BattleLens – Exploring the Dynamics of Conflict and Defense Economies

* CSE578 Data Visualization Project

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I. Introduction

In a world marked by political instability and economic disparity, the Middle East stands as a striking example of the interplay between conflict and commerce. This region, often synonymous with unrest, serves as a critical hub for the global arms trade, where weapons manufacturing and defense economies flourish even amidst the devastation of war. This project aims to uncover the economic and political dynamics that drive these industries and their role in perpetuating global conflicts. By analyzing the connections between conflicts in the Middle East and the revenues generated by defense companies, we explore the complex web of economic dependencies that sustain both warfare and peacekeeping efforts.

Through data-driven analysis, we examine how arms sales influence the GDP of producing nations, identify patterns linking defense revenues to conflict events, and discuss the implications for greater transparency and accountability within the global arms trade. The project, an interactive narrated design website which utilizes scrollytelling[7][8], BattleLens, offers users an immersive look into the economic forces that shape modern warfare, providing critical insights into how the business of war influences global stability. Our aim is to empower policymakers, researchers, and the public with the knowledge to navigate the intricate relationship between military spending, economic power, and international conflict.

II. IMPLEMENTATION

The implementation of ”BattleLens: Exploring the Dynamics of Conflict and Defense Economies” is an interactive web platform designed to visualize and analyze the interplay between global conflicts and economic dynamics, particularly focusing on the arms trade in the Middle East. The system is built using HTML5, styled with CSS and Bootstrap for responsive design, and incorporates the D3.js[1] library for dynamic data visualizations. This allows the platform to efficiently manage and render complex data visualizations such as timeline-based maps, attack relationship charts, and economic impact analyses, all of which are crucial to understanding the interconnected nature of conflicts and defense economies.

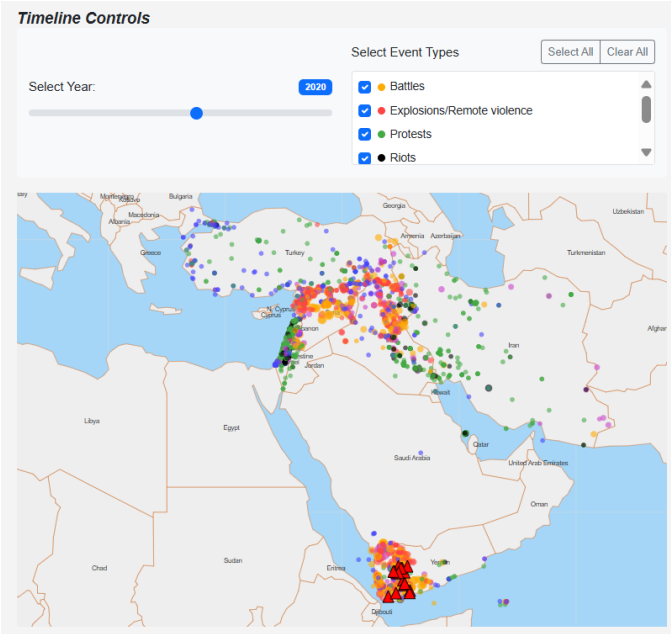

Fig. 1. Interactive Conflict Geo Map

The platform leverages Scrollama[2], an interactive library that provides a seamless scrollytelling experience, guiding users through a series of steps as they scroll through the platform. Scrollama enables real-time updates to the various SVG-based charts and maps, creating a dynamic narrative as users interact with the platform. For geographical mapping, the system uses TopoJSON[3], which efficiently encodes geographic data and ensures smooth rendering of maps. This integration of libraries allows the platform to update the visualizations interactively based on the timeline selected by the user, ensuring that each visualization corresponds to a specific year of conflict data. The implementation of ”BattleLens: Ex-

