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Žilina, Slovakia
24-26 May 2023

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- Artificial Intelligence, Robotics and Automation
- Coding Theory, DevOps and DevSecOps Technologies
- Emerging Wireless Technologies, 5G and beyond
- Internet of Things: Apps and Enabling Technologies
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- Intelligence, Social Mining and Web
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- Networks and Applications
- e-Health and Wellbeing
- Security and Privacy
- Algorithms and Modeling
- Workshop: The DataWorld

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Proceedings

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24-26 May 2023

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Preface of the 33rd Conference of Open Innovations Association FRUCT

On behalf of the organizing team, I warm welcome you to the 33rd Conference of Open Innovations Association FRUCT. This year, the conference is hosted by the University of Žilina. The FRUCT33 conference embraces a hybrid format, combining onsite participation in Žilina, Slovakia, with online engagement through MS Teams.

Building upon a rich legacy of fostering enduring academic and business collaborations, the FRUCT conference has consistently been at the forefront of innovation. The program for this conference comprises 10 sessions, featuring 3 keynote talks, an invited talk, demo and poster section, the 6th DataWorld workshop, and the Oracle day. Spanning three days, the conference program accommodates both onsite and online participants. The first one and a half days of the conference (May 24-25, 2023) are primarily dedicated to attendees present in person. However, the latter half of the second day and the entire third day (May 26, 2023) are reserved for online sessions. Consequently, the conference proceedings are tailored to optimize the experience for both onsite and online participants.

For the onsite portion of the conference, we will adhere to the traditional format of presentations. Furthermore, the onsite sessions will be live streamed via MS Teams, ensuring that remote participants can also benefit from these sessions. As for the online component, all presentations have been pre-recorded by the authors and uploaded to YouTube. The conference program includes links to individual presentations as well as playlists encompassing all talks for each section. To manage your participation effectively, please consult the conference program brochure, which can be downloaded from www.fruct.org/program33.

The online conference sessions consist of two modules. Firstly, we encourage you to watch the pre-recorded presentations on YouTube. The conference program provides playlists for each session along with links to the individual presentations. Secondly, the sessions feature a question-and-answer segment, during which attendees can interact with the authors of the papers presented. These Q&A sessions will take place on MS Teams. We kindly request all paper authors to join their respective Q&A sessions and respond to questions from the conference attendees. The conference program includes designated time slots and corresponding MS Teams links for these sessions. We encourage you to allocate time beforehand to watch the relevant videos. Additionally, we invite you to provide feedback to the conference authors through likes, dislikes, and comments on the YouTube videos. We also encourage you to subscribe to the FRUCT channel for updates and future content.

We are proud to announce that the conference is technically sponsored by IEEE. All conference papers have undergone rigorous peer reviews. Full papers were selected based on stringent criteria, including research quality, paper length, structure, format, and other formal requirements. Each full paper submission was reviewed by at least three expert peers, and acceptance was granted only to those that received positive review comments. Authors were given the opportunity to address all review comments or provide compelling justifications if they chose not to implement specific suggestions. The second volume of the conference proceedings accommodates all other accepted submissions that were not classified as full papers and were not submitted to IEEE Xplore. This partitioning of the proceedings ensures that the highest quality FRUCT publications can undergo proper international indexing and be published in renowned databases such as Web of Science.

We are delighted to present the proceedings of the 33rd Conference of Open Innovations Association FRUCT. With a total of 104 conference submissions, we are proud to announce that 42 papers have been accepted for publication as full papers, resulting in a commendable conference acceptance rate of 40%.

Once again, we extend our warmest welcome to all participants and express our gratitude to the University of Žilina for hosting the FRUCT33 conference. We hope that the ensuing discussions, presentations, and interactions will inspire new avenues of open innovation and contribute to the advancement of research and industry collaboration.

The accelerating pace of innovation and the increasingly shorter lifespan of commercially viable technologies pose unique challenges for the IT and ICT industries. Fierce competition among market players and rapid technological progress fueled by extensive investments in research and development necessitate a proactive response from educational and research institutions worldwide. The FRUCT community strives to foster cooperation and cultural exchange, supporting regional teams in effectively aligning university research and education with industrial challenges. Our primary mission is to strengthen collaboration within the academic community, enhance the visibility of research teams, and facilitate direct personal connections between academic and industrial experts.

The FRUCT conference embodies the principles of continuous development and strategic partnerships between industrial and academic research, which serve as crucial factors for success in the modern innovation ecosystem. Throughout the world, there exist remarkable success stories of such frameworks, which yield significant benefits for all involved parties, fueling their respective research and development endeavors. While fundamental science driven by universities and academic organizations should not be tethered directly to existing industries, industrial research greatly benefits from early access to results and information on emerging trends and weak signals. Likewise, many universities actively engage in applied research, but to maximize their efficiency, they require feedback channels from the industry. Thus, establishing stronger connections between academia and industry is pivotal, especially given the shrinking innovation cycles discussed earlier. An intriguing new trend to address this need involves constructing open innovation frameworks specifically designed to develop strategic partnerships between industrial and academic research, enabling the identification of suitable research partners and facilitating collaborative incubation of new competencies.

