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Perceived safety and fear of crime: A web-based GIS platform.

Pavlos **TSAGKIS**[1*] & Yorgos N. **PHOTIS**[1]

[1] *National Technical University of Athens, Greece*

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Abstract

Fear of crime is a social phenomenon that mainly affects the population of urban communities and it is recognized as an issue by both the academic community and society itself. To study the phenomenon, it is necessary to collect primary data, either using traditional data collection methods or using well-established online questionnaires. This paper describes the process and architecture of developing an interactive data survey, analysis, and geovisualization web-based platform to support online questionnaires and surveys, related to the urban fear of crime. The main goal is to provide tools and utilities for researchers, journalists, groups or individuals, interested in the scientific aspect of fear of crime, to collect related data and analyze them within a common interface. The fear of crime platform utilizes a client-server Web-GIS application that gives access to a worldwide spatial database. As the fear of crime platform is a dynamic ecosystem that grows up every day, this database is also growing proportionally by individuals around the world. The project's development is accessible at the following web address: www.fearofcrime.com

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1. INTRODUCTION

Over the last decade, WebGIS tools have gain popularity as a result of computer technology improvements, established spatial standards (OGC, wms, wfs etc) (Blaschke, et al., 2012) as well as the availability of free mapping services to mainstream internet users (Rouse, Bergeron, & Harris, 2009). Apparently, there are numerous studies developing online spatial platforms (WebGIS), tools and utilities to carry out, support and visualize geography issues. Some of them are related to physical geography (haemi, Swift, Sister, Wilson, & Wolch, 2009; Lim, et al., 2005), some other to urban planning (Bugs, 2012; Wu, He, & Gong, 2010; Bartzokas-Tsiompras, Photis, Tsagkis & Panagiotopoulos, 2021) while some other to social geography (Musa, et al., 2013; Karnatak, Saran, Bhatia, & Roy, 2007). There is also o small number that has been specifically designed to support fear of crime research (Podor, Revesz, Racskai, & Sasvar, 2016) while few others are designed to support data related to socioeconomic analysis (Kienberger, Hagenlocher, Delmelle, & Casas, 2013) (Yin & Feng, 2009). One of the main purposes of the platform presented on this article is to provide individuals, all the necessary tools, in order to achieve dynamic adjustability and flexibility of the spatial dimension of the online survey. A secondary objective is to achieve best performance using the latest web mapping technologies without limiting functionality.

All the online tools mentioned are using the client/server technology. A typical WebGIS is handling all the data querying and geoprocessing on the back end (server) whereas user interaction, parameters passing, and map display is handled on the front end (client side). However, latest web technologies (Open layers, leaflet, JSTopologySuite etc.) have given developers the ability to transfer much of the heavy processes taking place on the server side to the client side. Such architecture, decongest server operations and split the entire heavy load to the clients, whereas at the same time it eliminates network traffic, resulting best performance.

Among all the WebGIS tools, reported on the literature, the tool presented in this paper is the first online tool that supports the analysis and geo-visualization of survey answers. Analyses may apply to any answer selected while it may extend to two questions. Their outcomes and results are provided as one or two-way tables and charts. Correspondingly, geo-visualizations may take place in the form of point density or thematic maps at a respondent or country level. Users have the functionality to filter results either by attributes (age, gender etc.) or spatially. Results may be exported both as an image (png) or data (CSV, GeoJSN) file format.

The innovative part of our system is the shift of analysis operations from server side to the client side, either we talk about chart creation, thematic map production, application of statistic methods or geoprocessing operations. In this way, all the heavy load operations are transferred to client requiring such tasks while network traffic and server tasks are minimized ensuring the best possible performance of the system. The article is organized as follows. Introduction with some literature concepts is discussed in current chapter, while software design, system architecture, characteristics as well as the developed modules and tools are discussed in detail, in chapter 2. Then, the results and conclusions of the developed platform are presented followed by some thoughts for extending the system in the final section.

2. BACKGROUND & LITERATURE REVIEW

The fear of crime refers to the fear of being a victim of crime as opposed to the actual probability of being a victim of crime (Hale, 1996) (Farrall, Gray, & Jackson, 2007). Fear of crime has received significantly attention in the academic literature, as well as in national and local politics in recent years. Consequences are noticeable not just to individuals who suffer by the feeling, but also among the society these individuals live and associate with. As a result, several academic research has been carried out to determine, describe, explain and identify the causes and consequences of fear of crime. According to (Farrall, Gray, & Jackson, 2007), earlier research has been carried out among the UK and North America, but during the last decade there are numerous research papers among the EU and Asia.

The phenomenon itself has been studied from various different disciplines including criminology, sociology, psychology and geography (Van der Wurff, Van Staalduinen, & Stringer, 1989). Consequently, various approaches have been developed to study, analyze and finally understand its nature and its impact in social life. Some of them have been carried out for specific geographic regions (Brunton-Smith & Sturgis, 2011; Jones, MacLean, & Young, 1986), while some others are missing the spatial dimension (Henson, Reyns, & Fisher, 2013; Heath & Gilbert, 1996) and in turn are focusing in specific groups like women or the elderly as these groups seems to be more affected than other groups (Bennett & Flavin, 1994; Sundeen & Mathieu, 1976). Most of these articles cover enough the social and psychology aspect of the phenomenon but its link to social and physical environment is not well understood and scrutinized (Loukaitou-Sideris, Liggett, & Iseki, 2002).

