Determining Statistical Pattern on the Drug-Related Killing in Philippines Using ARIMA and Poisson Techniques

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Abstract

A univariate time series technique was conducted to determine statistical pattern on killings of drug suspects in Philippines from May 19 to July 7, 2016. The technique reveal a moving-average of order 2, MA(2) with a positive coefficient suggestive that value of outcome variable x tend to increase, on the average, than the recent value of x. This means that drug-related killings will tend to be higher than the most current rate; and killings is seen to increase as weekend comes. Poisson regression indicated an average of 13 deaths on a Sunday; only 2 on Monday average; odds of survival increases as well as weekend comes.

Finally, the forecast model and the simulation are limited by the data used. Structure of the univariate series may change as additional data are added; this is also true for the forecasted average occurrence.

Keywords: drug violence, influence, government

INTRODUCTION

Philippines drugs problem had evolved to become a narco-political concern, from a crime problem to a national security (Blumenfeld, 2010) a nathad been observed to be evolving to include narco-politics. A multi-billion worth of illegal drugs was seized by drug enforcement agency revealing the depth of involvement of government employees, police personnel and local politicians in the drug trade (Xinhua News Agency, 2013) as violence in the country have been associated with illegal drug use as evidenced by a shooting rampage killing 8 people in Cavite (Xinhua News Agency, 2013) making Philippines' drug problem as second worst in Asia (BusinessWorld, 1999). Young delinquents are not an exemption to this (Kirschbaum et al., 2013)

Series of drug-related raids and buy bust operations were conducted by the Philippine National Police on drugs suspects with suspects ending up dead after Duterte became President of the Philippines. Duterte claim to power to be the 16th President of the Republic of the Philippines on May 2016 on the platform of eliminating crime, illegal drugs in 3 to 6 months. Before formally assuming the post, he told the public to go after the drug traffickers. Hence then, reports of drug suspects being killed occur almost daily.

On July 5, 2016 a report of a national broadsheet carried the banner "Drug killings alarm the Palace" in response to the spike in drug killings across the country. Ordinarily, it may seem as human rights violations, but some experts pointed out alongside these is the government's effort in firming up its democratic processes (O'Neil, 2009).

Philippines war on drugs is a re-staging of the 2005 Mexican war on drugs in some scale where drug suspects ended up dead, drug lords continuing drug operations from within maximum security prisons (Freeman, 2006) and police (ccnphilippines.com)and public officials themselves involved in drug operations (http://www.philstar.com). The high degree of drug personalities' influence only reveals the weakness of the state in a developing country. Vellinga (2005) quipped that in the events when social institutions decayed and when government cannot institute constraints to individual behavior, illegal activities relating to drugs escalate; it is the lack of ability of the institutions that facilitate the spread of illegal drugs trade rather than poverty, as Vellinga told.

The drug operations when Duterte became President were found to show successful outcomes. Series of drug raids and buy bust operations were conducted across the country with suspects who allegedly fought the government forces ended up dead. In some instance, a barangay official and a police official were also killed. The killings sent a chilling effect among the drug users, with more than a thousand thronged to the police station or their local officials to surrender: 700 in Quezon City; 400 in Tagum City; 3500 in Negros Island.

On Tuesday, July 5, President Duterte went even further to name five generals who are protecting the drug lords operating in the country. A week before it, a drug lord of Cebu was killed in Las Piñas City believed to keep under wraps the involvement of some top police officials in drug activities in the Philippines. Meantime, anti-drug operations continue all over the country with more activities reported in Calabarzon region, and Quezon City.

Given the quick spike in the deaths of drug personalities, it was the aim of this paper to determine statistical pattern on the reported deaths drug suspects. Likewise, a simulation to determine average occurrence of drug suspects getting killed was conducted.