The FRUCT association is actively working to involve students and postgraduates in scientific activities at an early stage, fostering joint teams to tackle challenging scientific problems using knowledge-intensive technologies, and elevating the prestige of scientific and research work. Through the development of various processes, FRUCT supports win-win cooperation and the advancement of strategic partnerships between academic and industrial research. These processes serve to overcome barriers to open innovation, demonstrating how businesses can embrace social responsibility and contribute to long-term research and academic collaborations.

The FRUCT conference stands as a significant event celebrating academia-to-industry cooperation. With over 100 participants representing 26 countries, the 33rd FRUCT conference promises to be a vibrant gathering. Additionally, we anticipate that the presentations on YouTube will garner at least tenfold more views, extending the reach and impact of the conference beyond its physical boundaries.

The primary topics of the FRUCT conference are as follows:

- Artificial Intelligence in Text Analysis and Generation
- Artificial Intelligence, Robotics and Automation
- Coding Theory, DevOps and DevSecOps Technologies
- Emerging Wireless Technologies, 5G and beyond
- Internet of Things: Apps and Enabling Technologies
- Gamification, E-learning and Smart Data in Education
- Commercialization of Technologies and Digital Economy
- Location Based Services: Navigation, Logistics, Tourism
- Wearable Electronics: Novel Architectures and Solutions
- Natural Language Processing and Speech Technologies

- Big Data, Knowledge Management, Data Mining Systems
- Cloud, Fog and Edge Computing and Engineering, HPC
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- Blockchain Technology and Applications
- Artificial Intelligence Applications
- Intelligence, Social Mining and Web
- Smart Systems and Embedded Networks
- Networks and Applications
- e-Health and Wellbeing
- Security and Privacy
- Algorithms and Modeling
- Workshop: The DataWorld

We extend our gratitude to all the authors, reviewers, and participants who have contributed to the success of this conference. The special words of thanks go to the local organizing team and especially Michal Kvet, who despite all problems and obstacles managed to organize this conference. I wish to thank all people who contributed efforts and a lot of personal time to the organization of the FRUCT conference, and all members of the organizing committee and FRUCT Advisory Board for reviewing the papers and other forms of contribution to the success of the 33rd FRUCT Conference. I hope that the proceedings and the ensuing discussions will inspire fruitful collaborations, foster innovative solutions, and drive further advancements in the field of open innovations.

May 2023

Sergey Balandin
FRUCT President

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Information System for Crime Monitoring in Europe

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***Abstract*— The goal of the project was to create a full-featured information system, the major role of which is the correct processing of data regarding crime for the European region. The main function of the information system is the statistical processing of data into a suitable representative form. In the entire information system, we want to focus on monitoring four categories of data, namely reported and convicted crimes, the situation of prisons and the number of police forces in each state. The information system allows administrators to log in to the application, where they can add and edit individual data. Data are processed in three main categories, namely data processing for Europe in the form of a report and an interactive map with a criminal index, for an individual state and for comparing states. The result of the work will be the developed web application that can be used by the countries in Europe, data analysts for searching interesting comparisons and the European Union for crime monitoring to increase the security of states, or it can be used by people who just want to expand their horizons in such a field.**

I. INTRODUCTION

The information system project for monitoring criminality in Europe is part of a larger project that includes detailed monitoring and analysis of crime in the territory of the Slovak Republic, but also monitoring traffic accidents in the territory of the Czech Republic. Together with the monitoring of Europe, they will form a complete web application with multifunctional use and the possibility of analysis in each of these parts of the project.

In the past, the information system contained only the first two of the mentioned parts of the project, and crime monitoring in Europe was created as the newest part of the project, while it was implemented into the existing parts, which were unified into one project using the React framework for the frontend and .net for the backend implementation. Monitoring for crime in the territory of Europe fits perfectly into these frameworks, because this information system must be created as a dynamic site that uses multiple graphs and reports to achieve the desired results for the users of the information system.

II. ANALYSES OF EXISTING INFORMATION SYSTEMS

Before the web development has started, we had to do analyses of existing information systems with crime monitoring. First Web application we analyse was spotcrime [1], which offers us interactive map with icons of crimes, which are situated on the map, where the crime has happened. This map is used in USA states. We can search for area we are interested in or we can choose state from United States list of states and we get map for those area. Under the map we can see table with all reported crimes on the map and with details. This website has disadvantage, that it does not support a lot of filters, only in report you can choose which crimes you want to see in charts.

