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The role of predictive policing in predicting spatio-temporal crime mapping

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Since the modern criminology critically reviews the contribution of socio-environmental factors to the crime mapping in terms of their spatio-temporal distribution, a statistical/machine learning technique namely called the risk terrain modelling (RTM) is currently being used as a software solution to diagnose the socio-environmental conditions that lead to crime in a specific area's geography (Study Area), through geospatial and temporal analyses of crimes by linking them to hotspots and analysing them into big data (criminal data), and as a result, appears the new predicting patterns of risks in geographical area under survey (Survey Area) in future, all that for a sake of a rapid and effective response by the Predictive Police, firstly, for setting the priorities for the deployment of precautionary resources to prevent crime and reduce potential risks in the event of a crime, and secondly, what is required to be done upon arrival as a precautionary step to control the crime with a minimum disadvantage to the police forces. The Risk Terrain Modelling represents a systematic investment for more than a decade in the field of criminal investigation, it is have been founded by Leslie W. Kennedy and Joel M. Caplan at Rutgers University, and it currently testes in over than 45 countries around the world.

Keywords: predictive policing, near-repeat phenomenon, crime prediction, risk terrain modelling, artificial intelligence, machine learning, agent-based modelling.

> The naysayers want you to believe that humans are too complex and too random that this sort of math can't be done… but humans are not nearly as random as we think… In a sense, crime is just a physical process, and if you can explain how offenders move and how they mix with their victims, you can understand an incredible amount.
>
> *Joel Rubin* (Rubin 2010)

1. Introduction

In conjunction with an increase in methodological accuracy about crime-fighting initiatives and the increase in partnerships between programmers and legal experts (academics in the field of criminal justice), many analytical programs have been introduced into the police institution, based on the geographic information system (GIS), as an analytical tool for determining crime motives and analysing them on the one hand, and developing and evaluating crime prevention programs on the other hand, in order to identify hotspots on the crime map (Lazzati, Menichini 2014), after conducting spatio-temporal analyses that clarify the relationships between the crime and the features of socio-environmental data in places where crimes are concentrated (Briz-Redón, Martínez-Ruiz, Montes 2022, 594–602).

These efforts to draw a criminal map using a retroactive effect (criminal data and land use data of crimes) for determining early warning (spatial) and building a proactive approach in terms of resource preparedness by the police to prevent crime, and aiming to enhance the predictive capabilities of the spatio-temporal distribution of crime, the RTM[1] (Kennedy, Caplan 2012) will be used to determine the temporal correlations between successive events, and after measuring the socio-environmental features by using the GAMLSS R package model[2] (Smith et al. 2018, 2359), there will appear the F1-score of the mutual influence between these socio-environmental factors in predicting process on one side, and on the spatio-temporal distribution of crime on the other side.

The importance of the research is demonstrated by evaluating the results of the theoretical application of artificial intelligence applications, namely RTM and GAMLSS R package, and their importance in enhancing the security performance of the police in combating the crime, or rather preventing it before it occurs, and reducing the cases of suspicion unintentionally (victims of justice) of innocent people, meaningly reducing the circle of suspicion to its narrowest limits.

The scope of the research includes the use of artificial intelligence applications in general, RTM and GAMLSS R package in particular, and trigging to build academic partnerships through joint researching between programmers (IT specialists) and criminal law specialists in the field of criminal justice (algorithmic criminology).

The research deals with its content on the following aspects:

— the interaction between socio-environmental factors and the spatio-temporal distribution of the crime mapping;

— rooting algorithmic prediction (algorithmic criminology) in contemporary criminal doctrine, in the form of precautionary measures (inferential measures).

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[1] Risk Terrain Modeling. Accessed October 18, 2023. https://www.riskterrainmodeling.com.

[2] Generalized Additive Models for Location, Scale and Shape. Accessed October 18, 2023. https://www.gamlss.com.

The research aims to step out the principles of modern criminology and integrating them into the Iraqi criminal system, by interaction with the principles of algorithmic criminology, and adopting the applications of artificial intelligence in the field of the predictive policing, and encouraging Iraqi criminal legislator to issue contemporary legislation to regulate the purposeful use of forensic artificial intelligence applications to preventing the crime.

