

Evaluating the Adoption of Deductive Database Technology in Augmenting Criminal Intelligence in Zimbabwe: Case of Zimbabwe Republic Police

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ABSTRACT

The sophisticated modus operandi of modern day criminals has necessitated the development of modern policing initiatives that are centered on Criminal Intelligence. As a law enforcement strategy, criminal intelligence has altered the policing pattern by reinforcing the traditional approaches of investigating. Although the use of advanced information systems has become necessary in the profiling and prediction of crime threats, their full potential has not been realised. The purpose of this qualitative research was to evaluate the adoption of deductive databases in augmenting criminal intelligence in Zimbabwe. The major data collection instruments were document review and semi-structured interviews. The study established that ZRP has been yet to adopt deductive database technology. All the systems that are currently being used rely only on data stored in the database. There is no inference of new facts from the databases. In order to augment criminal intelligence, the study recommends that ZRP should adopt a deductive database technology for empowering decision makers and achieving strategic intent. The identified application areas of deductive databases can bring about improved service delivery system coupled with effective decision making at all levels of planning.

Keywords

Deductive database, evaluating deductive database, adoption of deductive database, criminal intelligence, Augmenting Criminal Intelligence

1. INTRODUCTION

The organisation of crime have transformed rapidly in the 21st century. According to Pascual (2015), modern day criminals have arisen and grown faster than the law enforcement agencies. Their sophisticated modus operandi has necessitated the development of modern policing initiatives that are centered on Criminal Intelligence (CI) (Milliken and Shaw 2012). As a law enforcement strategy, criminal intelligence has altered the policing pattern by reinforcing the traditional approaches of investigating the crime. The thrust is to prevent crimes from being committed rather than solely depend on reacting to their commission. Decision makers should be able to have CI information at their disposal at any time for them to make informed

decisions to proactively deal with crimes and criminal activities (Moreto 2015).

Crimes and criminal activities information stored in law enforcement agent database form the much-needed information data bank for CI strategy. Although the use of advanced information systems has become necessary in the profiling and prediction of crime threats, their full potential use to realise strategic intent has not been realised (Arvidsson et al. 2014). The key technology that has been slowly adopted to improve police decision-making in combating crime is the deductive database. These databases provide actionable criminal intelligence which is critical in crime prevention, reduction and investigating (Moreto 2015). In addition, criminal intelligence can play a substantial role in providing the direction for prioritising police resources.

2. BACKGROUND OF THE STUDY

In the modern-day policing, law enforcement agencies need to get quality information in order to close investigating gap through CI and support the strategic intent of the organisation. According to Grobler et al. (2013), CI empowers authorities within the law enforcement agency to create a timeously response strategy to crime by having a thorough understanding of the crime pattern. If the authorities know the forms in which crimes are committed, they can channel resources to specific crime domains.

However, as the requirement of CI continues to expand to law enforcement agencies (Smith et al. 2014), many countries still find it challenging to control or prevent crime within their jurisdiction and beyond. Criminals have created syndicates from local to regional and international settings. A number of criminal activities have become a major concern to policing agencies. It has been submitted that because of the lucrative deals in crimes such as poaching, drug and human trafficking and smuggling, criminals are now operating in associations within and beyond their borders (Milliken and Shaw 2012).

Law enforcement agencies have many data stores about crime and criminal activities. Collected information about crimes and criminal activities can allow new information or criminal intelligence to be derived that is useful in law enforcement for crime detection and prevention. As emphasised by Shen et al. (2014), information stored in database can provide CI if certain rules and extrapolations are applied. However, these data stores are not being utilised for CI at ZRP. Therefore, it can be argued that a deductive database may play an important role in police organisation to improve the quality of law enforcement. Intrinsically, ZRP as a law enforcement agent can implement deductive databases to allow informed decision making and



help them to conduct informed deployments of both material and human resources in fighting crime.

3. STATEMENT OF THE PROBLEM

Regardless of the availability of database systems that keep records of crimes and other criminal activities, the global nature of the crime has created a difficult equation in national and global policing (Rudolph et al. 2013). Therefore, in order to attain strategic policing intelligence, there is a need for a concrete model that can be used to map criminal relationships and identify the associations of criminal syndicates. (Milliken and Shaw 2012). As demonstrated by modern policing initiatives, there is great need to establish a crime analysis system that can facilitate purposeful deployments of resources and promote a culture of intelligence-led policing system (Mashiloane 2014).