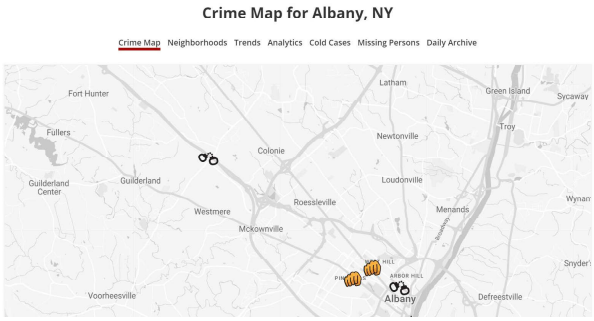

Fig. 1 Spotcrime interactive map

Assault	02/20/2023 10:05 AM	MADISON AVENUE
Arrest	02/19/2023 6:52 PM	I-90
Shooting	02/17/2023 9:21 PM	GRAND ST AND MADISON AVE
Arrest	02/13/2023 9:46 PM	CLINTON AVENUE
Assault	02/10/2023 1:10 PM	500 BLOCK OF CENTRAL AVE

Fig. 2 Spotcrime table with crimes

Second webpage we analysed was Communitycrimemap [2]. This web application differs in some ways with Spotcrime. Basically, we can see map of USA with intensity of criminal activity. We can also go to table, which is similar with that on Spotcrime. But by default, it is set to whole USA. The advantage of this application is, that it offers a lot of filters, which we can apply. We can set location and radius, in which crime has happened or type of criminal offence, time filters and more.

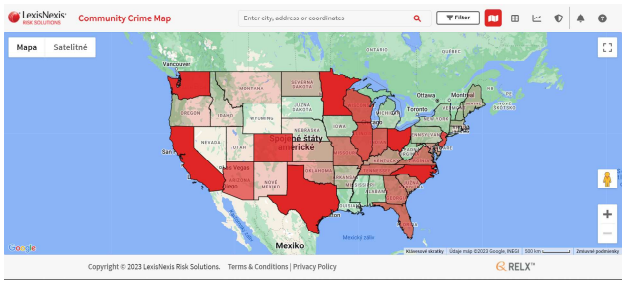

Fig. 3 Interactive map on Communitycrimemap

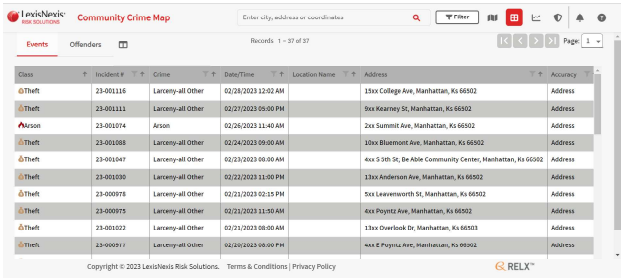

Fig. 4 Table with crime details on Communitycrimemap

We analysed more then this pages, but the important point was, that in Europe is does not exists similar to information system as in USA. In USA we can find a lot of more systems, lot of processed data of crime activity on their area and in Europe we don't have system to process those data and also, we don't have so much detailed data we can use to do such an analysis. The main reason to develop application in Europe area is need of it. We need some more complex system that will process data from criminality and offers us comparisons, statistics and in the future, we hope we can have similar applications as we can find today in the USA. It can be very useful for Europe to have a system like that.

III. PROJECT DEVELOPMENT

A. *Evaluation of the work performed according to goals of the project*

1) Data layer

Data for the evaluation and processing were formed in the star schema data warehouse [14] [15] enhanced by the tuning techniques done by the partitioning, data security and distribution [16]. Besides, all the data are temporaly oriented [9] [10], defined by the validity time frame [11] in the group level granularity [12]. All the data changes and updates were ensapsulated by the transactions [13] to ensure consistency.

2) Upload and preparation of data

The first part of the development of the project was a detailed analysis of the data and the determination of the implementation procedure of the information system. The data was provided by the website [3] - European Sourcebook of Crime and Criminal Justice Statistics, which belongs to the University of Lausanne in Switzerland. This organization provides data obtained from official sources of individual countries in Europe. The data on this page are collected every 5 years into a book, that has been made for it. Data has individual codes of special records and are there explained. The data includes all information about committed criminal offences, convicted criminal offences, police forces, but also about the state of prisons in individual countries. Other data contains information on various amendments to laws in individual crimes and states, as some of their amendments may differ within countries. The data are grouped in one .xlsx file, which we had to study with the help of a book and analyse. After analysing the data, we designed an information system that will focus on the analysis of such data. Subsequently, we created a data model of the system, which was easily expandable by other subjects. Subsequently, we prepared an entity in the relational database where individual records will be stored.

