting strength of association (Lambda, Gamma, Pearson's *r*) to judge the strength of the Lambda values: 0.0 = no relationship, ±0.0 to ±0.9 = weak relationship, ±0.10 to ±0.29 = moderate relationship, ±0.30 to ±0.99 = evidence of strong relationship, ±1.00 = perfect/strongest possible relationship (Babbie et al, 2007).

To explain how the results in the table should be interpreted, we take the relationship "Target type / Type of incident" as an example: There is a significant two-sided relationship between the variables 'Target type' and 'Type of incident'. The number of incorrect predictions about the target type will decrease with 2.5% when we know what the type of incident is (λ= .025, *p*= .000), in contrast to a situation in which we do not take the type of incident into account. When we need to predict the type of incident, incorrect predictions will decrease with 1.4% when we know what the target type will be (λ=.014, *p* =.000). Using the guidelines for interpreting the strength of association, both relations can be characterized as weak.

Table 15

Results Lambda H1 until H6

	Dependent variable	Value	% PRE	Approx. Sig.
Target Type / Type of Incident	Target type	.025	2.5	.000
	Type of Incident	.014	1.4	.000
Target Type / Weapon Type	Target Type	.008	0.8	.000
	Weapon Type	.043	4.3	.000

Target Type / Sub-Weapon Type	Target type	.013	1.3	.000
	Sub weapon type	.102	10.2	.000
Type of Incident / Weapon Type	Type of Incident	.542	54.2	.000
	Weapon Type	.705	70.5	.000
Type of Incident / Sub-weapon Type	Type of Incident	.616	61.6	.000
	Sub weapon type	.325	32.5	.000
Weapon Type / Sub-weapon Type	Weapon Type	.999	99.9	.000
	Sub weapon type	.374	37.4	.000

5.2.3 Conclusion Test 1

From Table 1 we may conclude that there are significant relations between all combinations of tested variables. However, some combinations of variables are stronger related to each other than other combinations. We will list the six combinations of variables in descending order of the strength of their relations:

1. Weapon type vs. Sub-weapon type (strong relationship)
2. Type of Incident vs. Weapon type (strong relationship)
3. Type of Incident vs. Sub-weapon type (strong relationship)
4. Target type vs. Sub-weapon type (weak to moderate relationship)
5. Target type vs. Weapon type (weak relationship)
6. Target type vs. Type of Incident (weak relationship)

It can be easily explained that ‘Weapon type’ and ‘Sub-weapon type’ are highly related variables since the latter complements the former. As the sub-weapon type of an incident is known, one can easily induce the category of weapon type the weapon belongs to. When a rifle is used during an incident, the value for sub-weapon type will be ‘rifle’ and the value of weapon type will off course be ‘firearms’ and not ‘Nuclear’. It obviously is more difficult to reason the other way around. When the category of weapon type is known, there still can be different sub-weapon types belonging to that category. Finding bullet holes on a crime scene suggests that a firearm has been used but does not immediately tell you what kind of firearm it was.

Besides the strength of the relationships, the results also indicate for each variable what their best predictor variable is. When ‘Target type’ is unknown, one has the best chance to correctly predicting it when reasoning from ‘Type of incident’. ‘Sub-weapon type’ is the best predictor of both ‘Type of incident’ and ‘Weapon type’. Finally, to predict ‘Sub-weapon type’, the highest change on an accurate prediction will be received when ‘Weapon type’ is known.

5.3 Test 2

To increase the reliability of our results, we wanted to subject our data to a more severe test than the Lambda. Therefore it was decided to perform a second analysis. In order for us to be able to use the Chi Square, the data or variable set needed to be changed so that it did not violate the Chi Square assumptions anymore.

It was chosen to expand the variable set from the first test with the variable 'Terrorist group'. Many groups have their own mode of operation. Therefore, each group is expected to have its 'own' indicators such as a specific type of incident or target type. Revealing relationships between target type, type of incident, weapon type and sub weapon type and different terrorist groups, might support this expectation and open a window for predicting the terrorist group (protagonist) of an incident on the basis of other variables. Pandora contains over 2000 different terrorist groups; we chose to first analyze relationships between the four variables for the ten most occurring groups. By limiting the number of terrorist groups in our tests, we exclude all cases that belong to the remaining terrorist groups from our analysis. The groups that are included in our analysis are those that occur most often in the dataset and therefore contain the most data. It is expected that this increases the cell frequencies so that we can perform a Chi Square analysis for this set of variables and cases. If this measure is not sufficient, it can be decided to combine different values within the variables in order to increase the cell frequencies of these variables.

Table 16 shows which terrorist groups occur most often in the entire dataset, together with their exact frequency and their percentage with regard to the entire dataset. Despite the fact that the category 'Unknown' contains the most data, we will not include this category in our analysis. The category 'Unknown' does not refer to a specific terrorist group but to a jumble of incidents related to multiple unknown terrorist groups. Therefore we will not expect to find particular indicators for this category on the basis of which a specific terrorist group can be identified.

Table 16.
Top 11 Terrorist Groups with highest frequency

		Frequency	Percent
Terrorist group	Unknown	26959	50.5
	Taliban	1744	3.3
	Revolutionary Armed Forces of Colombia (FARC)	1233	2.3
	Liberation Tigers of Tamil Eelam (LTTE)	1188	2.2
	Communist Party of India - Maoist (CPI-M)	964	1.8
	Kurdistan Workers' Party (PKK)	953	1.8
	Shining Path (SL)	896	1.7
	National Liberation Army of Colombia (ELN)	612	1.1
	Irish Republican Army (IRA)	601	1.1
	Basque Fatherland and Freedom (ETA)	522	1.0

To measure the existence of relationships between the four variables for each of the ten high frequency terrorist groups, we performed a Chi Square analysis. It appeared that it was not possible to perform a Chi Square analysis because both of the Chi Square assumptions were violated by all terrorist groups for each combination of variables. First, the expected cell frequencies were not equal to or bigger than 1. Secondly, the percentage of expected cell frequencies between 1 and 5 exceeded the maximum of 20%. Therefore we decided to perform a Lambda Analysis again. Subsections 5.3.1 to 5.3.6 each present the results of the Lambda analysis of one specific combination of variables for all selected terrorist groups. Tables are presented and need to be interpreted on the same way as for the first analysis in Section 5.2. In addition to the tables we will highlight three aspects of the results. First, for each combination of variables we discuss the strength of their relationships. Second, we mention which of the two variables within the combination is the most easy to predict. Third, we discuss for which of the terrorist groups we found the strongest and weakest results and which of the groups thus seem to be most easy or most difficult to predict.

5.3.1 Relationship between Target type and Type of incident

Table 17 presents the results for the two-sided relationships between the variables 'Target type' and 'Type of Incident' for each terrorist group. The results are threefold. Firstly, we notice that, except for the FMLN, for which we found strong relations between the variables (λ=.543, *p* =.000 and λ=.777, *p*=.000), the strength of the relations can generally be considered as weak to moderate. Secondly, for eight of the ten groups it is easier to predict the type of incident by use of the target type than the other way around. Thirdly, although the overall strength of this relation is moderate, there is a clear difference in the proportional error reduction between the different groups. The strongest relation between 'Target type' and 'Type of Incident' has been found for the Farabundo Marti National Liberation Front (FMLN). Both the target type and the type of incident of this group could be predicted more accurately than those of other groups. The weakest relations between these variables are found for the Tigers of Tamil Eelam (LTTE) and the Taliban. Predicting the target type by use of the type of incident was most difficult for the LTTE. For the Taliban, it was most difficult to predict their type of incident by using information about the target type. The fact that the variables of one group are easier to predict than those of another group can reveal that groups differ in the extent to which they often use the same mode of operation. This idea will be elaborated upon in Subsection 5.3.7.

Table 17

Lambda Results for Relations between variables 'Target Type' and 'Type of Incident' per Top

Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Target type	.079	7.9	.000
	Type of Incident	.042	4.2	.020
Revolutionary Armed Forces of Colombia (FARC)	Target type	.102	10.2	.000
	Type of Incident	.114	11.4	.000
Liberation Tigers of Tamil Eelam (LTTE)	Target type	.059	5.9	.000
	Type of Incident	.092	9.2	.000
Communist Party of India - Maoist (CPI-M)	Target type	.096	9.6	.000
	Type of Incident	.219	21.9	.000
Kurdistan Workers' Party (PKK)	Target type	.219	21.9	.000
	Type of Incident	.343	34.3	.000
Shining Path (SL)	Target type	.142	14.2	.000
	Type of Incident	.262	26.2	.000
National Liberation Army of Colombia (ELN)	Target type	.180	18.0	.000
	Type of Incident	.257	25.7	.000
Irish Republican Army (IRA)	Target type	.227	22.7	.000
	Type of Incident	.329	32.9	.000
Basque Fatherland and Freedom (ETA)	Target type	.071	7.1	.000
	Type of Incident	.000	0.0	.[a]
Farabundo Marti National Liberation Front (FMLN)	Target type	.543	54.3	.000
	Type of Incident	.777	77.7	.000

a. Cannot be computed because the asymptotic standard error equals zero.

5.3.2 Relationship between Target Type and Weapon Type

Table 18 presents the relationships between the variables 'Target type' and 'Weapon type' for each of the ten terrorist groups. We make three observations: Firstly, we conclude that the relations between 'Target type' and 'Weapon type' of the different groups vary from weak (λ=.035, *p*=.000 for the prediction of the target type of the Taliban) to really strong (λ=.762, *p*=.000 for the prediction of the weapon type of the FMLN). Secondly, we can say that, although the differences are marginal, for nine out of ten groups it is easier to predict the weapon type by use of the target type than the other way around. Thirdly, there is a clear difference in the proportional error reduction of the ten groups. Again both researched variables are easiest to predict for the FMLN. The groups of which the target type and weapon type were most difficult to predict were also the same. When the weapon type is

known, it is most difficult to predict the target type of the LTTE. Predicting the weapon type by use of the target type is most difficult for the Taliban.

