

System Dynamics Approach towards the Drug Use Problem in the Philippines

Joshua Matthew Lee¹, Kent Louie Wong² and Dr. Jose Edgar Mutuc³

¹ De La Salle University - Manila, Industrial Engineering Department

² De La Salle University - Manila, Industrial Engineering Department

³ De La Salle University - Manila, Industrial Engineering Department

*Corresponding Authors: joshua_matthew_lee@dlsu.edu.ph, kent_wong@dlsu.edu.ph, jose.edgar.mutuc@dlsu.edu.ph

Abstract: Drug use has been an issue that plagues several countries and would be more so in the future as the number of drug users has continued to rise each year. As such, initiatives have begun to gain popularity such as the “war against drugs,” which aims to eradicate drug use. The Philippines, much like other countries, have relied heavily on law enforcement through the justice system and police task force. This, however, begs the question whether or not the relied upon strategy is the most effective, which can be determined through system dynamics. The system dynamics approach is a multi-faceted approach which focuses on the action-reaction components of subsystems to get a better understanding of the complex real system. It was considered appropriate as it is able to evaluate the relationships between different variables and factors which are important especially in large systems that consider multiple sectors such as the problem of drug use. This system was quantitatively simulated through the Vensim software. Among the designed solutions tested, it was identified that rehabilitation among drug users should be the prioritized solution towards mitigating drug use in the country while raising awareness through education and reintegration of drug users in society may also be explored to further reduce drug users given more resources among corresponding agencies. Hopefully, this study can be among the pioneers of incorporating methodologies of systems dynamics in various solution-seeking organizations as it is an effective and empirical way of deriving results from proposed alterations to rid undesirable behaviors in the system.

Key Words: System Dynamics, Problem Variable, Feedback Loops, Drug Use

1. INTRODUCTION

1.1 Background of the Problem

Drug use has been linked to multiple detrimental effects which goes beyond the commonly known psychological and physical dependence of an individual. The negative consequences which stem from illicit drugs would mainly be outlined by the economic and social effects which include but are not limited to: economic, welfare, family, health, education, environment, and judicial/criminal sectors (UNODC,1998). Given the nature of drugs, the effects

and factors can become increasingly dangerous as it can be described through an addiction cycle which can not only trap users to rely on drugs but can also influence new drug users.

When President Rodrigo R. Duterte rose to power in 2016, his first initiative was to eradicate the illegal drugs in the Philippines through a campaign against drugs which is more commonly known as the “War on Drugs” (Simbulan et al. 2019). In doing so, he made a vow to solve the illegal drug problem which he claimed to have wrecked the lives of many Filipino

families and corrupted the Filipino youth. The supposed war would then target users, peddlers, producers, and suppliers with the help of the Philippine criminal justice system and national security.

Despite the adoption of international cooperations towards integrated balanced strategies against drug abuse, the Philippines remains among the highest in abuse rate for drugs such as methamphetamine hydrochloride, also known as shabu, in East Asia for the year 2012 (DDB, 2018; Esplanada, 2012). It was also cited that the Philippine Drug Enforcement Agency records show that in 2011, 9,850 anti-illegal drug operations resulted in the arrest of 8,491 suspects and 9,995 cases being filed. In addition to this, Philippine authorities seized 250 kilos of methamphetamine; 4.8 million marijuana plants and seedlings; 17,222 grams of cocaine; and 960 ecstasy tablets alone in that same year. These statistics capture just a snippet of the problem as drugs and the drug trade continues to grow and expand. Regardless of the increased attention and focus towards the anti-drug campaigns, the number of drugs being distributed as well as the number of drug users still remain relatively high.

1.2 Problem Definition

Given the staggering statistics it poses the question whether or not the anti-drug policies which have been implemented in the Philippines is the most effective means of reducing the number of drug users. The drug problem, particularly in the Philippines, has been viewed as an issue of law enforcement and criminality as the country continues to solve this issue through criminalization and punishment (Simbulan et al., 2019).

To provide a general overview of the problem, the Dangerous Drugs Board (DDB) has kept track of estimates on the number of drug users nationwide (Ranada, 2017). It can be observed that there are missing data points in a number of years which can be attributed to the country's lack of interest in proper record keeping. In addition to this, it can be increasingly difficult at times to monitor the extent of drugs due to the geographic location, border controls, criminal

justice system, tradelinks, and inconsistencies in management.

