Effect of enforcement operations during festive seasons called Ops Sikap on road traffic accidents of Malaysia

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Abstract. The road safety statistics have shown a remarkable increase in number of injuries during the festive seasons in Malaysia. To anticipate the burden of the injuries, the police has carried out an advanced enforcement operations called “Ops Sikap” since 2001. Evaluations on the effectiveness of the operations are, however, found inconclusive. This study employed ARIMA and intervention model to further evaluate the effect of the Ops Sikap. The effect of an intervention on the number of accidents is measured using the pulse function. ARIMA model is used to forecast the series without such intervention and become the basis for the ARIMA(p,d,q) process of the intervention model. Forecasted accidents from the intervention model are then compared with the ARIMA one to attain how far the effect. The results show that the operations have reduced the number of accidents in many years. Out of twenty five Ops Sikap carried out, fourteen times (56%) have successfully brought the accidents down. The operations have provided the reduction of the monthly accidents up to 0.7% as compared with the accidents if there were no such operations taken.

1. Introduction
Malaysia targeted to have the rate of road traffic fatalities of 2.0 per 10,000 vehicle registrations. To achieve the rate, the government implements various strategies, interventions and safety measures. The rules relating to traffic safety have been imposed since the early 1970s. As such, the 1973 Motorcycles (Safety Helmet) Rules, the 1978 Motor Vehicles (Seat belt) Rules, Road Transport Act 1987, and the 1989 Motor Vehicles (Speed Limit) Rules. Besides the rules, the authorities released the standards for vehicle safety, technical guidelines for road safety, launched the national road safety plans and programmes. The government has formed the agencies to manage the road safety programmes of the country as well. The country has also joined the Decade of Action for Road Safety 2011–2020 initiated by the United Nations.

The enactment of the rules and regulations are, however, not promptly reduce the number of injuries in Malaysia. Even, the trend of fatalities continues to increase over the years. The rates of fatalities per vehicle registrations, however, continue to decline. The remarkable decline (8.9%) on the number of fatalities occurred in the period 1997–1998 [1, 2]. This may be owing to the effects of the National Road Safety Plan launched in 1996 that consists of various strategies and efforts, including the more intense campaigns and enforcements to improve the road safety. Nevertheless, another explanation can also be related to the major decline i.e. the financial crisis occurred in 1997–1998. It is believed that traffic exposure to the risk on the roads decreased at that time due to the substantial reduction (6.7%) of the road sector energy consumption in the period 1997–1998. This indicates that more efforts to improve the safety are still required.

The government may realise that with the less intense campaigns and enforcements, the rules and regulations shall not provide a remarkable improvement on road safety. Many studies also have shown
that enforcement is essential. For instance, the use of speed camera shall reduce the injuries and efficient [3-6]. Thus, in the recent years, the more intense safety campaigns and followed by enforcements have been conducted. Moreover, the road safety statistics have shown that higher number of injuries occurs during the festive seasons, specifically during the holydays for the *Eid* festival, the Chinese New Year (CNY) and the Deepavali respectively. To anticipate the burden of the injuries during the festive seasons, the road safety enforcement operations called “Ops Sikap” has been taken by the Royal Malaysian Police (PDRM) since 2001. The operation is intended to increase the compliance on the road traffic safety rules and regulations. Later, some other government agencies as such the Road Transport Department (JPJ), the Public Works Department (JKR) and the Road Safety Department (JKJR) joined the enforcement operations in accordance with their responsibility. This integrated operations aim to intensify the enforcement during the festive seasons and called “Ops Bersepadu” and have been taken place since 2006. The police conducted the *Ops Sikap* until the early 2012 and since the mid 2012 onwards they named the operations as “Ops Selamat.”

The police claimed that the enforcement operations has generally provided the better road safety situations during the festive seasons over the years, especially in reducing the injuries. Several studies have also been conducted to evaluate the effectiveness of the enforcement operations, especially under the Malaysian Institute of Road Safety Research (MIROS) [7-10]. The study by Jamilah et al. [10] urged that enforcement activities should be improved in the future to further reduce the number of crashes and fatalities in the country. Another study by Yaacob, Husin, Abd. Aziz, and Nordin [11] revealed that out of fifteen Ops Sikap implemented (for the period 2001–2007), only Ops Sikap II conducted in February 2002, VI (January & February 2003), XIII (January 2004), XII (October 2006) and XIV (October & November 2007) show a reduction in the number of road accidents occurrence though the reduction is not statistically significant.

