Using Geographical Information Systems to Organize Police Patrol Routes Effectively by Grouping Hot Spots of Crash and Crime Data

Pei-Fen Kuo
UIN: 617008256
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Abstract

Because highly visible traffic enforcement reduces the crimes and crashes simultaneously, applying DDACTS can help the law enforcement allocate their limited resources more efficiently by focusing on the hazardous areas. Most studies focused on the reduction of crimes and crashes after applying new patrol routes instead of the change of police dispatch time. Hence, the objective of this study is to compare the dispatch time between: (1) with police patrol routes (organized with hotspots) and (2) without patrol routes. The study result shows the crash and crime in College Station are clustered based on their Getis-Ord G value and their hot spots in point map and Kernel Density map are also close to each other. Applying two patrol routes organized by connecting Top 5 and Top 10 hot spots of crash and crime combining data can save the police dispatch time by 17.5% and 43% respectively, while the patrol travel time are 30 min and 45 min. This study provides a clear and step-by-step procedure to calculate the change of dispatch time, and then law enforcement can follow this evaluate steps for judging whether they want to perform DDACTS method by their own crash and crime data.
INTRODUCTION

Traffic crashes and crime events are the main threats to public safety. According to the statistics from National Highway Traffic Safety Administration (NHTSA) and Federal Bureau of Investigation (FBI), there are 33,808 fatalities and 2.2 million injuries in traffic crashes, and 1.31 million violent crimes reported which caused 15.2 billion properties lost in the United State on 2009.

Law enforcement officers play a main role to improve traffic safety and crimes rate. However, some police departments face the challenges of enforcement because of the increasing police service demands, growing operation cost, and shrinking budget, especially for the area with economic downturn recently. (Alexander et al., 2008) Another problem is that most law enforcement departments focus on the officer’s productivity instead of the traffic safety, hence officers tend to choose the locations where they can write most citations instead of the place where their action can reduce most crashes.

Based on the above reasons, this study focused on organizing best police patrol route by concentrating on the area with high crime rates and crash risks; then, the law enforcement can allocate their limited resources more effectively and efficiently. There are two reasons to consider crash and crime data together: (1) highly visible traffic enforcement can reduce the crime rates and traffic crashes simultaneously and (2) dealing with crashes and crimes cost most dispatch time for the police departments.

LITERATURE REVIEW

Related Programs

Actually, it is not a new idea to combine the crash and crime data for law enforcement department to allocation their limited resource. There is a similar method called DDACTS (Data Drive Approaches to Crime and Traffic safety) which is a national initiative developed by NHTSA, the Bureau of Justice Assistance, and National Institute of Justice. So far, there are seven cities in the United State applied DDACTS and most of them got positive results. From table 1, the crimes rate decrease up to 41% and crash decrease up to 24%. These local agencies used ArcGIS, CrimeStat, CrimeView.9, and Spatial Analyst for hot spot analysis. (Hardy, 2010)
Table 1. The DDACTS results from seven demonstration Sites

<table>
<thead>
<tr>
<th>Demonstration Site</th>
<th>Results</th>
<th>Software</th>
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| Baltimore                 | 1. Crime: Burglaries decreased 16.6%, robberies decreased 33.5%, vehicle thefts decreased 40.9%  
2. Crash: Injury crashes decreased 0.2%, total crashes decreased 1.2 | ArcMap           |
|                           |                                                                        | CrimeStat        |
| Nashville                 | 1. Crime data: Uniform Crime Reporting (UCR) part 1 crime decreased 13.9%, and DUI arrest increased 72.3%  
2. Crash: Injury crashes decreased 30.8%, fatal crashes decreased 15.6% | ArcGIS7          |
|                           |                                                                        | CrimeView9       |
| Rochester                 | 1. Crime: Homicides reduced 36% and the number of vehicle theft is the lowest.  
2. Crash: Crash reduced 6% (374 crashes). | ArcGIS           |
|                           |                                                                        | Spatial Analyst  |
| Washoe County, Nevada     | 1. Crime: Burglaries decreased 21%; vehicle thefts decreased 8%; assault reduced 6%.  
2. Crash: The crash observed number is too small to analysis. | unknown          |
| Nashville, Tennessee      | 1. Crime: The property crime rate and auto theft rate are the lowest. The number of DUI arrests in 2008 increased by 12%.  
2. Crash: Fatal crashes reduced by 24% and injury crashes reduced 16%. | unknown          |
| Lafourche Parish, Louisiana | 1. Crime: DDACT area has lower crime rate (1.6%) than other adjust area (2.3%).  
2. Crash: Injury crashes decreased 11% ~14.7% in subarea. | unknown          |
| St. Albans, Vermont       | 1. Crime: vandalism reduced 27%, fraud reduced 29%, assaults reduced 37%, and burglaries reduced 38%.  
2. Crash: Injury and fatal crashes reduced 19% and property damage only (PDO) crashes reduced 21%. | unknown          |