The data provided by the organization was in raw format, so we had to edit it and divide it into several files that would have the required format for easy filling of the database. For each entity, we have prepared its loading in the information system. It is developed in .net and it can bring several benefits. This platform is speedy and compatible across multiple platforms, indicating that there are no issues with building code on devices that operate on varying operating systems. Additionally, it stands out as one of the most efficient platforms for developers, thanks to its comprehensive supportive ecosystem and robust tooling capabilities. [4] We use a database from Oracle, this relational database from Oracle is a database that stores data points which have a connection with one another and provides access to them. The relational model serves as the basis for such databases, which is a simple and intuitive way of organizing data into tables. Each record in the table is represented as a row in the relational database and is given a unique ID called a key. [5]

Loading the header of the given file of the loaded file, but also checking the uniqueness of the inserted records, so that they do not contain duplicate records and those individual messages are not negatively affected. The data are currently prepared for the area of crimes for the years 2007-2016. Later in the period, we will also process data for convicted criminal offences, police forces and the state of prisons. For better analyses, it would be appropriate to add new data that will be added to the system when we have access to them (they will be published on the organization's website).

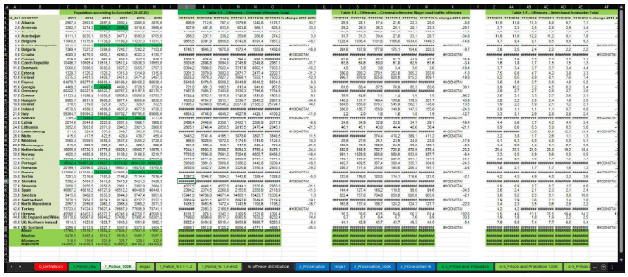

Fig. 5 Data in raw format

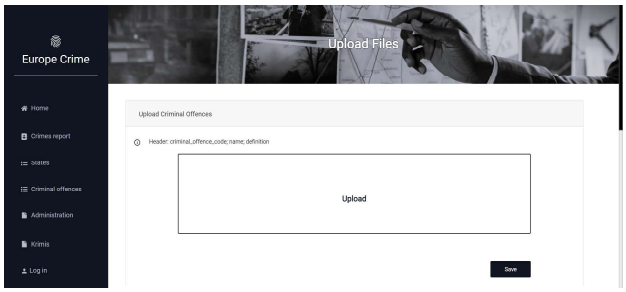

Fig. 6 Page for uploading data

3) Re-design and addition of a sub-page for crime in Europe

Part of our work was also a very simple re-design of the site. In the field of frontend development, we utilize React, a JavaScript library that operates on a component-based system. By utilizing React, new functionalities can be added without needing to rewrite any previously existing code. This is possible because React allows for the creation of isolated components that are capable of managing their own state, which can then be combined to create intricate user interfaces. [6]

Re-design included changing the colour palette used on the site, modifying the navigation bar and small details in the page display.

The main reason for the redesign was that the original design was very over combined and the ease of use of the web application was disappearing from it. In the new design, we tried to make the design more pleasant for the eye and the use of the information system. We tried to make the information system not only process data, but also attract and simplify the work of the final user.

The colours and images in the new modified website were designed to express the essence of the information system. The colour of the menu was chosen to be dark blue to grey to create a pleasant contrast against the white background on the page. All images are adjusted to a black-and-white filter to express the tension that is caused by the execution and investigation of criminal offences, the content of the images also expresses the individual components of the data that we want to focus on the site (convicted crimes, police forces, ...).

Another necessary new functionality of the information system was the addition of a universal language - English, because the site dedicated to European criminal monitoring is not intended only for users of a specific area (Slovak and Czech), but for global users, therefore we considered it necessary to use a universal language that would be understood by people in Europe , as English is the most widely spoken foreign language for most countries. When the system will be used practically, it would be advisable to add other more widespread languages such as German, French, ...

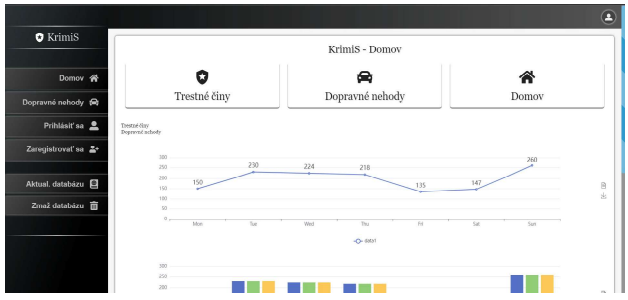

Fig. 7 Site before re-design

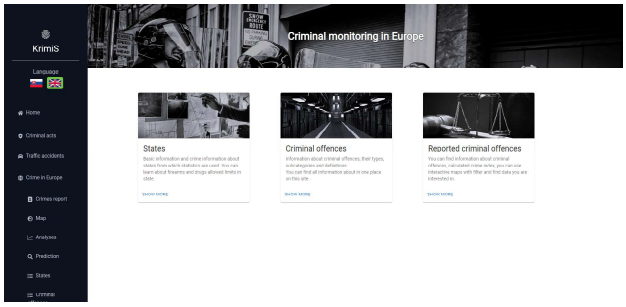

Fig. 8 Site after re-design

Our next task, it was necessary to add sub-sites to the existing system, which would also be dedicated to monitoring criminality in Europe. We have added to the main menu individual links to the currently functional pages of the new part of the system. In addition, these links are also found on the main page of criminality monitoring in Europe.