Table 18

Lambda Results for Relations between variables 'Target Type' and 'Weapon Type' per Top Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Target type	.035	3.5	.000
	Weapon Type	.048	4.8	.023
Revolutionary Armed Forces of Colombia (FARC)	Target type	.086	8.6	.000
	Weapon Type	.139	13.9	.000
Liberation Tigers of Tamil Eelam (LTTE)	Target type	.018	1.8	.000
	Weapon Type	.117	11.7	.000
Communist Party of India - Maoist (CPI-M)	Target type	.099	9.9	.000
	Weapon Type	.216	21.6	.000
Kurdistan Workers' Party (PKK)	Target type	.201	20.1	.000
	Weapon Type	.314	31.4	.000
Shining Path (SL)	Target type	.145	14.5	.000
	Weapon Type	.443	44.3	.000
National Liberation Army of Colombia (ELN)	Target type	.174	17.4	.000
	Weapon Type	.187	18.7	.000
Irish Republican Army (IRA)	Target type	.237	23.7	.000
	Weapon Type	.402	40.2	.000
Basque Fatherland and Freedom (ETA)	Target type	.055	5.5	.000
	Weapon Type	.000	0.0	.[c]
Farabundo Marti National Liberation Front (FMLN)	Target type	.539	53.9	.000
	Weapon Type	.762	76.2	.000

a. Cannot be computed because the asymptotic standard error equals zero.

5.3.3 Relationship between Target Type and Sub-weapon Type

Table 19 presents the results of the Lambda analysis on the relationship between target type and sub-weapon type for each of the terrorist groups. The results are threefold: Firstly, we notice that the relations between 'Target type' and 'Sub-weapon type' vary from weak (λ=.075, *p*=.000 for the prediction of the Taliban's target type) to strong (λ=.767, *p*=.000 for the prediction of the sub-weapon type of the FMLN). Secondly, for seven out of the ten groups it is easier to predict the sub-weapon type by use of the target type than the other way around. Thirdly, we notice that the highest amount of correct predictions of the target type and sub-weapon type would be obtained for the

FMLN again. The Taliban is also represented. For this group it is most difficult to predict the target type on the basis of information about the sub-weapon type. It is the Irish Republican Army (IRA) for which predictions of the Sub-weapon type by use of the target type will most often be incorrect.

Table 19

Lambda Results for Relations between variables 'Target Type' and 'Sub-weapon Type' per Top Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Target type	.075	7.5	.000
	Sub-weapon Type	.079	7.9	.000
Revolutionary Armed Forces of Colombia (FARC)	Target type	.176	17.6	.000
	Sub-weapon Type	.228	22.8	.000
Liberation Tigers of Tamil Eelam (LTTE)	Target type	.130	13.0	.000
	Sub-weapon Type	.156	15.6	.000
Communist Party of India - Maoist (CPI-M)	Target type	.140	14.0	.000
	Sub-weapon Type	.167	16.7	.000
Kurdistan Workers' Party (PKK)	Target type	.129	12.9	.000
	Sub-weapon Type	.101	10.1	.000
Shining Path (SL)	Target type	.148	14.8	.000
	Sub-weapon Type	.307	30.7	.000
National Liberation Army of Colombia (ELN)	Target type	.193	19.3	.000
	Sub-weapon Type	.209	20.9	.001
Irish Republican Army (IRA)	Target type	.192	19.2	.000
	Sub-weapon Type	.070	7.0	.107
Basque Fatherland and Freedom (ETA)	Target type	.117	11.7	.000
	Sub-weapon Type	.005	0.5	.705
Farabundo Marti National Liberation Front (FMLN)	Target type	.604	60.4	.000
	Sub-weapon Type	.767	76.7	.000

5.3.4 Relationship between Type of Incident and Weapon Type

Table 20 presents the lambda results for relations between the variables 'Type of Incident' and 'Weapon type' for the ten terrorist groups. We make three observations: Firstly, it can be seen that the strength of the relations between these variables are strong (λ=.502, *p*=.000 for the prediction of the type of incident of the FARC) to almost perfect (λ=.958, *p*=.000 for the prediction of the weapon type of the FMNLN). Secondly, we notice that for eight out of ten groups it is easier to predict the

weapon type by use of the type of incident than the other way around. However, the differences in proportional reduction of error between these relations are marginal. Finally, it can be said that predicting the type of Incident of a group by use of its weapon type and the other way around is most difficult for the Basque Fatherland and Freedom (ETA). Best results for these predictions will again be obtained for the FMLN.

Table 20

Lambda Results for Relations between variables ''Type of Incident' and 'Weapon Type' per Top Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Type of Incident	.598	59.8	.000
	Weapon Type	.666	66.6	.000
Revolutionary Armed Forces of Colombia (FARC)	Type of Incident	.502	50.2	.000
	Weapon Type	.652	65.2	.000
Liberation Tigers of Tamil Eelam (LTTE)	Type of Incident	.707	70.7	.000
	Weapon Type	.848	84.8	.000
Communist Party of India - Maoist (CPI-M)	Type of Incident	.728	72.8	.000
	Weapon Type	.698	69.8	.000
Kurdistan Workers' Party (PKK)	Type of Incident	.677	67.7	.000
	Weapon Type	.782	78.2	.000
Shining Path (SL)	Type of Incident	.528	52.8	.000
	Weapon Type	.817	81.7	.000
National Liberation Army of Colombia (ELN)	Type of Incident	.530	53.0	.000
	Weapon Type	.587	58.7	.000
Irish Republican Army (IRA)	Type of Incident	.709	70.9	.000
	Weapon Type	.882	88.2	.000
Basque Fatherland and Freedom (ETA)	Type of Incident	.465	46.5	.000
	Weapon Type	.429	42.9	.000
Farabundo Marti National Liberation Front (FMLN)	Type of Incident	.926	92.6	.000
	Weapon Type	.958	95.8	.000

5.3.5 Relationship between Type of Incident and Sub-weapon Type

Table 21 presents the relations between the variables 'Type of Incident' and 'Sub-weapon type'. As for the preceding combinations of variables we make three observations: Firstly, we notice that the strength of the relations varies from weak (λ=.121, *p*=.001 for the prediction of the sub-weapon type

of the ETA) to very strong (λ=.929, *p*=.000 for the prediction the type of incident of the FMLN). Secondly, for each of the terrorist groups it is easier to predict the type of incident by use of the sub-weapon type than the other way around. Then we conclude that the least errors in predictions about a group's type of Incident will occur when predicting the type of incident of the FMLN by use of information about their sub-weapon type. Predicting the FMLN's sub-weapon type on the basis of their type of Incident also has the highest change of success when comparing this with similar predictions for other groups. The sub-weapon type of the ETA for instance, was most difficult to predict by using information of this groups' type of Incident. Predicting the type of Incident with knowledge about the sub-weapon type was most difficult for the National Liberation Army of Colombia (ELN).

Table 21

Lambda Results for Relations between variables 'Type of Incident' and 'Sub-weapon Type' per Top Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Type of Incident	.637	63.7	.000
	Sub-weapon Type	.264	26.4	.000
Revolutionary Armed Forces of Colombia (FARC)	Type of Incident	.596	59.6	.000
	Sub-weapon Type	.313	31.3	.000
Liberation Tigers of Tamil Eelam (LTTE)	Type of Incident	.726	72.6	.000
	Sub-weapon Type	.183	18.3	.000
Communist Party of India - Maoist (CPI-M)	Type of Incident	.795	79.5	.000
	Sub-weapon Type	.464	46.4	.000
Kurdistan Workers' Party (PKK)	Type of Incident	.685	68.5	.000
	Sub-weapon Type	.258	25.8	.000
Shining Path (SL)	Type of Incident	.661	66.1	.000
	Sub-weapon Type	.534	53.4	.000
National Liberation Army of Colombia (ELN)	Type of Incident	.485	48.5	.000
	Sub-weapon Type	.434	43.4	.000
Irish Republican Army (IRA)	Type of Incident	.515	51.5	.000
	Sub-weapon Type	.252	25.2	.000
Basque Fatherland and Freedom (ETA)	Type of Incident	.522	52.2	.000
	Sub-weapon Type	.121	12.1	.001
Farabundo Marti National Liberation Front (FMLN)	Type of Incident	.929	92.9	.000
	Sub-weapon Type	.856	85.6	.000

5.3.6 Relationship between Weapon Type and Sub-weapon Type

Table 22 presents the results of the Lambda analysis for the relation between the variables 'Weapon type' and 'Sub-weapon type'. We make three observations: Firstly, the results show an interesting but logic finding about the prediction error reduction of the variable 'Weapon type'. When the sub-weapon type is known, the number of incorrect predictions of the weapon type always decreases with 100% (λ= 1.000). This indicates a perfect prediction relationship between weapon type and sub-weapon type when weapon type is the variable to be predicted. As sub-weapon type is a sub category of the main category 'Weapon type' this result was expected in advance. The strength of the relation between weapon type and sub-weapon type with sub-weapon type as to be predicted variable, vary from moderate (λ=.213, *p*=.000 for the LTTE) to very strong (λ=.884, *p*=.000 for the FMLN).Secondly it is easier to predict a group's weapon type by use of the sub-weapon type than the other way around. Thirdly, the proportional error reduction of the sub-weapon type slightly differs between the ten groups. It is most difficult to predict the sub-weapon type of the LTTE. The sub-weapon type of the FMLN is the easiest to predict.