The time period which would be considered is from the year 1999 to 2017 which is data obtained before the Duterte administration as shown in **Figure 1**. This graph illustrates the number of estimated drug users in the Philippines which serves as the problem variable in this study. By recalling past data and events it aims to create a retrospective view on the situation by determining the best actions that the Duterte administration could have undertaken relative to what actually happened in the "war of drugs". There has been controversy surrounding the actual number of drug users because of this, since Duterte's office had estimated more than the one conducted by the DDB.

Generally speaking, the effectiveness of the government's actions in dealing with drug use is rather inconclusive despite what is shown in the graph of estimated drug users. An increase in the estimated number of drug users during the Duterte administration can be misleading since there could have been an increase in the detection methods or an increase in the number of anti-drug campaigns. In lieu of this, a greater emphasis was placed on evaluating the factors involved in the system through the simulation of a model that aims to depict a similar situation to the real world system.

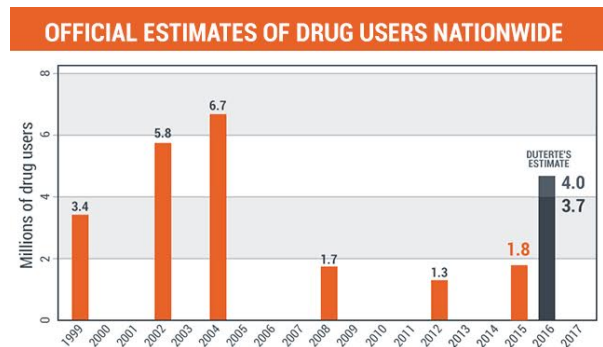


Fig. 1. Estimated Number of Drug Users in the Philippines

Note. The graph shows that the number of recent drug users are increasing from 2012 to 2016. Figure shows data available from 1999 to 2017. Copyright 2017 by Rappler Inc.

1.3 Objectives of the Study

The aim of this paper would be to evaluate the drug situation in the Philippines with the lens of system dynamics as an approach in identifying key factors which contribute to the problem. Each key factor can then be isolated to determine how it is able to impact the total system. In doing so, a better understanding of the system would be achieved which would then help in the formulation of policies or actions to mitigate the growth of drug users.

2. METHODOLOGY

2.1 Base Run

In light of the challenges experienced towards the drug problem in the Philippines, it was determined that it can be addressed through the system modeling methodology of system dynamics. The foundation of system dynamics is characterized by its ability to illustrate the complex real world systems with resulting accumulation of resources/people through the balancing and reinforcing feedback mechanisms. In doing so, computerized simulation models are able to be created to not only understand the system but also to test the effectiveness in implementing alternative policies and solutions. A model consists of the causal loop diagram to illustrate relationships of the feedback mechanisms, and stock flow diagrams which simulate the accumulation of variables.

Causal loop diagram shows the major variables that affect the problem directly and indirectly. System Dynamics particularly focuses on the feedback loops formed by these factors. These feedback loops represent the structure of the problem that makes the problem more difficult to resolve and improve on as they reinforce or control the part of the system. Thus, the causal loop diagram that represents the problem system shows the boundaries and limits of the model.”

Conversely, stock-flow diagrams are associated with quantitative analyses as it builds on the current understanding of causal loop diagrams and their relationships. Unlike causal loop diagrams, the stock-flow diagrams contain flows and rates which determine the increase and decrease of certain parameter levels. In the model, these flow rates are

affected by the drug addiction factors, which can then be traced from the effect of drugs that form the loops. The time series simulations use the flow rates from the previous time period to determine the net change/s towards the parameter levels in the current period. This allows the model to act as a simulation of the situation.

2.2 Solution Determination

To develop possible solutions, the base run of the current system was evaluated. The major factors would be isolated and assessed to determine how the factor correlates to the problem variable, number of drug users. From this, a sensitivity analysis was also conducted to investigate further into its effect on the entire system. The analysis was conducted by increasing and decreasing the variables by a set amount and then comparing the results with the current system. The current solutions being implemented by the Duterte administration can thus be compared along with the developed solutions to determine if the solution achieves the goals, why the solution fails or succeeds, and how the solution affects the system.

3. RESULTS AND DISCUSSION

Causal Loop Diagram

The causal loop diagram presented the behavior of the problem through both reinforcing and balancing loops.

