DESIGN RESEARCH: ANALYTICAL ANALYSIS AND VISUALIZATION OF LOS ANGELES POLICE DEPARTMENT/OLYMPIC DIVISION CRIME DATA 2010-2017

Marshall Vallelunga, Center for Information Systems & Technology, Claremont Graduate University, 150 E. 10th Street, Claremont, CA 91711, 909-621-8209, marshall.vallelunga@cgu.edu

ABSTRACT

Critical to the optimization of law enforcement resource utilization is a deep understanding of georeferenced factors in crime analysis. Descriptive analytics are applied to crime data for the years 2010 to 2017 encompassing the LAPD Olympic Division. Data modeling and analytics utilize the FBI Part 1 definitions of crime categories. Analytical results are then visualized using ArcGIS for further analysis.

INTRODUCTION

Like most police departments serving large urban areas the Los Angeles Police Department (LAPD) requires more patrol officer's then budget allows. Per Captain Nordquist of the LAPD the number of patrol officers has remained at the same level for the last 20 years, while the workload has significantly increased. The use of software tools can help inform the Dispatch Officer how to most efficiently use the available resources. To date many of these tools are separate and distinct entities with little or no integration. The long-term focus of this work is to create a dashboard that integrates the most desired features of the various software packages into single tool that provides advanced analytics in the form of descriptive, predictive and prescriptive analytics. Driving the prescriptive analytics will be machine learning algorithms that identify patterns and associations in real time and offer proactive recommendations to the dispatch officer.

CURRENT TOOLS

This section of the report discusses the software tools in use by the Los Angeles Police Department today.

1. Automatic License Plate Recognition System (ALPR) created by PIP who was acquired by 3M and then sold to Neology Inc. The system cross references the viewed license plates with a daily "hot sheet" of stolen vehicles in near real time
2. Remote Camera Surveillance System by General Electric and Hamilton Pacific companies. The system has the capability to identify, track and record criminal activity. The first deployment of the system was in MacArthur Park in 2005.

3. Facial Recognition Software by Neven Vision. The software can rapidly scan human faces against very large facial databases to identify fugitive suspects and criminal street gangs with permanent gang injunctions [1].

4. PredPol (Predictive Policing) was the outcome of a research project initiated by Chief Bratton between the Los Angeles Police Department and UCLA. Mathematicians and behavioral scientist from UCLA and the Santa Cruz University studied COMPSTAT (COMPuter STATistics) data with the goal of creating a system that could recommend where and when future crimes might occur. The tool allows the Dispatch Offer to pre-emptively deploy officers to prevent these crimes. An interesting outcome of this research is that the most important independent variables to crime forecasting are: crime type, crime location and crime date and time [2].

5. Real-Time Patrol Car Monitoring (Telematics) monitors assets such as a vehicle fleet through the use of telecommunications and sensors is currently under evaluation by the department. Through the use of a Telematics system, the department will be able to monitor vehicle utilization statistics for fleet management and maintenance, driver characteristics for better risk management and the near real time location of patrol vehicles from GPS data, for officer safety and situational awareness [3].

6. CopLink by Forensic Logic formerly IBM is a law enforcement search engine. With CopLink officers can search across agencies, geographies, and IT systems to gain insights into criminal activity [3].

7. COMPSTAT is computer based statistical analysis and was first used by the New York Police Department in the mid 1990's. The LAPD utilizes a customized geographic information system (GIS) application that integrates software from Esri with Microsoft SQL server database. The system identifies crime hotspots and provides both maps and reports for each of the 21 police divisions. There are four core principles within the COMPSTAT operational paradigm:
   - *Accurate and timely information* to inform officers at all levels with information and intelligence to make fact-based decisions whether they are in patrol cars or detectives working a case.
   - *Effective tactics* every case is handled with a sense of urgency, resources both internal and external are considered in responding to a problem. Systematic investigation and thinking outside the box are the new norm.
   - *Rapid deployment* the outdated reactive manner of policing driven by responding to calls has been replaced with strategic response. The use of plainclothes, non-traditional decoys and sting operations is becoming more integrated into policing protocols.
   - *Relentless follow-up and assessment* a significant change in recent years is the assessment of effectiveness within the LAPD. "The bottom line with COMPSTAT is results."[4] A form of continuous measurable improvement using information provided COMPSTAT to the cycle of reviewing, strategizing, taking action and accountability is showing positive results in a streamlined organization that is better prepared to respond to crime within the city.