Source: (Hardy, 2010)

Placed Based Theorem

In DDACTS guideline, the law enforcement will perform Highly Visible Traffic Enforcement in their police patrol routes. There are different enforcement methods and operation plans for different patrol need, such as stop and contact all passengers on suspected vehicles.

The reason why Highly Visible Traffic Enforcement works is because most people near patrol route will drive carefully and potential criminals may also stop their
activities or be arrested before they violate the law. Figure 1 shows the possible variables (human, environment, and other factors) related to crash and crime events, and the crash and crime rate will decrease when the human risky factors are improved by law enforcement. However, the place of crashes and crimes need to be close to each other, otherwise highly visible traffic enforcement cannot work. In other words, if crashes and crimes are distributed randomly or their hot spots are far from each other, DDACTS may not able to reduce crime rate. It should be noted that most crime and crash incidents are committed by many people instead of specific individual. Currently, B. F. Skinner’s study can provide a placed-based theory to explain why crime and crash may happen in the same neighborhood, even there is no causal link between these two events themselves. (Ronald 2010)

\[
\text{Crash} = A \times V_{\text{human}} + B \times V_{\text{space}} + C \times V_{\text{other}} \\
\text{people drive safely} \downarrow \\
\text{Crime} = a \times V_{\text{human}} + b \times V_{\text{space}} + c \times V_{\text{other}} \\
\text{stop potential criminal offenders} \downarrow
\]

Figure 1 How DDACTS works for Crash and Crime model

**Saving Dispatch Time**

DDACTS can also save the dispatch time by reducing the crash and crime rate. Figures 2 explains its mechanism. If new police patrol can avoid some crashes and crimes happen, and the police officer can save the dispatch time from seven to three times.

Red cross: road accident, Yellow sign: crime event, Green Star: police officer location

Figure 2 How DDACTS Save Dispatch Time
**Hot Spots**

There are many studies discussed about how to defined the hot spot in crash or crime area. In this study, we only focus on the disaggregate data analysis because of accurate level from defining police patrol route. Studies about aggregate data are not discussed here.

**Crash hot spot**

Before the application of GIS software are popular, traffic safety analysts tend to use traditional statistical test to define the hotspots area where with significant high crash rate. Using this traditional method is inconvenient and inefficiently, because traffic engineers need to separate road network as many segment with equal size, record crash by each segment, and show the hot spot result by tabulate data. Also, using traditional statistic method cannot show the geographical relationship between crash and other environment variables.

GIS software can solve the above problems by providing the graphical output, and it become the most popular tool for visualization of crash data and hop spots analysis. The following paragraph summarized the study results and the limitations from four important papers.