2. Basic research

2.1. Predictive policing

2.1.1. Definition of predictive policing

Predictive policing in its general content, is the process of bringing data from various sources related to the crime (the subject of the prediction), and after those data analysing process (crime analysis) (Ratcliffe 2010, 9), the results of the analysis process are used (selection, collection and preparation) in the crime future prediction process, in order to prevent its occurrence by taking precautionary measures, and effective response to crime, if it occurs.

The concept of the predictive policing in our project is that the main focus of law enforcement authorities will move from the framework of (what happened) to the framework of (what is going to be happen), and thus the effective distribution of crime-fighting elements in the predicted place and time to prevent crime, or control the consequences of crime, in case it occurred.

The predictive policing is by no means intended to replace traditional policing, but rather it bases the predictive policing approach to data analysis on the principles of problem-oriented policing, community policing, evidence-based policing and intelligence-led policing.

As Colleen McCue, CEO of MC Solutions, has pointed out that there is no predictive policing is not in a box, and in her analysis of the topic she advised "Let the problem guide the solution" (McCue 2007), in other words, it requires the application of modern tools and techniques in hotspot identification, data mining and analysis, and crime mapping, geographical (spatio-temporal) crime prediction, and socio-environmental network analysis (criminal justice problems), all of that would be used in the crime predictive process.

2.1.2. Community trust in predictive policing

The community's trust in the work of the predictive policing (PP), is the touchstone in the predictive process, and this could be achieved through the transparency of law enforcement agencies dealing with data, since the data are dealt within an open manner according to the constitutional framework, this might be done by involving privacy advocates and community leaders in the process, and explaining the mechanism of predictive models and programs, doing that to allay their concerns and ultimately, to obtain their views on the overall process within the principle of democracy of justice.

The public have to be assured that the work of the predictive policing does not deprive them from civil and constitutional rights, in other words, that the arrest of individuals is not carried out by the mere possibility of committing a criminal act in future, but rather the police must have a real predictive reason within the specified constitutional

frameworks, all of this would be done according to the legal mechanism which base on the Domain Awareness System[3] assessments, which is a network of sensors, databases (criminogenic features), devices, software and infrastructure that delivers tailored information and analytics to mobile devices and precinct (survey area) desktops of predictive police, video analysis of cameras, environmental sensors, license plate readers, acoustic correlation processing of gun firing (e. g. ShotSpotter) to keep track of criminal activity in the study's area geography.

According to the latest analytical comparisons between traditional hot spot policing with the predictive policing software and the accuracy of predicting certain types of criminal behaviour, by using predictive tools, which is built on assumptions about criminal risks and their social and spatio-temporal connections, but despite all that, even in cases of perfect surveillance, there was no possible to predict future crimes with certainty, so the model used by predictive police depends on a set of technical, organisational, social, and ethical assumptions which weighted by the predictive police, as stated in the listing of the assumptions of the four stages of the predictive policing cycle: data collection, analysis, police operations, and criminal response (Perry et al. 2013), as the result, the efficiency of the officers was improved as they could *better respond* on criminal activity and find suspects through the full network of sensors by which it is easier to find suspects or stolen vehicles through license plate recognition. Also, officers can respond faster on shootings through ShotSpotter (which registers the sounds of shootings).

From the constitutional aspect, privacy, rights and civil liberties must be guaranteed as a strategic imperative for the success of the PP, and this could be achieved by developing a comprehensive constitutional privacy policy, training staff on the mechanism in the correct constitutional manner, imposing legal accountability, and continuously striving to improve the policy of the PP, and clarifying the mechanism of sharing data with other specialised agencies.

2.1.3. Dealing with data

It is certain that the success of the predictive policing lyes on its reliability, the mechanism of data integration and the methodology of its analysis, and since the police institution collects a huge amount of data without ensuring its reliability and validity, therefore, supervision and auditing them is considered a necessary as an accompanying preliminary step, for the Selection, Collection and Preparation operations, in order to ensure the cleanliness of the data.