Our platform aims to cover this gap and highlight the spatial aspect of the phenomenon, providing tools to customize the geographic regions, survey answers may be projected, as well as to customize the presentation method in terms of spatial distribution. Spatial dimension will also help to examine the physical environment which in turn is considered to influence the level of fear (Pain, Place, social relations and the fear of crime: a review, 2000).

2.1 Causes and Consequences

Relevant literature shows that fear of crime causes, may be divided into two main categories. The first one is related to the vulnerability of individuals whether this is physical, economic or psychological. For example, an older man or someone in bad health is more vulnerable of being a victim of crime compared to a younger or a healthy one. The second is related to the likelihood that victimization will occur, either this is based in actual crime index or obtained from the mass media, friends, neighbors suffered crime events or even rumors among the local society (Skogan, 1986; Hale, 1996; Warr & Stafford, Fear of victimization: A look at the proximate causes, 1983). Such an example is the dramatization of the crime events from the media in conjunction with images of the crime scene and the victim himself which in turn coincide individuals with the victim. The mass media operate as a powerful tool which can spread within hours, to thousands or millions of people, information known only to a few. But also, media tend to report serious crimes, like rape or murder, which are least likely to occur (Warr, Fear of crime in the United States: Avenues for research and policy, 2000). According to (Killias, 1990) all the above may produce fear but each factor individually may not. As an assumption we may conclude that the more factors apply, the more likely is fear of crime to be cultivated.

Fear of crime, regardless of its intensity, decisively influences the daily lives of citizens, poisons the social life and shapes a negative social and psychological feeling among the society. As fear of crime mainly occurs among specific social groups like the elderly and women, consequences seem to have greater affect to such groups (Gabriel & Greve, 2003). Studying the consequences gives researchers a tool to understand the anatomy of fear of crime. To get a wider image of the problem, investigators may not focus only to direct victims of crime but also concentrate to those being indirect victims suffering from the feeling of crime (Warr, Fear of crime in the United States: Avenues for research and policy, 2000). In general, fear of crime affects individuals but also has a major impact to the society, causing public concern about neighborhood disorder, social cohesion and collective efficacy (Jackson, 2009). Individuals suffering from fear of crime, produce information about risk and generate a sense of unease, insecurity and distrust in the environment. In order to study and understand the phenomenon, it is necessary to collect primary information, either using traditional data collection methods or using the well-established online surveys.

2.2 Online Surveys and Web maps

Over the last three decades technology has driven the way we administer and manipulate surveys. Survey's evolution has evolved from the traditional face-to-face or telephone surveys to the email surveys during the 1980's and finally to the online surveys during the 1990's (Duffy, Smith, Terhanian, & Bremer, 2005). Today researchers have various options and techniques to create, administer, manipulate and execute surveys. The online method has several advantages compared to the old traditional ways of surveying such as flexibility, low administration cost, interaction, timeliness and convenience of data entry and report output analysis. However, there are some weaknesses such as respondent lack of online experience, privacy and security issues, internet dependence and low responsive rate because of bad survey design or poor instructions about filling the survey (Evans & Mathur, 2005). Furthermore, to get a deeper understanding of the collected data it is important to visualize them either as independent graphs and charts or as map-linked graphs and thematic\choropleth maps using GIS tools. The importance of cartography is proven through time but since early 2000's the Internet mapping technology gave new potential (Peterson, 2012). Geographical Information Systems (GIS) is a tool utilized to help individuals understand the spatial distribution of various phenomena (Sakamoto & Fukui, 2004) either we talk about the physical environment, the build-in environment or the social environment. Technology evolution has led to the development of web GIS applications and frameworks, so that large datasets can be manipulated on the web and presented to client computers through web browsers as various outcomes, such as choropleth maps, heat maps, graph and chart maps and statistical maps (see for example Bartzokas-Tsiompras, Photis, Tsagkis, & Panagiotopoulos, 2021). On top, various free and open data sources can be used to display on the background including Google maps, OpenStreetMap etc. so that viewers can easily navigate to the area of interest and achieve a better understanding of the phenomenon they are interested in.

3. SYSTEM ARCHITECTURE, TECHNOLOGIES AND IMPLEMENTATION OF WEB-GIS PLATFORM

3.1 System Architecture

The two main architectures are the two-tier and three-tier architecture (Oluwatosin, 2014). The Fear of crime platform design is based on the client-server architecture as 3-tier architecture. Client-server three-tier architecture is made up of the (Application Tier) application server, (Data Tier) database server and (Presentation Tier) PC. The online survey as well as the mapping tool are integrated on both client and server side. User Interface (UI), including maps, tabular data, graphs and pivot tables are integrated on the client side, while transactions and procedures take place on the server side. Development standards are one of the most important part of the web-platform development process (Adnan, Singleton, & Longley, 2010). Right choice of techniques and technologies at this stage can enhance the performance of the final product.

3.1.1 Basic coding principles and patterns

In all aspects of project development, we have followed the Object-Oriented Programming (OOP) paradigm. Object-oriented programming is the software design and coding model of computer programming in which software developers define objects as data types and structures, as well as methods that can be applied to these objects. All individual subsystems operate independently. In this way we achieve maximum flexibility and modularity. According to (Stefik & Bobrow, 1985) the term object-oriented programming has been used to mean different things, but one thing these languages have in common is objects.