Table 22

Lambda Results for Relations between variables 'Weapon Type' and 'Sub-weapon Type' per Top Ten Terrorist Group

	Dependent variable	Value	% of proportional error reduction	Approx. Sig.
Taliban	Weapon Type	1.000	100	.000
	Sub-weapon Type	.328	32.8	.000
Revolutionary Armed Forces of Colombia (FARC)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.321	32.1	.000
Liberation Tigers of Tamil Eelam (LTTE)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.213	21.3	.000
Communist Party of India - Maoist (CPI-M)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.590	59.0	.000
Kurdistan Workers' Party (PKK)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.328	32.8	.000
Shining Path (SL)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.600	60.0	.000
National Liberation Army of Colombia (ELN)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.412	41.2	.000
Irish Republican Army (IRA)	Weapon Type	1.000	100	.000

	Sub-weapon Type	.346	34.6	.000
Basque Fatherland and Freedom (ETA)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.238	23.8	.000
Farabundo Marti National Liberation Front (FMLN)	Weapon Type	1.000	100	.000
	Sub-weapon Type	.884	88.4	.000

5.3.7 Conclusion Test 2

Three different conclusions can be drawn upon the second test. Firstly, it can be said that overall the strength of the relations vary from weak to strong. However, for each of the six combinations of variables strong relations were found for at least two of the terrorist groups and for two out of the six combinations moderate to really strong relations were found for all terrorist groups. As the strengths of the relations of each variable combination highly differ per group, it is not possible to make a clear-cut distinction between the variable combinations that are easy to predict and those that are not as was done in Subsection 5.2.3.

Secondly, it can be concluded that for the majority of the groups, one of the variables within a combination is always easier to predict than the other variable. When we compare the results from this test with the results from test 1 that are presented in table 15, we notice that the results of the second test correspond highly to the results of the first test. When one of two variables within a combination has been found to be the most easy to predict in the first test, this result was repeated in the second test. The only exception to this is the variable combination 'Target type' vs. 'Type of Incident'. In the first test the variable 'Target type' is the easiest to predict and in the second test it is the other way around. However, the difference is small and we expect that it is not significant.

Thirdly, it was found that the variables of some groups are easier to predict than those of other groups. For each of the six variable combinations, the indicators of the terrorist group FMLN are easiest to predict. For three of the six variable combinations, the LTTE and the Taliban have the lowest Lambda value. Both the LTTE and the Taliban are thus found to be the most difficult to predict. These results suggest that the FMLN often uses the same technique and directs at a specific target group while this is not, or to a smaller extent, the case for the two lowest scoring groups. These premises can be supported by descriptive statistics (see Appendix 6). Frequencies of the FMLN's target types and type of incidents for instance, show that this group most often attacks utilities and military-related targets. The types of incident they use most are assassination and bombing. When attacking a military-related target the FMLN frequently uses assassination while they choose bombs for attacking utilities. The target types and type of incidents of the LTTE and the Taliban on the other hand, are more divergent and therefore less predictable.

5.4 Test 3

The first two tests have shown that it is not possible to perform a Chi Square analysis on the four variables 'Target type', 'Type of Incident', 'Weapon type' and 'Sub-weapon type', nor on a combination of these variables for a selected group of terrorists. The main reason is that there are too many empty frequency cells when we combine the values of two variables in a frequency table. We provide the following example to illustrate this problem: When we request a cross-table with the frequencies of the variables 'Target type' and 'Type of Incident' for the Taliban, a table is given with the number of incidents for each possible combination of target type and type of incident. There are a total of 144 assassinations by the Taliban; however, none of these assassinations was performed against Tourists or Airports and Airlines. Consequently, the frequency for the combinations 'Assassination/Tourists' and 'Assassination/Airports and Airlines', is 0. When more than 20% of all possible combinations have a frequency of less than 5, the Chi Square cannot be performed. As this has been the case for all tested groups, each of these groups clearly seems to have a preference for a particular type of incident and/or target types.

If we would eliminate the unpopular type of incidents from a terrorist group from our dataset, there should be less empty or lower-than-five frequency cells. To see if we could perform the Chi Square when ignoring the less preferred type of incidents, a third test has been performed. We arbitrary decided to include only the two highest frequency terrorist groups in this test. This is because we are not necessarily interested in the actual results of the test but we only want to know whether the Chi Square test could be used when modifying the values of a variable.

Frequency tables showed the type of incidents that are most often used by the Taliban are 'Armed Assault' and 'Bombing and Explosions'. Therefore, we tried a Chi Square test for the variables type of incident (with only the values 'Armed Assault' and 'Bombing and Explosions') and target type (with all original values). Still, this set of variables and values was not suited for a Chi Square analysis because it violated the Chi Square assumptions.

It is possible to ignore the least occurring values of the variable 'Target type' as well, or to recode this variable into a variable with fewer categories. However, this would restrict the extent to which the results of the test will say something about the actual variables even more than eliminating values of the first variable has already done. We should conclude the variables in this model simply are not qualified for a Chi Square analysis.

As in the first tests, the Lambda could be computed for these variables. The prediction error reduction is higher when only the two main types of incident are taken into consideration. The number of incorrect predictions of the Taliban's type of incident when choosing between the options 'Assassination' and 'Bombing and Explosions' will decrease with 5.3% when the target type is known (λ=.053, p=.118). As we have seen in test 2, the number of incorrect predictions of the Taliban's type

of incident will decrease with 4.2% (λ =.420, *p*=.020), when the target type is known and all options for the type of incident are open.

The next high frequency group that mainly uses the type of incidents 'Bombing and Explosions' and 'Armed Assault', is the FARC. For this group, the number of wrong predictions of the type of incident will decrease with 22.6% when one can only choose between their two preferred types of incident and the target type is known (λ =.226, *p*=.000). When all types of incident can be chosen, the number of wrong predictions of the type of incident is 11.4% when the target type is known (λ=.114, *p*=.000).

Conclusion Test 3

The results of the third test are twofold. Firstly, from this test we conclude that the variables of Pandora that we have been testing for this research simply are not suited for a Chi Square analysis. The values of variables might be modified so that they can be used for a Chi Square analysis; however, this would also negatively influence the extent to which the results say something about the initial variable.

Secondly, the differences in the results of the second and the third Lambda analysis indicate there is a higher chance to correctly predict the type of incident of a terrorist group when the least favorable type of incidents of this group are eliminated first. Further investigation is needed to discover if this strategy is also applicable when predicting other variables.

5.5 Additional test

In Chapter 4 we presented the idea that it might be easier to find patterns with a ratio scaled variable than with a variable with exact values. If this idea is correct, it could be considered to replace all possible variables with exact values by variables that are measured on a ratio scale.

To test if it really is easier to find patterns between a variable X and a categorical variable than between a variable X and a variable with exact values we tested the relationships between the variable 'Target type' and two variants of the variable 'Number of assailants'; one with exact values and one that is measured on a ratio scale. As target type is the independent variable and is measured on a nominal scale, the Chi Square analysis is the preferred method to be used. However, during the test it appeared that both the variable combinations violated the Chi Square assumptions. Therefore we performed a Lambda analysis of which the results can be found in Table 23.

In contrast with what was expected, the Lambda indicates a stronger relationship between target type and the exact number of assailants (λ=.010, *p*=.020) than between target type and the grouped numbers of assailants (λ=.005, *p*=.002). In the first instance this result means that our initial idea - that it is easier to find patterns with a categorical variable - is wrong. However, a closer look at the data reveals a remarkable pattern within one of the variables itself. It seems that the values that

occur most often in the variable 'number of assailants' with exact values, are the 'rounded' values such as 25, 30, 50, 200, etc. As it is not really likely that most incidents are performed by a perfectly rounded number of persons, this suggests that the number of assailants were often filled in as a rounded value instead of the exact value. There are three possible explanations for this: Firstly, this could have been done because the person who entered the value did not know he could fill out an exact value. Secondly, rounded values could have been used because the exact value was unknown and therefore an estimate was used. Thirdly, it could have been arbitrary decided to use rounded values because the exact number of assailants is often unknown.

As results of this test do not seem to be reliable we cannot draw any conclusions about what type of variables is preferred to be incorporated into the model. More tests of this nature should be performed to offer reliable results.

Table 23
Lambda Results for Relations between variable 'Target type' and variable 'Number of Assailants' with exact values and variable 'Number of Assailants' measured on a ratio scale

	Dependent variable	Value	Approx. Sig.
Target Type versus	Number of Assailants – exact value	.010	.020
	Number of Assailants – ratio scaled value	.005	.002

5.6 Summary

From the results it can be concluded that there are significant relations between the variables 'Target type', 'Type of Incident', 'Weapon type' and 'Sub-weapon type'. This means that knowing the value of one of the variables increases the chance on a correct prediction of the value of another variable. However, some variables are easier to predict than others and each variable has its own best 'predictor-variable'. It was also found that the variables of certain terrorist groups are easier to predict than the variables of other groups. This indicates that groups that are easy to predict employ a more constant work method than less predictable groups do. In addition to this, one of the relations that were found becomes stronger when the least occurring values of the variables are eliminated before the analysis. This indicates there is higher chance to correctly predicting the value for a variable when the least expected values are eliminated first.

6. Conclusion

In this chapter we will provide an answer on the problem statement of this research:

To what extent can the quality of the Pandora model be improved?

We do this by discussing the answers on the three research questions. First we will shortly describe the different components that form the framework of the Pandora model (6.1). Then it will be discussed if these components and their corresponding values are suited for statistical analysis (6.2) and what the relationships and dependencies between these components are (6.3). Finally, the implemented improvements and results of the analyses will be discussed and recommendations for further improvement of the model will be given in order to answer the problem statement (6.4).

6.1 Answer to research question 1

This section will provide an answer on the first research question:

"Which different components currently form the framework of the Pandora-model?"

The use of a scenario-model within the KLPD has two main advantages: (1) the creation of storylines or scenarios of incidents enables criminal investigators to compare multiple cases in order to explore associations between those cases. (2) A scenario model can serve as a tool for the storage and sharing of knowledge and experience across different organizations and departments.