8. Gotham by Palantir is an analytic platform that integrates many of the previously stove-piped data sources into a single searchable system. The analytical functions within Palantir provide investigators with an ability to search across multiple data sets using a single query to assist in finding non-obvious relationships that previously would have taken hours, days, weeks of painstaking manual searches to uncover. Palantir also provides the ability to visualize data as link diagrams on a map.

9. Premier Computer Aided Dispatch (CAD) by Motorola is currently used for intake, dispatch and management of 911 calls for service. This system is scheduled to be replaced by Motorola's next generation Premier One CAD in 2019. The new system will not only log and track the management of a call, it will also utilize GIS to provide suggestions on which police unit to assign a call to and routing instructions to the location of the call.

10. TEAMS II System was developed in response to a Consent Decree placed on the City of Los Angeles to provide LAPD managers better accountability, oversight and insights on officer activities. The overall TEAMS II System is actually the integration of several databases into a single data mart housed in an Oracle database and using IBM's Cognos Business Intelligence Suite which comprises the core of the Risk Management Information System. Several of the key data sources that provide officer event data which is used to identify 'at risk" officers are use of force cases, complaint cases, traffic pursuits, vehicle and pedestrian stops, and traffic collisions.

RELATED WORK

Kernel Theory

The ontology of design research consists of three main categories. The exploratory perspective helps us understand human behavior and develop empathy for users of the product. The generative perspective leads to new and innovative artifacts. The evaluative perspective validates the usefulness, usability and the ability of the product to satisfy the product design goals [5].

In order to accurately forecast future crimes, consideration of the data granularity is critically important. A spatial resolution that is to fine will yield no data values with predictive statistical value. Whereas, as an excessively broad data set will reduce the specificity the results [6]. Scaling theory, Norman's naturalness and appropriateness principals inform the choice statistically relevant data.

Central to the concept of predictive policing is the idea that human behavior is not too complex and too random to be understood. Jeff Brantingham an anthropologist at the University of California, Los Angeles helps supervise the predictive policing project for the LAPD. His work is based on theories of criminal behavior such as routine activity theory, rational choice theory, and crime pattern theory. Brantingham consolidated these theories into his blended theory:

➢ "Criminals and victims follow common life patterns; overlaps in those patterns indicate an increased likelihood of crime.
➢ Geographic and temporal features influence the where and when of those patterns.
➢ As they move within those patterns, criminals make "rational" decisions about whether to commit crimes, taking into account such factors as the area, the target's suitability, and the risk of getting caught".

Blended theory is best suited to offenses involving robberies, burglaries and thefts. It is less applicable to vice and relationship crimes which involve human connection [7].

Analytics

Analytics is the process of taking a deep dive into data to find patterns and associations, from which future predictions and anticipatory actions can be taken. Descriptive analytics seeks to understand historical data by asking "*what happened and why?*". Predictive analytics uses that understanding to predict what may happen by asking "*what do we think will happen and why?*". Finally, prescriptive analytics seeks to find anticipatory responses the what we think may happen by asking the "*so what?*" *question*.

The predictive policing is a four-step process. The first step is to collect data from relevant sources into a centralized database. Step two is to analyze the data for patterns, associations and trends to make predictions.

Prediction-Led Policing
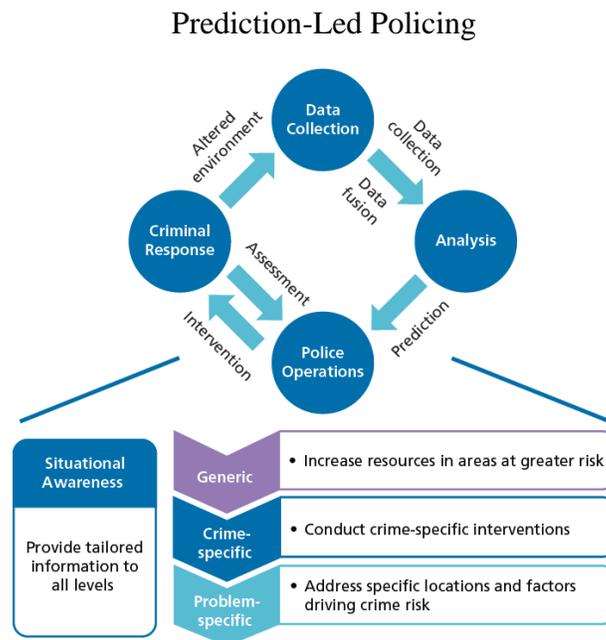
[7]

The third step is to engage police operations in anticipation of future crimes and immediately evaluate the effectiveness of those operations. The final step is to measure the criminal response to the proactive police operations. Hopefully, crime rates will decrease, community safety will increase and trust in local law enforcement will be strengthen.