Great attention has been paid to organize and write the code based on the originally designed architecture of the platform including its subsystems. In that way we keep our code clear and understandable to prospective developers who are likely to get involved in any future development. Respectively, database development has followed the platform architecture. As GIS web-based applications are normally required to serve large amounts of spatial data from a database, it is important that the database perform efficiently in response to different user requests

Finally, we have used common and widely used protocols either for the communication between individual internal subsystems or for communication with third party services like OpenStreetMap (OSM), google maps, Nominatim geocoder, etc. (OGC, wms, wfs, xml, http). Use of a common communications protocol enhances the performance of the web application because the information contained in the application does not need to be converted into the application data format (Adnan M., 2010).

3.1.2 Website structure and design

Website design has been identified as one of the main factors contributing to repeat visits. High quality content, simplicity and performance are the top factors influencing repeat visits (Rosen & Purinton, 2004).The project itself is presented through a website with several pages, which help those interested to get general information about the project itself, fill in the online survey and navigate to the specific tools, developed to analyze the produced data as well as to create and manage their own accounts. Website has been divided into the following sections expressed as single web pages:

Project presentation web page is the main page to present and promote the project itself. In this page we provide the main navigation of the platform among its different components. There is a short review about the subject and targets of the project, the people developed and maintain the project, any published citations as well as general information about the Geochoros Laboratory which supports and maintains the project.

WebGIS page hosts the geo-analysis and geo-statistics tool. It has been developed using a variety of different modules related to existing data manipulation and visualization, production of thematic and chart maps, exporting maps as simple images or geofiles (GeoJSN, kml) as well as a great number of different tools that help individuals to carry out research for the geographic area of their choice. A detailed description of this component is given in section **Error! Reference source not found.** of this article.

Survey page hosts the online survey of fear of crime. It has been integrated using the Limesurvey OS web tool. The online survey consists of 28 different questions related to fear of crime, as well as some personal and demographic questions related to the feeling of crime. All questionnaires are filled in anonymously and the whole process requires approximately 10 minutes to be completed. Questions are divided into four different groups: 1. Personal questions 2. General Questions related to fear of crime 3. Questions related to fear of crime within the residence area 4. Questions related to the demographic characteristics.

Finally, the general statistics page hosts graphs and charts for every single question included within the questionnaire. Its contents may be formed from the Admin tool of Limesurvey component. The results presented cover all the answers without classified in different geographical regions. So, this component gives a general view of the collected data. For more detailed information, as well as extra graphs and statistics capabilities we have developed the WebGIS Geo-Analysis and Statistics tool as described in the next chapter.

3.2 WebGIS GeoAnalysis and Statistics tool

The WebGIS Geo-Analysis and Statistics tool is the heart of the platform in terms of productivity and data presentation. Its main purpose is the visualization of the spatial dimension of each individual answer. According to (Doran & Lees, 2005), GIS systems have proven to be useful tools for investigating and assisting in the management of spatiotemporal phenomena.

This tool consists of six different modules as presented in Figure 1. WebGIS Architecture. All the modules presented operate independently but they communicate to each other through the central repository. In this way the web application itself, becomes modular and thus can be customized to any extra needs and development. For example, if we decide to extend our RDBMS to a new vendor like Oracle or Postgres, we may change our code included within DB module only, without the need to change any other part of the platform.

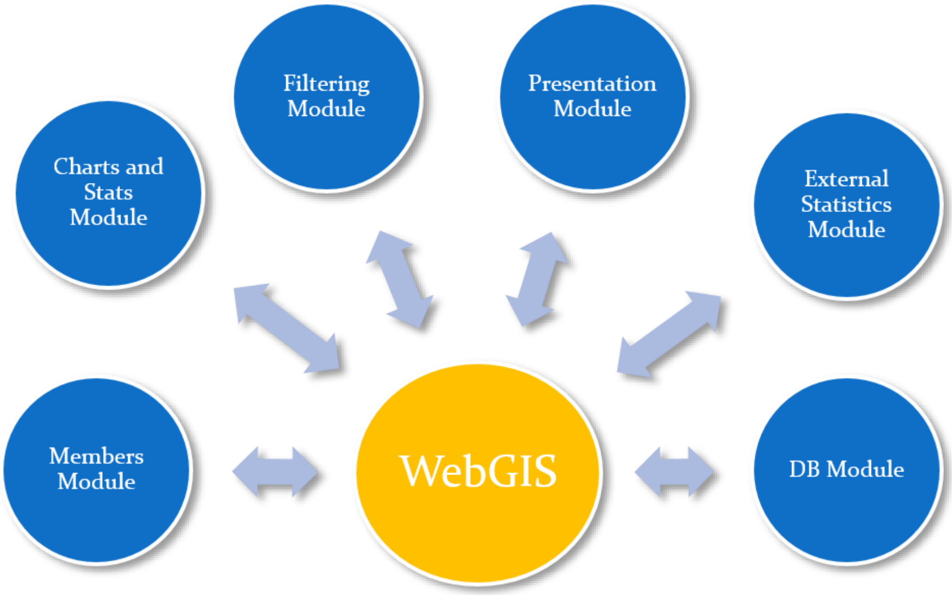

Figure 1. WebGIS Architecture.

3.2.1 Presentation and Spatial Analysis Module

This module consists of three different layers that can be switched on and off. These are:

i. Cluster Point layer representing the exact location any individual questionnaire refers to.
ii. Heatmap layer dynamically produced using the value of each point.
iii. Vector areas Graph Map layer.