The problem of drugs is dominated mainly by reinforcing loops. Each positive feedback loop creates a snowball effect – the more drug users there are the higher the exposure by non-users leading them to experimentation and becoming users. Similarly, drug dealers could encourage others to join the bandwagon of selling drugs, especially in cases where there is a need for additional or higher income. The third positive feedback loop involves increased purchases of drugs that reduce drug supply that eventually raises the price of drugs. The higher the price becomes a motivation to become drug dealers and increases drug exposure, thereby reinforcing the growth of the drug user population.

Meanwhile, the lone negative feedback loop which describes a balancing behavior controls the problem as it reduces the exposure when the supply is reduced. Conversely, as the supply is replenished the exposure increases once again. Thus, the loop explains how availability of drugs can raise or lower exposure. The relationships can be further expressed through the causal loop diagram presented in **Figure 2**, the variables interact with one another to generate positive and negative loops which then affects the problem of drug users.

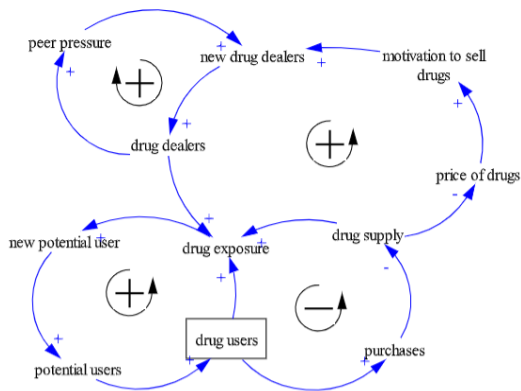


Fig. 2. Causal Loop Diagram

Stock Flow Diagram

Greater insights were achieved in the stock-flow diagram while further strengthening the knowledge obtained from the causal loop diagram. This stock-flow diagram is illustrated in **Figure 3** wherein the flow rates can be better observed as to how it affects the problem variable, being the drug users in public.

It was observed when evaluating the loops that the major loops were categorized based on two main functions regarding: the effect of drugs towards an individual and the effect of drugs towards society, these are presented in **Table 1** to show the categories and subcategories that act as steps towards drug addiction.. The key difference between the two would be the length of time for each cycle as there is a shorter turnaround time for individual effects such as fatigue from the psychological effects. As such, these loops could immediately cause an individual to remain addicted to drugs as a result of the hidden side effects that it can

pose. Meanwhile, the effects on society showed how the cycle can span through different institutions in the system such as the legal department, enforcement, imprisonment, etc. Rather than focusing on individuals, the larger loops considered drug supply through drug distributors who maintain and manage the exposure of drugs to the susceptible population. The societal effects can take a considerable amount of time as it explains how current drug users can influence new adopters in future generations.

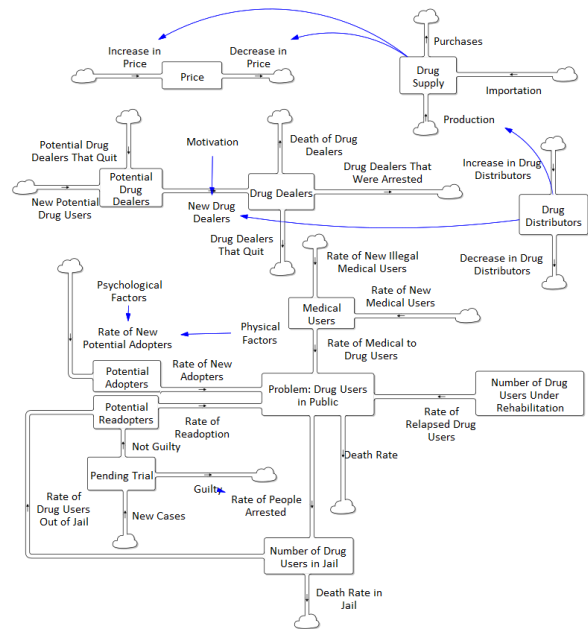


Fig. 3. Stock Flow Diagram

The first set of loops correspond to the main effects of drug use, mainly: physical change, psychological change, and drug exposure. An increase in any of these major variables would result in increasing the likelihood that an individual remains dependent on drugs. The associated risks of drug use are thus capable of increasing further drug use.

The second set of loops would mainly correspond to the factors of potential drug dealers who are able to manipulate and distribute drugs to different people. As such, they were identified to be valuable and key contributors towards the problem of drug use. The key motivations which can influence drug distributors

included: ease of work, thrill, need for money, and peer pressure. An increase in one of these variables would result in an influx of drug supply and subsequent increase in exposure for the susceptible population.