We undertook this study to further evaluate the effect of the Ops Sikap as there are various conclusions and opinions on the achievement of the enforcement operations. The more monthly accidents data are used i.e. from January 1998 to January 2012. So, the impact of the twenty five Ops Sikap on the number of accidents are made possible to be analysed.

2. Materials and methods
2.1 Data
This study prefers to analyse the impact of the enforcement operations on the number of fatalities. The unavailability of the data, however, become the limitation. In Malaysia, the road traffic safety related data are collected, recorded and published by the PDRM. At the moment, only number of accidents are published in monthly basis, the rest types of injuries are provided annually. Hence, the series of the monthly number of accidents are used in the analysis. Other data that are needed to know are the months when the enforcement operations conducted. Figure 1 shows the series of the accidents and the months when the Ops Sikap were carried out.

2.2 Methods to attain the impact of an intervention
In general, there are two patterns of the intervention effect i.e. step and pulse function. The step function represents an intervention occurring at time T that remains in effect thereafter. Whilst, the pulse function represents an intervention taking place at only one time period [12]. On the basis of the time plot graph (Figure 1), the pulse function is appropriate to be used to attain the impact of the safety operations on the number of accidents. Therefore, the effect of an intervention on the number of accidents is measured using the pulse function of the intervention model. This model is the combination of the intervention function and the noise process. Hence, the autoregressive integrated moving average (ARIMA) model for the series is developed first. This model is also used to forecast the series without such intervention and become the basis for the ARIMA (p, d, q) process of the intervention model. Forecasted accidents from the intervention model are then compared with the ARIMA one to attain how far the effect.
2.3 ARIMA model
A combination of the autoregressive and moving average models is called the ARMA model. Typically, this model is denoted by ARMA \((p, q)\), where \(p\) is the order of the autoregressive part and \(q\) is the order of the moving average part. An ARMA \((p, q)\) model has the general form as follows [13, 14].

\[
Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + \epsilon_t - \omega_1 \epsilon_{t-1} - \omega_2 \epsilon_{t-2} - \cdots - \omega_q \epsilon_{t-q}
\]

where

- \(Y_t\) = response (dependent) variable at time \(t\)
- \(Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}\) = response variable at time lags \(t-1, t-2, \ldots, t-p\) respectively. These \(Y\)'s play the role of independent variables.
- \(\phi_0, \phi_1, \phi_2, \ldots, \phi_p\) = coefficients to be estimated
- \(\omega_1, \omega_2, \ldots, \omega_q\) = error term at time \(t\) that represents the effects of variables not explained by the model. The assumptions about the error term are the same as those for the standard regression model
- \(\epsilon_t, \epsilon_{t-1}, \epsilon_{t-2}, \ldots, \epsilon_{t-q}\) = errors in previous time periods that, at the time are incorporated in the response \(Y\).

Time series needs to be stationary (white noise) to apply the ARMA \((p, q)\) models. When \(q = 0\), the model change to a pure autoregressive model of order \(p\) (ARMA \((p, 0)\)). Similarly, when \(p = 0\), the model change to a pure moving average model of order \(p\) (ARMA \((p, 0)\)). An ARMA \((p, q)\) model forecasts will depend on current and past values of the response \(Y\) as well as current and past values of the errors (residuals). The orders \(p\) and \(q\) in an ARMA model are determined from the patterns of the sample autocorrelation function (ACF) and partial autocorrelation function (PACF). For an AR\((p)\) model, the pattern of the ACF is die out and PACF is cut off after the order \(p\) of the process. Whilst for an MA\((q)\) model, the ACF pattern shows a cut off after the order \(q\) of the process and PACF shows a die out pattern. If both ACF and PACF show the die out pattern, the model is an ARMA \((p, q)\) model.

The steps in Box-Jenkins (ARIMA) approach consist of initial model identification, coefficient estimation, and model checking (residuals analysis). Usually, an iterative process is conducted until the model residuals indicate no further modification is necessary. Then, the fitted model can be used for forecasting.