Beside these advantages, the use of a model for criminal investigation also has two limitations: (1) confident information should be protected against unauthorized use and (2) the content of the model needs to be of consistent quality. Berenschot considered both these limitations when he designed 'Pandora', the test version of his initial scenario model.

Pandora is based upon the ESC12, the twelve Elementary Scenario Components (Berenschot, 2012). In complementation to the ESC12 categories, four general categories and many sub categories were added to the model. The following main categories can be found in the model: Case ID, Background, Successful attack, Peripeteia, Protagonist, Primary purpose of incident, Antagonist, Time, Arena, Context, (Possible) Motive, Security, Type of Incident, Modus Operandi, Casualties and Opmerkelijkheden ('Remarkabilities').

Pandora contains text, numerical and categorical variables. Text variables are open for interpretation and are filled out manually by each person that adds information to the model. For the numerical variables (e.g. 'Total injured'), users select a value from a list of options or manually add the right number. The categorical variables are either binary (yes or no, male or female) or nominal (e.g. different target types or primary purposes) and users need to select a value out of a list of options.

6.2 Answer to research question 2

This section will provide an answer to the second research question:

"To what extent is the current version of the Pandora-model suited for statistical analysis?"

A close examination of the framework of Pandora revealed there were conceptual and technical improvements that needed to be made in order for Pandora to be suitable for statistical analysis. Some improvements were both conceptual and technical. Conceptual improvements were mainly aimed at improving the quality of the dataset. This was elicited in two ways: (1) by adding variables that were not incorporated in the model yet, such as the variable 'number of antagonists died', or (2) by decomposing a variable with conflicting values into two variables that complement each other or that contain the same information but present it in a different way.

The technical improvements that were implemented, improved the quantity of the model and the statistical measurability of the variables. The two main technical improvements were: (1) the numeration of textual variables and (2) the extension of the number of records in the dataset. To increase the amount of incidents in the model, Pandora has been merged with the Global Terrorism Database (GTD).

The implementation of all conceptual and technical improvements has led to a new and improved version of Pandora that contains over 50.000 different incidents and can be used for statistical analysis: Pandora II. However, results of the third research question have also shown that the extent to which the different variables of the model can be analyzed by statistical methods is limited. This will be explained into further detail in the next section.

6.3 Answer to research question 3

This section provides an answer on the third research question:

"To what extent are there any relationships and dependencies between the different components of the Pandora-model?"

To analyze the relationships and dependencies between variables, the statistical analysis program SPSS was used. We noticed that of all the variables in Pandora II, only 23 could be used for analysis in SPSS. The variables that could not be used were either text variables or did not contain enough data. Eventually, five out of the 23 variables have been used for statistical analysis: 'Target Type', 'Type of Incident', 'Weapon Type', 'Sub-weapon type' and 'Terrorist group'.

The five selected variables were measured on a nominal scale. The most common method to analyze associations between two variables of this type is to use a Chi Square analysis. We performed three different tests with each time a different set of variables or values, to see if we could measure relations between the five variables with a Chi Square analysis. It appeared that the variables of

Pandora that we used were not suited for this test as they constantly violated one or both of the Chi Square assumptions. As the Chi Square could not be used, it was decided to perform a Lambda analysis. Since the Lambda is less severe than the Chi Square analysis, results should be interpreted with reticence.

Based upon the results of the first two tests we can draw four conclusions to the third research question: (1) The four variables 'Target Type', 'Type of Incident', 'Weapon Type' and 'Sub-weapon type' are significantly related to each other. This means that knowing the value of one variable increases the chance on a correct prediction of the value of another variable. (2) The strengths of the different relations vary from weak to nearly perfect. This means that some variables are easier to predict than others. In addition to that it was found that (3) each of the four variables has its own best predictor variable and (4) terrorist groups differ in the extent to which their variables can be predicted by other variables. The variables of some groups are easier to predict than those of other groups. This indicates that groups that are easier to predict often use the same techniques and aim at the same kind of target while these indicators are more fickle for less predictable groups.

Based upon the results of the third test we can draw a fifth conclusion to the third research question: (5) relations that were found become even stronger when the variables are modified. This suggests that there is a higher chance to correctly predict the value of a variable when the least expected values for this variable are eliminated first.

6.4 Answer to the problem statement

This section combines the results explained in Sections 6.1, 6.2 and 6.3 to provide an answer on the problem statement of this research:

"To what extent can the quality of the Pandora model be improved?"

It was found that the quality of the Pandora-model could be improved to a large extent. Conceptual and technical improvements have been implemented to improve both the quality and the quantity of the model. New variables and records were added to the model, conflicting values or scales of existing variables were modified and values of categorical variables were numerated. These improvements have led to a new and improved version of Pandora that, in its foundations, is suitable for statistical analysis; Pandora II.

As a result of the implemented improvements, the initial model has thus shifted from a relatively 'soft' scenario method that relies upon creativity and imagination, towards a more 'hard' scenario method, based upon mathematical techniques. This enables users to obtain quantitative results out of the model and that increases the models' 'truth value' (Bandhold & Lindgren, 2009;

Berenschot, 2010). However, a large majority of the variables in Pandora II cannot be used for statistical analysis. This has two main reasons: firstly, many variables are textual and cannot be numerated as their values are highly divergent and cannot be divided into different categories. Secondly, a large number of variables do not contain enough data. These are the variables that were found in Pandora but not in the GTD and which therefore only contain information from the initial 124 incidents that were recorded in Pandora.

To cope with the first problem, one can opt to analyze the variables by using techniques such as text data mining or pattern recognition in machine learning. The second problem can be addressed by looking up and (manually) filling out the values of the blank variables for all remaining records.

Besides these problems there is a third drawback that makes it more difficult to statistically analyze Pandora II. Testing five of the variables has shown that only few statistical methods can be used for the majority of the variables. As most of the categorical variables within Pandora II are measured on a nominal scale, a lot of techniques cannot be applied. On top of that, the most common method used for the comparison of nominal variables, the Chi Square analysis, cannot be used either because the variables do not meet the Chi Square assumptions. Expanding the number of records in Pandora II theoretically is a solution to this problem as this might decrease the number of empty or low frequency cells. However, Pandora II already contains most of the terrorist incidents until now. Expanding the number of records thus is a matter of time and patience and the wish to increase the number of records conflicts with the purpose of the research on terrorism, namely countering it. In an ideal world, no more terrorist incidents would happen and therefore we would not need to add more incidents to the model.

In addition to the Chi Square, there are some other techniques for the analysis of nominal variables. In this research we used the proportional error reduction method Lambda and that has shown significant relations between Pandora's variables 'Target type', 'Type of Incident', 'Weapon Type', 'Sub-weapon type' and 'Terrorist group'. Since Lambda is a less severe technique than the Chi Square it might be considered to repeat the analysis that was done for this research with other techniques such as Kendall's Tau. That way it can be tested if the results of this research are solid.

Results of the Lambda have shown that the five variables mentioned above are all related to each other. Therefore, none of the components should be removed from the model. However, some variables are better predictors of a specific variable than others. This information can be used to improve Pandora II for its practical use in criminal investigation as it reinforces the scenario´s possibility to make an analyst salient to important events (Kahn, 1962 in; Carroll and Go, 2004) and to anticipate unexpected real world behavior (Ringland, 2006). Knowing that 'Sub-weapon type' is the best predictor of a protagonist's 'Type of Incident', a criminal investigator can better use

information about the kind of weapon that is expected to be used to predict the Type of Incident, than information about the kind of target that is aimed at. While these implications might seem pretty straight forward, they can help criminal investigators by quickly focusing their attention to those aspects of a story that are most important.

To avoid human errors in decision making, different tools can sometimes be used. A possible application of Pandora in this regard is the design of a program that helps criminal investigators anticipating on criminal behavior by predicting the protagonist, method or other characteristics of a possible incident by use of multiple indicators. Information like the strength of the relationships between variables as found in this research, can be used to determine the weights (importance) of different variables in such a program. That way, just like a human being, a program can 'bear in mind' that the kind of weapon is a more determinant indicator for the Type of Incident than the target type is. In addition to the use of a program for anticipation, it might also be used in retrospect to identify missing values in cases of incidents that are already carried out. Knowledge about the operation mode of different terrorist groups can be used to reveal what group is most likely to have performed an incident.

In addition to the technical and conceptual improvements that were already implemented, two general recommendations that improve the reliability and validity of the model can be proposed. First, to ensure internal validity of the model and to simplify the process of adding new records, Pandora should come along with a guidebook. This guidebook should contain a detailed description of all variables since some variables are very straightforward but others are open for interpretation. With help of the guidebook every future user of Pandora can easily and unambiguously add information to the model.

Second, sources of the information in Pandora II should be stored in the model itself. This enables future users to retrieve information that was used when more details are required or elements of the story are unclear. Also, the quality of the information in the model is as good as the quality of its sources so identifying the sources that have been used gives the users an idea of the trustworthiness of the content. Off course all information is verified by multiple sources in the first place to ensure reliability of the model. Storing the sources is therefore mainly useful for the prospective monitoring of the content's quality.