Firstly, Pulugurtha et al. (2007) used Simple method and Kernel Density Estimation (KDE) to create crash concentration maps and ranked pedestrian crash hot spots by individual methods (crash frequency, crash density, and crash rate method) and composite methods (sum-of-the-ranks and crash score method). Five year pedestrian crash data in Las Vegas urban area were used to for this study. For simple method, the crash density is calculated by the ratio of the crash number divided by the search area. Hence, the radius of search area is a main factor for the density result. Larger radius of search area will cause a smoother density map, but it is hard to find the actual hot spots locations. For Kernel density method, a circular search area is drawn by “each” crash and the sum of individual cell density is the overall density map. In general, Kernel density method will result in a smoother looking density than Simple method, and it is also more suitable for identifying severe crash problem. The results from this study (Figure 4 and Figure 5) support the above argument. Five methods were used to rank the twenty nine hot spots that identified by Kernel density method, and the ranking difference between all methods are compared. For individual methods, the crash frequency only uses crash numbers for ranking; crash density method uses crash number per length or area; and crash rate method uses the crash number per exposure.
(vehicle volume, pedestrian volume, or population). These individual methods all have advantages and disadvantages, hence, composite methods, are developed to keep benefit and remove the limit of each individual method. Sum-of-the-ranks method takes the average of the ranks by using three methods as its final rank and crash score method normalizes all crash density to same scale and sum up these score to rank it. Pulugurtha et al. (2007) recommend using the crash score method because it can help discover the cause of crash.

The second study (Erdogan et al., 2008) used GIS to identify hot spots in the highways in Afyonkarahisar, Turkey. There are three parts in their study: transforming textual accident records into geographic data, checking data clustered pattern, and using two methods, repeatability analysis and Kernel Density analysis, to define hot spots and compare the difference. Because the accident data in Turkey are recorded as textual form, a transforming procedure is provided to explain how the authors transfer original data to tabular form (Access) and make these data visualized in the graphs. “Linear referencing”, a toolset in ArcGIS 9.0, was used to identify the accident locations by combing “kilometer of crash” data on the route of highways and the highway graphs of Afyonkarahisar. As for the cluster pattern, Chi-square test is used to check whether the frequency of observed crash data different from the frequency of the random distribution. If the frequency of observation data is higher than the random distribution, then this crash data may has some cluster pattern. The observation number of accident in each site is assumed to follow Poisson distribution with mean, \( \lambda \), and this crash mean rate (\( \lambda \)) is estimated by the total crash number divided by the segment number. In other words, \( \lambda \) represent the average crash number in one km length road. The probability of each site with \( x \) crash numbers, \( P(x) \), can be estimated as follows,

\[
P(x) = \frac{e^{-\lambda} \lambda^x}{x!}
\]  

(1)

So for repeatability analysis, the hot spots are defined as the locations with more crash than other 95% and 99% sites. As for Kernel Density method, Spatial Analysis, an ArcGIS extension, is used to define hot spots, the site (0.5*0.5 km2) with more than 4 crashes per year. The result shows that repeatability analysis identifies more hot spot than Kernel Density analysis, but this study did not provide the possible reason cause the difference. The advantage of this study includes: providing detail information about ArcGIS commands and the initial settings value. However, there is a problem about ignoring the possible effects of traffic volume. Without considering traffic volume, the hot spot here may be just an intersection with heavy traffic instead of a site actually with higher crash risk.
Anderson (2009) also used GIS and Kernel Density Estimation (KDE) to identify crash hot spots and their spatial pattern in London, UK. Then, by clustering these hot spots by their environment and land use information, Anderson created 5 groups (A~E) and 15 clusters (1~15), and two clusters, A5 (illicit late night zone 1 pedestrians) and C10 (cyclists in Westminster), are chosen to be discussed as examples to show how to discover the possible impact factors by examining the characteristics of these two clusters. Compared to simple method, Kernel density method is an advanced method because KDE can determine the spread of crash risk and an arbitrary spatial unit can be defined for the whole study area for comparison. Two important factors will affect the outcome of KDE, bandwidth and cell size. This study assumed the bandwidth is 200 m and the grid cell size is 100m, but this decision is subjective and the value of bandwidth and cell size may be adjusted by other conditions such as the study area or data. Five possible impact factors were used as the criteria to classify hot spots, and they are central London pedestrians, high density vehicle damage, cyclist in danger, multiple main road accidents, and weekend risk takers. Five London boroughs were be founded with high proportions of A5 (illicit late night zone 1 pedestrians), and there are more bar and clubs in these area. This characteristic supports the idea that the drunk pedestrians from Central London and has higher crash risk when they cross the road to home or to a bus station.

