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**MAKERERE**

**UNIVERSITY**

TRACEME - A Vehicle and Passenger Tracking & Monitoring System using GPS and GSM/GPRS

By

Team TRACEME

DEPARTMENT OF NETWORKS

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

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# List of Acronyms

GPS - Global Positioning System

GSM - Global System for Mobile Communication

GPRS - General Package Radio Service)

PHP - Hyper Text Preprocessor

HTML Hyper Text Markup Language

SMS - Short Message Services

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# CHAPTER 1: INTRODUCTION

## Background to the Problem

Criminal activities such as theft have become so rampant in the country, most especially in public means of transport such as taxis, buses, special hires where by people’s laptops, phones and other valuable properties are stolen or even accidentally left behind by the passengers and they are unable to trace them thereafter.

It’s a known fact that majority of individuals in Uganda on rare occasions take it upon themselves to identify information (license numbers) about the vehicles they board, as a result of this, most of the cases attached to these criminal activities meet a dead end because of the inability of the victims to provide sufficient information to back up the cases.

Below are some of the scenarios where passengers have fallen victims as they board public transportation means:

* For the case of theft, for example you have boarded a public means of transport and along the way you are thrown out and your property is taken, unfortunately you didn’t bother identifying the number plate and therefore you have no ground for proper investigation, so you forward the case to the proper authorities and they keep tossing you around due to lack of enough information about the case making them unable to carry out proper investigation in attempt to retrieving the stolen item or property. As a result of such scenarios, the levels of theft in public means of transport has kept high due to the fact that 95% of these cases always end up not being resolved thus motivating the culprits to continue with their acts.
* For a scenario where by a passenger boards a vehicle and does not take note of the number plate, along the way he or she realizes that she is the only passenger left in the vehicle before reaching the final destination, therefore the vehicle operators may take notice and decide to take advantage given the situation and sexually harass the individual on board and letter on drop you by the road, so in such a situation the victim of circumstance decides to report the case to the authorities but later on the case is dismissed due to inadequate information to build a solid case.
* For the case whereby a passenger leaves his or her property in the vehicle unknowingly, it really becomes so hard for him or her to trace out the information about the vehicle in case he or she did not take note of the license number. Basing on the above, it’s hard to carry out investigations.

More so, even if the passenger has taken all the precautions of taking note of the vehicle’s license number, it does not help much in solving the case as there is no system in place that keeps all the vehicles’ details in the country such that when a case involving a vehicle is reported, the police is able to quickly and easily solve it. So in the end, it all ends up not helping to solve the case.

## Problem Statement

The country is greatly affected by a variety of criminal activities some of which have to do with the public means of transport.

Our project will mainly address the issue of theft and that of a passenger leaving his or her property in the vehicle unknowingly.

Theft in the sense that a passenger’s valuable property is forcefully snatched away from him or is cornered to give up the items unnoticed by the vehicle’s operators.

These two concerns are our main target because passengers’ lives have been lost in trying to recover their property.

In addition, citizens have been left stranded and penniless due to such inconsiderate crime doers.

More so, people have lost valuable items to such criminals. Items that contain a lot of important information that can be worth a fortune.

## Proposed/ Envisioned Solution

An efficient vehicle tracking system is to be designed and implemented for tracking the movement of any equipped vehicle from any location at any time. The proposed system is to make good use of a popular technology that combines a Smart phone application with a microcontroller. This will be easy to make and inexpensive compared to others. The designed in-vehicle device will work using Global Positioning System (GPS) and Global system for mobile communication / General Packet Radio Service(GSM/GPRS) technology that is one of the most common ways for vehicle tracking. The device is embedded inside a vehicle whose position is to be determined and tracked in real-time.

A microcontroller is to be used to control the GPS and GSM/GPRS modules. The vehicle tracking system will use the GPS module to get geographic coordinates at regular time intervals. The GSM/GPRS module is to be used to transmit and update the vehicle location to database. A Smartphone application is also developed to be able to allow a user log info about the currently boarded vehicle and his credentials for tracking purposes.