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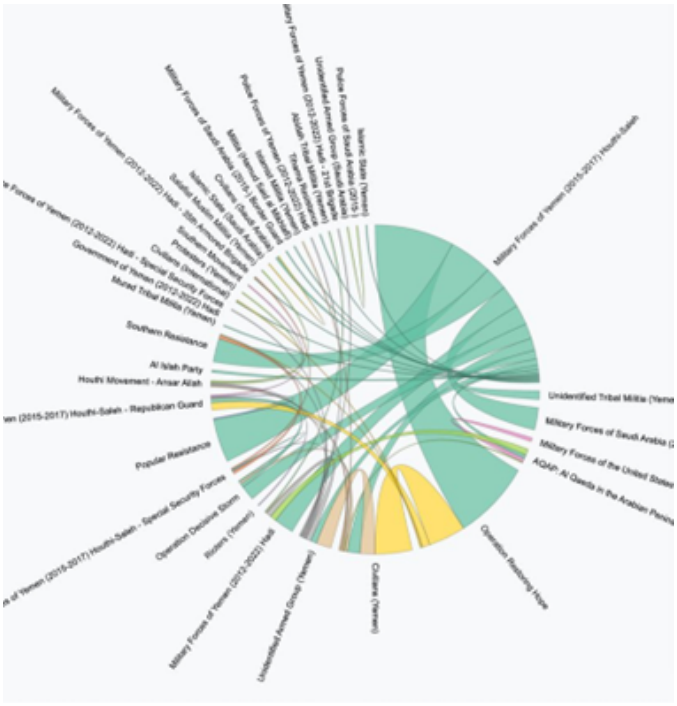

Fig. 2. Chord diagram representing relationship between two conflict actors.

provides a seamless scrollytelling experience, guiding users through a series of steps as they scroll through the platform. Scrollama enables real-time updates to the various SVG-based charts and maps, creating a dynamic narrative as users interact with the platform. For geographical mapping, the system uses TopoJSON, which efficiently encodes geographic data and ensures smooth rendering of maps. This integration of libraries allows the platform to update the visualizations interactively based on the timeline selected by the user, ensuring that each visualization corresponds to a specific year of conflict data. The layout of the platform is designed with dedicated containers for different visual components such as timeline controls, pie charts comparing UN and non-UN contributions, and stacked bar charts illustrating weapon manufacturer revenues. As users adjust the timeline slider, a D3.js range input dynamically updates the map and charts to reflect the events specific to the selected year, allowing for a clear visualization of temporal trends and shifts in conflict intensity. Custom JavaScript scripts handle the rendering and updating of these visualizations, ensuring each step in the narrative is accompanied by relevant and engaging graphics. Additionally, the platform features horizontal scrolling mechanics and interactive elements, which enhance user engagement and provide a more comprehensive, data-driven storytelling experience. By integrating diverse data sources and cutting-edge visualization techniques, BattleLens offers users an in-depth understanding of the complex dynamics between global conflicts and their economic underpinnings. Overall, the system seamlessly integrates diverse data sources and visualization techniques to offer users an in-depth understanding of conflict dynamics and their economic underpinnings. Central to its innovation is the timeline selector, implemented using a D3.js range input that allows users to traverse through years of conflict data seamlessly. As users adjust the timeline slider, the system dynamically updates the map and accompanying charts to reflect events specific to the selected year, enabling a clear visualization of temporal trends and shifts in conflict intensity. The interactive map as shown in Fig. 1 serves as a core component, meticulously designed with D3.js to display geographical hotspots of conflict in the Middle East. It distinguishes different types of wars and conflict events using a comprehensive color-coding scheme and varied markers, enhancing the user's ability to quickly identify and differentiate between political violence, battles, protests, and strategic developments. Moreover, the map's interactivity is heightened

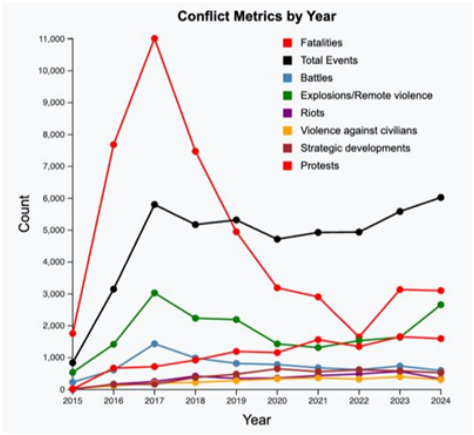

Fig. 3. Fatalities Line Chart

by its integration with the chord diagram depicted in Fig. 2 — a feature that allows users to select specific relationships or actors within the chord diagram, which in turn highlights and marks corresponding locations on the map. This bidirectional linkage ensures that selections in one visualization component are immediately and visually reflected in another, fostering a more interconnected and insightful analysis experience. Additionally, the map incorporates pan-and-zoom functionality with intuitive controls, enabling users to explore regions in greater detail or gain a broader overview with ease. Tooltips provide immediate, contextual information upon hovering over specific conflict events, enhancing the depth of information accessible