2.4 Model identification
As the time series data should be stationary i.e. appears to vary about a fixed level, the first task taken is to determine whether the series is stationary. The plot of the series along with the sample ACF and
PACF may be used to check whether the time series is stationary or not. A nonstationary time series is indicated if the series appears to grow or decline over time and the sample autocorrelations fail to die out rapidly. Many time series are not stationary, but they can be converted to a stationary series. Typically, the Box-Cox transformation followed by a differencing technique are employed. Thus, the original series is replaced by a series of differences. An ARMA \((p, q)\) model is then defined for the differenced series and this is called ARIMA\((p, d, q)\) model. Consequently, modeling changes are taken rather than modeling the levels.

The original time series with order \(p = 1\) and \(q = 1\) has the following form.

\[
Y_t - Y_{t-1} = \phi_1(Y_{t-1} - Y_{t-2}) + \varepsilon_t - \omega_1\varepsilon_{t-1}
\]  

If \(Y_t - Y_{t-1} = \Delta Y_t\) and \(Y_{t-1} - Y_{t-2} = \Delta Y_{t-1}\), thus the equation above can be written

\[
\Delta Y_t = \phi_1\Delta Y_{t-1} + \varepsilon_t - \omega_1\varepsilon_{t-1}
\]  

Sometimes the first differencing is not adequate to provide the stationary data. Subsequently, the second differencing is conducted. This process can be achieved through the following equation

\[
\Delta^2 Y_t = \Delta(\Delta Y_t) = \Delta(Y_{t-1} - Y_{t-2}) = Y_t - 2Y_{t-1} + Y_{t-2}
\]  

The level of differencing given i.e. 1, 2 … to achieve stationarity is denoted by \(d\). The differencing technique, however, aims to transfer the series to be stationary.Forecasts for the original series can always be computed directly from the fitted model.

After the stationary time series attained, the next tasks are to compute and plot the ACF and PACF. This is to compare the ACF and PACF computed from the data to the theoretical ACF and PACF for the various ARIMA models. Various theoretical correlations for some of the more common ARIMA models can be referred from literatures as the guidance. To simply the process, usually, both the sample ACF and PACF are compared with \(\pm 2/\sqrt{n}\), where \(n\) is the number of observations in the time series. From these tasks the tentative ARIMA models are attained. The judgment on which model is adequate will be done in the next steps as some measurements need to be conducted. Nevertheless, it was kept in mind that simple models are preferred to complex models (the principle of parsimony).

2.5 Model estimation

The first task in this part is to estimate the coefficients (parameters) of the tentative models. This can be done through minimising the sum of squares of the fitting errors. The least squares or maximum likelihood technique is used to specify the parameters to be estimated. Once the parameters and their standard errors are determined, the t-value of each parameter can be constructed and interpreted. Parameters that are significantly different from zero (\(p\)-value < 0.05) are included in the fitted model. Conversely, parameters that are not significant are excluded from the model.

2.6 Model checking

The model should be checked for its adequacy before using for forecasting. The adequate model is obtained when the residuals cannot be used to improve the forecasts. Thus, the residuals should be random. Some criteria in checking the model include: the individual residual autocorrelations \(r_k(e)\) should be small and generally within \(\pm 2/\sqrt{n}\) of zero. The residual autocorrelations as a group should be consistent with those produced by random errors. The checks on adequacy can be done through a Chi-square (X2) test based on the Ljung-Box Q statistic. The residual autocorrelations as a group is examined using this test. The Q statistic is

\[
Q = n(n + 2) \sum_{k=1}^{m} \frac{r_k^2(e)}{n - k}
\]

where \(n\) = the number of residuals
\( k \) = the time lag  
\( m \) = the number of time lags included in the test  
\( r_k(e) \) = sample autocorrelation function of the residuals lagged \( k \) time periods.

It is approximately that the Q statistic distributed as a Chi-square random variable with \( m - r \) degrees of freedom where \( r \) is the total number of parameters estimated in the ARIMA model. If the p-value associated with the Q statistic is small (\( p < 0.01 \) for this study), the model is considered inadequate. A new or modified model need to be developed until a satisfactory model has been determined.

### 2.7 Forecasting with the model

Forecasts are usually made using the satisfactory or might be the one that classified as the best model. Associating the confidence level to determine the upper and lower bound is also useful to see the variation that might be occurred. Ensuring the model is still possible in this step, as such, by monitoring the forecast errors. If the magnitudes of the most recent errors tend to be consistently larger than previous errors, reevaluation of the model is needed. Model correction is also required if the recent forecast errors tend to be consistently positive (underpredicting) or negative (overpredicting).