The Google Maps API is used to display the vehicle on the map in the web application. Thus, users will be able to continuously sync with any vehicle that has the device in order to log the

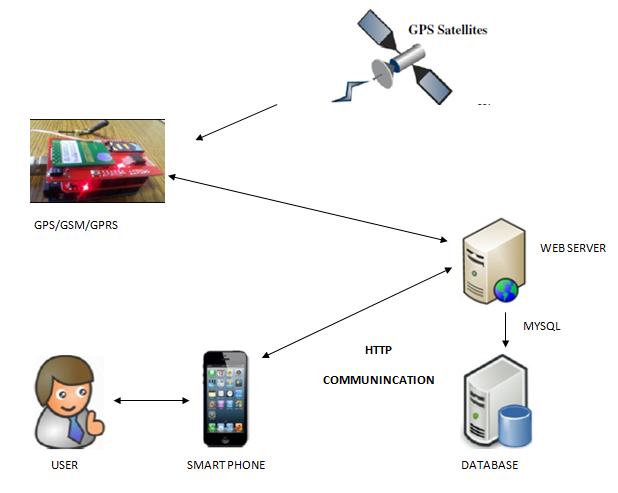
**Diagram of High level Architecture**  

Figure 1.1 : Proposed High level Architecture

## Objectives

This section entails the objectives that have been set out as the driving factors of the entire project at large taking into consideration the expected impact of the project in the society/community.

**Main Objectives**

To Reduce the rate of criminal activities occurring as a result of the use of public transportation means.

**Specific Objectives**

* To track vehicle positions
* Monitor Individuals transportation movements
* To ease the work of police in tracing any public vehicle operating in the country.
* To track down the individual’s movements in the public vehicles.

## Scope of Solution

This section contains the detailed explanation of the scope(area of coverage) of the system

**System Scope**

The system shall be able to track and locate the position of vehicles with the help of GPS and through the use of android enabled mobile phones. This shall enable the easy follow up of criminal activities within the transport sector. The intended users are; passengers, the police. The reason is basically for the concern of reducing the criminal activities within the transport sector.

**Geographic Scope**

The project will put into consideration the region of Kampala city for the proposed solution because apparently, it the most affected area when it comes to these criminal activities.

The area is also considered because it has so many public vehicles in usage and a big population that uses these vehicles.

## Stake Holders/ Interested Parties

This section describes the different stakeholders of the system and also states the benefits of the system to each of the stakeholders involved.

The stakeholders include the following;

**Passengers(Public vehicles)**

These are the individuals who on a daily basis come to use the public transportation means more especially the taxis within the city/town.

The Passengers shall benefit as follows;

* The system enables them to trace back their travel journeys in order to recover their stolen or lost property.
* Improve on their travel safety

**Police**

These are the people in-charge of the law keeping and enforcement within the region of interest. There activities include carrying out investigations and making arrests etc..

The police shall benefit as follows;

* The system will enable them to carry out their investigation work easily.
* Tracking wanted vehicles will be made easy through the system.
* Tracking movements of suspicious vehicles will also be easy

## Tools

**Requirement Analysis tool**

Data Collection Techniques

* **Interviews.**

This data collection technique shall be used to gather information from different stakeholders on what problems they are currently facing in line with our proposed system and how they would like us to help them solve this problem.

Under the interview, we shall use questionnaires and oral interviews.

These are the tools that are to be used during the interview;

**Paper and pen**, the tools shall be used to draft the questionnaires

**Audio recorder**, the voice recorder shall be used for the case of oral interview.

* **Reviewing existing documents**

This will involve using already available data got from various sources such as journals, technology reviews, dissertations, publications and online papers among others. This technique is cheap as it does not require spending any money and it also gets what information is already known about the current system.

Besides the techniques that are to be used in collecting requirements, the following are the different system design techniques that shall be used to clearly show the requirements;

* Use Cases
* Activity Diagrams
* Class diagram
* Data flow diagram

**Prototyping software**

* MICROSOFT VISIO

Microsoft Visio can be used to create simple or complicated diagrams. It offers a wide variety of built-in shapes, objects and stencils to work with. You can also make your own shapes and import them, if you’re willing to do all that extra work. The driving ideal behind Visio is to make diagramming as easy as possible for the user, and I think Visio is on the right track.