4) Details of criminal offences

One of the sub-pages of the new system is a page devoted to the definition, categorization, and overview of individual crimes. On the website, we can find a list of all crimes that we deal with as part of crime monitoring. After selecting a crime, we can find the category in which the crime falls, its subcategories, which the crime includes, and its definition.

Such a subpage was designed so that the user could accurately identify the crime that he entered in the individual filters.

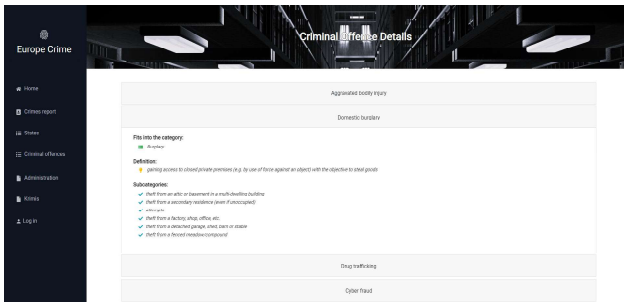

Fig. 9 Criminal offences categorization page

5) Information about individual countries

With the subpages about individual countries, we deal with data for individual countries, some of their basic rules within the framework of criminal laws. After clicking on the item "states" in the main menu, we get to a page that displays 46 countries in Europe - the states that we follow in the project.

After clicking on one of the countries, information about it will be displayed, both basic data about the country and about criminal laws. Such a report is created for each of the monitored countries, while the filled-in information differs slightly, because some countries do not provide information with this data.

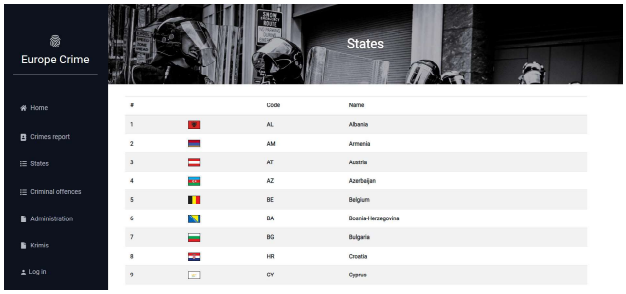

Fig. 10 Page with list of states

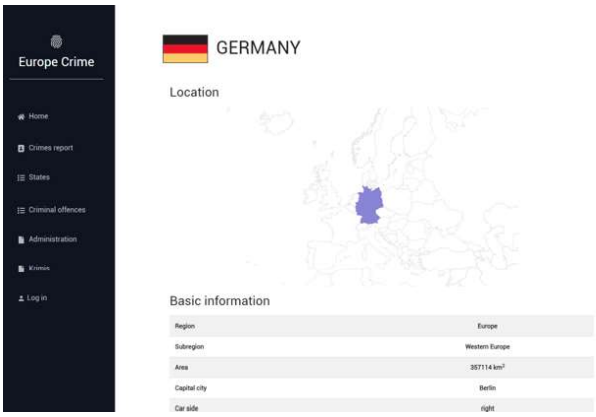

Fig. 11 Country page with basic information

On the website, we can find information about the location of the given state about the territory of Europe within the general information. Next section, we will learn information about the area, the region within Europe into which it fits, the capital of the given country, the side on which the country is driven (the possibility to analyse accidents, whether the accident rate is higher on the left or right side) and whether the country is legislatively recognized as a state.

Furthermore, on the page there is a graph showing the development of the population in the years in which we monitor crime.

The following information talks about the rules for a given state, such as the limit of alcohol allowed behind the wheel in parts per million or the law of the age limit for sexual intercourse - the age limit from which minors can legally have sexual intercourse.

Another section of the site is devoted to drugs, their legal restrictions for individual countries, while we have information on marijuana, heroin, cocaine, and ecstasy. The stated values of the limits are in grams and, since they differ significantly for each country, they can be important for the analysis of drug activity in the countries.

The last section for now is the section that deals with weapons and whether a certain item is a weapon in each country. In the table, we used a simple distinction with signs, while a green pipe means that the given weapon is considered a weapon and a red cross means the opposite. Weapons monitored are revolvers, rifles, shotguns, submachine guns, machine guns, grenade launchers, improvised and special firearms, unloaded firearms carried with ammunition on hand, legally owned firearms, hand grenades, Molotov cocktails, air rifles, gas pistols, paintball guns, crossbows, bows and arrows, replica firearms and other counterfeits, unloaded firearms carried without ammunition.

