

VISUALIZING TERRORISM THREATS AND POLITICAL CLIMATE

Gwendoline Tan Wan Xin, Lim Kim Yong, Tan Kee Hock

Abstract— Terrorism is on the rise and agencies around the world are devising plans to detect and prevent against these attacks. This research project attempts to complement current efforts by helping policymakers, government and intelligence agencies identify possible causes of the increase in terrorist attacks. With the use of an exploratory visualization tool, this project aims to help analysts visually discover interesting patterns that could help them in devising policies to reduce the occurrence of terrorist attacks and to better understand the relationship between terrorist attacks and a country's development. To achieve this, extensive data exploration, planning and designing a visualization has been done. Key components of the visualization include a bar chart, choropleth map, radar chart and a force bubble plot. A key insight, that analysts can derive through the exploratory visualization tool, is how the political climate of a country will affect the occurrence of terrorist attacks that take place within the country itself.

Index Terms—Governance, Political Climate, Terrorism

I. INTRODUCTION

With a rise in terrorism threats worldwide, many government or intelligence agencies have been putting in efforts to detect and prevent against terrorist attacks from happening. Many of these efforts are focused on detecting threats (e.g. bombs) or radicalization of individuals in the country itself. Although current efforts are effective in deterring terrorist attacks, there is a lack of research efforts to understand the underlying root causes of these attacks. Such research work would enable us to better understand the nature of these threats and enable us to deploy more effective and appropriate solution to rectify these root causes. In this project, we are interested to identify the target victims of these terrorist attacks and establish correlations between the political climate of each country and the number of attacks that took place. This will provide policy makers, government or intelligence agencies a tool to understand more about why these attacks took place, and to better understand the political climate of its own country. By doing so, respective parties can

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take steps to resolve pressing issues so as to prevent against a rise in terrorist attacks within its home-grounds.

Consisting of 9 main sections, this paper attempts to report on the research and development efforts taken to design and implement a web visualization application to help respective agencies identify the target victims of terrorist attacks and establish possible correlations between the political climate in its country and the number of terrorist attacks that took place. Section 1 attempts to provide a general introduction to the project. This is followed by an overview of the motivation and objectives of the research conducted. Also, as background information, further elaboration on past works related to terrorism will also be included in the next section. In Section 4, the approach taken to complete this project will be elaborated. Section 5 and 6 will include an explanation on the process of collating, exploring and preparing data required, followed by the design considerations of developing the visualization application. Next, key findings and insights that could be derived from the visualization will be stated. A case study to demonstrate the usage and effectiveness of our visualization tool is also included to assist analysts in their initial phase of data exploration. Finally, the paper will conclude by highlighting future extensions to the research.

II. MOTIVATION AND OBJECTIVES

Our research is motivated by a general lack of visualization tools to discover possible causes of terrorist attack occurring in the country. Through our research and development, we hope to develop a visualization tool that can help policy makers, government or intelligence agencies visually discover interesting patterns that could help them in devising policies to reduce the occurrence of terrorist attacks. Specifically, the visualization focuses on analyzing the political climate of countries as a possible cause of terrorist attacks. Through the use of the visualization tool, it attempts to help analysts by providing them with the ability to:

- 1) Identify the target victims of terrorist attacks across countries
- 2) Explore each country's existing political climate
- 3) Compare the political climate of each country
- 4) Establish possible correlations of a country's political climate with the number of terrorist attacks happening in a country

III. RELATED WORKS

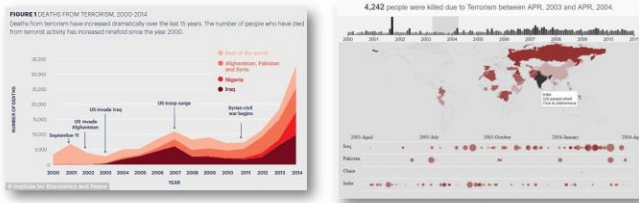


Fig. 1. An illustration of related works on terrorism. The left of the figure shows the use of an infographic, while the right of the figure shows the use of an interactive visualization.