* PHOTO SHOP

Photoshop is a graphics-editing program that is used to create and manipulate images. The program's versatile nature makes it useful for a huge range of imaging tasks, and Photoshop is used in fields as diverse as architecture, astronomy, animation, forensics, web design and medicine.

**Application development environments (IDE)**

* Android studio

Android Studio is a fairly new IDE (Integrated Development Environment) made available for free by Google to Android developers. Android Studio is based on [IntelliJ IDEA,](http://www.jetbrains.com/idea/) an IDE that also offers a good Android development environment.

* Proteus VSM for PIC® Bundle

Proteus VSM PIC® Bundle is the complete solution for developing, testing and virtually prototyping your embedded system designs based around the Microchip Technologies™ series of microcontrollers.

* Arduino IDE

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software.

* PHPStorm

​PhpStorm is smart code editor that provides excellent support for PHP (including the latest language versions and frameworks), HTML, JavaScript, CSS, Sass, Less, Coffee Script, and many other languages.

* IDEA

IntelliJ IDEA offers outstanding framework-specific coding assistance and productivity-boosting features for [Java EE](https://www.jetbrains.com/idea/features/java_ee.html), [Spring](https://www.jetbrains.com/idea/features/spring_framework.html), GWT, [Grails](https://www.jetbrains.com/idea/features/groovy.html), [Play](https://www.jetbrains.com/idea/features/play_framework.html) and other frameworks, along with deployment tools for most application servers.

* Mysql workbench

MySQL Workbench is a visual [database design](https://en.wikipedia.org/wiki/Database_design) tool that integrates [SQL](https://en.wikipedia.org/wiki/SQL) [development](https://en.wikipedia.org/wiki/Software_development), [administration](https://en.wikipedia.org/wiki/Database_administration_and_automation), [database design](https://en.wikipedia.org/wiki/Database_design), creation and maintenance into a single [integrated development environment](https://en.wikipedia.org/wiki/Integrated_development_environment) for the [MySQL](https://en.wikipedia.org/wiki/MySQL) database system.

**Programming Languages**

JAVA

PHP

C/C++

ASSEMBLER

JSON

XML

HTTP

Jscript

**Application frameworks (if any)**

* LARAVEL

Laravel is a free, [open-source](https://en.wikipedia.org/wiki/Open-source) PHP [web application framework](https://en.wikipedia.org/wiki/Web_application_framework), created by Taylor Otwell and intended for the development of web applications following the [model–view–controller](https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller) (MVC) [architectural pattern](https://en.wikipedia.org/wiki/Architectural_pattern).

* TWITTER BOOTSTRAP

Bootstrap, a sleek, intuitive, and powerful mobile first front-end framework for faster and easier web development.

**Embedded hardware (if any)**

* ARDUINO HARDWARE

Arduino hardware is an open-source circuit board with a microprocessor and input/output (I/O) pins for communication and controlling physical objects (LED, servos, buttons, etc.). The board will typically be powered via USB or an external power supply which in turn allows it to power other hardware and sensors.

* ARDUINO CONTROLLER

Microcontroller is used as the brain to control the system. Arduino Shields are used for the GPS and the GSM/GPRS modules. A software program to control them is written in the C programming language, compiled and then saved into the microcontroller’s flash memory.

* GPS MODULE

The Global Positioning System in vehicle tracking systems is commonly used to provide users with information such as the location coordinates, speed, time, and so on, anywhere on Earth. In this work, a GPS module and a GPS receiver available from the system website, is adopted to implement the in-vehicle device. The GPS module has the GPS receiver with antenna. There are two slide switches and one push button switch.

* GSM/GPRS MODULE

The GSM/GPRS module is responsible for establishing connections between an in-vehicle device and a remote server for transmitting the vehicle’s location information, using TCP/IP connection through the GSM/GPRS network.