The present database management systems in ZRP do not provide inferences and conclusions for them to achieve their broad crime strategic objective. It is only fixed on data collection and storage. Yet the stored data can point to some very crucial CI information which can help the organisation to make some informed decisions for effective policing. Therefore, given a strong positive association between criminal syndicates and crimes committed, there is a need to develop technologies that can map crimes in relationship to criminal syndicates. Hence, the purpose of this qualitative research is to evaluate the adoption of deductive database technology in augmenting criminal intelligence in Zimbabwe.

4. CONCEPT OF DEDUCTIVE DATABASE

Deductive database is a database system that has a deductive functionality. Through the augmentation of the inference engine, the database can perform computations for decision rules. Moore (2015) posits that this database system has a latent of improving predictions from the available facts. This form of database has been widely used to combine data sets from different formats and retrieve information for intelligence value using inference engines (Jha 2014). This database consists of rules and facts through a declarative language used to specify what to be achieved. The major concepts that underlies the deductive database are DATALOG and PROLOG. This enables logical reasoning and amalgamation of information to become knowledge (Cohen 2016).

The concept of deductive database demands that data is stored using specific rules so that the database is not just a simple storage facility, but a knowledge source. This enables inferences to be performed while reducing



the amount of storage space on the database. In the context of the ZRP, these rules can be specified declaratively, which, when compiled and maintained by the DBMS can determine when and where offences and criminal activities are likely to take place. Therefore, it can be concluded that a deductive database is grounded on database storage and the logic to derive information so that rules can be evaluated against facts to answer emerging queries (Jha 2014).

4.1. Features of a deductive database system

It has been suggested that the user interface in deductive database system should enable the specification factual data and instructions concerning the system using a predicate logic. According to Sáenz-pérez (2014), a deductive database should have three major features. These are tabling feature, fixpoint computation and dependency graph feature. Each of these should serve a distinct purpose. The function of the tabling feature is to provide a template for computations and all the computations using annotations. This will enable the database to handle further queries and updates. Tabling is the confluence of a deductive database in such that all transactions have to be requested and stored in a table. The major properties of tabling are logical presentation and declaration. Moreover, the tabling feature provide an incremental process of rules since a deductive database is a rule based function. In addition, this feature enables information to be shared among various users of the database. Lastly, it should ensure that information is preserved during requests.

The second feature which is the fixpoint computation is responsible for solving queries within the database management system. It allows the database to combine functions that facilitate computations. Because of its presence the retrieval of duplicates from external database is also avoided. This feature can also be seen as an algorithm for performing interruption and continuation of queries from the tabling. The third feature is the dependency graph. The major function of the dependency graph is for the database to decide the order and priority of carrying out computations. The dependency graph evaluates the order of transactions in a database. It also ensures that annotations in the table are done in their order. It works in conjunction with the tabling feature and the fixpoint computation.

4.2. Role of Deductive Databases in augmenting criminal intelligence

Criminal intelligence is vital in operations that are designed to detect and prevent criminal activities. Law enforcement agencies can user pointers from the database to deduce crime patterns. This will enable the agency to device adequate intervention strategies. Deductive databases make use of the expressive power of logical rules and non-atomic data structures to exploit stored information (Wojnicki 2013). In the context of criminal



intelligence, deductive databases should facilitate the exploration of avenues of information gained during collection so that it can be converted to intelligence. In order to achieve this, appropriate information software applications and analysis tools should be used. These may include Crime Pattern Analysis, General Profile Analysis, Offender Group Analysis, Specific Profile Analysis, and Investigations Analysis.