### 2.8 Box-Cox transformation

Box-Cox transformation is the most commonly used variance-stabilising transformation. This transformation changes the variance of residuals becomes constant. The equation below illustrates the Box-Cox transformation

\[
y = \begin{cases} 
(Y^\lambda - 1) / \lambda, & \lambda \neq 0 \\
\log Y, & \lambda = 0
\end{cases}
\]  

(6)

where \( \lambda \) is the shape parameter and a real number. The \( \lambda \) of 0 means that the suggested transformation is using a logarithmic equation (\( y = \log Y \) or \( \ln Y \)). If the \( \lambda \) equal to -0.5, the \( y = 1/\sqrt{Y} \) transformation is suggested to be used, while the \( y = 1/Y \) transformation is for the \( \lambda \) equal to -0.1, and so forth.

### 2.9 Model selection criteria

Identifying the ARIMA models by examining the plot of the series and matching their sample ACF and PACF patterns is the initial approach. Further analysis is, however, required when selecting the satisfactory model have been developed. The scientists have developed the approaches for selecting the best model. These involve the use of the Akaike information criterion (AIC) and the Schwarz's Bayesian criterion (SBC) respectively. Often, the two criteria to produce the same result. Nevertheless, as the SBC imposes a greater penalty for a number of parameters than in the AIC criterion, the decision based on the minimum SBC will result in a simpler model. Hence, the SBC is employed in this study. The criterion is obtained using the following equation. The second term of the equations is called the penalty factor for including additional parameters in the model. The minimum value of the SBC will show the best model.

\[
BIC = \ln \hat{\sigma}^2 + \frac{\ln n}{n} r
\]  

(7)

where

\( \ln \) = the natural log  
\( \hat{\sigma}^2 \) = the residual sum of squares divided by the number of observations  
\( n \) = the number of observations (residuals)  
\( r \) = the total number of parameters (including the constant term) in the model.
2.10 Intervention analysis with pulse function pattern
The model for the single intervention input with pulse function and the ARIMA \((p, d, q)\) as the noise is given by

\[
Y_t = \mu + \frac{\omega_0(B)}{1 - \delta_1(B)} I_t + \frac{(1 - \theta_q B)}{(1 - \Phi_p B)(1 - B)^d} \alpha_t
\]

where \(\mu\) is the constant mean, while the second part is the intervention function that consist of:

- \(I_t\) is the input time series at time \(t\) and in this study the input is considered as a pulse function that lead to an abrupt and temporary effect.
- \(\omega_0(B)\) is the numerator polynomial of the intervention function for the input series.
- \(\delta_1(B)\) is the denominator polynomial of the intervention function for the input series.

(see e.g. [14-16] for the detailed).

3. Results
The ARIMA and the intervention modeling processes have provided a total of twenty five paired models. This is in accordance with the number of Ops Sikap. Initially, the series of the monthly number of accidents was not stationary. Thus, the pre-whitening process was carried out. The transformation using the equation of \(y = 1/Y\) and the second order of differencing has successfully provided the stationary series. Table 1 shows the parameters of the twenty five ARIMA and the intervention models developed in this study. All the parameters of the models have the \(p\)-value < 0.01, while the Chi-square of the Q statistic at most of lags are greater than 0.01. Thus, all the models developed are white noise series and sufficient for forecasting purposes.