**Operating system/Cloud computing platforms**

* ANDROID

Is mobile operating system made by American company; Google. It most commonly comes installed on a variety of smart phones and tablets from a host of manufacturers offering users access to Google’s own services like Search, YouTube, Maps, Gmail and more.

**Communication protocols/Network Infrastructure required**

* HTTP

A HTTP communication takes place usually through TCP/IP connection. The standard port for HTTP servers is 80.In order to send data over the Internet, a socket connection needs to be established. In this work, the socket is useful for working with our server and it enables users to establish a TCP socket connection for sending data. The socket is characterized by three main entities, a protocol, an IP address / a host name and a port number.

# CHAPTER 2: LITERATURE REVIEW

This chapter of the proposal contains the general description of the problem that this project will address. It discusses the review information and documents that relate to the project title. This will be achieved by looking at the problem background and review, systems, current processes, and past and current research in the same problem domain. Also, software systems that do similar work, and or have related functionality, and or have been implemented using the same approach will be reviewed.

## Introduction

The country is greatly affected by a variety of criminal activities some of which have to do with the public means of transport. This project will mainly address the issue of theft and that of a passenger leaving his or her property in the vehicle unknowingly.

Theft in the sense that a passenger’s valuable property is forcefully snatched away from him or is cornered to give up the items unnoticed by the vehicle’s operators.

These two concerns are our main target because passengers’ lives have been lost in trying to recover their property.

In addition, citizens have been left stranded and penniless due to such inconsiderate criminals.

More so, people have lost valuable items to such criminals. Items that contain a lot of important information that can be worth a fortune.

## Similar Projects

Real-time tracking and management of vehicles has been a field of interest for many researchers

and a lot of research work has been done for tracking system. Recently the various anti-theft

modules like steering wheel locked equipment, network tracking system and traditional electronic alarm are developed along with client identification and real time performance monitoring.

The paper presented by El-Medany, W.; Al-Omary et al describes a real time tracking system that provides accurate localizations of the tracked vehicle with low cost. GM862 cellular quad band module is used for implementation. A monitoring server and a graphical user interface on a

website is also developed using Microsoft SQL Server 2003 and ASP.net to view the proper

location of a vehicle on a specific map. The paper also provides information regarding the vehicle status such as speed, mileage. [1] In relation to the proposed system the main difference is with the Location finding module implementation where the proposed system is to use GPS and GSM module. It also lacks the component of being able to track the passengers as the board there various public transport vehicles.

Hu Jian-ming; Li Jie; Li Guang-Hui describes an automobile anti-theft system using GSM and

GPS module. The system is developed using high speed mixed type single-chip C8051F120 and

stolen automobile is detected by the use of vibration sensor. The system remains in contact with

automobile owner through the GSM module, for the safety and reliability of automobile. [2]

Fleischer, P.B.; Nelson et al describes development and deployment of GPS (Global Positioning

System)/GSM (Global System for Mobile Communications) based Vehicle Tracking and Alert

System. This system allows inter-city transport companies to track their vehicles in real-time and

provides security from armed robbery and accident occurrences. [4] The similarity with the proposed system come in the part where vehicle tracking and monitoring is concerned though the proposed system will not be able to do the alerting with use of messages. In all, the proposed system is to go further and track passengers by taking logs whenever the passenger is to board a vehicle but the passenger will be required to provide some input to the android application in order to sync with the attached tracking device on the vehicle being boarded.

Le-Tien, T.; Vu Phung describes a system based on the Global Positioning System (GPS) and

Global System for Mobile Communication (GSM). It describes the practical model for routing

and tracking with mobile vehicle in a large area outdoor environment .The system includes the

Compass sensor-YAS529 of Yamaha Company and Accelerator sensor-KXSC72050 of Koinix

Company to acquire moving direction of a vehicle. The system will acquire positions of the

vehicle via GPS receiver and then sends the data to supervised center by the SMS (Short Message Services) or GPRS (General Package Radio Service) service. The supervised center comprises of a development kit that supports GSM techniques-WMP100 of the Wavecom Company. Finally, the position of the mobile vehicle will be displayed on Google Map. [5]. This in relation to the proposed system has some different and added functionality such as the direction and speed acquisition. They both have a common functionality at hand which is tracing the vehicle location using GSM and GPS.