METHOD

The study relied heavily on the reports from the newspaper. The desk review and compilation of reports was started on May 19 to July 7 of 2016. A reported drug-related death was cross-validated among news agencies. The inquirer.net also produced a kill list which was used heavily in this study.

The reported deaths were then profiled according to day of occurrence, and the personality of the involved person, either as a peddler, a drug lord.

A total of 47 data points was generated. The data set was subjected to univariate timeseries analysis. The aim was to determine trend in the occurrence and the characteristics of the trend. The $ARIMA(p,d,q)$ models were used where p is the number of autoregressive terms, d as the number of nonseasonal differences needed for stationarity, and q denotes the number of lagged forecast errors in the prediction equation.

The study proceeded by determining average occurrence of death over the period of study. On this, the Poisson distribution was used.

Poisson Model

The number of dead pushers, drug-lords had been occurring almost daily making an average of 5 kills in 5 days over the last 30 days. The incidence of deaths of alleged pushers, addicts or in some instance a drug lord is described using Poisson distribution. The incidents of deaths take positive integer, and though there is an impression that killing is happening everyday across the country, drug-related killing is considered as rare events, and such Poisson is an appropriate distribution.

Poisson experiment includes numerical values of a random variable X which is the number of drug-related killing resulting from the pushers or addicts themselves repulsing arrests. A police raid or serving of warrant of arrest resulting to death of the suspect occurring in an

interval can designate a length which could be a day, a week or a month. In the Philippines, drug problem have been a menace since administration of Arroyo, however, drug raids end up police being killed or the drugs being recycled after being rounded up. Long before, police operations barely become successful, and in some instance, policemen involved in operations ended up dead.

The situation has changed upon the rise to presidency of Duterte, the number of raids, X outcomes, where police came out alive and suspected drug lords or pushers either caught or dead have become an occurrence over the last 2 months.

Note, in the formulation of the equation, it is assumed that the number of X outcomes, in this study was the number of drug-related kills after a police raid, occurring in a Poisson experiment is known as Poisson random variable. The probability therefore takes Poisson probability distribution of the Poisson random variable X may take any positive integer, including zero (0). Thus, the distribution takes the form:

$$p(\chi;\upsilon) = \frac{e^{-\upsilon}\upsilon}{x!}, \text{for } x = 0,1,2,3.\ldots, \qquad \text{[eq. 1]}$$

Where μ is the average number of dead pusher occurring within the day from May 19 to July 7 of 2016. Employing regression technique in a Poisson distribution would take a logarithmic function of the predictor variables. The predictor variables in the study are the type of day the raid resulting to death of pusher or drug lord occurred, and the type of suspect killed, a pusher or a drug lord. For the purpose of consistency, the outcome variable used in the study is the number of dead illegal drugs suspect. The data were taken from the newspapers, primarily relying on the list provided by the inquirer.net and many national broadsheets.

Hence, the regression equation takes the form

$$\log(X) = \beta_0 + \beta_1 day_n + \beta_2 suspect_n + \varepsilon_n \qquad \text{[eq.2]}$$

or in the form

$$X = (e^{\beta_o})(e^{\beta_1 day_1})(e^{\beta_1 suspect_1}) \qquad \text{[eq.3]}$$

Poisson regression model takes the logarithmic outcome as a linear function given the set of predictors. Moreover, Poisson regression includes logarithm of the outcome variable X as changing linearly at an increase proportionate with the increase in explanatory variables. This means that the changes in the number of dead illegal drugs suspects along with the combined effects of the predictors are multiplicative in nature. At each level of the covariates, the number of dead suspects has variance equal to the average value and that the incidents are independent from each other.

Goodness-of-Fit Statistic

The Poisson regression employed the Pearson chi-square is given as $X^2 = \sum_{i=1}^{r} X_i^2$.

The Pearson chi-square is employed to estimate the scale parameter which normally takes value of 1 in a Poisson regression also this is used to obtain a more robust significance values.