4.3. Application areas of deductive database systems in law enforcement

Deductive database has been used in various areas within the law enforcement domain as presented below:

4.3.1. Autonomous robots for law enforcement

Autonomous robots can be used in quite a number of situations in policing. These include public order management, accident scene reconstruction, targeted patrol and intelligence gathering, locating suspects and vehicle pursuit (Mashiloane 2014). For the robot to be relevant and appropriate, it has to sense its environment. In order for the autonomous robot to be effective in its operations, it should implement a deductive database system to allow it to deduce some other facts from the data it can collect from the environment. As articulated by Greeling (2013), Unmanned Air Vehicles (UAV) like drones may be useful in monitoring and controlling of crowd at large public order events like soccer matches, marches, demonstrations and strikes. Hot spots in which trouble is brewing could be quickly located, as well as finding signs of violence or vulnerable bystanders being trampled in a crowd. Information collected by these drones can be stored together with some rules and can help them to draw some new facts that they use in their operations.

4.3.2. Criminal profiling system (CPS) and Criminal intelligence (CI)

Systems that can be used in law enforcement for criminal profiling and criminal intelligence will need deductive database systems. This allows new facts to be inferred from data stored in criminal profiling system. Rules in deductive database let storage of new kinds of data to be possible (Fernando 2015). For example, recursively defined data or indefinite data. In crime profiling, law enforcement agents can use rules to store new information implicitly pertaining to criminal activities, their crime patterns and frequency as well as areas of concentrations. This CI information can be very important to both investigating officers and commanders at different levels of management for formulating crime prevention strategies, tactical planning as well as equipment and human resource deployments.

4.3.3. Crime cases reporting system (CCRS)

Recording of crime cases is paramount not only to have crime incidents on record but also for crime analysis purposes. Crime analysis and crime



prevention are identified as broad objectives for any crime prevention strategy (Wojnicki 2014). Crime analysis acts as an aid to crime prevention by facilitating information dissemination prior to any deployment plan. Information that can be used for deployment purposes and crime prevention activities cannot be generated from explicitly data capture alone but data inferences. Therefore, its capability to make derivatives among various relations during execution makes it an important design in crime analysis.

5. METHODOLOGY

Reflecting the adoption of information systems requires a rigorous research. A qualitative approach was used to evaluate the adoption of deductive database technology in augmenting criminal intelligence in Zimbabwe. Qualitative research provides an in-depth study to the problem. The major data collection instruments were document review and semi-structured interviews Terrell (2012). This was made to ascertain whether ZRP has adopted a deductive database management system or not. Document reviewed included systems documentation and database design. The participants chosen for interviews were system developers and administrators. These participants were chosen purposefully because they were assumed to be having adequate knowledge on the status and the performance of the ZRP's database systems.

6. FINDINGS AND DISCUSSION

From the semi-structured interviews that were conducted with the participants the study established that ZRP does not have systems that are using deductive database. The organisation is still using relational databases which appears to be fragmented. The level adoption is precisely low. All the system that are currently being used relies on data stored in the database only and that there is no inference of new facts from the databases. This has made it difficult to precisely map relations of crime incidents around the country and beyond the borders. This has left the organisation with bulk crime backlogs. The organisation is faced with challenges of crime clearance due to inadequate crime analysis procedures. Due to the vast criminal information in the data stores, the criminal analysts are not able to cope with the crime occurrences.