Currently, the collecting data process could be done by relying on the Public Records of General Directorate of Police Department of the study's area geography as an essential data source, but in future, the researcher suggests establishing a special program in this

[3] The Domain Awareness System was initially developed by U.S. law enforcement to enhance urban public safety (Accessed February 10, 2024. https://www.stopspying.org/latest-news/2019/9/26/domain-awareness-system). However, real-time awareness and decisions-making applications extend across the physical and digital spectrums of the public safety, law enforcement, intelligence, military, space, cybersecurity, maritime, and environmental protection domains. Emerging Internet of Things (IoT) sensor technologies, 5G network telecommunications, and Artificial Intelligence (AI) empowered Machine Learning means that we will increasingly be able to automatically "sense" and then make informed human decisions about what is taking place around us, across both structured (urban) or unstructured (rural) spaces.

regard, similar to the American Crime/Law Enforcement Status program UCR[4] (Uniform Crime Reporting Program).

And in order to take the necessary legal measures to protect the rights, freedoms and protect the legal interests of data subject (Rights of the data subject and the conditions for the Collection and Processing of the data) by the data controller and the processor, when he performs the technological processing of this data, and in terms of the right to receive crime and land use data (license, permit and certification), and the legal obligation to provide these data (Obligations of the Controller and the Processor), and the procedures of granting access to personal data without prejudice to the principle of confidentiality of the investigation, defining the sensitive data, cross border movement of personal data, prohibiting of electronic data marketing, the mechanism of establishing of personal data protection center, the procedures of issuing, amendments and cancelling of licenses, permits and certifications, and regulating the requests and complaints of data subject, and clarifying the judicial seizure process (crimes and sanctions): Collecting, Processing, Disclosing, Granting access or circulated personal data by any means illegally, or without the consent of the data subject, the researcher proposes to take advantages of the legal approach which taken by the Egyptian legislator in this regard (The Egyptian Personal Data Protection Law No. 151 of 2020, and the executive regulation of the accompanying this law)[5]. In order to accurately process the socio-environmental features, it is also necessary to make a maximum use of the available data, such as medical data and code-compliance data, and to integrate them with other basic data (crime data and land use data), and thus, dealing with all these data from a comprehensive perspective, taking into account the features of the local environment.

And to conduct correct and effective predictive decision making process (Zubi, Mahmmud 2014, 80), it is mandatory to have effective integration between data warehouses and analyses warehouses (phenomenology and etiology).

2.2. Predictive police problems

The main problem in the work of the predictive policing, it represented in its laying up on the automatic mechanism of data analysis, which in turning side affects on the basic assumptions for describing the crime (place, time and local conditions), as it clear that an objectively, fully integrated description of the crime is not possible until the moment, especially when the criminal effects are not observed or not subjected to the usual measurement standards, so in our methodology work, we have adopted the three basic dimensions that affect on the quality of standards measurement: 1) the criminal dimension; 2) the spatial dimension; 3) the temporal dimension. However, due to the difference in the

[4] The Uniform Crime Reporting (UCR) Program generates reliable statistics for use in law enforcement. It also provides information for students of criminal justice, researchers, the media, and the public. The program has been providing crime statistics since 1930. The UCR Program includes data from more than 18 000 city, university and college, county, state, tribal, and federal law enforcement agencies. Agencies participate voluntarily and submit their crime data either through a state UCR program or directly to the FBI's UCR Program. Accessed February 10, 2024. https://www.fbi.gov/how-we-can-help-you/more-fbi-services-and-information/ucr/publications.

[5] See: The Egyptian Personal Data Protection Law No. 151 of 2020. Accessed February 10, 2024. https://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=111246&p_count=7&p_classification=01.

jurisdictions of each country, then appears the difference in the application of predictive models, as it appears that a particular model produces more accurate predictive work than another model, or perhaps there could appear the difference in the same model applied in two places with different jurisdictions (responsibilities).

In order to deal with the predictive problem in the PP methodology, two questions would be focused: 1) is it possible to produce effective predictions that could approximate the methodology of perpetrators preparation for the criminal act; 2) could the predictions which produced by the PP be used in their precautionary measures to prevent crime or control its outcome?

2.3. Predictive policing methodologies

2.3.1. PreCobs (Pre Crime Observation System)[6] *methodology*

In this methodology, the PP uses the following steps: 1) determining the criteria for detecting repeated crimes (the trigger criteria); 2) the mechanism of calculating the geographical area subject of the survey (area of interest), the places were the occurrence of semi-repetitive data is discovered in the retrospective analysis, and then the area which called the survey area is the spatial unit of prediction object, so the predictive criteria are tested in the calculated areas through a retrospective simulation to find out the validity of the assumptions which made earlier (analysed).