The advantage of this paper is that the author not only use KDE to identify the area with high crash risky but also demonstrate how to cluster this site for further analysis by using spatial interpolation technique. However, the author did not explain how he chooses these criteria for clustering and the reader don’t know the detail information of other 13 clusters. Hence, it may be difficult for the further studies to apply this clustering procedure.

Gundogdu (2010) combined traditional statistical test and Getis-Ord Gi analysis to examine the hotspots in Konya. The hotspot maps of crashes with different severity levels are show individually, and then the highest risk points are defined by clustering all crashes. Potential hot spots are also defined for further analysis and prevention. Firstly, there are some contributions of this study. The author improved the accuracy of identifying hotspots by using two methods and the readers know this analysis confidence intervals are 95%. For other studies, their results may not be statistically defined by just using simple method. In addition, Gundogdu also noticed that several segments have high (but not over threshold value) crashes numbers, so he label these segments as potential hot spots for notice or future improvement. However, there are some obvious weaknesses of this study. In Figure 2 (a) to (d),
Gundogdu tried to compare the hotspot locations of four types of crashes, but actually there are no obvious differences shown on these maps. Also, in conclusion, Gundogdu mentioned the fatal crashes are tend to happened on the straight roads, but it is hard to see this relationship in Figure 2 (b) because of the map scale. A better way is to provide detailed maps of fatal crash hotspots for illustration. This suggestion also works for another impact factor, road level. If time is available, a fatal crash prediction model should be built, and the possible crash causal factors, such as road line type (straight or curve), road service level (international road or not), can be add as variables. Besides, the author should provide more explanation about the cluster procedure, because it is not clear about what statistic method, function, or software he used and what kinds of crashes are included for cluster analysis.

**Crime hot spot**

The theorem of defining hot spots in crime study is more mature than traffic study area and the relative package software has been developed for several years. The common extension software for crime data includes CrimeStat, Spatial Analysis, HotSpot Detective, Vertical Mapper, Crime View, and SpaceStat. However, most geographical profiling software are especially used for analyzing several crimes committed by the one person or several sites linked to the same crime, while the crime and crash incidents are committed by many people in DDACTS model. Hence, this study chose ArcGIS for our analysis tool.

The main crime management department, NIJ, published a special report, “Mapping crime: understanding hot spots”, about the procedure and methods to define the crime hot spots. (Eck et al, 2008) The important contains standard deviation ellipse, test of cluster (NNI, Moran’s I, Geary’s C statistic), Crime mapping, point mapping and surface mapping. Because these method are introduced by the previous section, we don’t repeat its detail the contents here. As for organizing patrol route, most studies are focus on algorithms instead of application, so we also skip this topic here.

**Summary**

From the previous discussion, we find most studies just focused on the reduction of crime and crash rate after applying new patrol routes, and few studies focused on the change of police dispatch time in before and after. Also, there is no a step by step data analysis procedure. So, the motivation of this study is to examine how much dispatch time can be saved? Does this method allocate police resource more effectively?
METHODOLOGY

Figure 4. Data analysis Procedure

Figure 4 shows the data analysis procedure of this study, and yellow boxes list the corresponding methodology and ArcGIS functions. These procedures can be separated as four stages: data geocoding, hot spots defining, best patrol route organizing, and effectiveness estimating. The following paragraphs will introduce the detail information of each step.