Default option for this layer is the world countries border, but user has the option to load his own GeoJSN polygon file. Subsequently, each point is projected to the geographic areas, either we talk about world countries or custom geographic regions and the result is multiple charts plotted over map, expressing grouped results projected to the geographic areas of our choice. Several base maps may be used as a background for the displayed map. These include OSM, Google Satellite, Stamen terrain and many others acquired and integrated form various open-source services, using the well-known WMS protocol.

i. Cluster point layer

Each individual questionnaire is presented as a single point within a global map. Depending on the zoom level, points are represented as clusters or as single points. This gives a more reliable view of the completed questionnaires and its spatial distribution among earth's space. By cluster analysis we mean the partitioning of data into meaningful subgroups, when the number of subgroups and other information about their composition may be unknown (Fraley & Raftery, 1998).

Every point or cluster of points is clickable, and it gives information about the answer or the number of points included on the clickable cluster point. Within the platform we may define the cluster distance, meaning the minimum distance in pixels in which points should be considered as equal and thus merged and displayed as cluster points. While distance is defined as pixel distance, clustering algorithm is applied in every change of map scale. So, every time map resolution changes, the pixel dimension changes (in terms of ground distance) and so every cluster changes accordingly using the hierarchical clustering technique and the agglomerative algorithm.

According to (Davidson & Ravi, 2005), hierarchical clustering algorithms are run once and create a dendrogram which is a tree structure containing a k-block set partition for each value of k between 1 and n, where n is the number of data points to cluster allowing the user to choose a particular clustering granularity.

Our clustering implementation is based on agglomerative clustering algorithms and follows the described process:

1. Define each point to each own cluster.
2. Calculate distances between all clusters.
3. Merge the two clusters that are closest to each other searching within a predefined buffer area (the minimum cluster distance expressed in pixel distance).
4. Return to step 2 until there is only one cluster left.

ii. Heatmap

Heatmap layer is a data matrix visualizing values in the cells using a color gradient. This gives a good overview of the largest and smallest values in the matrix (Metsalu & Vilo, 2015). Thus, heat map analysis and representation is currently used in many different scientific fields, including epidemiology, biomedical research as well as sociology (Zhao, Guo, Sheng, & Shyr, 2014). All the answers presented get a float value among 0 and 1. Depending on the type of question these values change accordingly. For example a question with possible answers as “true” or “false” will be translated to 0 and 1 respectively, or for a question with possible answers 1,2,3 and 4 will be translated to 4→1, 3→0.66, 2→0.33, 1→0 and so on. As a result, heatmap representation (Figure 2. Heatmap analysis) measure the concentration of points among space, adding on top the translated values for each point as described on previous paragraph. User can choose the colors shaping the gradient, as well as the density radius and blur level effects. Consequently, heatmap becomes a handy tool to visualize both quantitative and qualitative characteristics, giving users a very convenient way to focus on crime hot spot areas among the entire map.

iii. Thematic Map per geographic region

This is the most common, flexible and easy understandable method of qualitative data analysis. According to (Virginia, Victoria, Nikki, & Gareth, 2019) thematic analysis is a method for systematically identifying, organizing, and offering insight into patterns of meaning (themes) across a data set. Data values are grouped into several classes and each group is visually represented with a unique color. On top, WebGIS provides tools to customize the colors of each class. Methods for classification vary depending on the nature of data along with research field and objectives. In this system we have used the following statistical methods to execute the classification: Equal intervals, quintiles, standard deviation, arithmetic progression, geometric progression, Jenks (natural breaks) and unique values. However, our data nature creates limitations in terms of thematic mapping, as questionnaire responses, may contain multiple answers and thus information would be generalized to a large extent. As an alternative and in cases that we want to display all the possible responses, graphs and charts mapping analysis has been used, which turns into the traditional thematic mapping, when filtering only one choice from responses.