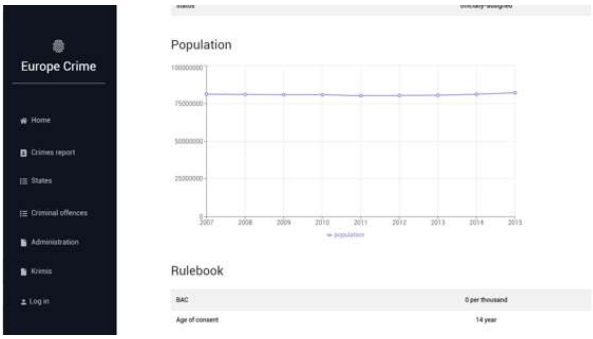

Fig. 12 Country page with population development in years

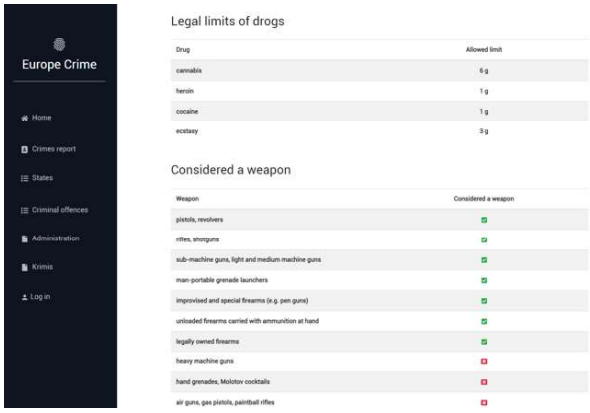

Fig. 13 State page showing legal drug limits and gun information

6) *Interactive report with map*

So far, the most interesting page in the section on crime in Europe is the page containing an interactive report with a map. Using a filter to display data is very intuitive. Within the filter, we have 3 components, the first is the country, where it is necessary to select the countries that we want to follow in the resulting report, by checking the fields in the dynamic list. Subsequently, from a similar list, we choose the years for which the data should be calculated, that means that currently between 2007 and 2016, we can choose any year and the resulting report will be calculated for these years. The advantage is that the selected years do not have to be within the interval but can be chosen discretely. The last step is to select the crimes for which we want to create this analysis. We click on the list of criminal offenses in the same way as for states or years. After selecting these data, the page creates a map for us, which is coloured according to the value of the crime index in the given country from the given data.

Criminal index – the normalized number of crimes for countries, calculated as the ratio of the number of crimes in the

given years and the average number of inhabitants in those years. Subsequently, it is multiplied by 100,000 so that the value is given per 100,000 inhabitants, that is, it expresses how many crimes were committed per 100,000 inhabitants. [7]

On the map, we can see that countries with a higher value of the crime index are coloured in a darker colour and with a lower value in a lighter colour. This is how we can analyse the crime index also based on the location of countries using a map. It allows for easy clarity and a unique type of graph that catches the eye of the application user. Countries that have not been added to the filter are white by default. Furthermore, the map allows quick information such as the name of the country and the value of the index after moving the mouse over the state within the map, which allows us to learn this information exactly (not just by using the colour) if we just move the mouse.

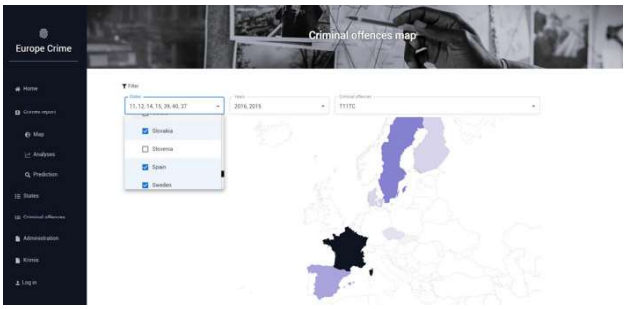

Fig. 14 Criminal report with map

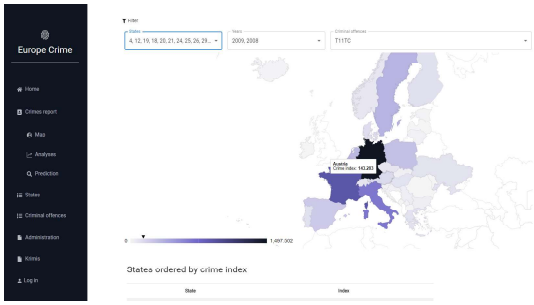

Fig. 15 Criminal report with an overview of the country

Furthermore, the report contains a table sorted by criminal index with selected countries from the filter. This table allows a quick overview of the data in a sorted form, and we can quickly find the countries with the maximum and minimum value of the crime index.

In the report section, we would like to implement the export of this data as soon as possible, in addition to the crime index, add a specific value of the number of crimes in the countries and, after clicking on a state, add a link to information about that state, which would simplify and speed up the use of the application. Another planned functionality is the addition of additional types of graphs and statistics that will better reflect the state of crime in the monitored area.

Fig. 16 Table with crime indexes of countries

7) Data analyses

In our further development, we also devoted ourselves to data analysis, while trying to extract as much informative information as possible from our system. With the graphs, we would like to bring the development of criminality in Europe as close as possible and it shows the current situation to the user. We tried to select graphs and tables according to similarly focused systems, which we mentioned in the analysis of existing systems. As an example, we can see in Figure 17 the development of the number of all crimes in the territory of the UK for the years 2007 to 2016. Similar graphs will be created for all other monitored statistical values on other pages of the application.