It is also interesting to note that the reliance of the government in placing drug dependent users can become a double-edged sword. Specifically, it succeeds in reducing the current number of drug users in public, however, fails to account for the unintended consequences of these actions. The future generation who were born into families which have relatives or parents in jail have a greater likelihood of falling into drugs themselves.

Table. 1. Factors Affecting Potential Adopters and Potential Drug Dealers

Factors Affecting Potential Adopters	Factors Affecting Potential Drug Dealers
<i>Physical Change</i>	<i>Motivation Due to Ease of Work</i>
1.1 Illnesses Adopted From Drug Use	1.1 Ease of Work
a. Health Care Costs	a. Availability of Customers
b. Financial Situation	b. Drug Supply
c. Educational Attainment	<i>Motivation to Thrill</i>
<i>Psychological Change</i>	2.1 Opportunities For Selling
2.1 Academic Performance	a. Availability of Customers/Drug Supply
2.2 Adoption of Mental Illnesses	2.2 Risk of Arrest
2.3 Work Productivity	a. Number of Police
a. Occupation Stability	b. Cost Allocation Per Capita
b. Financial Situation	<i>Motivation Due to Need For Money</i>
c. Educational Attainment	3.1 Price
d. Awareness on Drug Use	a. Drug Supply
<i>Drug Exposure</i>	b. Production/Imp
3.1 Social Peer Pressure	<i>Motivation Due to Peer Pressure</i>
	4.1 Drug Dealers
	a. New Drug Dealers

Base Run

When simulating the model, ideally the graph representing the number of drug users should mimic as close as possible to the statistics obtained by the DDB. This ensures that the relevant variables have been considered which contribute to the real world problem.

The positive feedback loops reinforced the current trends as the increased exposure was reinforced. However, at a certain point, the supply would reduce and slow down the exposure of new drug users. The slowing down action due to the negative feedback loop and availability of supply will be reinforced and shown with the declining number of drug users and subsequent increase in prices due to inadequate supply. In time, supply is replenished and the prices stabilize and become more affordable to the drug

users. This is shown in the trough of the data set indicating a possible rebound.

As observed from the graph in **Figure 4**, it appears that the current trend of the problem would continue through the year 2040 despite the positive recent trends wherein it appears that it is being controlled. The extended simulation beyond the last available data shows a change in direction as the positive feedback loops will sustain this positive trend. Notably, in-depth analysis conducted showed that there is a large accumulation of drug users in jail which would then have an impact towards the future generation of possible drug users. Having observed this, it suggests that the problem may persist even towards the future.

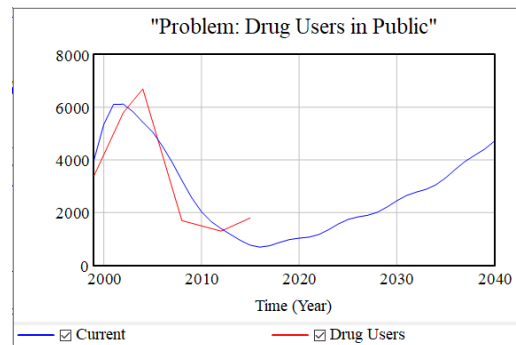


Fig. 4. Simulated Behavior of Drug Users in Public

Sensitivity Analysis

To determine the ways in which the problem can be controlled, a sensitivity analysis was necessary which outlines the possible changes that could be made on the variables. Notably, changing individual variables provided little effect on the overall problem. However, among the variables chosen, many of the variables correlated to the drug supply such as importation laws, drug exposure and availability of customers. On the other hand, the multiple variable analysis showed improved changes towards controlling the problem, however, it still yielded rather undesirable results. Again similar variables towards drug supply appeared to have the greatest effect.

When simulating the current efforts of the Duterte administration mainly towards drug supply and awareness, it showed in **Figure 5** that there were slight improvements, however, the general trend of the graph

still remains undesirable. Rather than improving the behavior, the current solutions were able to delay the growth of the problem in terms of number of drug users.