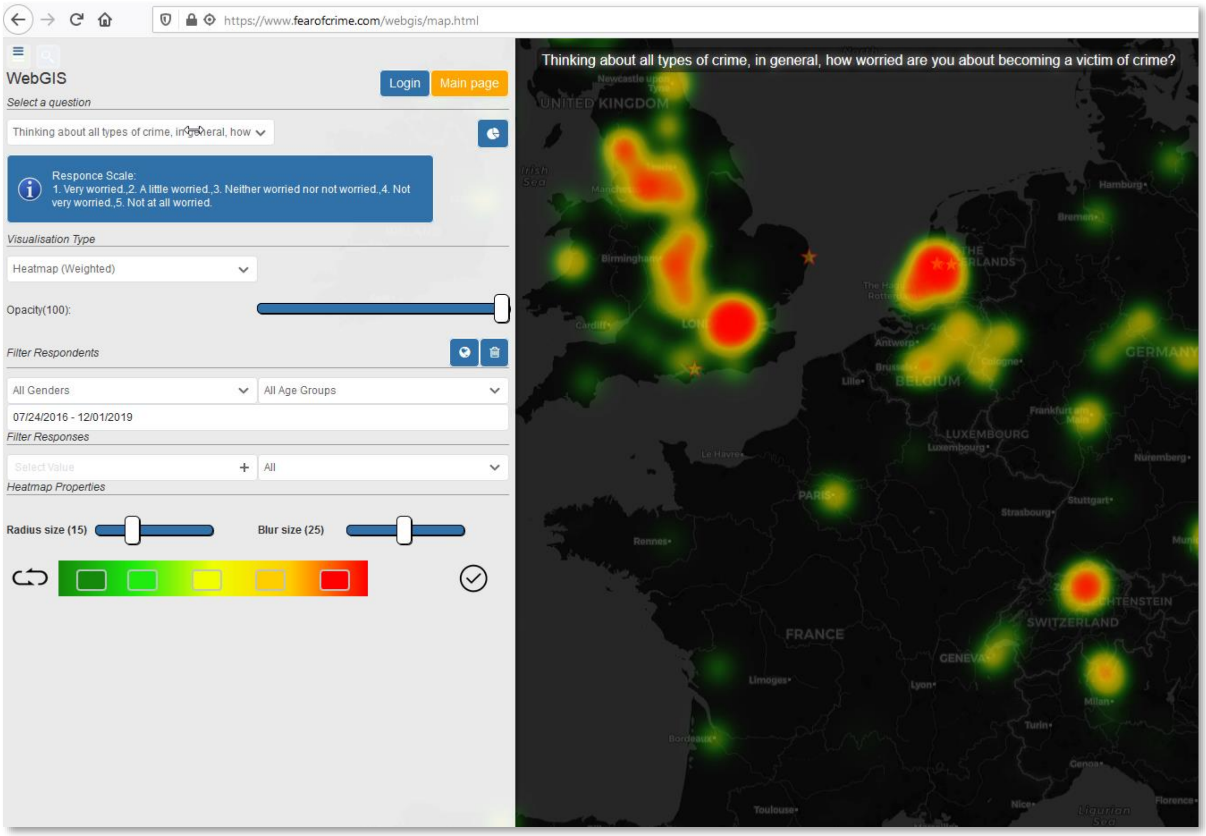

Figure 2. Heatmap analysis.

Users may select and customize dynamically 4 different types of charts. These are 3D pies, pies, donuts and bars. A second dimension has also been attached to every chart, which is the size of the chart expressing the number of questionnaires completed. Each chart is plotted over the corresponding geographic region (polygon) either this is world countries or geographic regions of user's choice (Figure 3. 3D pie charts). Subsequently, users have a quick and reliable view for the number of questionnaires submitted for each geographic area as well as a chart representing the answer values.

Every geographic region is a clickable polygon, and a popup window appears on click, so that user can examine in detail every chart. Chart data are displayed in a table holding the value, chart color as well as the count and percentage of grouped responses. Extra information included within GeoJSN files is displayed on the top area of this window. These may be district name, population as well as other social factors measured for that area like unemployment, crime rate etc.

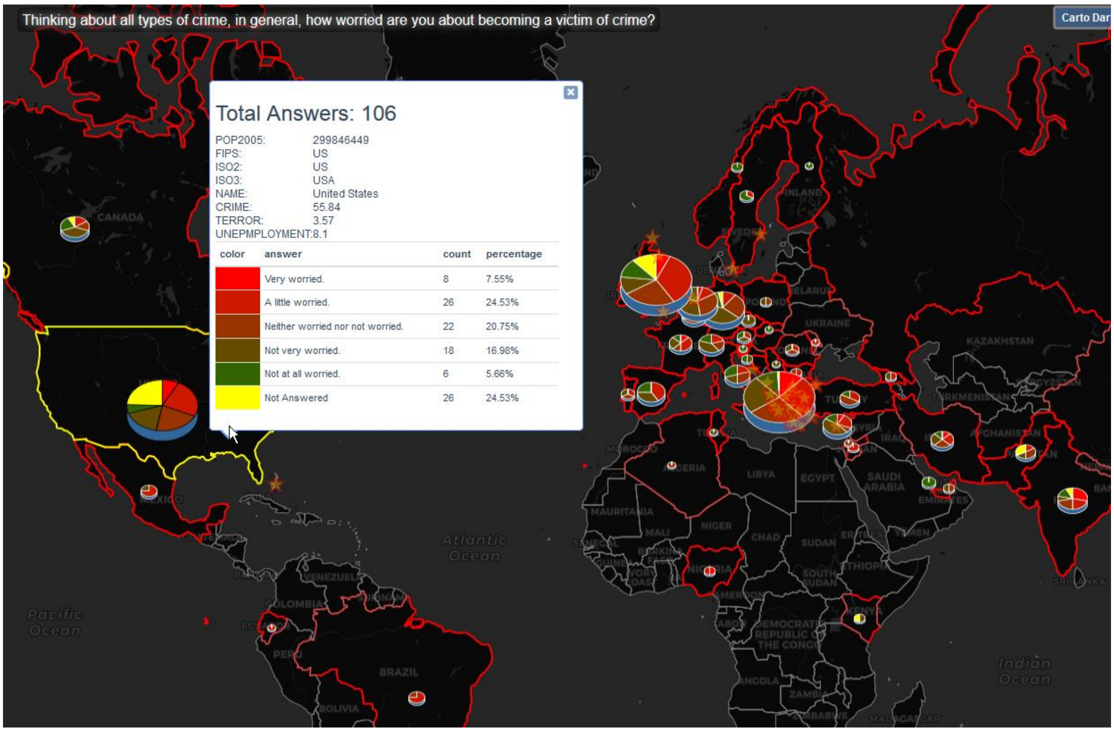

Figure 3. 3D pie charts.