Majority of existing visualization tools are created to visualize the spread of terrorist activities worldwide, such as its death toll. Some of these interesting and useful visualization are shown in Figure 1.

Through both the infographic and interactive visualization, analysts can better visualize the rise/fall of death tolls caused by terrorist attacks across different years and geographical regions. In the infographic, the use of annotations provides analysts with contextual information of key events that shook the world. This is useful for the analysts when they explore the data. In addition, the interactive visualization consists of numerous charts that are linked to assist analysts in their data exploration. Furthermore, the use of interactive techniques like brushing is used to provide analysts the ability to narrow down the range of data to analyze. This helps to prevent confusion for the analyst, while they are analyzing the data. Lastly, the use of tooltips is a useful mechanism to help analysts understand the death toll in the country without overcrowding the application with information.

These applications are well-designed but are primarily focused on analyzing the spread of terrorist attacks. This does not provide significant help to existing agencies to prevent against the possibilities of future attacks. As such, this research project attempts to complement current efforts by looking at political climate of countries and identify possible causes that led to the rise of attacks in these countries.

IV. VISUALIZATION APPROACH

In order to develop a visualization tool that can help analysts to explore the correlation between different sets of data, 3 main phases of activities were conducted. These 3 phases include the process of (1) collating, exploring and preparing the data, (2) planning the visualization tool and (3) creating the visualization tool. The process of collating, exploring and preparing the data forms the foundation of the research project and 2 iterations of this phase were conducted. Section 4 will elaborate on the stage of collating, exploring and preparing data while Section 5 will explain the design considerations of planning and creating the visualization.

V. DATA COLLATION, EXPLORATION & PREPARATION

The research project begins with the selection of a dataset that can provide the ability to analyze each terrorist attack on a detailed level (e.g. target victims of each attack and its

geographical location). The Global Terrorism Database (GTD) provides a comprehensive repository of all terrorist events between 1970 to 2015. However, in our analysis, we will be focusing on terrorist events that took place between 2000 to 2015. The rationale for the selected range is due to rapid changes in the globalized world and that, analyzing all data in the past 45 years does not provide strong relevance to the analyst. As such, the data range has been narrowed down. Furthermore, there are data and technical limitations which can only provide information and support from 2000 to 2015.

In the first phase of our research project, hypotheses were formed and these hypotheses led us to gather and explore related data to establish the truth of the hypothesis. The process of exploration is conducted by the creation of charts in Tableau to visualize potential relationships between different sets of data. Two iterations of data gathering and exploration were conducted, as elaborated in the following subsections.

A. Iteration 1 – Economic & Education Level

In the first iteration, our team formed a hypothesis that the economic conditions/education level of a country may lead to a rise in terrorist attacks in the country itself. The basis of this hypothesis stems on the issue that poverty may cause people to resort to violence in order to survive and lack of access to proper education leads people to the path of terrorism. To test our hypothesis, we collected the World Development Indicators dataset from the World Bank to establish a possible correlation that poor economic conditions in a country will play a role in causing the rise in terrorist attacks. Some of these attributes that our team focused on include the annual GDP growth of a country, the poverty ratio and the unemployment rate. Through the UNESCO Institute for Statistics, the literacy rate of the population is also retrieved to establish possible correlation between people's education level and a rise in terrorist attacks. During the process of data exploration, our team could not establish a possible correlation that poor economic conditions/low literacy rate in a country will bring about higher rates of terrorist attacks. To validate the truth of our hypothesis, we found research papers¹ that could verify our findings. As such, this renders our hypothesis false and leading us to form another hypothesis to explore possible causes of the rise in these terrorist attacks.