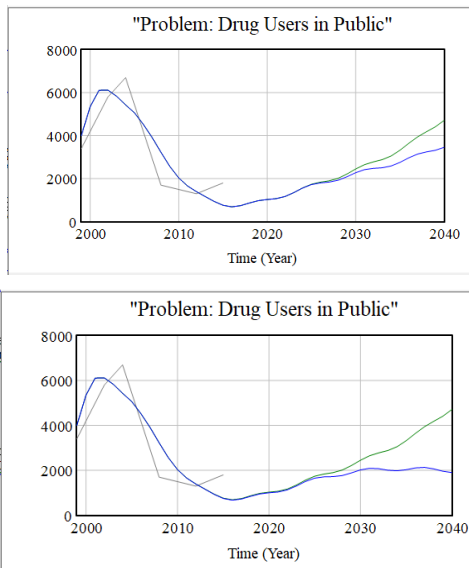


Fig. 5. Failed Solutions (Drug Supply: top, Awareness: bottom)

(Gray- Reference; Blue- Solution; Green- Base Run)

The phenomenon behind the failure of the government towards the problem can be explained by their overreliance towards immediately reducing the number of drug users in public rather than observing the system holistically. Though they are able to momentarily reduce the drug users, they do not tackle the risk factors such as family influence, education, poverty, etc. which increases the risk of adoption for the future generation. Due to this three different solutions were proposed: education, rehabilitation, and reintegration which aimed to address the shortcomings of the government.

It appeared that the solution providing proper rehabilitation to drug dependent users rather than placing them in jail proved most effective as observed in **Figure 6**. The results of the simulation showed that initially the problem was worse as compared to the original results, however, by the year 2027 the system returned into an equilibrium. This proposed solution proved effective since it ensured that there was a lower chance of relapsing, an increase in integration/influence from family, and education on prevention techniques which all contribute towards helping the future. It is also

somewhat contradictory to the punitive measures the government emphasizes as providing treatment rather than imprisonment of these dependent users.

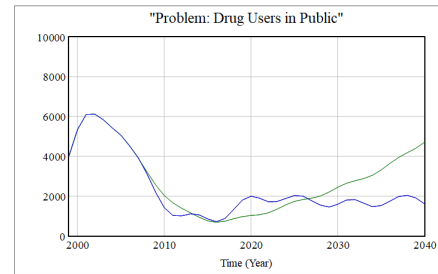


Fig. 6. Simulated Solution of Drug Users in Public

4. CONCLUSIONS

The system dynamics approach was utilized to provide a different perspective on the drug problem. A good solution must address the feedback loops that reinforce the problem and should compose of a set of simultaneous preventive and corrective measures. As such, singular efforts can address only a part of the large system while allowing other parts to still reinforce the problem. In other cases, unintended consequences such as reducing supply or imprisonment can encourage new dealers or increase the susceptible future respectively. It is advised that rehabilitation of drug users be prioritized as it focuses on the unintended consequences.

In some ways, the drug usage problem is structurally similar to the COVID pandemic. Exposure is the key variable that reinforces contamination and spread of the disease. As the number of COVID patients increase, the available vaccines, medicine and hospital facilities decrease, exposure increases and the number of cases increase. (Note, however, that the effect of supply is positive in the COVID problem instead of negative in the drug problem). In addition, as the price of medicine increases with inadequate supply, exposure increases due to the lack of safety equipment. In fact the COVID model is worse because it does not have a controlling loop as all loops are positive and reinforcing.

Areas for further studies focus on improving the model with the addition of variables and loops that may not be present in this study. The complexity of the system makes it vulnerable to these improvements since there may be more pressing issues that can better control the drug trade in the Philippines.

5. REFERENCES

- Dangerous Drugs Board (DDB). (2018). Philippine anti-illegal drugs strategy. Retrieved on November 4, 2021 from https://www.ddb.gov.ph/images/downloads/Revised_PADS_as_of_Nov_9_2018.pdf
- Esplanada, J.E. (2012). UN drug report: Philippines has highest rate of shabu use in East Asia. Retrieved on November 13, 2021 from <https://newsinfo.inquirer.net/168143/un-drug-report-philippines-has-highest-rate-of-shabu-use-in-east-asia>
- Ranada, P. (2017). Is Duterte's '4 million drug addicts' a 'real number'? *Rappler*. Retrieved on November 14, 2021 from <https://r3.rappler.com/rappler-blogs/169009-duterte-drug-addicts-real-number>
- Rappler. (2017). *Official Estimates of Drug Users Nationwide* [Graph].
- Simbulan, N., Estacio, L., Dioquino-Maligaso, C., Herbosa, T., & Withers, M. (2019). The Manila Declaration on the Drug Problem in the Philippines. *Annals of Global Health*, 85(1). <https://doi.org/10.5334/aogh.28>
- UNODC (1998). Twentieth special session of the General Assembly. Retrieved on November 13, 2021 from https://www.unodc.org/unodc/en/commissions/CND/Political_Declarations/Political-Declarations_1998-Declaration.html