3.2.2 Filtering Module

Whether results are presented as heatmap or thematic map, filtering is a major tool which gives users the ability to focus dynamically on data of their interest. Filtering may be applied to various factors, while filtering capabilities may be classified into two major classes. These are:

Filter respondents: This is an additional filter tool which helps researchers to isolate responders of scientific interest. According to several research papers about the fear of crime attention (Pain, Gender race age and fear in the city, 2001; LaGrange & Ferraro, 1989), age and gender play a vital role when researching fear of crime and as a result these are the social identities which have received most among other social characteristics like religion or education. Thus, it was important to supply dedicated statistical tools for these social groups. Most important is the age class filtering. There are five different age classes to filter data. These are:15-24, 25-34, 35-44, 45-54, 55-64, 64-70,70+. User can choose one or more age classes. In this way users have the option to focus on the specific age group or groups they are interested in. Equally important is the gender filtering, in which user can choose male, female or both genders. Finally, users are capable to filter displayed data using the supplied time slider. Time slider has few predefined time-period choices, but it can also be used to produce a fully custom time period.

Filter Responses: This is one more major filtering component helping researchers to focus on specific answers or specific groups of answers. Filtering responses is based on all possible answers for the selected question. Each time any user changes the displayed question, selector gets populated with all possible answers. Therefore, user can filter using one or some of these answers. All responses belong to a general group called "The fear of crime project" but there is also the ability for authenticated users to create their own groups and thus filter responses using their own groups. Finally, user can draw polygons, rectangles or circles over map and execute spatial filtering using these drawn geometries.

3.2.3 Mapping Statistics and Graphs Analysis Module

This tool is a major component to execute statistical analysis among the filtered or all the questionnaires. User can view its selected questionnaires as graphs and tables. Investigators may also compare questions and display compared graphs, as well as view tabular data including pivot tables for the cases of comparing questions. Finally, there is an option to filter the displayed data, on top of any other filtering, using the selected GeoJSN file used and some of its attributes. All the data displayed on this tool may be exported as csv files or as simple images including graphs and tables. The component itself provides the following methods and sub tools:

Graph generation tool help users to draw, any time, a summary graph for the questionnaires currently displayed. The graph type may be customized using five different options, consisting of lines, pies, bars, donuts and radar graphs. Hovering over graphs rise tooltips stating the label together with the value for the hovered portion of the graph. Graph type may be changed anytime giving a dynamic and interactive vision to this module.

Question comparison gives the ability to researchers to compare the currently displayed question with any other question they are interested in. For example, they can compare the question "How worried are you about having your home broken into and/or something stolen within the next twelve (12) months?" with the question "Gender" or "Age group" (Figure 4. Comparing Questions). Using the same logic as single graphs display, both graphs may be customized using the graph types mentioned. Graphs can also turn form absolute numbers to percentages and vice versa, at any time, using the corresponding button.

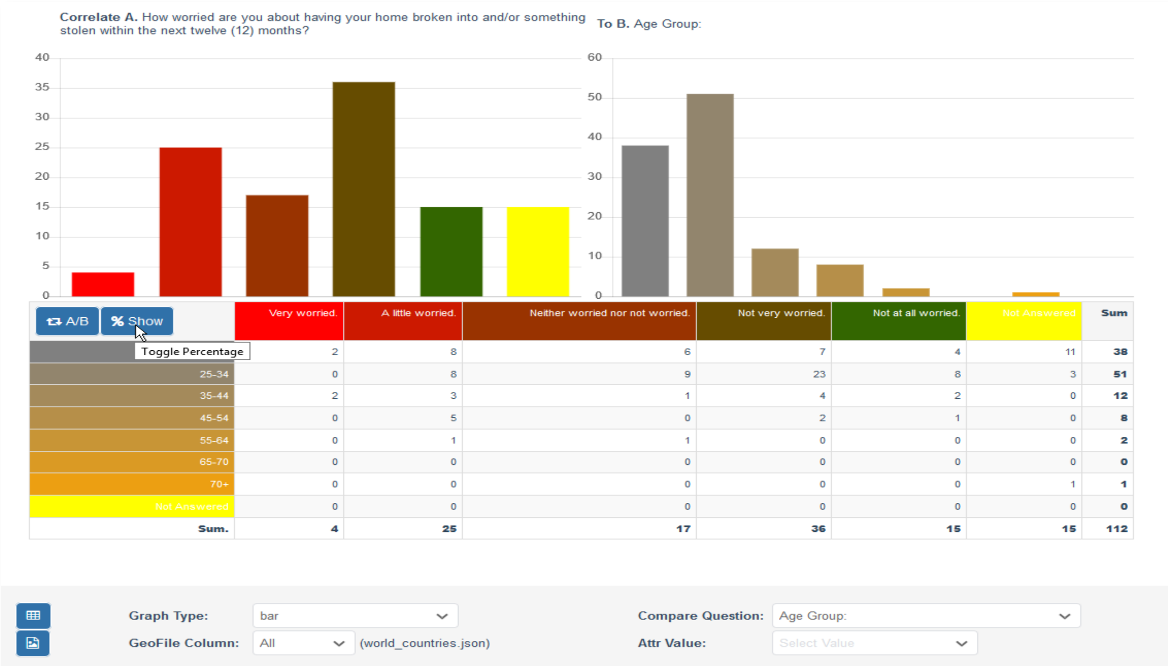

Figure 4. Comparing Questions.