The basic idea of PreCobs is to predict the subsequent offences (near repeats approach) and to be assumed by the assumed repetition pattern of professional serial offences for a previously defined spatial and temporal, to create the forecast, geographic information system (GIS) technologies and police case data on crime scenes, crime times are combined with each other and finally tiles are visualised on a map that show areas of prediction which would be visualised in 250 × 250 m squares, and appears the probability of a subsequent offence which would be high (red = over 70 %), as soon as the alarm message which would generate automatically by PreCobs was reported, the responsible police officer — called "operator" at PreCobs — checks whether this is forwarded or suppressed. In order to rule out false-positive alarms as far as possible, and to identify only those offences as trigger offences that were actually associated with a probability of repetition in the sense of the near repeat pattern, and either it was committed by a serially acting profiteer, PreCobs works within the upstream filter system consisting of trigger and anti-trigger features. This means that every offences that has taken place in one of the so-called near-repeat areas in the respective police area of responsibility, based on a retrospective analysis of the offences data of recent years, which were checked to see whether it were carried out by profiteers — because only for them the repetition assumption applies, therefore a "trigger offence" is an act that is to be regarded as the trigger for a series of offences and which, according to the concept, can be predicted spatially and temporally, so according to the PreCobs (Egbert, Krasmann 2019a, 908), there are anti-trigger, trigger and neutral characteristics.

[6] "PRECOBS — software for predicting crimes". Germany — Land of Ideas. *Institute for Pattern-based Forecasting Technology IfmPt*. 2015. Accessed February 10, 2024. https://land-der-ideen.de/en/project/precobs-software-for-predicting-crimes-355.

2.3.2. Crime situation report — operative (KLB-operativ) methodology

This methodology is used to provide an improved and more efficient strategic force for the Predictive Policing. It is carried out in the following steps: 1) the KLB-operativ application[7] would be loaded on the smartphone devices of members of the Predictive Policing; 2) the daily (usually in the morning) update of the application, by adding the areas of criminal offences to the application's map.

Basing on this methodology (Kai, Felix, Florian 2018), a 24-hour operational planning and crime's combat concept would be drafted mmm, which is subject to central control, only police databases relating to a determined crime which is also the only crime in interested area would be update in the police prediction map-would be used, and the focus would be conducted on the near-repeat pattern, and by the daily updating the application during a period of ten past days, the daily hot spots would be highlighted (based on the approach of near repetition), and with the same mechanism, the importance of prediction (the danger's degree) would be encoded according to the colour's darkening of the area on the map.

2.3.3. PreMAP (Predictive Mobile Analytics for Police)[8] methodology

This methodology is implementing in cooperation with IBM and the Karlsruhe Research Institute (Egbert, Krasmann 2019b, 33), according to the focus which would be on the crime prevention mechanism, where the main theoretical basis lies in the following steps: 1) the occurrence of victims almost-repeatedly in a certain area; 2) The appearance of these areas as hot spots on the interactive map; 3) Instructing the police to carry out patrols in those areas.

Since there is an internal police data warehouse, which simplifies the independent development of the software, some of whom are equipped with tablet computers, with a mobile PreMAP application so that they can already view forecast-relevant data and corresponding maps in the patrol car. The PreMAP focuses solely on burglary and, as a result, on the near repeat pattern, when evaluating the probability of a recent burglary occurring again, a scoring system is used to determine whether the crime was professionally carried out and a repeat offences can be expected according to the near-repeat hypothesis, the PreMAP differs from the otherwise well-known tile-shaped risk visualisation by using a heat-map design.

2.3.4. SKALA (System for Crime Evaluation and Situation Anticipation)[9] methodology

According to this methodology: 1) examining the possibilities and limitations of crime prediction; 2) investigating the efficiency and effectiveness of predictive police interventions; 3) predicting crime risks using spatial data for each area of the city under the responsibility of a determined police officer (station), and thus crime is predicted at the city level as a whole.

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[7] The operating system for global decision making. Accessed February 10, 2024. https://plantar.com.

[8] The Cutting Crime Impact (CCI) project. Accessed February 10, 2024. https://www.cuttingcrimeimpact.eu.

[9] Projekt SKALA — Predictive Policing in NRW. Accessed February 10, 2024. https://lka.polizei.nrw/artikel/projekt-skala-predictive-policing-in-nrw.