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Appendix 1 - Pandora II – explanation of variables used for SPSS and their values

Variable	*Explanation of numerical variables and their values*
Attack/attempt	1 = attack 2 = attempt -9 = unknown
Claimed by means of	1 = Letter 2 = Call (post-incident) 3 = Call (pre-incident) 4 = E-mail 5 = Note left at scene 6 = Video 7 = Posted to website, blog, etc. 8 = Personal claim 9 = Other 10 = Unknown
Number of assailants	Each number simply represents number of assailants - 99 = unknown
Terrorist group	0 = no group, for other values see GTD
Ties with third parties	"..."
Target Type	1 = Business 2 = Government (General) 3 = Police 4 = military 5 = Abortion Related 6 = Airports & Airlines 7 = Government (Diplomatic) 8 = Educational Institution 9 = Food or Water Supply 10 = Journalists & Media 11 = Maritime 12 = NGO 13 = Other 14 = Private Citizens & Property 15 = Religious Figures/Institutions 16 = Telecommunication 17 = Terrorists 18 = Tourists 19 = Transportation 20 = Unknown 21 = Utilities 22 = Violent Political Parties
Day	1 = 1st 2 = 2nd 3 = …
Month	1 = january 2 = february 3 = ...
Year	1991 = 1991 1992 = 1992

	1993 = ...
Region	1= North America Canada, Mexico, United States 2= Central America & Caribbean Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, St. Kitts and Nevis, Trinidad and Tobago, Virgin Islands (U.S.) 3= South America Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela 4= East Asia China, Hong Kong, Japan, Macau, North Korea, South Korea, Taiwan 5= Southeast Asia Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, South Vietnam, Thailand, Timor-Leste, Vietnam 6= South Asia Afghanistan, Bangladesh, Bhutan, India, Maldives, Mauritius, Nepal, Pakistan, Seychelles, Sri Lanka 7= Central Asia Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan 8= Western Europe Andorra, Austria, Belgium, Corsica, Denmark, East Germany (GDR), Finland, France, Germany, Gibraltar, Great Britain, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Man, Isle of, Netherlands, Northern Ireland, Norway, Portugal, Spain, Sweden, Switzerland, West Germany (FRG) 9= Eastern Europe Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Czechoslovakia, Hungary, Kosovo, Macedonia, Moldova, Poland, Romania, Serbia-Montenegro, Slovak Republic, Slovenia, Yugoslavia 10= Middle East & North Africa Algeria, Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, North Yemen, Qatar, Saudi Arabia, South

	Yemen, Syria, Tunisia, Turkey, United Arab Emirates, West Bank and Gaza Strip, Western Sahara, Yemen 11= Sub-Saharan Africa Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Kinshasa), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rhodesia, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe 12= Russia & the Newly Independent States (NIS) Armenia, Azerbaijan, Belarus, Estonia, Georgia, Latvia, Lithuania, Russia, Soviet Union, Ukraine 13= Australasia & Oceania Australia, Fiji, French Polynesia, New Caledonia, New Hebrides, New Zealand, Papua New Guinea, Samoa (Western Samoa), Solomon Islands, Vanuatu, Wallis and Futuna
Country	-99 = Unknown 4 = Afghanistan 5 = Albania 6 = Algeria 7 = Andorra 8 = Angola 10 = Antigua and Barbuda 11 = Argentina 12 = Armenia 14 = Australia 15 = Austria 16 = Azerbaijan 17 = Bahamas 18 = Bahrain 19 = Bangladesh 20 = Barbados 21 = Belgium 22 = Belize 23 = Benin 24 = Bermuda 25 = Bhutan 26 = Bolivia 28 = Bosnia-Herzegovina 29 = Botswana

	30 = Brazil 31 = Brunei 32 = Bulgaria 33 = Burkina Faso 34 = Burundi 35 = Belarus 36 = Cambodia 37 = Cameroon 38 = Canada 40 = Cayman Islands 41 = Central African Republic 42 = Chad 43 = Chile 44 = China 45 = Colombia 46 = Comoros 47 = Congo (Brazzaville) 49 = Costa Rica 50 = Croatia 51 = Cuba 53 = Cyprus 54 = Czech Republic 55 = Denmark 56 = Djibouti 57 = Dominica 58 = Dominican Republic 59 = Ecuador 60 = Egypt 61 = El Salvador 62 = Equatorial Guinea 63 = Eritrea 64 = Estonia 65 = Ethiopia 66 = Falkland Islands 67 = Fiji 68 = Finland 69 = France 70 = French Guiana 71 = French Polynesia 72 = Gabon 73 = Gambia 74 = Georgia 75 = Germany 76 = Ghana 77 = Gibraltar 78 = Greece 79 = Greenland 80 = Grenada 81 = Guadeloupe 83 = Guatemala 84 = Guinea 85 = Guinea-Bissau

	86 = Guyana 87 = Haiti 88 = Honduras 89 = Hong Kong 90 = Hungary 91 = Iceland 92 = India 93 = Indonesia 94 = Iran 95 = Iraq 96 = Ireland 97 = Israel 98 = Italy 99 = Ivory Coast 100 = Jamaica 101 = Japan 102 = Jordan 103 = Kazakhstan 104 = Kenya 106 = Kuwait 107 = Kyrgyzstan 108 = Laos 109 = Latvia 110 = Lebanon 111 = Lesotho 112 = Liberia 113 = Libya 115 = Lithuania 116 = Luxembourg 117 = Macau 118 = Macedonia 119 = Madagascar 120 = Malawi 121 = Malaysia 122 = Maldives 123 = Mali 124 = Malta 125 = Man, Isle of 127 = Martinique 128 = Mauritania 129 = Mauritius 130 = Mexico 132 = Moldova 134 = Mongolia 136 = Morocco 137 = Mozambique 138 = Myanmar 139 = Namibia 141 = Nepal 142 = Netherlands 143 = New Caledonia 144 = New Zealand

	145 = Nicaragua 146 = Niger 147 = Nigeria 149 = North Korea 151 = Norway 152 = Oman 153 = Pakistan 155 = West Bank and Gaza Strip 156 = Panama 157 = Papua New Guinea 158 = Paraguay 159 = Peru 160 = Philippines 161 = Poland 162 = Portugal 163 = Puerto Rico 164 = Qatar 166 = Romania 167 = Russia 168 = Rwanda 173 = Saudi Arabia 174 = Senegal 175 = Serbia-Montenegro 176 = Seychelles 177 = Sierra Leone 178 = Singapore 179 = Slovak Republic 180 = Slovenia 181 = Solomon Islands 182 = Somalia 183 = South Africa 184 = South Korea 185 = Spain 186 = Sri Lanka 189 = St. Kitts and Nevis 195 = Sudan 196 = Suriname 197 = Swaziland 198 = Sweden 199 = Switzerland 200 = Syria 201 = Taiwan 202 = Tajikistan 203 = Tanzania 204 = Togo 205 = Thailand 207 = Trinidad and Tobago 208 = Tunisia 209 = Turkey 213 = Uganda 214 = Ukraine 215 = United Arab Emirates

	216 = Great Britain 217 = United States 218 = Uruguay 219 = Uzbekistan 220 = Vanuatu 221 = Vatican City 222 = Venezuela 223 = Vietnam 225 = Virgin Islands (U.S.) 226 = Wallis and Futuna 227 = Samoa (Western Samoa) 228 = Yemen 229 = Congo (Kinshasa) 230 = Zambia 231 = Zimbabwe 233 = Northern Ireland 235 = Yugoslavia 236 = Czechoslovakia 238 = Corsica 296 = Kurdish 311 = Roma (Gypsy) 321 = Arab 334 = Asian 338 = African 347 = Timor-Leste 349 = Western Sahara 351 = Commonwealth of Independent States 359 = Soviet Union 362 = West Germany (FRG) 376 = Korea 377 = North Yemen 381 = Jewish 383 = Peru/U.S. 403 = Rhodesia 406 = South Yemen 422 = International 428 = South Vietnam 449 = Hindu 499 = East Germany (GDR) 512 = European 520 = Sinhalese 523 = Tuareg 529 = Middle Eastern 532 = New Hebrides 999 = Multinational 1000 = Kashmir 1001 = Serbia 1002 = Montenegro 1003 = Kosovo
Type of Incident	1 = Assassination 2 = Armed Assault 3 = Bombing/Explosion

	4 = Hijacking 5 = Hostage Taking (Barricade Incident) 6 = Hostage Taking (Kidnapping) 7 = Facility/Infrastructure Attack 8 = Unarmed Assault 9 = Unknown 11 = CBRN 12 = Vehicle Attack - 9 = attempt - 10 = other (remarks; there is no value '10', values '11', '12', '-9' and '-10' are adopted from Pandora and do not occur in GTD data)
Weapon type	- 7 = miscellaneous 1 = Biological 2 = Chemical 3 = Radiological 4 = Nuclear 5 = Firearms 6 = Explosives/Bombs/Dynamite 7 = Fake Weapons 8 = Incendiary 9 = Melee 10 = Vehicle (not to include vehicle-borne explosives, i.e., car or truck bombs) 11 = Sabotage Equipment 12 = Other 13 = Unknown
Suicide Mission	0 = no 1 = yes - 9 = unknown
Antagonist dies from attack	0 = no 1 = yes - 9 = unknown
Other fatalities	0 = no 1 = yes - 9 = unknown
Total fatalities	Numbers speak for themselves -9 = unknown
Total fatalities	Numbers speak for themselves -9 = unknown
Antagonist dies from attack exact	Numbers speak for themselves, exact numbers
Total fatalities exact	Numbers speak for themselves, exact numbers
Total injured exact	Numbers speak for themselves, exact numbers
Part of multiple incident	0 = no 1 = yes - 9 = unknown
Sub-weapon type	1 = Poisoning 2 = Automatic Weapon

	3 = Handgun 4 = Rifle/Shotgun (non-automatic) 5 = Unknown Gun Type 6 = Other Gun Type 7 = Grenade 8 = Land Mine 9 = Letter Bomb 10 = Pressure Trigger 11 = Projectile (rockets, mortars, RPGs, etc.) 12 = Remote Trigger 13 = Suicide (carried bodily by human being) 14 = Time Fuse 15 = Vehicle 16 = Unknown Explosive Type 17 = Other Explosive Type 18 = Arson/Fire 19 = Flame Thrower 20 = Gasoline or Alcohol 21 = Blunt Object 22 = Hands, Feet, Fists 23 = Knife 24 = Rope or Other Strangling Device 25 = Sharp Object Other Than Knife 26 = Suffocation