Data Geocoding
The first stage is transfer the tabulate crash and crime data to geographic data. The “geocoding” function is used and the first match rates of crimes and crashes are only about 70%. The researcher examined the unmatched cases and found that there are two reasons causing the low match rate. The first one is that police officers use abbreviation to record the locations in the report. For example, the incidents happened on South Texas Avenue and Texas South Ave are just recorded as Texas in the database, and it make ArcGIS geocoding in the wrong place. The second reason is the multiple names of the same road, and these alternative names cannot be recognized on the address locator. For example, the segment of Highway 6 in college station is called “Earl Rudder Freeway”. After finding the original name of abbreviations and adding the alternative road names in address locator there, the match rates of crimes and crashes are up to 90%.
**Hot Spots Defining**

The second stage is to figure out where are the hot spots of crashes and crimes. Based on the literature result, this study chose three series steps to define the hotspots locations more accurately. The first step is to examine whether the data is cluster or not. If the crashes or crimes just happen randomly without any cluster pattern, then highly visibility traffic enforcement may not work because there is no hotspots actually. The second step is to calculate the frequency of each point because of the overlapping problem. Also, the actual frequency can be used for further statistic analysis. The last step is to draw the kernel density surface, and it can show the continuous possibility of our study area instead of the single point.

**Cluster Index**

Average Nearest Neighbor (ANN) and Getis-Ord General G are two main methods for checking whether our crime and crash data are clustered or not, and the following sections introduce the theorem and formulas.

**Average Nearest Neighbor (ANN)**

ANN is to calculate nearest neighbor index (NNI) based on the average distance from each point to its nearest neighboring point. Formula 2 show the calculation of ANN.

\[
ANN = \frac{\bar{d}}{\bar{\delta}} = \frac{\bar{d}}{0.5 \times \sqrt{A/n}}
\]  

Where

- \(\bar{d}\): the average nearest neighbor distance
- \(\bar{\delta}\): the average random distance
- \(A\): the area of the study region
- \(n\): the number of points

If ANN is less than 1, the data are clustered points. If ANN is greater than 1, the data is dispersion. It should be noticed that the ANN value can only be interpreted if the Z score is significant. The ArcGIS function of ANN is in the Spatial Analyst extension. The computation result will return the ANN value and Z value, while the null hypothesis is the data set follow random distribution. If the Z score is not significant, the ANN value means nothing because it is possible that it occurred by random chance.
Getis-Ord General G (Gi)

The second tool is Getis-Ord General G (Gi), and it can measure the concentrations ratio of high or low values for our study area. The significance will judge by Z score because the null hypothesis assumes that there is no cluster in study area. Large Z (positive) means hot spots clustered together, while low small Z (negative) means cold spots clustered together. Formula 3,4, and 5 show the calculation of Gi and Z value.

\[
Gi(d) = \frac{\sum_i \sum_j W_{ij}(d)X_iX_j}{\sum_i \sum_j X_iX_j}
\]  

(3)

\[
Z(Gi(d)) = \frac{Gi(d) - E(Gi(d))}{\sqrt{Var(Gi(d))}}
\]  

(4)

\[
E(Gi(d)) = \frac{W}{N(N-1)}
\]  

(5)

Where

* Gi(d): the Gi value of distance d.
* W_{ij}(d): one, when d is less than the threshold value, otherwise is zero.
* X_i, X_j: the value X at location i and j
* Z(Gi(d)): the z value of Gi(d)
* E(Gi(d)): the expected value if Gi(d)
* W: the sum of weight of all pair points
* N: the number of the case

This study only used this index to compare the cluster patterns of crime and crash, but Getis-Ord General G can also be used for compare the different types of crime (robbery, DWI, gun related), and different time periods (day and night/weekday and weekend) in further analysis. In ArcGIS, the High/Low Clustering function is used to calculate the Gi value and its Z value.

Calculating Frequency

Point overlapping problem cause the difficulties for recognizing the hot spots area, especially for the high point density area. For solving this overlapping problem, this study use collect event function to calculate the frequency of each cell, and its result will return the point map with different radius. The points with large radius represent more events happened. This function is in the
Geoprocessing tool reference > Spatial Statistics toolbox > Utilities toolset > Tools. This function did solve the overlap problem, but there is another problem to combine crime and crash event: crashes are limited to road network but the crime hotspots can happen anywhere, like a campus building without any road access. Hence, there may no one specific place which is the coincident hot spots of crimes and crashes. Compared to one points map, the map with hot area may be more helpful.