Within this methodology, the relying would be on criminal and socio-scientific theories to measure socio-environmental and economic data, which would be able to explain the spatio-temporal distribution of crime, all based on the phenomenon of sequential temporal repetition of the criminal act affecting the predictive process, and the focus of this methodology would be on the integration and the analysis related to place and time.

This methodology were developed and tested as part of the SKALA project (System for Crime Evaluation and Situation Anticipation), which is based on the SPSS Modeller program from IBM and the geovisualization software ArcGIS from ESRI, initially, the focus was solely on burglary, but an extension to other types of offences is to follow or has already happened with reference to motor vehicle theft and commercial burglaries.

In future, the SKALA would be entrusted with developing additional possible applications for crime forecasts as part of the SKALA council set up after the end of the project; further developments in the field of the PP, in relation to micro-segments, but not least in relation to the expansion of the predictable offences and the processed data and theories, therefore, it might to be expected from the LKA NRW[10]. The tactical goal of the police is not only preventive, but also repressive (deteritive), since the envisaged benefit also refers to the "identification of potential suspect(s) in the prognosis areas".

In addition to the extended processing of data, it is the broader theoretical basis for algorithm programming that makes SKALA stand out from the other predictive policing projects and approaches in the German-speaking area. Thus, not only the near repeat hypothesis and the routine activity approach behind it which used as the basis for the prognostic analysis, rather, in a multi-stage, systematic and strongly theory-based approach, the first project step examined when crime theories are used for the prognosis of crimes appear predicting in the offence of burglary; in a second step, was determining which data must be accessible for the operationalisation of these theories, and finally only those theories were selected which the required data either already exist within the police authority or can be obtained from external sources, specifically, the following theories were used: rational choice theories, routine activity approach, theory of target search, crime pattern theory, disorganisation theory, broken windows theory, defensive space approach and the near repeat approach.

The latter has also distinguished itself as the most important theoretical reference for the creation of forecasts, all theories then used to model a forecasting algorithm, which is based on decision making models and were used every Monday for forecast production.

2.4. Materials and methods

2.4.1. Data

2.4.1.1. Crime data

In order for applying the RTM and the GAMLSS R Package model as required, a specific geographic area is initially should be defined (Survey Area), the crime data then should be fetched from the public records of the General Directorate of Police Depart-

[10] Administrative activities support the core business of the LKA NRW in Germany. The central department is a service-oriented service provider for the specialist departments of the LKA NRW and thus ensures smooth service operations. Accessed February 10, 2024. https://lka.polizei.nrw/artikel/zentralabteilung-0.

ment of that study's area geography, and then the type of crimes would be classified by reference to the place and the time of their committing in the survey area, following by the step of knowing the nature of the crime by carefully referring to the personal data of the perpetrators and their victims (in terms of socio-environmental features) (Pearsall 2010).

Then the coordination of longitude and latitude of the study's area geography would berecorded, by pointing each crime incident on the map, indicating the date (the day of crime committing) and the hour (the time of crime committing). For accurate criminal analysis, the study's area geography would be designed in our research into cells (distances) square meters (250 × 250 m squares) (in order to identify hotspots).

2.4.1.2. Land use data

As an independent variable (geographical environment risk factors) in the RTM, the spatial effects are considered among the effective criminal features for the Selection, Collection, Preparation and Analysis process of data, for example, nightclubs, gambling halls, brothels, liquor stores, weapons sales and places of drug sale, all of these places would be projected into the study's area geography within the coordination of longitude and latitude (space-time cells) of the location data (Busso, Gregory, Kline 2013, 911; Brantingham, Brantingham 1995, 17).

2.4.2. Pre-process terrain risk map

After collecting crime data and land use data and projecting them over the study's area geography representing by cells with dimensional distances, at the first step (phenomenology stage) for performing the RTM, the social and environmental risks would be processed via Poisson distribution[11] referring to within the model factors that are subject to permanent change (according to place and time) using a non-zero equation (Briz-Redón, Martínez-Ruiz, Montes 2022, 596; Danaher et al. 2017, 3; Caplan et al. 2015, 8–12), and at the second step of this model (etioligy stage) represented by using the GAMLSS R Package model in this predictive approach, the following methodological steps would be taken:

— the process of collecting data for the study's area geography;
— the process of separating existence data from abundance data;
— the process of integrating socio-environmental variables;
— the synthesis process between presence data samples and abundance data samples;
— the data validation process projecting to the study's area geography (Kennedy et al. 2020).