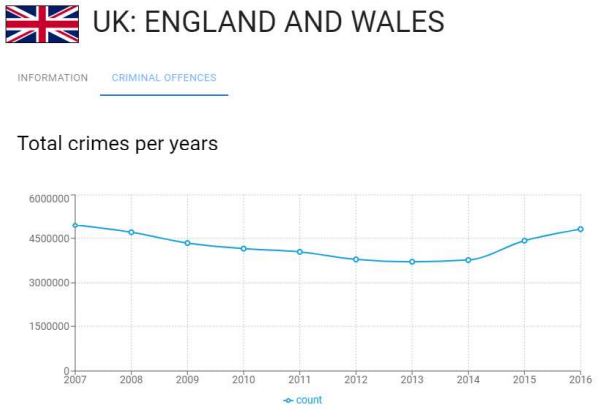

Fig. 17 Data analyses of total crimes per years for UK

IV. PLANNING FEATURES OF THE SYSTEM

A. Incorporation of data on convicted criminals

For the further expansion of the system, it would be great to include data on convicted criminal offences, which have a similar structure to the data we have on reported criminal offences.

We consider a convicted person to be a person who has been legally found guilty of committing a crime. With such statistics and data processing, we would monitor the number of reported crimes and their actual convictions. Based on the comparison of these numbers, we can find out whether crimes are sufficiently punished in the given country or vice versa.

The web application would ask for this extension directly, since we would know the actual data of convictions for crimes that we currently register. It would make it possible to expand the analysis of countries and add convictions in addition to crimes, which would significantly expand the current system.

For these data, the index of convicted crimes could be similarly recalculated, from which we would derive the normalized values of the countries.

To incorporate such data, it will be necessary to expand the data model with new entities resulting from this data, then expand the web application in the data loading section to load new entities and prepare .csv files that will be uploaded to the system with the help of data parsing.

B. Incorporation of data on the state of prisons

Another part, where the web application could be expanded is data on the state of prisons.

When we think of prison, we imagine a guard place where criminals serve their prison sentences, and the accused undergo detention.

Such data would add a new dimension to the already existing data in terms of the number of links in individual countries and would enable another analytical dimension interesting from the user's point of view.

From such data, we would allow users to create new reports, also with normalized data.

Like the previous expansion, the data and system would need to be supplemented with new parts of the application.

C. Incorporation of data on police forces in individual states

Another part of the data available to us through the organization is data on the state of individual police forces in the given state.

Police forces consist of natural persons called police officers. The police force is tasked with protecting basic rights and freedoms, detecting criminal acts, finding their perpetrators, and much more.

Such data could serve for organizations dealing with criminal activity to analyse the impact of the number of these components on the number of crimes in the given area. It will be appropriate to normalize the values of these numbers and work with them further.

The expansion of the system would be like the previous additions of new data types.

D. View detail for the state

In the current state of system, in the state display, we have a display of basic information about the given state and its legal norms, but we would like to enrich this functionality with additional tracked statistics. These statistics would be related to the processing of reports on reported crimes, convicted crimes, the state of prisons and the state of police forces for a given state. Such statistics could include reports such as:

- Most frequently reported/convicted crimes.
- Graph of monitored statistics in years.
- Ratio of monitored statistics.
- Index of monitored statistics in individual categories with a comparison of the global trend (average of the index of monitored statistics within all European countries)
- Trends of monitored statistics in the given state.
- Numbers of tracked statistics in years.
- And many others

Such an analysis would be very necessary for our system because it would bring the end user really detailed information for a specific state.

E. More states comparison

Another very useful functionality in our information system would be the comparison of several states. The whole idea is that the user of the application could choose several countries and a report about these countries would be displayed. The comparison would display all monitored statistics regarding reported crimes, convicted crimes, the state of prisons and a comparison of police forces in the given states. For comparison, we would use several graphs and tables that would nicely display the individual indices (crime index, police force index, convicted crime index and prison condition index).

F. Global filtering and save of the filter

A very useful functionality of the system would be the global use of filtering and the saving of such filters. We would allow all logged in users on the site to save filters like this and it would work as follows. The user would choose to use a global filter, if such a filter were selected, then changes in the filter of one subpage would also be reflected in other subpages of the system, which would clearly simplify the use of the system and make the system more user-friendly. In addition, if it were a user with an account, he could save such a filter in his saved filters, which would allow him to see these filters after logging into the application again, and he could simply select them again and use them again.

Another useful functionality of the use of filters could be that if the user has saved filters, he could download individual selected reports of the states he would like and already have them filtered according to his requirements.

G. Implementation of authorization

Since the current system does not include authorization, it is necessary to address this area as soon as possible. We would like to resolve the authorization area using a standard username and password method. After logging in, the user will be allowed to view administrative pages that would allow modification of data in the database - their addition, deletion, or modification. The system would thus be fully ready for deployment even with administrative pages.