In November 2009, the National Institute of Justice, in partnership with the Bureau of Justice Assistance and the Los Angeles Police Department held a Predictive Policing Symposium to explore the future of predictive policing. The three day event included representatives from research, crime analysts, scientists and police officers [8].

In recent years data visualization tools have been created to move beyond descriptive analytics into the realm of predictive analytics. Crime hotspot analysis have proven to be effective in proactive policing by forecasting areas of high crime probability and deploying patrol officers to these areas based on historic spatiotemporal trends [6]. An example of predictive analytics to promote proactive policing are PredPol which develops maps based on types of crimes, time and location.

RESEARCH METHODOLOGY

The research methodology employed in this paper is Design Science Research (DSR). Fundamental to this methodology is the creation of an artifact that solves a relevant problem and that is rigorously evaluated against the problem definition.
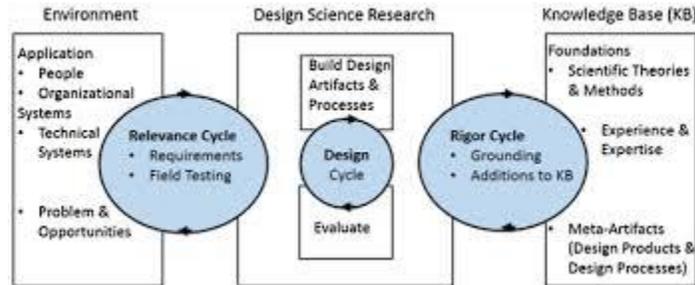
Design science research cycles [9]

EVALUATION

The artifact created was evaluated by a group of three members of the Los Angeles Police Department command staff. All three evaluators held the rank of Captain with 10+ years of experience. Each evaluator used the dashboard for about 15 minutes and then completed an evaluation form. After the evaluators completed their individual assessment, a group discussion was conducted. The focus of the interaction was to come up with a collective set of improvements and modifications to maximize the dashboards familiarity and usefulness. The evaluation process took just over an hour. Below is the evaluation form.

Effectiveness Evaluation Form

Name:
Position:
Date:

In one or two sentences how will you use this tool?

This prototype that will be further developed into a fully functional proactive policing dashboard based on predictive analytics. Please rate the effectiveness of the tool as it applies to your everyday work.

Rating System:
5   Extremely Effective
4   Very Effective
3   Moderately Effective
2   Slightly Effective
1   Not at all Effective

_____ The user interface is intuitively obvious.
_____ I can easily determine crime by reporting district or basic car area.
_____ The map effectively visualizes crimes of interest.
_____ The dashboard facilitates my understanding of crime location and frequency.

To make this dashboard and must have what additional features would you like?

1. _____
2. _____
3. _____
4. _____
5. _____

Suggestions for future development:

_____

_____

_____

_____

_____

RESULTS

The rating questions are summarized below. The feedback provides significant insights as how the officers want to interact with the tool.

Average Rating	Question	Comments
3	The user interface is intuitively obvious	The reporting district list is too long. Add bureau selection as a criterion. Incorporate clicking on the map to select geospatial areas of interest.
4	I can easily determine crime by reporting district or basic car area	The zoom and pan feature are effective. The dots are hard to click on.
3	The map effectively visualizes crimes of interest	Use standard LAPD symbology
3	The dashboard facilitates my understanding of crime location and frequency	Time based hot spot trend analysis would be a benefit

The feedback from the evaluation were consolidated in these recommendations:

Criteria Input
1. Remove the RD selection option
2. Add Bureau selection option
3. Reorder crime type by LAPD convention
   Violent Crimes
   Homicide
   Rape
   Robbery
   Aggravated Assaults

   Property Crimes
   Burglary
   GTA
   BTFV
   Theft
4. Missing BTFV
5. Report crimes events in parenthesis next to crime type
   Example: HOM (1)
6. Add DOW (Day of the week) selection
7. Add Watch selection to Date/Time Range
   AM1 0000-0559
   AM2 0600-1159
   PM1 1200-1759
   PM2 1800-2359

Reporting Output
1. Measure goals by week
   Current 4 weeks
   Last 4 weeks
   % Change
   YTD 18
   YTD 17
   % Change
2. Data does not match COMPSTAT data
3. Use standard LAPD symbology on map
4. Track shots fired

This feedback provided critical insights into how the LAPD uses data and what is important to the decision-making process. All of these recommendations will be incorporated into the next version of the prototype.