## Conclusion

Based on the literature reviews, the system proposed here is a GPS/GSM real time enabled vehicle tracking system that will have an external database to store all the location information of different vehicles as they are on the move and also will be in position to store data of passengers boarding particular vehicles and keep track of their movements. It shall also be aided by the web version for visual representation of vehicle positions in order to track them in real time.

# CHAPTER 3: METHODOLOGY

This section basically explains the methods/techniques that we are going to use to develop your system, the requirements elicitation techniques, requirements analysis techniques and tools and the system design techniques.

## The requirements elicitation techniques.

* + 1. Interview

This requirement elicitation technique shall be used to gather information from the stakeholders (Police) especially in the transport and CID department on what problems they are currently facing in line with our proposed system and how they would like us to help them solve this problem. The interview guide is shown behind in the appendices.

Through direct interaction with the stakeholders (police), it will help us to get fast hand and valuable information that may be helpful in the implementation of the proposed system.

The interview guide we used is shown in Appendix A below.

* + 1. Questionnaire

The technique shall mainly be used when gathering valuable information from the passengers who especially use public means. The technique shall include a series of questions where passengers are required to respond to them by writing the answers corresponding to the questions accordingly.

This technique shall be used because it captures a wide location hence providing variety of opinions from the stakeholders about the proposed system.

## Requirements analysis techniques and tools.

After gathering the requirements from the stakeholders using the above mentioned requirements elicitation techniques, the requirements analysis and validation shall be carried out since stakeholders always provide unclear information hence calling for more attention and therefore there is need to review the requirements. The activities below shall be used requirements validation

.

* + 1. Classification of Requirements.

Requirements shall be classified as functional, non-functional, system and user requirements.

## System Design Techniques

The system design techniques shall be used in the transformation of requirement specification into implementation. The following are the design techniques that shall be used during the system implementation

* + 1. Unified Modeling Language

The Unified Modeling Language is a general-purpose, developmental, modeling language that is intended to provide a standard way to visualize the design of the system.

During the course of the system design, different diagrams shall be used to show the system at different levels including use case diagrams, data flow diagrams, class diagrams as explained below;

#### Use Case diagram

Use Case diagrams illustrates a unit of functionality provided by the system. Therefore the main purpose of the use-case diagram is to help the team to visualize the functional requirements of the system, including the relationship of "actors" (human beings who will interact with the system) to essential processes, as well as the relationships among different use cases.

#### Class diagram

The class diagram is yet another UML diagram that shall be used and it specifically shows how the different entities (people, things, and data) relate to each other. A class diagram shall be used to display logical classes and implementation classes.

## User Interface Design techniques.

* + 1. **Visibility of system status**

Visibility of system status shall always keep users informed about what is going on, through providing appropriate feedback within reasonable time.[6]

* + 1. **Consistency and standards**

Information flow within the intended system should be consistent in a way that users shall not have any wonder about the different words, situations, or actions meaning the same thing.

This shall basically be used in the web based and android parts of the system.[6]

* + 1. **Constraints**

The design concept of constraining refers to determining ways of restricting the kind of user interaction that can take place at a given moment with the system.[6]

* + 1. **Design of message feedback**

Feedback is about sending back information about what action has been done and what has been accomplished, allowing the person to continue with the activity.

The web based section will have section of allowing user feedback.[6]

## Data modeling techniques

* + 1. **Entity Relationship Diagrams**

Entity-relationship modeling is a database modeling technique, used to produce a type of conceptual schema or semantic data model of a system, often a relational database, and its requirements in a top-down fashion. The diagrams created out this, is called an entity relationship diagrams. The modeling technique shall be used basically during the formation of the database model.

* + 1. **Domain analysis**

It involves analyzing relatedsoftware systems in adomain to find their common and variable parts. This shall therefore help in determining the different entities within the system after clearly understanding and analyzing the problem domain.