Appendix 2 – Pandora-model: type of explosives

Acetylides of heavy metals.
Aluminum containing polymeric propellant.
Aluminum ophorite explosive.
Amatex.
Amatol.
Ammonal.
Ammonium nitrate explosive mixtures (cap sensitive).
Ammonium nitrate explosive mixtures (non-cap sensitive).
Ammonium perchlorate composite propellant.
Ammonium perchlorate explosive mixtures.
Ammonium picrate [picrate of ammonia, Explosive D].
Ammonium salt lattice with isomorphously substituted inorganic salts.
*ANFO [ammonium nitrate-fuel oil].
Aromatic nitro-compound explosive mixtures.
Azide explosives
Baranol.
Baratol.
BEAF [1, 2-bis (2, 2-difluoro-2-nitroacetoxyethane)].
Black powder.
Black powder based explosive mixtures.
*Blasting agents, nitro-carbo-nitrates, including non-cap sensitive slurry and water gel explosives.
Blasting caps.
Blasting gelatin.
Blasting powder.
BTNEC [bis (trinitroethyl) carbonate].
BTNEN [bis (trinitroethyl) nitramine].
BTTN [1,2,4 butanetriol trinitrate].
Bulk salutes.
Butyl tetryl.
Calcium nitrate explosive mixture.
Cellulose hexanitrate explosive mixture.
Chlorate explosive mixtures.
Composition A and variations.
Composition B and variations.
Composition C and variations.
Copper acetylide.
Cyanuric triazide.
Cyclonite [RDX].
Cyclotetramethylenetetranitramine [HMX].
Cyclotol.
Cyclotrimethylenetrinitramine [RDX].
DATB [diaminotrinitrobenzene].
DDNP [diazodinitrophenol].
DEGDN [diethyleneglycol dinitrate].
Detonating cord.
Detonators.
Dimethylol dimethyl methane dinitrate composition.
Dinitroethyleneurea.
Dinitroglycerine [glycerol dinitrate].
Dinitrophenol.

Dinitrophenolates.
Dinitrophenyl hydrazine.
Dinitroresorcinol.
Dinitrotoluene-sodium nitrate explosive mixtures.
DIPAM [dipicramide; diaminohexanitrobiphenyl].
Dipicryl sulfone.
Dipicrylamine.
Display fireworks.
DNPA [2,2-dinitropropyl acrylate].
DNPD [dinitropentano nitrile].
Dynamite.
EDDN [ethylene diamine dinitrate].
EDNA [ethylenedinitramine].
Ednatol.
EDNP [ethyl 4,4-dinitropentanoate].
EGDN [ethylene glycol dinitrate].
Erythritol tetranitrate explosives.
Esters of nitro-substituted alcohols.
Ethyl-tetryl.
Explosive conitrates.
Explosive gelatins.
Explosive liquids.
Explosive mixtures containing oxygen-releasing inorganic salts and hydrocarbons.
Explosive mixtures containing oxygen-releasing inorganic salts and nitro bodies.
Explosive mixtures containing oxygen-releasing inorganic salts and water insoluble fuels.
Explosive mixtures containing oxygen-releasing inorganic salts and water soluble fuels.
Explosive mixtures containing sensitized nitromethane.
Explosive mixtures containing tetranitromethane (nitroform).
Explosive nitro compounds of aromatic hydrocarbons.
Explosive organic nitrate mixtures.
Explosive powders.
Flash powder.
Fulminate of mercury.
Fulminate of silver.
Fulminating gold.
Fulminating mercury.
Fulminating platinum.
Fulminating silver.
Gelatinized nitrocellulose.
Gem-dinitro aliphatic explosive mixtures.
Guanyl nitrosamino guanyl tetrazene.
Guanyl nitrosamino guanylidene hydrazine.
Guncotton.
Heavy metal azides.
Hexanite.
Hexanitrodiphenylamine.
Hexanitrostilbene.
Hexogen [RDX].
Hexogene or octogene and a nitrated N-methylaniline.
Hexolites.
HMTD [hexamethylenetriperoxidediamine].
HMX [cyclo-1,3,5,7-tetramethylene 2,4,6,8-tetranitramine; Octogen].

Hydrazinium nitrate/hydrazine/aluminum explosive system.
Hydrazoic acid.
Igniter cord.
Igniters.
Initiating tube systems.
KDNBF [potassium dinitrobenzo-furoxane].
Lead azide.
Lead mannite.
Lead mononitroresorcinate.
Lead picrate.
Lead salts, explosive.
Lead styphnate [styphnate of lead, lead trinitroresorcinate].
Liquid nitrated polyol and trimethylolethane.
Liquid oxygen explosives.
Magnesium ophorite explosives.
Mannitol hexanitrate.
MDNP [methyl 4,4-dinitropentanoate].
MEAN [monoethanolamine nitrate].
Mercuric fulminate.
Mercury oxalate.
Mercury tartrate.
Metriol trinitrate.
Minol-2 [40% TNT, 40% ammonium nitrate, 20% aluminum].
MMAN [monomethylamine nitrate]; methylamine nitrate.
Mononitrotoluene-nitroglycerin mixture.
Monopropellants.
NIBTN [nitroisobutametriol trinitrate].
Nitrate explosive mixtures.
Nitrate sensitized with gelled nitroparaffin.
Nitrated carbohydrate explosive.
Nitrated glucoside explosive.
Nitrated polyhydric alcohol explosives.
Nitric acid and a nitro aromatic compound explosive.
Nitric acid and carboxylic fuel explosive.
Nitric acid explosive mixtures.
Nitro aromatic explosive mixtures.
Nitro compounds of furane explosive mixtures.
Nitrocellulose explosive.
Nitroderivative of urea explosive mixture.
Nitrogelatin explosive.
Nitrogen trichloride.
Nitrogen tri-iodide.
Nitroglycerine
trinitroglycerine].
Nitroglycide.
Nitroglycol [ethylene glycol dinitrate, EGDN].
Nitroguanidine explosives.
Nitronium perchlorate propellant mixtures.
Nitroparaffins Explosive Grade and ammonium nitrate mixtures.
Nitrostarch.
Nitro-substituted carboxylic acids.
Nitrourea.

Octogen [HMX].
Octol [75 percent HMX, 25 percent TNT].
Organic amine nitrates.
Organic nitramines.
PBX [plastic bonded explosives].
Pellet powder.
Penthrinite composition.
Pentolite.
Perchlorate explosive mixtures.
Peroxide based explosive mixtures.
PETN [nitropentaerythrite, pentaerythrite tetranitrate, pentaerythritol tetranitrate].
Picramic acid and its salts.
Picramide.
Picrate explosives.
Picrate of potassium explosive mixtures.
Picratol.
Picric acid (manufactured as an explosive).
Picryl chloride.
Picryl fluoride.
PLX [95% nitromethane, 5% ethylenediamine].
Polynitro aliphatic compounds.
Polyolpolynitrate-nitrocellulose explosive gels.
Potassium chlorate and lead sulfocyanate explosive.
Potassium nitrate explosive mixtures.
Potassium nitroaminotetrazole.
Pyrotechnic compositions.
PYX [2,6-bis(picrylamino)]-3,5-dinitropyridine.
RDX [cyclonite, hexogen, T4, cyclo-1,3,5,-trimethylene-2,4,6,-trinitramine; hexahydro-1,3,5-trinitro-S-triazine].
Safety fuse.
Salts of organic amino sulfonic acid explosive mixture.
Salutes (bulk).
Silver acetylide.
Silver azide.
Silver fulminate.
Silver oxalate explosive mixtures.
Silver styphnate.
Silver tartrate explosive mixtures.
Silver tetrazene.
Slurried explosive mixtures of water, inorganic oxidizing salt, gelling agent, fuel, and sensitizer (cap sensitive).
Smokeless powder.
Sodatol.
Sodium amatol.
Sodium azide explosive mixture.
Sodium dinitro-ortho-cresolate.
Sodium nitrate explosive mixtures.
Sodium nitrate-potassium nitrate explosive mixture.
Sodium picramate.
Special fireworks.
Squibs.

Styphnic acid explosives.
Tacot [tetranitro-2,3,5,6-dibenzo- 1,3a,4,6a tetrazapentalene].
TATB [triaminotrinitrobenzene].
TATP [triacetonetriperoxide].
TEGDN [triethylene glycol dinitrate].
Tetranitrocarbazole.
Tetrazene [tetracene, tetrazine, 1(5-tetrazolyl)-4-guanyl tetrazene
hydrate].
Tetryl [2,4,6 tetranitro-N-methylaniline].
Tetrytol.
Thickened inorganic oxidizer salt slurried explosive mixture.
TMETN [trimethylolethane trinitrate].
TNEF [trinitroethyl formal].
TNEOC [trinitroethylorthocarbonate].
TNEOF [trinitroethylorthoformate].
TNT [trinitrotoluene, trotyl, trilite, triton].
Torpex.
Tridite.
Trimethylol ethyl methane trinitrate composition.
Trimethylolthane trinitrate-nitrocellulose.
Trimonite.
Trinitroanisole.
Trinitrobenzene.
Trinitrobenzoic acid.
Trinitrocresol.
Trinitro-meta-cresol.
Trinitronaphthalene.
Trinitrophenetol.
Trinitrophloroglucinol.
Trinitroresorcinol.
Tritonal.
Urea nitrate.
Water-bearing explosives having salts of oxidizing acids and nitrogen bases, sulfates, or sulfamates
Water-in-oil emulsion explosive compositions.
Xanthamonas hydrophilic colloid explosive mixture.
Combination of
Unknown

Appendix 3 – Pandora-model: amount of explosives

0 - 0,5 Kg
0,5 - 1 Kg
1 - 2 Kg
2 - 5 Kg
5 - 10 Kg
10 - 20 Kg
50 - 100 Kg
100 - 200 Kg
200 - 300 Kg
300 - 400 Kg
400 - 500 Kg
500 - 600 Kg
600 - 700 Kg
700 - 800 Kg
800 - 900 Kg
900 - 1000 Kg
1000 - 1200 Kg
1200 - 1500 Kg
1500 - 2000 Kg
2000 - 5000 Kg
5000 - 10000 Kg
Other
Unknown