B. Iteration 2 – Political climate

In the second iteration of the data exploration phase, our team formed another hypothesis that the political climate of a country may lead to a rise in terrorist attacks in the country itself. The basis of this hypothesis is derived from data exploration and research in Iteration 1 where our team identified that majority of target victims of terrorist attacks are primarily focused on governmental actors such as the police or military agencies. To test our hypothesis, our team collected the Worldwide Governance Indicators dataset from the World Bank. The governance indicators consist of 6 key factors including (1) control of corruption, (2) government effectiveness, (3) political stability, (4) regulatory quality, (5) rule of law and (6) voice and accountability. By aggregating

¹ Increasing Political Freedom May Be Key to Reducing Threats (<https://research.stlouisfed.org/publications/regional/09/10/terrorism.pdf>)

all these values, it helps to define how well a country is being governed and this provides possible insights to look at the levels of political freedom and violence in a country. Also, information on the levels of political violence and terror in a country can be derived from the Political Terror Scale dataset. This dataset is coded, on a scale of 1 (inflicts least political terror) to 5 (inflicts most political terror), based on reports from Amnesty International, a non-governmental organization focused on protecting human rights. Combining both datasets, one can establish information on the political climate of each country. This lends truth to our hypothesis that political climate does affect the number of terrorist attacks in a country. Based on this set of findings, our team then moved on to the next stage of data preparation.

In the data preparation stage, relevant attributes that will be used in our analysis are extracted from each dataset. These includes (1) target victims and description of each terrorist attack retrieved from the GTD, (2) 6 main governance indicators retrieved from the World Bank and (3) political terror scale derived based on reports from Amnesty International. From the list of terrorist attacks available in the dataset, our team filtered and retrieved attacks from 2000 – 2015 and description of attacks that has resulted in more than 15 deaths. The rationale behind the selection is that analysts would be more interested in looking at attacks that had resulted in higher death toll. Also, by extracting only required data, it helps to reduce the load on the application to get data required for the visualization. This will undeniably, improve the performance level of the visualization application. All files are also exported as Comma-Separated Values File (CSV) to further reduce the load on the application itself. Another major issue faced during the process of data preparation is that different datasets use different abbreviations and names for the same country. To resolve this issue, our team attempted to map these countries together to provide for a higher level of consistency in the final visualization. All the data are also modified into a consistent format to provide for accurate and easy analysis in Tableau before moving onto the next phase of activities.

VI. OUR DESIGN CONSIDERATIONS

In the second phase, our team researched on various chart technologies and designs. Eventually, our team decided to work on the d3.js data visualization library due to its flexibility and its wide array of examples published by the community. Furthermore, loading of CSV files using the d3.js library is also an asynchronous request and this meant more responsive applications could be developed. To explore the different charts that would be suitable for the visualization, a process of researching and brainstorming was done. A storyboard was then, developed as part of the plan to create the final web visualization application. As part of the design of the entire application, the Bootstrap library is used due to its simplicity and the availability of large amount of resources to develop a web application, in the shortest time possible. The following illustrates the design considerations, during our planning process, for each page in our web visualization application.

A. View of Homepage



Fig. 2. View of Homepage in the Visualization

Figure 2 provides an overview of the web visualization application. Information provided include an introduction and objectives of the application for the analyst's contextual knowledge. The following further explains our design considerations:

1) Navigation Elements

To navigate to the next page, analysts can click on the “Explore” button to begin their analysis.

B. View of Terrorist Attacks Geographically

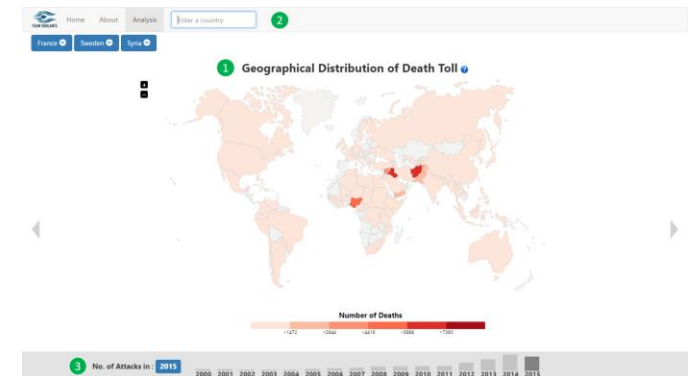


Fig. 3. View of Terrorist Attack Geographically in the Visualization

The main objective of the second page allow analysts to view the geographical distribution of deaths caused by terrorist attacks based on different year and act as a main filter for analysts to select their countries of interest. By default, year 2015 and 3 countries have been selected to assist the analyst in their analytical process and act as guidance for the analyst to begin their data exploration. The selection of year 2015 is based on the assumption that analysts will be interested to look at the spread of terrorist attacks in the most recent year. The 3 countries that were selected by default are Syria, France and Sweden. The rationale for these selection was due to the ability to spot interesting patterns from the comparison of these countries. Other design considerations include:

1) Selection of Countries Using Choropleth Map

The choropleth world map color-codes each country based on the number of deaths that took place in the country due to terrorist attacks for the selected year. Using a color gradient scale, it allows analysts to know which countries

have the most number of terrorist attacks and this could act as a platform to stimulate interest of analysts to understand why these countries have higher numbers of terrorist attacks. The world map can also be zoomed to allow analysts to focus their analysis on a particular region that are of their interest. Upon mouse-over of each country, the analyst will be presented with the name of the country and the corresponding number of terrorist attacks that took place in the country. The analyst can then, click on the country to add it into the list of countries that are of interest to him/her. All these countries will be used as inputs for the next stage of analysis.

2) *Selection of Countries Using Country Search Auto-Complete Field*

Another alternative that analysts can use to select countries of their interest is the use of the auto-complete field. This will allow the analyst to easily select countries that are of their interest by directly entering the name of the country in an auto-complete field. This removes the need for the analyst to look for the country in the world map and at the same time, it also provides easy filtering and selection of countries that the analyst is interested in.

3) *View & Filter Countries Based On Year (Bar Chart)*

The analyst will be able to look at the spread of terrorist attacks across different years through the selection of the bar chart, located at the bottom of the page. The bar chart is populated based on the total number of attacks that took place in a particular year. This provides an indication to the analyst on the total number of attacks that took place across different years. For example, if a particular year has a rapid increase in terrorist attacks, analysts can easily navigate to the particular year in their analysis. The corresponding choropleth map will be changed to display information for the selected year.

The selection of the year and countries are then used as inputs for analysis in their next phase of the exploration. By clicking on the left arrow or using the left arrow button on the keyboard, analysts will then be brought to the next stage of the analysis. The use of the left/right arrows help analysts to focus their attention on the same screen, without the need to scroll up/down which can easily disrupt their thought process.

C. *View of Target Victims & Country's Political Status*

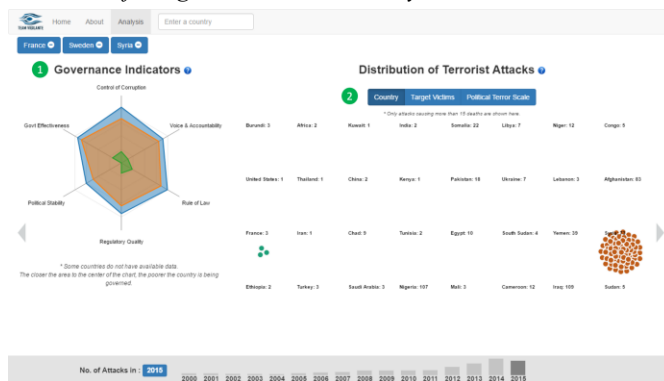


Fig. 4. View of Target Victims & Country's Political Status in the Visualization

The main objective of the third page is to allow analysts to explore different aspects of these terrorist attacks and focus on the political climate of each country. The inputs for the analysis are derived from the selection of year and countries in the previous stage (as shown in Figure 3). To provide for flexibility, analysts can also choose to modify their filters by adding/removing countries and selecting a year that are of their interest to conduct the analysis. All charts will then be changed based on the selection criterion.

1) *View Governance Level of Countries (Star/Radar Chart)*

Firstly, the star chart can be used to view the governance level of countries and how well the country is being governed. The larger the star in the chart, the better the country is being governed. Likewise, if the star is significantly smaller, it means that the country is poorly governed. By plotting the stars in the chart based on different countries, analysts can compare the level of governance in each country that are of their interest. This information can be used in conjunction with the bubble plot to reveal interesting insights. Upon mouse-over of each star, analysts can also view more information about the exact numerical values of these indicators. This provides detailed level information to help analysts in their exploration phase.