For regular users, we would like to add the possibility to register and then authorize outside the administrative part of the application. Such an account would allow, for example, the

storage of a filter, reports or other functionalities added over time.

H. Administration for individual states

After adding authorization, it will be convenient to expand the system with administration for individual countries. This means that each country would have its own administrator (instead of a global admin), who would secure data from his country, prepare it and upload it to the system.

This extension would ensure a fully functional stand-alone system for all countries, which would be very beneficial when putting such a system into practice. The administration would be simpler than from the point of view of a general global administrator, and the responsibility for the validity of the data would be taken by the administrator of the given country.

I. Data and reports export

Since, in addition to creating reports, it is also convenient to find connections, causes and effects in the data, it is convenient to extend the application with a quick export via .csv files. It would allow organizations and individuals to quickly access both processed and raw data, which could later be used for various types of analysis or processed through another application.

Such an export will be suitable for each interactive report within the application, but there could also be a page where it would be possible to download the information in the form that is in our database, and this would allow other organizations to use their own method of data processing or other use.

Another type of export would be the export of analyses, or graphs, or maps, which we could provide to users using the .pdf format.

J. Create predictions

It will be appropriate to create predictions for individual data and thus take the application to the next level. Such predictions would make it possible to predict the future of criminal offenses in individual countries from current developments and thus enable organizations in the countries to prepare for the future.

To carry out the implementation, it would be highly beneficial to employ a predictive model for forecasting. This model can generate estimates for metric values by utilizing historical data insights to compute new data values. [8]

In the case of a good implementation, it would mean for the given countries that they could adjust the legislation, according to these predictions and reports, and it would enable the basis for the creation of new laws or amendments to laws, which should be its main goal.

V. Conclusion

In this article, we evaluated the state of the criminality monitoring information system for the territory of Europe, its role within the larger information system, the need, and the result of the re-design of this web application, which is gradually developing and progressing. Within the scope of crime in Europe, we took a closer look at the websites that are already prepared in the project, as well as at those whose preparation will take place soon.

We think that the existence of such an information system is very necessary in the current era when data collection and analysis are part of the daily activities in our lives. Europe would need a system that would process this data and create reports that would reflect the state of Europe from the point of view of crime, and states would be able to prepare directions through laws based on such a system.

The goal for this application is to develop as much as possible in the future and provide users with a greater amount of information and reports that this data offers us.

Acknowledgment

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References

[1] SpotCrime, Web: https://spotcrime.com/

[2] LexisNexis , Web: https://communitycrimemap.com/map

[3] Sourcebook of Crime and Criminal Justice Statistics, University of Lausanne, Web: https://wp.unil.ch/europeansourcebook/?fbclid=IwAR0XgAyZ_aKrwiT-f_ObD0EfQXX4MjQuQmIcW0E0E6HKs89OATRMqAosr5Y https://wp.unil.ch/europeansourcebook/?fbclid=IwAR0XgAyZ_aKrwiT-f_ObD0EfQXX4MjQuQmIcW0E0E6HKs89OATRMqAosr5Y

[4] .net, Web: https://dotnet.microsoft.com/en-us/

[5] Oracle, Web: https://www.oracle.com/database/what-is-a-relational-database/

[6] React, Web: https://legacy.reactjs.org/

[7] Criminal index, Web: https://calculator.academy/crime-rate-calculator/

[8] Forecast model ,Web: https://www.projectpro.io/article/predictive-modelling-techniques/598#mcetoc_1g5gnldk23s

[9] M. Kvet, "Relation between the Temporal Database Environment and Disc Block Size", IEEE 16th International Scientific Conference on Informatics (Informatics), Slovakia, 2022.

[10] M. Kvet, "Autonomous Temporal Transaction Database", 30th Conference of Open Innovations Association FRUCT, 2021.

[11] M. Kvet and K. Matiaško, "Analysis of current trends in relational database indexing", 2020 International Conference on Smart Systems and Technologies (SST), Croatia, 2020.

[12] M. Kvet, J. Papán, "The Complexity of the Data Retrieval Process Using the Proposed Index Extension", IEEE Access, vol. 10, 2022.

[13] D. Kuhn and T. Kyte, Oracle Database Transactions and Locking Revealed. Oracle Database Transactions and Locking Revealed. (2021). https://doi.org/10.1007/978-1-4842-6425-6

[14] D. Kuhn and T. Kyte, Expert Oracle Database Architecture: Techniques and Solutions for High Performance and Producitivity. 2021, ISBN – 9781484274989

[15] A. Meier and M. Kaufmann: SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management, Springer, 2019

[16] R. Mikkilineni, G. Morana, S. Keshan: Demonstration of a New Computing Model to Manage a Distributed Application and Its Resources Using Turing Oracle Design, 25th IEEE International Conference on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), 13-15 June 2016