Tabular data and pivot tables are part of the graph analysis tool. They are created and presented as pivot tables displaying compared questions in a pivot table presentation. A pivot table summarizes selected fields and rows of data in a table format (Daniel, 2008). In the pivot table section, users can view data from different perspectives, flip the dimensions of the table and summarize every column as well as view the total sum. Following the same logic of graph comparison, pivot tables may show the percentage in conjunction with the absolute numbers.

GeoJSN data filtering is a tool, aims to give maximum flexibility to users who want to focus on specified geographic regions. Depending on the selected GeoJSN file used, either this is the default world countries file, or the file uploaded by any authenticated user, data may be filtered using any attribute information included within the GeoJSN file. This is a two-stage process, at first user must select the GeoJSN file column and then choose the desired values for this column.

As a result, users have the ability to fully customize their data projection according to their unique special needs. For example, someone form the USA can view the graphs for a specific county or even for a unique geographic region depending on the GeoJSN file uploaded and used. Finally, users have the ability to export graphs and data to common file formats for further manipulation. This includes csv files for tabular data or png images including both graph area and pivot table area as a single image.

3.2.4 Member's area (Admin module)

Individuals interested on the project may become members of the project at no cost, by registering through the registration page. After registration, users can login and get access to extra functionality. Member's area functionality is divided into three major sections:

An authorized user can create groups and then every completed questionnaire may be attached to this group. Every questionnaire, at its final stage of completion informs the respondent that there is the option to attach his responses to a specific group. This returns a personal unique key that can be stored as a proof of completion. Subsequently, the attached questionnaires to this group can be manipulated separately form the owner of the group. They can be download separately or displayed as filtered data to the map. This functionality empowers authenticated users to customize their research to their specific needs and requirements.

Registered users can upload and manage, privately, GeoJSN files. They can view all the GeoJSN files, their file size and its contents. They can also delete or draw the file over a map and examine it in detail. GeoJSN is a geospatial data interchange format based on JavaScript Object Notation (JSON) (Howard, et al., 2008). In order to support custom GeoJSN functionality, we have developed a simple GeoJSN parser to help users examine their GeoJSN files before uploading them to the system (Figure 5. GeoJSN Parser).

Users paste the GeoJSN contents within a text area. Data shall be supplied ideally projected in WGS84 projection but in case of different projection, parser should try to identify the projection and reproject them according to the EPSG code stored within the GeoJSN file. If projection information is missing, then users have the option to force parser to use any declared projection registered in https://epsg.io/ projections database.

In the next step, users parse the contents of GeoJSN file, and the result is visually displayed within a global map on top, as well as tabular information to the bottom of the map. At this stage users are able to examine their data before uploading them to the server. It is important to add that only polygon and multi-polygon geometry types will be parsed as any other type of geometry will have no impact to research objectives.

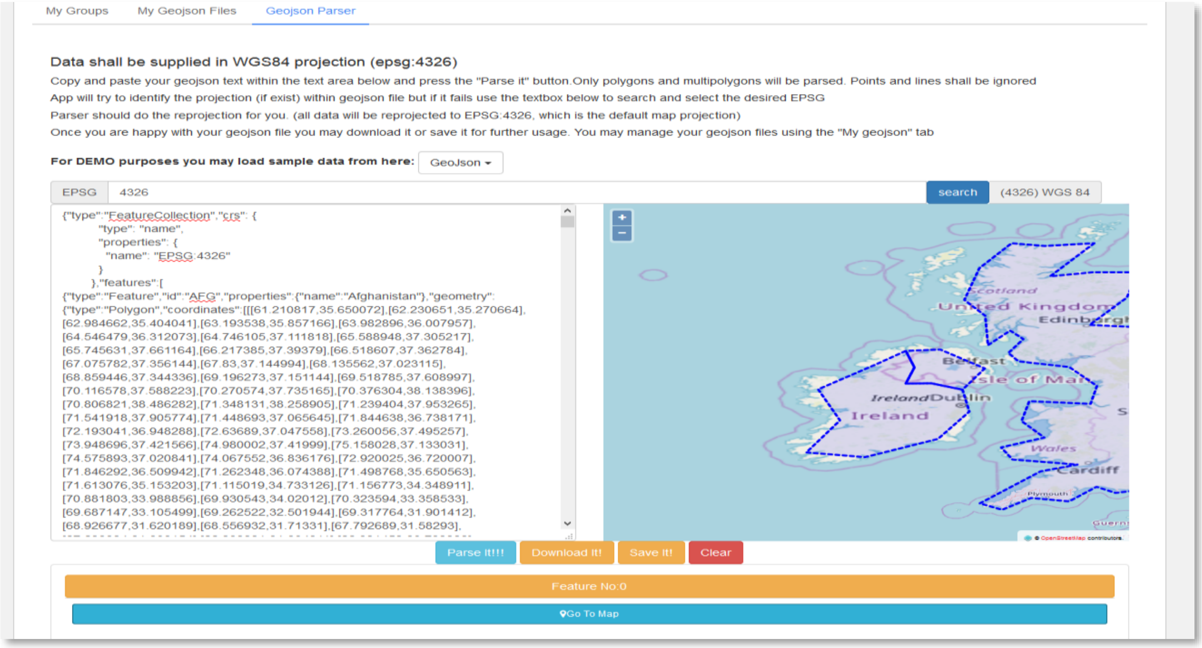

Figure 5. GeoJSN Parser.