2) *Re-express Distribution of Terrorist Attacks (Force Bubble Plot)*

The force bubble plot illustrates the distribution of terrorist attacks based on different attributes - country, target victims and political terror scale. This will allow the analyst to easily view varying types of information on one single chart. Furthermore, having the star chart beside the bubble plot allows the analyst to have easy reference of these attributes with each country's governance level. This will provide analysts the ability to compare and extract interesting insights during the analysis process.

The choice of the selected attribute to display in the bubble plot is further elaborated as follows. Firstly, the use of a "Country" attribute helps analysts to focus their attention on countries that they have selected. At the same time, labels of other countries are also shown in the bubble plot to help analysts identify other countries that may be of interest to them. By adding new countries to the list, attacks that took place in the country will also be displayed. Secondly, the use of the "Target Victims" attribute help analysts to identify who are the main targets of these terrorist attacks. This could provide a platform to help analysts narrow down the wide range of possibilities that cause an attack to happen. Lastly, the use of a "Political Terror Scale" attribute aims to complement the star chart by showing relationships between the governance level of a country and its respective political terror scale. Through the bubble plot, it can also show the relationship between the political terror levels and the number of terrorist attacks that took place. As such, the design of these information aims to help analysts generate such interesting and useful insights.

In addition, there are various categories of information within each attribute. For example, categories in the "Target Victims" attribute may include "Government", "Religious Figures" or "Business". The number of bubbles

congregated at each category represents the count of terrorist attacks and this provides the ability for analysts to understand which category has the most attacks and focus their analysis on these categories.

- 3) *Retrieve Information of Each Terrorist Attack (Tooltips)*
To provide more information to the analyst in their data exploration, tooltips are used. Each bubble in the plot are color-coded based on the country and each represents a terrorist attack. Upon mouse-over of each bubble, the analyst can get contextual information about the terrorist attack, as shown in Figure 5. This provides background information of the selected attack which could help analysts to conduct their analysis better.

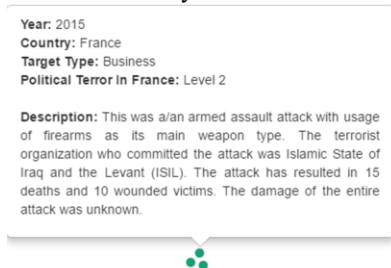


Fig. 5. Example of tooltip to provide contextual information

- 4) *Provide Help to Understand Attributes*
The use of technical terms in the visualization may prove difficult for analysts to understand and explore the visualization effectively. As such, appropriate help is provided with the use of the “information” icon. If an analyst is unsure of the definition of these key technical terms, they have the option of clicking on those icons to understand what the term means. This aims to improve the analytical thinking process for the analyst without the need for them to visit other webpages to understand the definition of key terms. As such, this will provide a smooth and seamless experience for the analyst. An example of provided help to analysts is as shown below, in Figure 6.

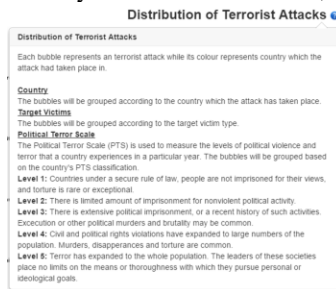


Fig. 6. Example of help provided to help analysts understand attributes

The tools that our team are using to develop the application includes Notepad++ for development and WAMP server for hosting of the application locally.

VII. KEY FINDINGS & INSIGHTS

The following lists some of the key findings and insights that could be derived from our visualization tool:

- 1) Across different years, countries in the South Asia Region (Afghanistan, Pakistan, Iraq) and Nigeria experienced the most number of deaths caused by terrorist attacks.