RESULTS

The Duterte administration had been noted to stand up to its promise of eradicating the drug problem of the country in 3 to 6 months. Before being sworn in to become the 16th President of the Philippine Republic, massive crackdown against drug personalities were made by the Philippine National Police under the leadership of General Dela Rosa.

By count, a total of 184 suspected drug pushers and drug lords were killed in encounters in different areas of the country, or an average of 4 drug suspect being killed over that last two months. Highest incidence of drug-related killings occurred on July 3, a Sunday, with 19 dead in Manila, Quezon City, Quiapo, Tondo, Bulacan, Surigao, Bohol, Caloocan, Davao City and Negros Oriental. Two days before, 26 drug suspects were killed on July 1 & 2, thus in three days alone, a total of 45 drug-related deaths happened.

Not that the killings only involved small fry, on June 17, a drug lord known as Jaguar in Cebu was killed in Las Piñas after fighting out with the policemen (Espina, 2016). Jaguar was killed with his bodyguard, analyst were saying that Jaguar was betrayed by Barok, another drug lord in exchange for the latter's life. Barok surrendered in Bohol few days after.

Given the incidents of killing of drug-related suspects, a statistical pattern was sought out to reveal whether the incidents have precedence. If a statistical pattern is observed, that is, if occurrences of killing of drug suspects are auto-correlated, there is a suspicion that the victims were silenced to death, otherwise, the police were just serving their long-overdue work of putting to jail if not neutralizing drug syndicates.

Graphically, the incidents of dead drug suspects reveal a pattern.

Seasonality was observed. A spike was observed in an almost regular occurrence; every other day. Highest incidence was observed on May 28 (17 deaths), June 22 (15 deaths) and on July 3 (19 deaths) when a suspected drug lord was also killed.