3.3 Technologies and 3d party tools used

Various technologies and third-party projects have been used to develop the platform and accomplish its goals and objectives. PHP programming language has been used on the server side and JavaScript for the client side. MySQL is the relational Database used to support both online questionnaires and the WebGIS tool. Most of the 3d party libraries used, are projects running on client side, while some of them are deployed on the server side. All the 3d party modules and frameworks are Open-Source projects (OS) and their choice was based on its contributor's investment, usage wideness, documentation, as well as on its development activity. Next, all the third-party OS libraries used for the completion of the platform are presented: 1) Limesurvey for the implementation of the online survey. 2) Open layers for the WebGIS implementation and capabilities. 3) Geostats.js for the geographical statistical classification. 4)Chart.js for the creation of Graphs and Charts. 5) Ol-ext to extend Open layers' functionality. 6) Open Street Map (OSM) and Google Maps in order to use various base maps within web-GIS tool. 7) Jstat.js for the tabular statistical analysis and finally 8) Jquery.js and Bootsrap.js for the UI. Next, we provide a short description, highlighting the reasons for their choice, about Limesurvey and Open layers as these are the main frameworks of Fear of Crime platform.

3.3.1 Limesurvey

Limesurvey is a reliable, open source, online survey application built in PHP and MySQL. Limesurvey is a web application that has gained a positive reputation within the academic IT (Information Technology) community. It is currently used by a wide number of universities, including the GeoChoros Research Group as its main survey tool to execute online surveys. Limesurvey main features can be briefly summarized as follows: Administration, 28 different question types, Multi-languages support, Panel integration, Question definition, Data security & anonymization, Survey design and Participants (Klieve, et al., 2010).

3.3.2 Open Layers

Open Layers is an open source WebGIS framework, written in JavaScript and running on client side. It was first released back in 2006 as an alternative to google maps. Since that time, Open Layers has gained the belief of academic community and today is widely used in various academic research projects, as well as commercial projects (Kim, Wang, & Jacobson, 2010; Bandyophadyay, Singh, & Singh, 2012). Its main components and features may be summarized as: The Map, Layers, Controls, Interactions and Projections.

4. CONCLUSIONS AND FURTHER RESEARCH

The Urban Fear of Crime Project is a fully functional platform supporting the collection of primary data, related to the fear of crime, implementing on online questionnaire. It is also a tool to analyze and geo-visualize these data offering the ability to customize the geographic regions of interest or focus on private filled questionnaires. The innovative part of the platform is the fact that is developed using the state of the art web technologies in order to shift most of the heavy load processes from server side to client side, resulting best possible performance of the system.

The implementation of the platform provides several advantages. Firstly, the platform provides location enabled data for all around the world, helping community groups or individuals to identify, not only the intense of the problem but also its spatial distribution among space. Secondly the tool may be used by researchers or journalists in order to collect primary data for geographic regions of their specific interest, using the "member's area" sub-tool which gives to users the option to collect their own questionnaires and handle them individually or in conjunction with the rest of collected data.On the other hand, there are some drawbacks within the existing version (2019). First and foremost, the online survey lacks the ability to add new questions or to adjust those exist, so every user is forced to carry out its research using the provided survey. In addition, spatial data are stored either as x,y data within RDBMS tables or as GeoJSN files within the file system. While database grows over time, the need to store spatial data within DB spatial data types will be urgent and necessary.

The fear of crime is a feeling, or a sense of perception based on the perceived danger of suffering a crime without this perception necessarily going hand in hand with the real possibility of being a victim of crime. As a result, study and analysis of the phenomenon is vital in order to understand it and tackle it, while online tools seem to be, technologically, mature enough to carry out such research and study. Although, various applications and online tools has been developed to understand and analyze phenomena related to physical or social geography, there is nothing related to the fear of crime as an interactive data survey, analysis and geovisualization web-GIS tool. The aim of this project is to narrow this gap.

The project has been running successfully for over a year now. During this period, we have managed to collect more than 3000 questionnaires form all around the world.

Though, most of them got collected from Greece as the institution holding and maintaining the project (Geochoros Research Group) is located in Athens, Greece and so the project got promoted among its members. But there are countries like United Kingdom, Netherlands and the United States of America that hold a representative number of questionnaires making the research for these countries available for successful analysis. The platform itself is a full WebGIS suite offering a large set of interactive mapping tools and utilities that help individuals or groups of individuals to carry out research related to the field of fear of crime. Platform has also been used by journalists who want to analyze fear of crime and draw results for specific geographic regions. Newspapers of national broadband readability have used the Fear of Crime platform for such purposes (Kathimerini, Proto thema)

Member's area proved to be a vital part of the platform as it operates as incentive for researchers to fill in questionnaires and execute their research using their own data. So, it is important to extend this functionality in order to give more incentives to users and thus help the project to grow proportionally. It is on our future purposes to extend this module and thus help platform to gain more prestige and momentum. The platform will be further developed, so that every kind of Limesurvey questionnaires can be attached to the platform and use all the available tools as presented in the current paper. We also plan to add an extra module (WMS module) in order to let users, import any Web Mapping Service (WMS) dataset within the fear of crime map and extend the current DB module so it can operate with more Database vendors like PostgreSQL or Oracle. In addition, our future developments will focus on growing the existing system according to user's feedback.

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