Appendix 4 – comparison Pandora and GTD

Comparison Pandora-model & Global Terrorism Database (GTD)						
Pandora			**In GTD?**			**Possible improvements of cells Pandora**
Category	*Name*	*Kind of variable*	*No = not in GTD Yes = exactly the same in GTD Different = in GTD but in a different form*	*GTD category*	*What is different?*	
Case ID	Name	Text	Different	GTD ID	Pandora uses name of offender or victim (depending on familiarity), GTD uses 12-digit Event ID system based on date event.	
	Category	Category	No			
Background	Description	Text	Different	IV. Incident information – A. incident summary	Pandora answers 'what, where, against whom', GTD notes 'when, where, who, what, how and	

					why'.	
Successful attack	Attack/attempt	category	Yes	V. Attack information – A. successful Attack		
Peripeteia (change of circumstance)	Description	Text	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
Protagonist	Protagonist known	Y/N	No			
	Incident attributed to	Text	No			
	Incident claimed by	Text	Different	IX. Perpetrator Claim of Responsibility – A. Claim of Responsibility?	Pandora names the one who claimed incident, GTD leaves that behind but answers Q whether incident is claimed or not	Adding extra variable: Incident claimed? → Y/N
	Claimed by means of	Text	Different	IX. Perpetrator Claim of Responsibility – B. Mode for claim of Responsibility	Pandora uses text variable, GTD uses categorical variable	Using a categorical variable
	Leakage	Category	No			
		Text	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
	Number of assailants	Category	Yes	VIII. Perpetrator Statistics – A. Number of Perpetrators	Pandora uses category, GTD has numeric variable	Using numeric variable
	Male / Female	M/F	No			
	Age group	Category	No			Using birthdate instead of category
	Terrorist	Category	Yes	VII. Perpetrator	GTD uses	

	group (GTD)			Information – A. Perpetrator Group Name	text variable but has list with group names to ensure standardization	
		Text	Different	VII. Perpetrator Information – B. Perpetrator Sub-Group Name	Pandora uses text field for extra but non-standardized information, GTD uses additional qualifiers or details about the name of the group (e.g. specific factions of group)	
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
	Category	Category	No			
		Description	No			
	Background/history	Text	No			
	Known previous incidents	Y/N	No			
		Text	No			
		Text	No			
	Known subsequent incidents	Y/N	Different	IV. Incident Information – E. Part of Multiple Incident	Pandora uses text variable to describe subsequent incident, GTD uses categoric	

					al variable to answer Q whether incident is part of multiple incident or not.	
		Text	No			
		Text	No			
	Ties with third parties	Y/N	No			
		Category	No			
		Text	No			
Primary purpose of incident		Category	No			
Antagonist	Primary target	Category	No			
	Specific/generic	Category	No			
	Target Type (GTD)	Category	Yes	VI. Target/Victim Information – A. Target/Victim Type		
	Name	Text	Different	VI. Target/Victim Information – B. Name of Entity & C. Specific Target/Victim	GTD uses 2 variables (VI. A & B) while Pandora mentions either the specific target or name of the Entity	Taking the GTD variables to distinguish name of entity and specific target. E.g. 'If the US Embassy in country X was attacked; name of entity = US department of state, specific target= US embassy country X.
	Description	Text	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
Time	Day of the week	Category	No			
	Day	Category	Yes	II. Incident Date – C. Day		
	Month	Category	Yes (small difference)	II. Incident Date – B. Month	GTD uses numeric variable	
	Year	Category	Yes	II. Incident Date –		

				A. Year		
	Hour (local time)	Category	No			
	Minutes	Category	No			
	AM/PM	Category	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
Arena	Region (GTD)	Category	Yes	III. Incident Location – B. Region		
	Country	Category	Different	III. Incident Location – A. Country	GTD uses entries that are not proper countries (e.g. European), Pandora only has proper countries (same as in GTD)	
	City	Text	Yes	III. Incident Location – D. City		
	Kill zone	Category	No			
	Static location	Category	No			
	En route	Category	No			
	Public route / location	Y/N	No			
	Description	Text	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
Context	Type	Category	No			
(Possible) Motive	Motivation	Category	No			
		Text	Yes	VII. Perpetrator Information – G. Specific Motive		
Security	Protection	Y/N	No			
	Driver	Y/N	No			
	Number of protectors	Category	No			Using exact number instead of categories or using broader categories (when use of categories is preferred when number of protectors is ambiguous)
	Armed	Y/N	No			

	protectors					
	Number of Armed protectors	Category	No			Using exact number instead of categories or using broader categories (when use of categories is preferred when number of armed protectors is ambiguous)
	Procedure	Text	No			
	Protection	Category	No			
		Category	No			
		Category	No			
	Previous security breach	Text	No			
	Security interventio n	Text	No			
Method	Incident	Category	Differen t	V. Attack Information – C. Attack Type	Some categories differ between GTD and Pandora	Adding the categories 'unarmed assault' and 'facility/infrastructure attack'
	Means	Category	Yes (small differen ce)	X. Weapon Information – A. Weapon Type	Pandora incorpora tes all categories of GTD plus some extra	
	Weapon	Text	Differen t	X. Weapon Information – B Weapon Sub-Type	Pandora uses some types of the GTD list but also other additional weapon informati on	
	Type of primary explosive	Category	Differen t	X. Weapon Information – B Weapon Sub-Type; explosives/bombs /dynamite	Types in Pandora are way more extended, GTD only incorpora tes 11 types	

	Amount of primary explosive	Category	No			
	Detonation	Category	No			
	Suicide mission	Category (Y/N)	Yes	V. Attack Information – B. Suicide Attack		
	Delivery method	Category	No			
	Description of explosives	Text	No			
	Description transportation	Text	No			
	Red Herring	*Text*	*No*			
	Symbolism	*Text*	*No*			
Modus Operandi	Level of intelligence	Category	No			
	M.O.	Text	No			
	Pre-incident actions	Category	No			
		text	No			
	Pre-incident actions	Category	No			
		Text	No			
	Pre-incident actions	Category	No			
	Pre-incident actions description	Text	No			
	Post-incident actions	Category	No			
	Post-incident actions	Text	No			
	Post-incident actions	Category	No			
	Post-incident actions description	Text	No			
	Communication	Text	No			
	Red Herring	*Text*	*No*			

	Symbolism	*Text*	*No*			
Casualties	Antagonist dies from attack	Y/N	Different	XI. Casualty Information – C. Number of Perpetrator Fatalities	Pandora only answers Q whether antagonist dies or not, GTD registers number of antagonist died	Pandora's variables are not clear in distinguishing injuries and fatalities between antagonists and protagonists and they are not exhaustive (there may for instance be 3 antagonist of which 1 dies, what do we then fill in for 'antagonist dies from attack'?). Therefore I suggest to replace current variables by the following numerical variables: • Number of Antagonists Fatalities • Number of Protagonists/other fatalities • Total fatalities • Number of Antagonists injured • Number of Protagonists/other injured • Total injured
	Other fatalities	Y/N	Different	XI. Casualty Information – A. Total Number of Fatalities	Pandora includes protagonists, GTD includes fatalities of antagonists and protagonists	
	Total fatalities	Category	Yes	XI. Casualty Information – A. Total Number of Fatalities		
	Total injured	Category	Yes	XI. Casualty Information – D. Total Number of Injured		
Opmerkelijkheden	'Extra veld'	text	Different	XIV. Additional information	Pandora registers remarkabilities which do not fit in other cells, GTD registers all kinds of extra information what does not fit in other cells and adds	
	'Extra veld'	text				
	'Extra veld'	text				
	'Extra veld'	text				

					information for cells which have specific indications for placing additional information	
General improvements	• Adding sources for reliability and possibility to check sources used.					

Appendix 5 – analysis of possibilities to analyze variables with SPSS

Pandora II - Which of its variables are numerical and contain enough data so they can be used with SPSS?	
Variable	**Analysis with SPSS possible? *(if not: why not?)***
ACaseIDNameTekst	Nee
BCaseIDCategory	Nee (geen gtd data)
DbackgroundDescriptionTekst	Nee
ESuccesfullAttackAttackAttemptCategory	Ja
FPeripeteiachangeofcircumstanceDescriptionTekst	Nee
GPeripeteiachangeofcircumstanceRedHerringTekst	Nee (geen gtd data en niet numeriek)
HperipeteiachangeofcircumstanceSymbolismTekst	Nee (geen gtd data en niet numeriek)
IProtagonistProtagonistknowncategory	Nee (geen gtd data)
JprotagonistIncidentattributedtotekst	Nee (geen gtd data en niet numeriek)
KprotagonistIncidentclaimedbyTekst	Nee (geen gtd data en niet numeriek)
LprotagonistClaimedbymeansofTekst	Ja
MProtagonistLeakageCategory	Nee
NprotagonistText	Nee (geen data)
OprotagonistRedHerringTekst	Nee (geen gtd data en niet numeriek)
PprotagonistSymbolismTekst	Nee (geen gtd data en niet numeriek)
QprotagonistNumberofassailantsCategory	Ja
RprotagonistMaleFemaleCategory	Nee (geen gtd data)
SprotagonistAgegroupCategory	Nee (of moet nog van GTD uitgerekend worden)
TProtagonistTerroristgroupGTDCategory	Ja (maar is nog niet numeriek)
UprotagonistTekst	Nee (niet numeriek)
VprotagonistRedHerringTekst	Nee (geen gtd data en niet numeriek)
WProtagonistSymbolismTekst	Nee (geen gtd data en niet numeriek)
XProtagonistCategory	Nee (geen gtd data)
YprotagonistDescription	Nee (geen gtd data en niet numeriek)
ZProtagonistBackgroundHistoryTekst	Nee (geen gtd data en niet numeriek)
AAProtagonistKnownpreviousincidentscategory	Nee (geen gtd data)
ABProtagonistKnownpreviousincidentsTekst	Nee (geen gtd data en niet numeriek)
ACProtagonistKnownpreviousincidentsTekst	Nee (geen gtd data en niet numeriek)
ADProtagonistKnownsubsequentincidentscategory	Nee (geen gtd data)
AEProtagonistKnownsubsequentincidentsTekst	Nee (geen gtd data en niet numeriek)