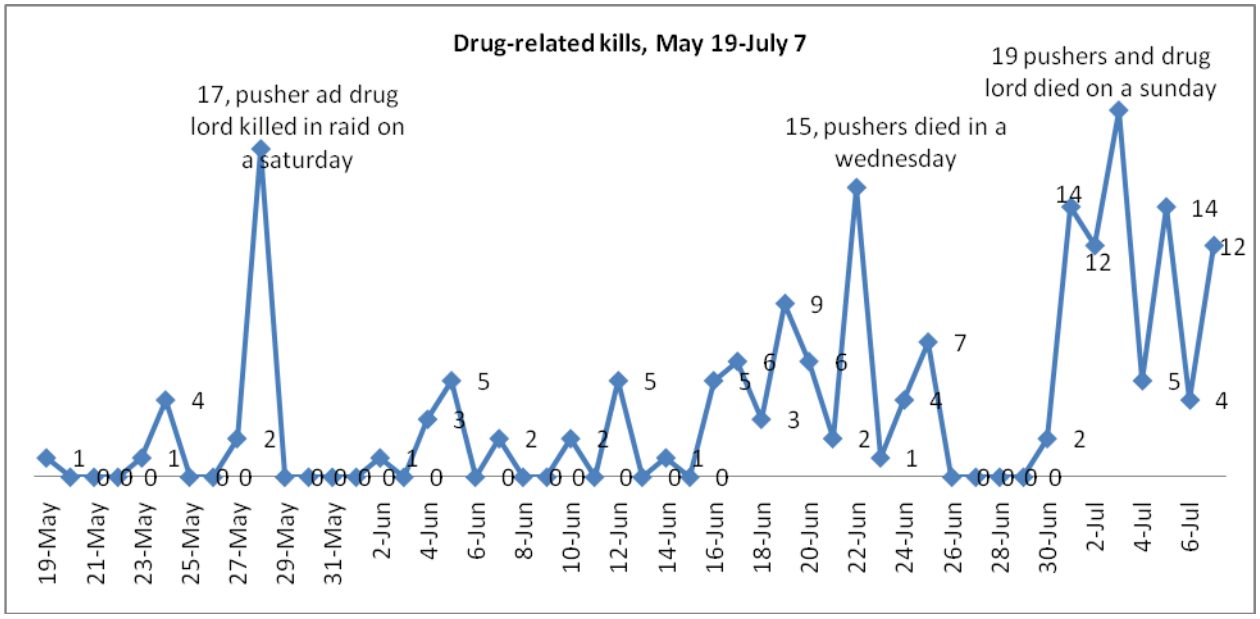

Fig 1. Incidents of drug-related deaths, May 19-July 7, 2016

Hence, the optical scanning using ACF and PACF for the graph of the series was implemented. A spike was found to occur on lag 2 showing statistical significance, while all other lags fall within the rejection level. The finding lead to suspicion that the series is non-stationary that time series testing would provide spurious analysis.

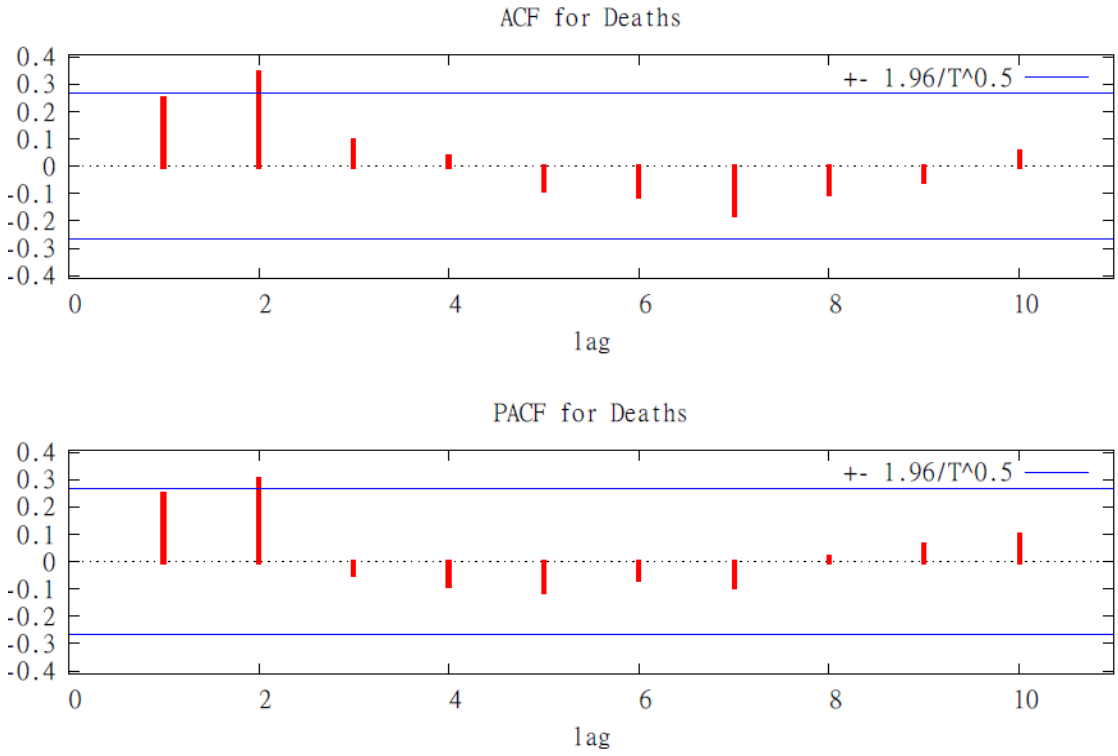

Fig 2. Auto-correlation and Partial Auto-correlation to determine type of series

There is the need for testing for unit root because regression results would all be fabricated when non-stationary series with unit root (Mushtaq, 2011). The Augmented-Dickey Fuller (ADF) test in determining presence of unit root was used, this along with the determination of the lag structure (Harris, 1992)

The data for drug-related deaths were found to be significant on with constant but not with the constant and trend and on mix process. Thereby, a unit root was detected which is suggestive that the data is non-stationary. Given that the series is not stationary, any further timeseries testing will only lead to spurious or fabricated regression coefficients. To address non-stationarity of the series, first differences was computed to model the differenced series (Dickey & Pantula, 1987; Dickey, Hasza & Fuller, 1984). After first differencing, the series became stationary.