without overwhelming the visual space. The combination of timeline-based navigation, interactive chord diagrams, and detailed, type-specific map markers not only enriches the user experience but also facilitates a deeper understanding of the complex interplay between conflict dynamics and economic factors. By enabling users to interact with multiple layers of data simultaneously, ”BattleLens” offers a powerful, multi-faceted platform for researchers, policymakers, and analysts to explore and interpret the nuanced relationships driving global conflicts and their economic ramifications. In total, the system provides six visualizations to analyze conflict events and arms revenue data. The Interactive Conflict Map in Fig. 1, shows fatalities in the Middle East using scaled circles, with interactive features like zoom controls, timeline filtering, and event type selection. It synchronizes with other visualizations for a cohesive experience. The Chord Diagram as in Fig. 2, demonstrates relationships between conflict actors, with highlighted connections and integrated synchronization with the map. The Line Chart in Fig. 3 tracks trends in fatalities and events with detailed tooltips and zoom controls. It also supports dynamic data aggregation for multiple event

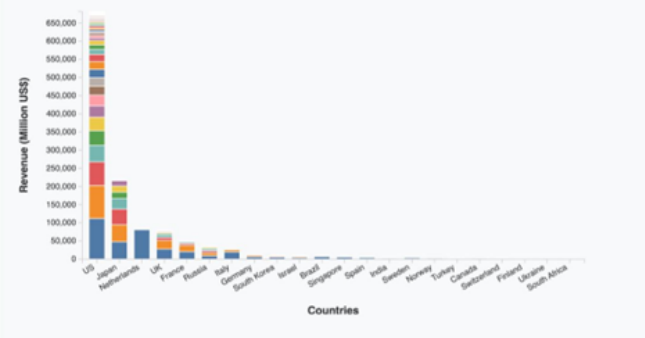

Fig. 4. Weapon Companies Revenue Bar Chart.

types. The Weapon Companies Revenue Bar Chart in Fig. 4 displays arms revenue by country through a dual-chart system, with animation for transitioning between stacked bars and a donut chart, and synchronized updates based on the timeline. The Pie Chart emphasizes global arms revenue distribution, particularly highlighting UN Security Council members, with hover effects and year-based updates. The GDP Stream Chart presented in Fig. 5 visualizes arms revenue and GDP growth (2015–2024) through a stream chart, showing correlations between these datasets with interactive tooltips and potential for further filters and synchronization with other visualizations.

III. DATASETS

Dataset 1: Middle East Conflict Dataset (ACLED) Middle East Conflict[4] Dataset is a CSV file containing records of events related to political violence, demonstrations, riots, and other forms of disorder, primarily in the Middle East. Each row represents a specific event with detailed information about the date, location, actors involved, type of event, and other relevant attributes. It is a tabular dataset with a size of 463,873 data points, 31 attributes and is static. For this project, we

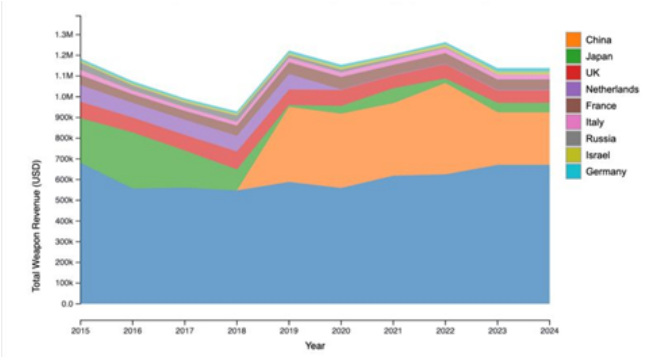

Fig. 5. The GDP Stream Chart

sampled the dataset to one-tenth of its original size and have used the sampled dataset for this project due to problems such as increased computational load, unclear visualizations and more time for loading and responsiveness. . Dataset2: Top 100 Weapon Manufacturers The top 100 weapon manufacturers[5] dataset that lists the top 100 weapon manufacturing companies globally, based on their defense revenues for the years 2000-2024. It includes attributes such as company leadership, country of headquarters, and comparative rankings from the previous year. It contains a separate csv file for each year with 100 rows representing the top 100 companies for that particular year and is also a tabular dataset. We have used the datasets for the years 2015-2024. Dataset 3: World GDP by Country (World Bank)[6] is a comprehensive dataset that records the annual GDP growth rates (expressed as percent changes) for a wide array of countries from 1980 to 2024. It is a tabular dataset and has key attributes such as Country (Country Name), Year, GDP (Gross Domestic Product) of the country. This dataset is from the World Bank’s website and contains 197 rows representing 197 countries.

