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T1 _____	**1919828**	F1 _____
T2 _____		F2 _____
T3 _____	Problem Chosen	F3 _____
T4 _____	**C**	F4 _____

2019
MCM/ICM
Summary Sheet

The LaTeX Template for MCM Version v6.2.1

Summary

fhakfhw

Keywords: keyword1; keyword2

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fhakfhw

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Contents

1 Introduction

1.1 Background

About 275 million people worldwide, which is roughly 5.6 per cent of the global population aged 15–64 years, used drugs at least once during 2016. Some 31 million of people who use drugs suffer from drug use disorders, meaning that their drug use is harmful to the point where they may need treatment. Initial estimations suggest that, globally, 13.8 million young people aged 15–16 years used cannabis in the past year, equivalent to a rate of 5.6 per cent. Roughly 450,000 people died as a result of drug use in 2015, according to WHO. Of those deaths, 167,750 were directly associated with drug use disorders (mainly overdoses). The rest were indirectly attributable to drug use and included deaths related to HIV and hepatitis C acquired through unsafe injecting practices.

Opioids continued to cause the most harm, accounting for 76 per cent of deaths where drug use disorders were implicated. PWID — some 10.6 million worldwide in 2016 — endure the greatest health risks. More than half of them live with hepatitis C, and one in eight live with HIV.The headline figures for drug users have changed little in recent years, but this stability masks the striking ongoing changes in drug markets. Drugs such as heroin and cocaine that have been available for a long time increasingly coexist with NPS and there has been an increase in the non-medical use of prescription drugs (either diverted from licit channels or illicitly manufactured).The use of substances of unclear origin supplied through illicit channels that are sold as purported medicines but are destined for non-medical use is also on the increase. The range of substances and combinations available to users has never been wider.

In 2015 and 2016, for the first time in half a century, life expectancy in the United States of America declined for two consecutive years. A key factor was the increase in unintentional injuries, which includes overdose deaths. In 2016, 63,632 people died from a drug overdose in the United States, the highest number on record and a 21 per cent increase from the previous year. This was largely due to a rise in deaths associated with pharmaceutical opioids, including fentanyl and fentanyl analogues. This group of opioids, excluding methadone, was implicated in 19,413 deaths in the country, more than double the number in 2015. It is necessary for us to study the law of drug spread and take corresponding measures to curb the trend of drug spread.[1]

1.2 Our Work

2 Assumptions and Notations

2.1 Assumptions

We make the following basic assumptions in order to simplify the problem. Each of our assumptions is justified and is consistent with the basic fact.

- **The reported counts contains all the cases of drug use in the states and counties.** There is no unreported drug use case and the report will not lead to a reduction in drug use.
- **The total population of the states and counties remains essentially stable in these years.** The effect of population density on drug use cases is constant.
- **The rest of America and the rest of the world have a constant impact on the five states.** We assume that the external influence on these five states remains the same.
- **States and counties have stable policies on drug use.** We assume that policy does not change during the study period.

2.2 Notations

The notation table [1] contains all the notations we use in this paper.

Table 1: The data example

ID	28221526017700008
Time	2018-02-28 22:15:26
PayMethod	Cash
Price	[0.982] Unit [Hainan Cherry Tomatoes] as [Season Fruit], Origin price [12.90] Discount Price [12.90]
isVip	False
SolderId	Merchant 22

3 Related Knowledge

Graph Theory

In **Part 1**, we need to describe the spread of the reported cases and identify possible locations where specific opioid use started. From aticle[2], we learn that weighted directed graph can solve this problem well. The advantage of using graph theory analysis is that it can directly reflect that interaction between the counties and it helps to analyze the path of transmission of certain drugs. Based on the linkages between the counties and counties, it is easier to derive strategies for controlling drug spread.

The following is the weighted directed graph we constructed. In this diagram [1], each node represents a county and the directed edge $W_{C,D}$ between two nodes C and D represents the influence coefficient of county C on county D is $W_{C,D}$ (The larger the influence coefficient, the more likely the county to be in county c, and the more likely the drug use in county D is to be transmitted from county C). Thus, a graph is constructed for all counties in the five states.

4 Data Analysis

4.1 Data Origin

The major data source is the "MCM_NFLIS_Data.xlsx" file. It contains all incidents involved with narcotic analgesics and heroin occurring from 2010 to 2017. Hopefully it can figure out the drug crisis spreading amount the northeast U.S.

4.2 Obvious Factors

Some factors are provided directly and can be grabbed at the first time:

- **Substances of Drugs**
  The main substances of all incidents were provided, hence we may separately analyze them to validate the model.
- **Case Count**
  Many drugs involved in all these incidents, but they are not equally significant. The reported count recording the troubles they made can be a convincing factor to determine how influential one drug is.
- **Geography Location**
  The specific county name in OH, KY, WV, VA, and PA are provided in detail. Thanks to $Simple\ Maps\ Corp.$[1] and their generous contribution, we