Then the point cells that processed within the threshold limits (1–5 as zones) would be dropped on the map of study area (Busso, Gregory, Kline 2013, 899), representing 5 zone as the highest risk zone, while the cells that were far from the threshold are represented as 0 (not the highest risk zone), and then the density variables are classified to the highest density (density ≥ mean + 2 standard deviations) and the lowest density (density < mean + 2 standard deviations) (Taylor, Harrell 1996), and thus, 0–5 zones represent the progressively zone's density, and the lowest is represented by the zone 0 (Garnier, Caplan,

[11] For calculating probabilities of the estimated values, the online Poisson distribution could be used. Accessed February 10, 2024. https://stattrek.com/online-calculator/poisson

Kennedy 2018). Finally, the areas after processing the study's area geography would be redrawn, representing by the socio-environmental features in the form of terrains (criminal risk), and those (areas) could be organised into tables consisting of rows (cells and columns) (Caplan et al. 2015, 12) representing by the variables affecting the crime.

2.4.3. Spatio-temporal factor

With the methodology of the RTM in the study's area geography, referring would be made to the occurrence of a criminal incident (a specific crime) in a specific place, the calculating the factors which increase the probability of a subsequent incident occurring in the same place or close to it during a period of time (Caplan, Kennedy 2011), in order to measure this effect, we calculate the spatio-temporal correlation as follows:

— selecting the place (Survey Area) within the study area geography;

— determining the duration of the study subject (in most cases would be one year);

— the probability (rate) of repeating the incident (spatially) and pointing this rate on the cells with the value m ($m = 0, 1, 2, \ldots, 40$);

— the probability of repeating the incident occur (temporal-with regard to time) also would be calculated with the value n ($n = 0, 1, 2, \ldots, 40$).

All four illustrated steps would be based on the original incident (the point of occurrence of the incident); the next step would be determining the predicted probability (higher or lower) forecasting the incident occurrence in future (Drawve 2014, 388) at the place and the time in the original incident location and adjacent which the incidents were processed (Near-repeat phenomenon) (Kennedy, Caplan, Piza 2013).

2.4.4. Post-process terrain risk map

According to the model results, there would appear in a bidirectional stepwise regression (Dugato 2013, 76), showing the areas of presence and areas of abundance (according to the crime risk) as a variable of place using (spatial) within the features of crime influence, for example, nightclubs and gambling casinos in Duhok (the capital city of Duhok Governorate, Kurdistan Region in Iraq) governorate is considered one of the places within a high risk of crime on a Terrain Map Risks for Duhok Governorate (based on press releases); thus, the regression (risk degrees) fluctuates from the minimum standardised risk score from 1 to 5 according to the GAMLSS R Package model.

2.4.5. Model performance

After performing the synthesis process between the presence data samples and the abundance data samples (criminal risk) and pointing them on the map of the study area geography, using the spatio-temporal equation, the estimated values of socio-environmental influences would be entered into the equation (using Poisson distribution) (Garnier, Caplan, Kennedy 2018) (Prediction Computation), as well as m and n as spatial and temporal influences, respectively, the predictive value of the spacetime cell on the map would be obtained.

So, *the Predictive Policing* process involves six steps (Završnik 2019) that would build on each other, starting with the analysing of a specific crime (0. Crime Analysis) and the

collection (1. Selection-Collection-Preparation of Data) and data process step would be required for statistician (Machine Learning), crime prediction (2. Modeling; 3. Prediction Computation), allowing an insight into the individual steps for implementing predictive policing from the police department's point of view (Public Records of General Directorate of Police Department of the study's area geography), (4. Visualisation of Prediction) as a Generating Predictions Stage, then at an intervention stage, there would be an action step by Predictive Police (5. Prediction Utilisation), and for all five mentioned steps there would be an essential step for data validation process, namely rating step (6. Formal Evaluation, Assessment and Feedback) (Kai, Felix, Florian 2018; Manté et al. 2016, 364; Taylor 2006; Perry et al. 2013).