IV. DISCUSSION

The key insights from our analysis of conflicts in the Middle East between 2015 and 2024 reveal a significant escalation in both the frequency and intensity of events. There is a sharp increase in conflict occurrences from 840 events in 2015 to 6,026 events in 2024, with notable surges in 2017 and 2024 that may be linked to regional or international triggers. Political violence remains the predominant disorder type, especially spiking in 2017 and 2018, while demonstrations have steadily risen, reflecting growing civilian activism. Strategic developments, although smaller in number, show consistent growth, indicating long-term planning in conflict strategies. Fatalities have peaked in 2024 with 6,026 deaths, demonstrating an upward trend since 2015 and aligning with periods of intensified political violence and large-scale battles. Geographical analysis highlights dense clusters of conflict events in specific regions, suggesting repeated incidents in urban centers or strategic locations and a heavy concentration in key zones of instability. Furthermore, examining weapon manufacturer revenues through stacked bar charts emphasizes

trends that may correlate with conflict intensification. Pie charts contrasting contributions from UN and non-UN countries shed light on the global dynamics of the arms trade[9]. Comparing the GDPs of conflict-affected nations with those of weapon-producing countries highlights the economic impacts on these nations. These insights offer valuable correlations and set the stage for our planned machine-learning-based forecasts to predict future conflict zones.

V. Further Improvements

To enhance the project, we can incorporate predictive analysis using machine learning algorithms, enabling the system to forecast future conflict zones based on historical conflict data and weapon sales trends. By identifying patterns and correlations in past conflicts, the system can predict potential hotspots and emerging tensions. Additionally, integrating more granular economic data—such as the impact of sanctions on defense company revenues—will provide users with deeper insights into how economic factors influence conflicts. This includes understanding how financial pressures from sanctions can affect defense industries and, in turn, geopolitical stability. These improvements will make the system more comprehensive and insightful, offering users a powerful tool to analyze and anticipate conflictsinfluenced by both historical and economic factors.

References

[1] Swizec Teller. 2013. Data Visualization with d3.js. Packt Publishing.

[2] D. Seyser and M. Zeiller, "Scrollytelling – An Analysis of Visual Storytelling in Online Journalism," 2018 22nd International Conference Information Visualisation (IV), Fisciano, Italy, 2018, pp. 401-406, doi: 10.1109/iV.2018.00075. keywords: Visualization;Media;Streaming media;Data visualization;Standards;Navigation;scrollytelling, storytelling, infographics, information visualization, online journalism, online newspaper,

[3] TopoJSON Project. *TopoJSON*. GitHub Repository. Available at: https://github.com/topojson/topojson. (Accessed: December 6, 2024).

[4] Armed Conflict Location and Event Data Project (ACLED). *Data Export Tool*. Available at: https://acleddata.com/data-export-tool/. (Accessed: December 6, 2024).

[5] Defense News. *Top 100 Weapon Manufacturers*. Available at: https://people.defensenews.com/top-100/. (Accessed: December 6, 2024).

[6] World Bank. *World Development Indicators*. Available at: https://data.worldbank.org/. (Accessed: December 6, 2024).

[7] Eric Mörth, Stefan Bruckner, and Noeska N. Smit. 2022. ScrollyVis: Interactive visual authoring of guided dynamic narratives for scientific scrollytelling. *IEEE Transactions on Visualization and Computer Graphics*, 29, 12 (Dec. 2022), 5165–5177. DOI: https://doi.org/10.1109/TVCG.2022.3174312.

[8] B. Mayer, N. Steinhauer, B. Preim, and M. Meuschke. 2023. A Characterization of Interactive Visual Data Stories With a Spatio-Temporal Context. In *Computer Graphics Forum* (Vol. 42, No. 6, Sep. 2023), Article e14922. DOI: https://doi.org/10.1111/cgf.14922.

[9] Hans Rattinger. 1976. From war to war to war: arms races in the Middle East. *International Studies Quarterly*, 20, 4 (Dec. 1976), 501–531. DOI: https://doi.org/10.2307/2600266.