DISCUSSION

With new innovations in automated surveillance and predictive policing. Transparency, auditing and due diligence are at the forefront of building and maintaining community trust. Privacy advocates and community leaders must be engaged to ensure the success of these efforts. There are several areas within the city of Los Angeles where trust in law enforcement is strained. As a result, increased policing efforts to protect the community in areas of high crime rates are viewed negatively [10]. It is imperative that the slogan "Service with Respect" be seen by the community as a command imperative. In my interaction with LAPD command staff they fully appreciate how difficult it is to change the attitude of a community. Every officer interaction with the community has the potential to be positive even when it leads to an arrest or explosively bad if there is a perception of abuse or illegal use of force (personal communication, December 7, 2018).

CONCLUSION

The key to successful proactive policing is good quality data and processing that data using state of the art tools. Empowering local law enforcement with situational awareness, accurate assessment of crime risks and tactical deployment will have a positive effective on crime reduction and enhance the safety and security of the communities and neighborhoods. The artifact created for this research is the first iteration of the DSR process in the development of a fully functional data visualization tool driven by machine learning algorithms to proactively utilize patrol officers to prevent future crimes based on kernel theory discussed in this paper.

FUTURE WORK

The need to visualize crime in real-time for a well-defined geographic space is of immediate importance. The artifact created for this paper is an initial prototype that solves this problem. The progression of development envisioned is as follows:

Version 2 will include all of the recommendations and suggestions of the evaluation group. This is a significant body of work. The addition of bureau functionality means moving beyond one division to include all 21 divisions.

Version 3 incorporates known crime patterns into the predication algorithms that will drive a predictor engine along with hot spot analysis. This will require writing custom Python code into the Esri dashboard code.

Version 4 will ingest live crime data in real-time. This will be the first usable dashboard that will enable LAPD command structure to realize benefit from this work. Version 4 will be production version 1.0.

With each cycle of the DSR iteration process an evaluation will be conducted which will no doubt lead to further improvements and possible additional iterations.

ACKNOWLEDGEMENTS

REFERENCES

[1] "LAPD Uses New Technologies to Fight Crime - Los Angeles Police Department." [Online]. Available: http://www.lapdonline.org/february_2005/news_view/19849. [Accessed: 25-Nov-2018].

[2] "PredPol Mission | About Us | Aiming to reduce victimization keep communities safer," *PredPol*. .

[3] "LEAP Search – LEAP Network." [Online]. Available: https://forensiclogic.com/leap/. [Accessed: 25-Nov-2018].

[4] "COMPSTAT - Los Angeles Police Department." [Online]. Available: http://www.lapdonline.org/search_results/content_basic_view/6363. [Accessed: 25-Nov-2018].

[5] B. Batokova, T. Waits, and A. Connell, "Design research in the context of federal law enforcement," in *2014 IEEE International Professional Communication Conference (IPCC)*, Pittsburgh, PA, USA, 2014, pp. 1–7.

[6] A. Malik, R. Maciejewski, S. Towers, S. McCullough, and D. S. Ebert, "Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics for Community Policing and Law Enforcement," *IEEE Transactions on Visualization and Computer Graphics*, vol. 20, no. 12, pp. 1863–1872, Dec. 2014.

[7] W. L. Perry, *Predictive policing: the role of crime forecasting in law enforcement operations*. Santa Monica, CA: RAND, 2013.

[8] B. Pearsall, "Predictive policing: The future of law enforcement?: (596372010-007)." American Psychological Association, 2010.

[9] A. Hevner and S. Chatterjee, *Design Research in Information Systems: Theory and Practice*. Springer US, 2010.

[10] M. M. Jr, "Activists Call For an End to LA's Predictive Policing Program," 09-May-2018.