**Kernel Density**

Quartic Kernel density is the most appropriate method to define the hotspot of crime data, because it can get a smooth continuous crime or crash risk surface in the study area (Chainey et al. 2002). Figure 4 show the idea of Kernel Density for point features. The basic idea of Kernel Density is this method calculates the density of points instead of showing the true value of the actual location of each point. The risk value is highest when the distance from the point is zero, and the risk decrease when the distance increases. Please see formula 5 for the detail calculation (Silverman, 1986).

![Figure 5](Silverman, 1986)

\[ K(u) = \sum_{d < \tau} \frac{3}{\pi \tau^2} (1 - \frac{d^2}{\tau^2})^2 \]  

(6)

Where
- \( K \): Kernel density value
- \( d \): the distance from event
- \( \tau \): bandwidth
**Optimum Route**
For organizing the best patrol route, another ArcGIS extension “Network analysis” is used to build the best route with shortest time. The detail street data is used to build the network database, and then the necessary stops are assigned for the best routes. This study defined the necessary stops as the coincident area defined by the previous functions.

**Effectiveness Estimating**

The effectiveness of using new police patrol route is calculated by the change of dispatch time in the before and after period. (Formula 7) However, this study made two assumptions for calculate convenience:

- The crime and crash rates will reduce 50% in the buffer area (within the patrol route 500 m) in after period.
- The dispatch time of each event point in the before \((T_{i,dis})\) and in the after period \((T_{j,dis})\) are equal.

The buffer area is suggested to use instead of assigning the same effectiveness for whole study area, because the visibility of law enforcement will decrease when the distance from patrol route increase.

\[
\theta (%) = \frac{\sum_{j=n}^{m} T_{j,dis} - \sum_{i=1}^{m} T_{i,dis}}{\sum_{i=1}^{m} T_{i,dis}} = \frac{n \times T_{i,dis} - m \times T_{j,dis}}{m \times T_{i,dis}} = \frac{n - m}{m} \tag{7}
\]

\(\theta\): effectiveness of patrol route

\(T_{i,dis}, T_{j,dis}\): the dispatch time of point I and point j

\(M\): the number of events in the before period

\(n\): the number of events in the after period
APPLICATION, RESULTS AND DISCUSSION

Study Data
The study area is limited by the service area of College Station Police Department, and the time period of data is from 2005 to 2010/9. All crime and crash data are from College station Police Department. There are 65,461 offense report and 14712 crash report. The road shape file, “All line Data”, is download from Census Bureau's MAF/TIGER database Website. The Coordination System is GCS North America 1983

Study Result
The first result is the points maps of crash and crime event after geocoding. Figure 6 shows the geocoding result and zoom in map of crimes in college station. Obviously, it is hard to judge where should be called as hot spot or hot area because the points are overlap each other even for zoom in map. Another problem is the same situation happened for crash data. (Figure 7) So, other methods are needed to find out the hot spots.

The next step is to defining the cluster pattern of crime and crash by using Average Nearest Neighbor Distance and Getis-Ord General G. Table 2 is the estimated ANN value, and the result show that two data are both cluster data, and crimes are more concentrate than crash.

Table 2. ANN Value of Crash and Crime Data in College Station

<table>
<thead>
<tr>
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<th>ANN (NNR, Z)</th>
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<tbody>
<tr>
<td>Crash</td>
<td>Cluster (0.08, -198.5)</td>
</tr>
<tr>
<td>Crime</td>
<td>Cluster (0.05, -455.8)</td>
</tr>
</tbody>
</table>
Figure 6 Geocoding result of crimes in College station (a) and zoom in map

Figure 7 Geocoding result of crimes in College station (a) and zoom in map
Following the study procedure, “collect event” is used to show the frequency of each location. The points with larger radius represent more crashes and the “count” field is the actual frequency of each location (Figure 8). Like the previous discussion in the method section, this function did solve the overlap problem, but it is still hard to judge the actual hot area. So, this study conducted the kernel density maps of crash and crime individually. (Figure 9) From these two figures, it is very clear to see their hot area are very close. In other words, the crashes and crimes are not only clustered to themselves but they also have spatial relations between each other. Hence, the researcher combines crash and crime data as one database and draws its kernel density map and adds the frequency layer together. The result shows the hot spot with the highest frequency and the hot area from the kernel density map are coincident. So, these red points are defined as our final hot spots.