7. CONCEPTUAL MODEL FOR DEDUCTIVE DATA BASE

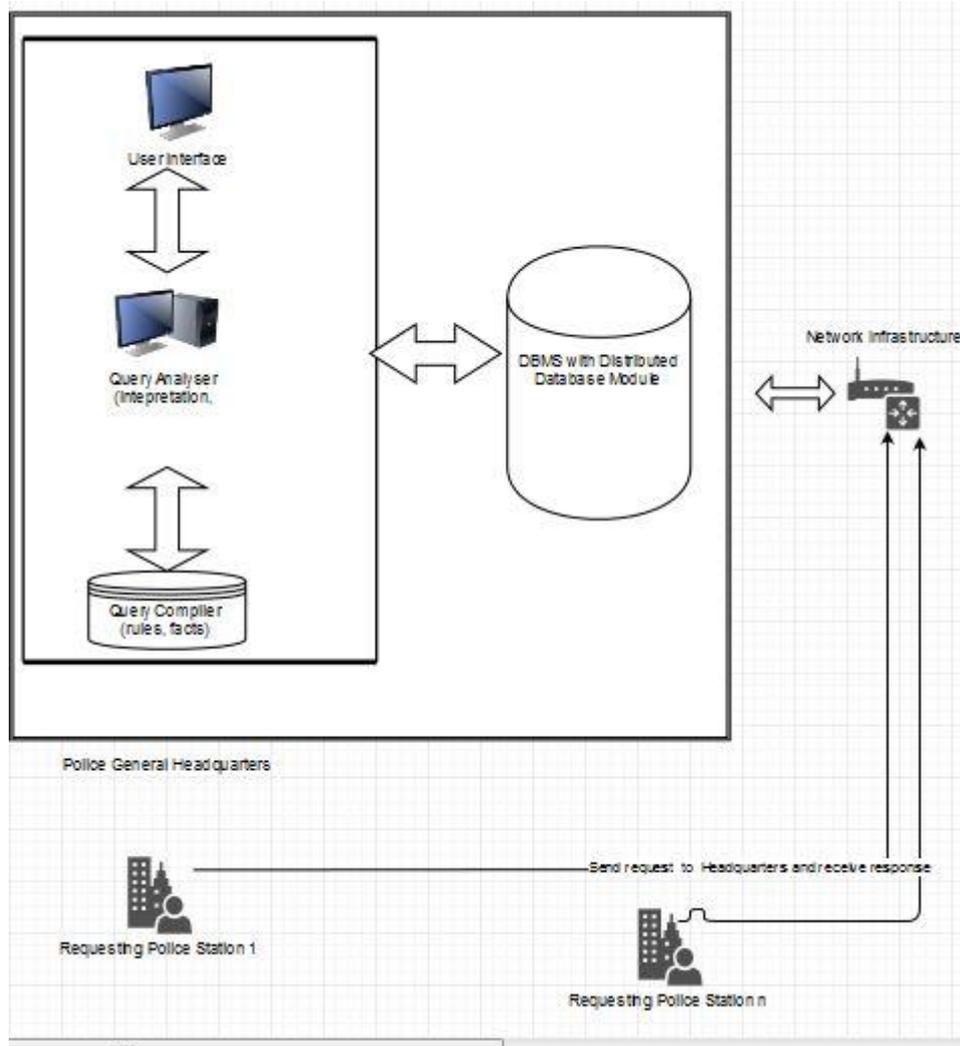


Figure 1: A conceptual model for deductive database

The sequence of the conceptual model is that each police station submits queries to any site. The query analyser that is located on the user site determines whether the query can be answered by the local site or it should be processed by the other sites. If the use of other sites is required, then the partaking sites must communicate. But, if sub-queries are not answered at the local site, they will be performed like autonomous queries. The closing operation which may include JOIN and PROJECTION is executed by the initiating site based on the rules defined in the database in conjunction with tabling, fixpoint computation and dependency graph features for implicit data representation. However, there is need for remote processing if the



police station initiating the query cannot communicate with the central police station.

To spell out the idea of implicit data representation, let's consider the following example. Suppose we have a deductive database that contains the following:

“James is a suspect for armed robbery of motor vehicle”

“James's modus operandi is use of firearm”

“IF x is a suspect for armed robbery AND x uses y to robbery THEN x is an armed robber.

In addition to the two facts, a deductive database can also contain the rule that specifies the armed robber relationship between a pair of entities. The database can prove the statement “James is an armed robber” by making the following substitution in the rule: $x = \text{“James”}$ and $y = \text{“firearm”}$. Since some associations many have multiple correlations, many rules can be added in the database to map these multiple associations. Furthermore, the algorithm must allow new associations to be added in the database as the need arises so that relevant deductions can be achieved. This deduction of facts from existing stored data can be applied by ZRP in the implementation of autonomous robots, criminal intelligence system and crime cases reporting system.

8. CONCLUSION

The research in deductive databases have produced plausible theoretical foundations that have been supported by greater prototype implementations. However, their applications in the industry have been insignificant, especially in law enforcement agencies. Therefore, this study established that there are many areas in ZRP that can make use of deductive database systems to improve the quality of law enforcement. The organisation need not to rely on stored data only, but make use of new facts that can be derived from the data. The identified application areas of deductive databases can bring about improved quality law enforcement coupled with effective decision making at all levels of planning. In order to augment criminal intelligence, ZRP need to implement the proposed model of deductive database.

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