Table 1
Testing for unit root

Random Walk	with constant and trend	Mix process

significant	not significant	not significant

Henceforth, the stationary series was analyzed to develop a univariate model from identification, estimation and checking (Ong, Huang & Tang, 2005). The model fitting allows understanding the data to predict future. The ARIMA models takes the parameters of (p, d, q) where p denotes autoregressive order, d is for the order of differencing, and q denoting order of moving averages (Spanos, 1990).

Series of univariate testing for model building indicate that a moving average of order 2 model, MA(2) is a better fit for the univariate series compared to the rest of the models of the ARIMA family. The choice was based on the power and goodness of fit of the model as indicated by the criteria like the log-likelihood, Schwarz & Akaike criteria. The rule is to observe a decaying value of the mentioned criteria, then compare the statistical power of the coefficients. An MA(2) model implies that the outcome value is linearly influenced by the previous stochastic term and on a stochastic term. Simply stating that the current value of x_t and all previous values are apart from the current value of the outcome variable x. Moreover, a positive value of the coefficient theta (θ) suggests a positive adjacent value of the variable x_t,which means that an above average will tend to be followed by a higher above average value. This means that there is an expected increase in the number of drug-related killings in the coming period.

Table 2
ARIMA family simulation to characterize timeseries

Coefficient	AR(1)	AR(2)	MA(1)	MA(2)	AR(1)I(1)MA(1)
Constant	0.678114	0.731627**	0.714284**	0.802573***	0.775127***
phi (1)	-0.74104***	-0.992706***			-0.421223***
phi(2)		-0.389206**			
theta(1)			-0.9999**	-1.35830 ***	-0.9999**
theta(2)			0.521122	0.521122**	
Log-likelihood	-150.5306	-148.1831	-148.0909	-144.6893	-144.9142
Schwarz Criterion	312.6117	311.7669	307.7323	304.7791	305.2290
Akaike Criterion	307.0612	304.3663	302.1818	297.3785	297.8284

Note however, there is predicted regularity of the process of smoothing of a Moving Average model, and a positive sign of the coefficient points to higher than the previous average

of the current value of the x, in this study, the number of drug-related deaths: trend has it that a drug raid on a weekend would end up more dead, and the incidence is expected to be higher than the previous value.

This could be attributed to the information and profiling of the activities of the drug suspects. A pattern was detected pointing to the condition that the drug suspects were already known, their movement and their locations. However, over some time, these people were beyond the reach of a successful raid, leaving the police to merely profile them. In effect, the police force able to develop deep familiarity with the suspects. When the time was ripe, that is, the current administration provided the blanket authority to go against the drug suspects through the declaration of President Duterte, going after the suspects were no beyond troubles.

It was coming like the list was just followed, and the order of serving a warrant followed regularity in terms of schedule.

Moreover, a count data analysis using Poisson regression was employed. The empirical testing revealed that the day of killing and the type of suspect (a drug lord or a peddler) were found to be statistically significant. The day killed which takes nominal value with 1 representing a Monday to 7 as Sunday obtained a positive coefficient of 0.0998 found to be statistically significant at 0.05, likewise the type of suspect being killed indicate statistical significance as indicated in the following table.

On this note, a simulation to obtain average occurrence using predictor variables was conducted.