- 2) For countries with poor governance level, they experienced more terrorist attacks over the years.
- 3) Majority of past terrorist attacks are targeted at the government and other state actors such as the police, military and marine forces.
- 4) For countries with high political terror, significantly higher number of terrorist attacks are experienced as compared to countries with lower levels of political terror.

Based on the above findings and insights, our hypothesis of political climate affecting the number of terrorist attacks that took place in a country could be established. Policy makers, government or intelligence agencies can easily make use of the visualization tool to explore the governance level of different countries and use them as a benchmark for creation of policies to reduce occurrence of terrorist attacks.

VIII. A CASE STUDY – SYRIA, FRANCE, SWEDEN

For the purpose of this case study, we will be looking at a comparison of 3 different countries to retrieve interesting insights on relationships between the political climate of a country and the occurrence of terrorist attacks. The 3 countries are selected because of its difference in its political climate and the number of attacks that took place in the country itself.

By default, we will start with the analysis in year 2015. From the choropleth map (Figure 3), we can see that countries in the South Asia region and Nigeria had the most amount of deaths caused by terrorist attacks. To begin our analysis, we will start by selecting and adding 3 countries into our list of countries of interest. To do so, we will select the specific country from the choropleth map. As seen from the choropleth map, Sweden has the lightest color shade while Syria has one of the darkest color shade. Other than these two countries, we will also select “France” due to its lower amount of deaths caused by terrorist attacks. After the selection of all 3 countries, we can then move into the next phase of our analysis by tapping on the left arrow key.

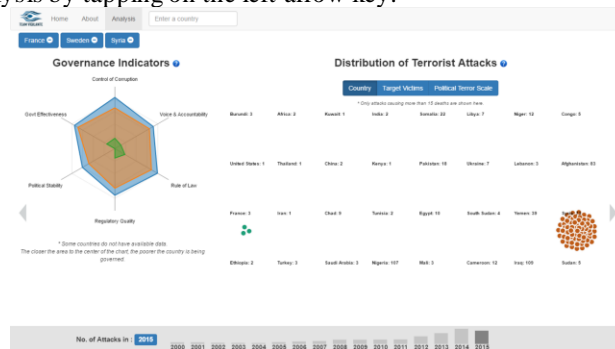


Fig. 7. Selected Countries to Analyze

Upon sliding to the next analytical stage (as shown in Figure 7), analysts can then begin their exploration phase to establish possible correlations between the political climate of various countries and the occurrence of terrorist attacks.

By exploring the star chart, one can see that Syria is poorly governed as compared to France or Sweden. This can be seen as the star for Syria is comparably smaller than France or Sweden in the chart itself. Contrast that to the number of attacks shown in the bubble plot, we can see that Syria had

significantly higher number of attacks. Similarly, France is not as well governed as compared to Sweden. In year 2015, France experienced 3 attacks while Sweden did not experience any attacks that cause more than 15 deaths. This shows that countries with poorer governance level experienced more terrorist attacks than countries with better governance. After which, one can also choose to explore different years of data by selecting on the bar chart. An interesting insight by exploring different years of data is that Syria had good governance level in the past. However, after 2011, the governance level in Syria worsened. This has also resulted in an increasing amount of attacks from 2011 onwards. Again, this has demonstrated that the political climate of a country does affect the occurrence of terrorist attacks.



Fig. 8. Target Victims of Terrorist Attacks

Moving on, we will analyze the target victims of these terrorist attacks (as shown in Figure 8). Focusing on the analysis of attacks in Syria, we can see that majority of attacks are targeted at the police/military/maritime forces. These forces are agents of the government and being targeted victims, it goes in line with the findings we discovered earlier on, that the political climate of a country does result in higher numbers of terrorist attacks.

Lastly, we will analyze the political terror scale of countries in which terrorist attacks occur (as shown in Figure 9). From the bubble plot, we can see that Syria's political terror scale is at level 5. This means that political terror has expanded to the entire population. This also goes in line with the level of governance in the country (as illustrated in the star chart) where Syria has significantly poorer governance level as compared to France or Sweden.