* + 1. **Binary relationships**

Refers to a situation when two entities participate in a given relationship. Therefore during the development of the system we shall encounter such conditions especially during entity relationship modeling so as to come up with a database model.

The following are the examples of the binary relationships that we shall encounter; one to one, one to many and finally many to many relationship.

* + 1. **Table schemas**

After coming up with the entity relationship model, we shall the map different entities and relationships to come up with different database tables. Through the help of MYSQL workbench as a tool shall help in forward engineering .i.e. coming up with different tables from the ERD models.

## Implementation tools

* + 1. **Application Frameworks**

**Laravel**

Laravel is a free,open-source PHPweb application framework, created by Taylor Otwell and intended for the development of web applications following the [model–view–controller](https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller) (MVC)architectural pattern.

**Twitter bootstrap**

Bootstrap is a sleek, intuitive, and powerful mobile first front-end framework for faster and easier web development.

**Android**

It is a rich application framework that allows you to build innovative apps and games for mobile devices in a Java language environment.

* + 1. **Programming languages**

The following are the programming languages that are to be used during the system implementation.

* **JAVA** it is an objected oriented language that shall be used on the mobile based side of the system
* **PHP** It is a server side scripting language that shall be used at the backend services of the system
* **C/C++** It is a structured programming language that is be used to write set of instructions to the microcontroller.
* **ASSEMBLER** It is a language to be used in writing instructions to Arduino controller.
* **JSON** Language used to move data from one platform to another
* **HTML** it is language used to structure the layout of contents within a web page. Therefore it is going to be used on the web-based side of the application.
* **CSS** It is a language to be used on the web-based side of the application.

## System testing and validation techniques

The following are the techniques that shall be used during the system development

**Unit testing**

Involves testing of individual software components or modules. It requires detailed knowledge of the internal program design and code. It is normally done by the programming team

**Usability testing**

It is a user-friendliness check. Application flow is tested, can new user understand the application easily, Proper help documented whenever user stuck at any point. Basically system navigation is checked in this testing.

**Acceptance testing**

Normally this type of testing is done to verify if system meets the customer specified requirements. User or customer carries out this testing to determine whether to accept application.

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# APPENDICES

Appendix A

**Interview Guide**

AN INTERVIEW CARRIED OUT AT THE CENTRAL POLICE STATION FOR A PURPOSE OF GATHERING REQUIREMENTS FOR THE INTENDED SYSTEM.

**Name of Interviewer: …………………………………………………………………………**

**Name of Interviewee:…………………………………………………………………………**

**Organization:………...………………………………………………………………………**

**Position: ……...………………………………………………………………….**

**Interview Questions**

1. What are some of the criminal activities registered in the public means transportation sector?

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1. How do you keep records of the information about vehicles in the public transportation sector?

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1. What kind of information do you always record about any vehicle in the transport sector?

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1. How do you always locate vehicles in cases where it has been reported by a passenger of any criminal activity attached to it?

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1. For how long does it take to locate a vehicle in case of any suspicious act attached to it?

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1. What is the possibility of solving those registered cases on the vehicle reported?

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Appendix B

Questionnaire

A study is being carried out to investigate the levels of criminal activities that take place in public transportation. Your participation will greatly contribute towards finding a solution for such criminal acts.

For the questions 1, 2 and 3, please select one of the provided answers for what suites your situation.

1. How do you account for public vehicle usage in the city of Kampala?
2. 70%
3. 90%
4. 20%
5. Not used at all
6. What is the likelihood that victims of circumstance recover their property after losing them in public vehicles?
7. 90%
8. 50%
9. 10%
10. Never recover
11. What is your estimated personal data usage per month on your mobile device?
12. My phone is incapable of browsing the internet.
13. Less than 10MBS
14. 100-500MBS
15. My phone is capable but I don’t use internet.

For the questions below, please provide a brief and clear answer to each of them.

1. Have you ever been frustrated and disappointed because of leaving a property in the vehicle and not getting back?

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1. How often do you witness criminal activities in public vehicles?

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1. What impact do such activities leave on the victims?

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1. Do you think there is a way in which such activities can be eliminated in the country? Give example.

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