The *Generating Predictions Stage* is just half of the predictive policing business process; taking actions to interdict crimes is the other half (Intervention). The specific interventions will vary by objective and situation. However, the intervention efforts success could identified by following features:

— there is substantial top-level support for the effort;

— resources are dedicated to the task;

— the personnel involved are interested and enthusiastic;

— efforts are made to ensure good working relationships between analysts and officers;

— the predictive policing systems and other department resources provide the shared situational awareness needed to make decisions about where and how to take action;

— synchronised support is provided when needed;

— responsible officers have the freedom to carry out interventions and accountability for solving crime problems;

— the interventions are based on building good relationships with the community and good intelligence information.

Designing intervention programs that take these attributes into account, in combination with solid predictive analytics, can go a long way toward ensuring that predicted crime risks do not become *real crimes*. The theoretical justification for predictive policing, then, is that we can identify many of these patterns and factors through analytics and then can steer criminals' decisions to prevent crimes with *Tactical Interventions*.

And the Interventions could be divided into three types: *Generic Intervention, Crime-Specific Intervention, and Problem-Specific Intervention*. In general, we hypothesise that the more complicated interventions will require more resources, but they will be better tailored to the actual crime problems, and get better results. Regardless of the type of intervention, those carrying it out need information to execute the intervention successfully. Thus, providing information that fills the need for situational awareness among officers and staff is a critical part of any intervention plan.

The *Interventions* lead to a *Criminal Response* that ideally reduces or solves crime. In the short term, PP agency needs to do rapid assessments to ensure that the interventions are being implemented properly and that there are no immediately visible problems. The longer term criminal response is measured through changes in the collected data (altered environment), which in turn drives additional analysis and modified operations, and the cycle repeats.

The type of intervention will vary with the situation and the department charged with intervening. In general, we hypothesise that the more complicated interventions will

require more resources, but they will be better tailored to the actual crime problems and get better results:

— *generic interventions*: allocating more resources in response to increased risk. For hot spots, this might mean allocating more officers; for "*hot people*", this might mean allocating more parole or probation officer contacts;

— *crime-specific interventions*: assigning resources that are tailored to combating the expected types of crime. Resources and interventions might focus on a given hot spot or a particular person who is at risk of offending;

— *problem-specific interventions*: identifying location, population, or persons specific problems generating crime risk and fixing them. This level includes measures to investigate and solve specific crimes, almost by definition.

Regardless of the type of intervention, those carrying it out from the command level to tactical officers will need information to execute the intervention successfully. Thus, a *critical part* of any intervention plan is providing information that creates the needed situational awareness among officers and staff. Once the police launch an intervention, some criminals may be arrested and removed from the streets. Others may choose to stop committing crimes, change where they commit crimes, or change the way they go about committing crime in response to the police intervention. Thus, a location that had been hot can cool off, with some criminal activity moving to another area. These changes will make the original data set obsolete. In this way, the cycle begins again with a new round of data collection, analysis, and intervention (Perry et al. 2013, 14).

3. Conclusions

As the modern criminology theory (Algorithmic Criminology) highlights on the nature of crime (crime data) from the individual aspect, that means it is dealing with the total crime rates in the study's area geography by evaluating individuals whom committing crime in individual places (spatial); in the other words, it is based on the individual behavioural (environmental data) (Zubi, Mahmmud 2014, 83; Taylor, Harrell 1996), and conditions of the perpetrators and their victims, and the hypothesis of the theory is that the effective way to combat crime is to use the mechanism of an Agent-Based Simulation technique, which is recently using in criminology.

Therefore, in conjunction with the hypothesis of modern criminology theory (A Theory of Risky Places), the research seeks to provide a systematic vision in order to enhance the process of crime analysis in the future, through:

— clarifying (modelling) the mechanism of combining between past criminal incidents (crime data and environmental data) for conducting the effective prediction incidents;

— supporting the hypothesis which situating that the perpetrators, before planning to commit crimes, they try to knew/imagine the consequences of previous crimes committed in the same and adjacent places;

— the research is presenting the using of the Risk Terrain Modelling and the GAMLSS R Package models, to measure crime risks by showing past incidents and socio-environmental influences and evaluating the impact of the predictive spatio-temporal factor on crime's outcomes distribution in the specific geographical area.

Finally, the main research's endeavour embodied in providing a modern legal scientific resource (models) in order to inspire the Iraqi criminal legislator to keep pace with developments in the field of artificial intelligence's mechanism for combating crime, utilising predictive police strategies to control the spatio-temporal crime map.

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