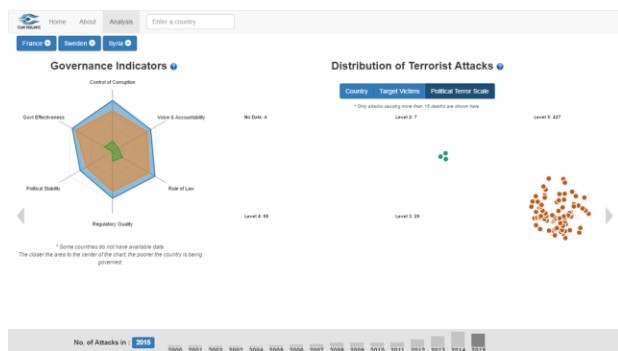


Fig. 9. Political Terror Scale of Terrorist Attacks in Different Countries

Of course, to fully explore the relationship between political climate and occurrence of attacks in a country, one can add

more countries into their analysis. Suggested countries that analysts can choose to add include Afghanistan or Iraq due to its high counts of terrorist attacks experienced over the years.

IX. CONCLUSION

The threat of terrorism is growing and as current efforts are taken by multiple agencies to detect and prevent against future attacks, this research project aims to complement the efforts by helping policy makers, government and intelligence agencies identify possible causes of these terrorist attacks. Through the research, it has been identified that economic and education level of a country does not necessarily cause an increase in terrorism threats. Conversely, how well a country is governed and the level of political terror indicates the rate of terrorist attack occurrence. By understanding these correlations with the aid of our visualization tool, it aims to help countries reduce terrorist threats by encouraging them to work on improving the country's political climate and developing policies to govern their country well. Of course, the use of our visualization serve as an exploratory platform and represent a means to guide analysts in discovering more information which may otherwise, not be presented in our visualization. In future, this research can be further extended to analyze on other possible causes such as armed trade deals between countries or in visualizing possible relationships between terrorist organizations in a region. This will help to identify the possible implications of existing economical deals and figure out relationships between terrorist organizations to better curb and reduce the spread of terrorism worldwide.

ACKNOWLEDGMENT

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REFERENCES

- [1] National Consortium for the Study of Terrorism and Responses to Terrorism (START). (2016). Global Terrorism Database [Data file]. Retrieved from <https://www.start.umd.edu/gtd>
- [2] The World Bank Group (2016). Worldwide Governance Indicators [Data file]. Retrieved from <http://data.worldbank.org/data-catalog/worldwide-governance-indicators>
- [3] The Political Terror Scale (2016). Political Terror Scale [Data file]. Retrieved from <http://www.politicalterrorscale.org/Data/>
- [4] The World Bank Group (2016). World Development Indicators [Data file]. Retrieved from <http://databank.worldbank.org/data/home.aspx>
- [5] Victor Asal; R. Karl Rethemeyer; Ian Anderson, 2011, "Big Allied and Dangerous (BAAD) Database 1 - Lethality Data, 1998-2005", hdl:1902.1/16062, Harvard Dataverse, V3
- [6] D3.js Library (2016). Tutorials and galleries of sample visualizations retrieved from <https://d3js.org/>
- [7] Hall, S. (2013, December 20). Force Bubble Charts in D3. Retrieved from [delimited.io: http://www.delimited.io/blog/2013/12/19/force-bubble-charts-in-d3](http://delimited.io/blog/2013/12/19/force-bubble-charts-in-d3)
- [8] JQVMap. (2016, March 15). jQuery World Vector Maps. Retrieved from JQVMap: <https://jqvmap.com/>
- [9] Meeks, E. (2015, August 29). d3.svg.legendexample. Retrieved from Popular Blocks: <http://bl.ocks.org/emeeks/8855733967174fe4b1b4>
- [10] Xin, K. PSC Scholarship. Retrieved from Educuity: <http://www.thiakx.com/educuity/>
- [11] GED Project (2016). Visualizing Global Economic Relations. Retrieved from GED Viz: <http://www.thiakx.com/educuity/>
- [12] Data Design Group Inc. Convert CSV to JSON. Retrieved from ConvertCSV: <http://www.convertcsv.com/csv-to-json.htm>