Figure 8 Geocoding result of crimes in College station (a) and zoom in map
Figure 9 Kernel Density Maps of crashes (a) and crimes (b)

Figure 10 Kernel Density Maps of combining data
After defining the hot spots, the Top 5 Hot Spots and Top 10 Hot Spots as the necessary stops in the police patrol route one and route two. The street file is downloaded from College station GIS department was used for build the network database. It should be noted that speed limit and turn information are necessary for building network database. However, three data sources from TIGER website, local GIS department and Texas A&M library map room are not accurate enough, because there are some segments without speed limit information. Currently, the best route (suggested from ArcGIS) is different from the route got from Google map. Please see figure 11 and 12. Considering the real traffic condition, the researcher choose the result from Google Map because its shortest time. If this study has more accurate street data, the best routes from ArcGIS and Google Map may be coincident. In the other hands, it is suggest the rural police department without GIS technician or without enough funding to purchase ArcGIS extension: Network Analyst may try to use Google Map to organize the best patrol route.

Figure 11 Best Patrol Route Suggested form ArcGIS
Currently, this study used Google Map result as the best routes, and the buffer area for these two routes were built within 500 meters. (Figure 13) According to formula (7), the total dispatch time may reduce 17.5% and 43 % respectively by performing two patrol routes one and two. The patrol travel time are estimated as 30 min and 45 min when the patrol speed is 20 MPH. However, this study did not put petrol travel time to estimate the effectiveness because using Spatial analyst (cost distance) or “Network analyst (travel time) to calculate the actual travel time will slow down the system because of numerous data.
Figure 13 Best Patro Route Suggested form Google Map
CONCLUSIONS AND SUGGESTIONS

1. It is important for law enforcement departments to allocate their limited resources more efficiently, because traffic crashes and crimes are the main threats to public safety. However, some police departments face a challenge to operate enforcements because of the increasing police service demands, growing operation cost, and shrinking budget, especially for the area with economic downturn recently. Another problem is that most law enforcement departments focus on office productivity instead of the traffic safety, hence officers tend to choose the locations where they can write most citations instead of the place where their action can reduce most crashes.

2. A new police patrol route by focusing on the area with high crime rates and crash risks can solve the above problems, because the several DDACTS studies proved that highly visibility enforcement can reduce the crash and crime rate simultaneously.

3. Most studies focused on the reduction of crime and crash rate of applying new patrol routes, and few studies focused on the change of police dispatch time in the before and the after period. Also, most study did not show their analysis procedure in detail, and there are no enough information about how to combine crash and crime data and how to organize the best route.

4. This study provides a clear and step-by-step procedure to calculate the change of dispatch time, and then law enforcement can follow these steps for judging whether they want to perform DDACTS by their own crash and crime data.

5. In College station, the crash and crime are clustered data based on their Getis-Ord G value, and their hot spots are also close to each other. Applying two patrol routes organized by combing Top 5 and Top 10 hot spots of crash and crime data can save the police dispatch time by 17.5% and 43 % respectively, while the patrol travel time are 30 min and 45 min.

6. The preliminary route suggested from “Network Analysis” is not ideal, so the researcher will search other street data for building a network database in the future. Also, another function, “Cost Distance”, will be included in the further analysis because it can estimate the travel time more precisely.
7. For showing a whole procedure to calculate the dispatch time, this study assumed several parameters’ value, such as effectiveness of patrol route, bound area, and patrol speed etc. Further study may conduct a sensitive analysis for better estimate the possible impact by using different scenarios. For example, the effectiveness can be down to 25% or up to 75%, and the boundary can be 100 or 1000 meters. Other setting parameter, Bandwidth and cell size can be changed too.

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REFERENCE LIST