Table 3
Poisson analysis of drug-related deaths resulting from police drug raids

	Coefficient	*Std. Error*	*z*	*p-value*	
const	-0.0826624	0.222616	-0.3713	0.71040	
day	0.0998951	0.0396577	2.5189	0.01177	**
killed	0.621859	0.0562116	11.0628	<0.00001	***

Mean dependent var	3.442308	S.D. dependent var	5.077492
Sum squared resid	907.4534	S.E. of regression	4.303424
McFadden R-squared	0.318886	Adjusted R-squared	0.305131
Log-likelihood	-148.5555	Akaike criterion	303.1110
Schwarz criterion	308.9647	Hannan-Quinn	305.3552

Overdispersion test: Chi-square(1) = 20.8496; p-value=0.0000

Table below provided the simulation by day and the average occurrence and the odds of survival of the suspect. The odds of survival are the degree of success on the part of the suspect to elude being killed on a simulated day. The multiplicative property of the Poisson regression was employed here.

It was noted that the average drug-related death on a Sunday is 13 with odds of survival 7 times less likely to survive. Killings reduced on a Monday with suspects experiencing better chances of survival given odds of 11%. However, average killings on the proceeding day would increase by two along with increasing odds of survival of the pushers. Fridays average drug-related death is simulated at 9 incidents with 4 times less likely to survive. Average death increases to 11 on a Saturday at much higher odds of surviving.

Notably, drug-related deaths due to police operations seemed to increase on a weekend than on any other days. This perhaps may be attributed to the familiarity of the police operatives of the activities of the suspects. The raids usually occur at the communities of the drug suspects, perhaps, selling of drugs occur. Suspects might have used their homes as staging ground for the drug sessions where paraphernalias are prepared. In addition, the drug pushers themselves may have been relying heavily on the security system provided to them by their friends and their neighbors (Sales, 2009) who may have assented to the activities given that there is nothing that could be done against it.

Meantime the police may have decided to conduct the raids on a weekend, usually on the wee hours where pot sessions are happening, as dictated by the profiling of the suspects that they do.

Tale 4
Simulation of drug raids resulting to death of pushers

simulation	constant -0.0826624	day 0.0998951	killed 0.621859	average	odds of survival
Sunday	0.92	7.74	1.86	13	6.74
Monday	0.92	1.11	1.86	2	0.11
Tuesday	0.92	2.21	1.86	4	1.21
Wednesday	0.92	3.32	1.86	6	2.32
Thursday	0.92	4.42	1.86	8	3.42
Friday	0.92	5.53	1.86	9	4.53
Saturday	0.92	6.63	1.86	11	5.63

CONCLUSION

Given the empirical results, the drug-related deaths occurring on a daily basis showed an MA(2) of univariate timeseries model with a positive value of the coefficient which means that the expected average will tend to increase for the next value of outcome variable x_t. This means that more drug-related deaths in the coming days at an increasing rate than the recent number. This will continue unless the suspected drug personalities themselves turn themselves in to the police or to the officials of the barangays.

Meantime, average drug-related kills range from 2 to 13, with lowest incidence occurring on a Monday and continue to increase as weekend approaches. Note, odds of survival for the drugs suspects also increase. The recorded deaths points to the consternation that the drug-related deaths are not ordinary erratic incidents.

Thus, the drug war was effectively carried by the Philippine government through its principal instrument which is the Philippine Police. Taking that suppliers of drugs are either killed, police officers and public officials with alleged links to drugs publicly named, and drug users turning themselves in, drug menace is expected to reduce in not totally eradicated within the term of Duterte administration.

Moreover, the data used in the analysis should not be used to justify the killings of the suspects for the crimes they have committed. Instead, the study opens the perspectives on the reach and complexity of the drug problems, if and only if, all of the reported dead individuals were truly killed due to their involvement with drugs.

Taken altogether, it can be inferred that the police force is taking the upper hand in its war against drugs, and in effect in subscription to the campaign promises of Duterte to get rid of the crime in three to six months. The three to six months target is achieved if the volume of Philippine index crimes are associated with illegal drugs.

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