AFProtagonistKnownsubsequentincidentsTekst	Nee (geen gtd data en niet numeriek)
AGProtagonistTieswiththirdpartiescategory	Nee (geen gtd data)
AHProtagonistTieswiththirdpartiescategory	Ja (maar nog niet numeriek en moet gecombineerd worden met AG...)
AIProtagonistTieswiththirdpartiestekst	Nee (geen gtd data en niet numeriek)
AJPrimarypurposeofincidentCategory	Nee (geen gtd data)
AKAntagonistPrimaryTargetCategory	Nee (geen gtd data)
ALAntagonistSpecificGenericCategory	Nee (geen gtd data)
AMAntagonistTargetTypeGTDCategory	Ja
ANAntagonistNameTekst	Nee (niet numeriek)
AOAntagonistDescriptionTekst	Nee (geen gtd data en niet numeriek)
APAntagonistRedHerringTekst	Nee (geen gtd data en niet numeriek)
AQAntagonistSymbolismTekst	Nee (geen gtd data en niet numeriek)
ARTimeDayoftheweekCategory	Nee (geen gtd data)
ASTimeDayCategory	Ja
ATTimeMonthCategory	Ja
AUTimeYearCategory	Ja
AVTimeHourlocaltimeCategory	Nee (geen gtd data)
AWTimeMinutesCategory	Nee (geen gtd data)
AXTimeAMPMCategory	Nee (geen gtd data)
AYTimeRedHerringTekst	Nee (geen gtd data en niet numeriek)
AZTimeSymbolismTekst	Nee (geen gtd data en niet numeriek)
BAArenaRegionGTDCategory	Ja
BBArenaCountryCategory	Ja
BCArenaCityTekst	Nee (niet numeriek)
BDArenaKillzoneCategory	Nee (geen gtd data)
BEArenaStaticlocatonCategory	Nee (geen gtd data)
BFArenaEnrouteCategory	Nee (geen gtd data)
BGArenaPublicroutelocationcategory	Nee (geen gtd data)
BHArenaDescriptionTekst	Nee (geen gtd data en niet numeriek)
BIArenaRedHerringTekst	Nee (geen gtd data en niet numeriek)
BJArenaSymbolismTekst	Nee (geen gtd data en niet numeriek)
BKContextTypeCategory	Nee (geen gtd data)
BLPossibleMotiveMotivationCategory	Nee (geen gtd data)
BMPossibleMotiveMotivationTekst	Nee (niet numeriek)
BNSecurityProtectioncategory	Nee (geen gtd data)
BOSecurityDrivercategory	Nee (geen gtd data)
BPSecurityNumberofProtectorscategory	Nee (geen gtd data)
BQSecurityArmedProtectorscategory	Nee (geen gtd data)

BRSecurityNumberofarmedprotectorscategory	Nee (geen gtd data)
BSSecurityProcedureTekst	Nee (geen gtd data en niet numeriek)
BTSecurityProtectionCategory	Nee (geen gtd data)
BUSecurityProtectionCategory	Nee (geen gtd data)
BVSecurityProtectionCategory	Nee (geen gtd data)
BWSecurityPrevioussecuritybreachTekst	Nee (geen gtd data en niet numeriek)
BXSecuritySecurityinterventionTekst	Nee (geen gtd data en niet numeriek)
BYMethodIncidentCategory	Ja
BZMethodMeansCategory	Ja
CAMethodWeaponALSDANconstr	Nee (geen gtd data en niet numeriek)
CBMethodTypeofprimaryexplosiveCategory	Nee (geen gtd data en niet numeriek)
CCMethodAmmountofprimaryexplosiveCategory	Nee (geen gtd data)
CDMethodDetonationCategory	Nee (geen gtd data)
CEMethodSuicidemissionCategory	Ja
CFMethodDeliverymethodCategory	Nee (geen gtd data)
CGMethodDescriptionofexplosivesTekst	Nee (geen gtd data en niet numeriek)
CHMethodDescriptionoftransportationTekst	Nee (geen gtd data en niet numeriek)
CIMethodRedHerringTekst	Nee (geen gtd data en niet numeriek)
CJMethodSymbolismTekst	Nee (geen gtd data en niet numeriek)
CKModusOperandiLevelofIntelCategory	Nee (geen gtd data)
CLModusOperandiM.O.Tekst	Nee (geen gtd data en niet numeriek)
CMModusOperandiPreincidentactionsCategory	Nee (geen gtd data)
CNModusOperandiPreincidentactionsDescriptionTekst	Nee (geen gtd data en niet numeriek)
COModusOperandiPreincidentactionsCategory	Nee (geen gtd data)
CPModusOperandiPreincidentactionsDescriptionTekst	Nee (geen gtd data en niet numeriek)
CQModusOperandiPreincidentactionsCategory	Nee (geen gtd data)
CRModusOperandiPreincidentactionsDescriptionTekst	Nee (geen gtd data en niet numeriek)
CSModusOperandiPostincidentactionsCategory	Nee (geen gtd data)
CTModusOperandiPostincidentactionsDescriptionTekst	Nee (geen gtd data en niet numeriek)
CUModusOperandiPostincidentactionsCategory	Nee (geen gtd data)
CVModusOperandiPostincidentactionsDescriptionTekst	Nee (geen gtd data en niet numeriek)
CWModusOperandiCommunicationTekst	Nee (geen gtd data en niet numeriek)

CXModusOperandiRedHerringTekst	Nee (geen gtd data en niet numeriek)
CYModusOperandiSymbolismTekst	Nee (geen gtd data en niet numeriek)
CZCasualtitiesAntagonistdiesfromattackCategory	Ja
DACasualtitiesOtherfatalatiesCategory	Ja
DBCasualtitiesTotalfatalatiesCategory	Ja
DCCasualtitiesTotalinjuredCategory	Ja
DEOpmerkelijkhedenExtraVeldTekst	Nee (niet numeriek)
DFOpmerkelijkhedenExtraVeldTekst	Nee (niet numeriek)
DGOpmerkelijkhedenExtraVeldTekst	Nee (niet numeriek)
DHOpmerkelijkhedenExtraVeldTekst	Nee (niet numeriek)
DJToegevoegdecategorieënCasualtitiesantagonistdiesfromattackexac	Ja (maar Pandora data moet – eventueel-nog ingevuld worden)
DKToegevoegdecategorieënTotalnumberofFatalatiesexactCategory	Ja (maar Pandora data moet – eventueel-nog ingevuld worden)
DLToegevoegdecategorieënTotalInjuredexactCategory	Ja (maar Pandora data moet – eventueel-nog ingevuld worden)
DMToegevoegdecategorieënPartofmultipleincidentCategory	Ja
DNToegevoegdecategorieënSubWeaponsCategory	Ja

Appendix 6 – Cross table Method and Target Type for FMLN, LTTE and Taliban

Method * Target type * TNumerical Crosstabulation

Count

TNumerical			Target type																						
			Business	Government (General)	Police	Military	Airports & Airlines	Government (Diplomatic)	Educational Institution	Food or Water Supply	Journalists & Media	Maritime	NGO	Other	Private Citizens & Property	Religious Figures or Institutions	Telecommunication	Terrorists	Tourists	Transportation	Unknown	Utilities	Violent Political Parties	Total
FMLN	Method	Assassination	0	0	1	3					0				0		0			0		0	0	4
		Armed Assault	1	3	10	219					0				32		0			4		3	0	272
		Bombing or Explosion	19	4	8	20					2				2		2			3		157	0	217
		Hostage Taking (Barricade Incident)	0	1	0	0					1				0		0			0		0	0	2
		Hostage Taking (Kidnapping)	0	1	0	0					0				0		0			0		0	1	2
		Facility or Infrastructure attack	0	0	0	0					1				0		0			0		1	0	2
		Unknown	0	1	0	1					0				0		0			0		0	0	2
	Total		20	10	19	243					4				34		2			7		161	1	501
LTTE	Method	Assassination	0	29	6	8	0	3	0	0	0	0	0	2	25	4	0	3	0	0	1	0	10	91
		Armed Assault	3	21	67	151	0	0	0	1	3	1	2	4	126	4	0	1	1	10	0	1	3	399
		Bombing or Explosion	20	31	74	188	1	4	3	1	2	10	4	4	72	10	5	2	1	49	12	12	8	513
		Hijacking	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	8
		Hostage Taking (Barricade Incident)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
		Hostage Taking (Kidnapping)	2	2	1	2	0	0	0	0	0	2	2	0	17	1	0	0	0	1	1	0	0	31
		Facility or Infrastructure attack	0	1	1	2	2	0	0	0	0	0	0	0	3	1	0	0	0	3	0	3	0	16
		Unarmed Assault	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
		Unknown	1	1	32	34	0	0	0	1	0	0	0	0	9	0	1	1	0	1	0	6	0	87
	Total		26	85	182	389	3	7	3	3	5	14	8	10	253	20	6	8	2	71	14	22	21	1152
Taliban	Method	Assassination	0	64	26	5	0	6	2	0	0	0	0	12	17	10	0	2	0	0	0	0	0	144
		Armed Assault	20	98	98	41	0	4	11	0	1	1	23	35	155	7	1	4	1	8	0	2	0	510