| Ops Sikap | ARIMA models | Intervention models | Ops Sikap | ARIMA models | Intervention models |
|-----------|---------------|---------------------|-----------|---------------|---------------------|
| I         | \(\phi_1 = -0.391\) | \(\omega_0 = 1.662E-7\) | \(\delta_1 = 0.100\) | XIV | \(\phi_2 = -0.379\) | \(\omega_0 = 5.420E-8\) | \(\delta = 0.100\) |
| II        | \(\phi_2 = -0.379\) | \(\omega_0 = 1.339E-7\) | \(\delta_1 = 0.100\) | XV  | \(\phi_2 = -0.373\) | \(\omega_0 = 5.314E-8\) | \(\delta = 0.100\) |
| III       | \(\phi_2 = -0.266\) | \(\omega_0 = 0.122E-7\) | \(\delta_1 = 0.100\) | XVI | \(\phi_2 = -0.380\) | \(\omega_0 = 5.253E-8\) | \(\delta = 0.100\) |
| IV        | \(\phi_2 = -0.366\) | \(\omega_0 = 0.428\) | \(\delta_1 = 0.305\) | XVII | \(\phi_2 = -0.374\) | \(\omega_0 = 4.969E-8\) | \(\delta = 0.100\) |
| V         | \(\phi_2 = -0.411\) | \(\omega_0 = 9.232E-8\) | \(\delta_1 = 0.100\) | XVIII | \(\phi_2 = -0.380\) | \(\omega_0 = 4.938E-8\) | \(\delta = 0.100\) |
| VI        | \(\phi_2 = -0.372\) | \(\omega_0 = 0.412\) | \(\delta_1 = 0.317\) | | \(\phi_2 = -0.365\) | \(\omega_0 = 4.358E-8\) | \(\delta = 0.100\) |
| VII       | \(\phi_2 = -0.381\) | \(\omega_0 = 8.000E-8\) | \(\delta_1 = 0.100\) | XIX | \(\phi_2 = -0.372\) | \(\omega_0 = 4.512E-8\) | \(\delta = 0.100\) |
| VIII      | \(\phi_2 = -0.405\) | \(\omega_0 = 7.526E-8\) | \(\delta_1 = 0.100\) | XX | \(\phi_2 = -0.364\) | \(\omega_0 = 4.352E-8\) | \(\delta = 0.100\) |
| IX        | \(\phi_2 = -0.403\) | \(\omega_0 = 6.874E-8\) | \(\delta_1 = 0.100\) | IM | \(\phi_2 = -0.362\) | \(\omega_0 = 4.169E-8\) | \(\delta = 0.100\) |
| X         | \(\phi_2 = -0.387\) | \(\omega_0 = 6.593E-8\) | \(\delta_1 = 0.100\) | XIX | \(\phi_2 = -0.364\) | \(\omega_0 = 4.000E-8\) | \(\delta = 0.100\) |
| XI        | \(\phi_2 = -0.435\) | \(\omega_0 = 0.379\) | \(\delta_1 = 0.363\) | | \(\phi_2 = -0.367\) | \(\omega_0 = 3.864E-8\) | \(\delta = 0.100\) |
| XII       | \(\phi_2 = -0.384\) | \(\omega_0 = 6.120E-8\) | \(\delta_1 = 0.100\) | XX | \(\phi_2 = -0.363\) | \(\omega_0 = 3.864E-8\) | \(\delta = 0.100\) |
| XIII      | \(\phi_2 = -0.463\) | \(\omega_0 = 5.851E-8\) | \(\delta_1 = 0.100\) | XX | \(\phi_2 = -0.360\) | \(\omega_0 = 3.752E-8\) | \(\delta = 0.100\) |

Note: all the parameters have \(p\)-value \(< 0.01\)
All the models are then used to produce the monthly number of accidents. The forecasted accident based on the ARIMA model is considered as the number of accident without the integrated enforcement of the safety rules and regulations or the “business as usual scenario.” Whilst, the forecasted accident produced by the intervention model is with the intervention (enforcements). In addition, some of the enforcement operations are conducted in days of two subsequent months. This study only measured the impact of the Ops Sikap in the second month when the impact is usually greater. Table 2 shows the forecasted number of accidents from December 2001 to January 2012 in the month when the Ops Sikap was conducted. The difference in the number of accidents between with and without the enforcements are also highlighted in the table to show whether there is a decrease or an increase, respectively.

| Month-Year | Number of accidents | The difference | Ops Sikap |
|------------|---------------------|----------------|----------|
| Dec 2001   | 23370               | 5              | 0.02%    | I        |
| Feb 2002   | 23245               | -140           | -0.60%   | II       |
| Dec 2002   | 24474               | -78            | -0.32%   | III      |
| Feb 2003   | 23753               | 34             | 0.14%    | IV       |
| Dec 2003   | 26731               | -7             | -0.03%   | V        |
| Jan 2004   | 26309               | 7              | 0.03%    | VI       |
| Nov 2004   | 29446               | -207           | -0.70%   | VII      |
| Feb 2005   | 27285               | 30             | 0.11%    | VIII     |
| Nov 2005   | 27563               | 114            | 0.42%    | IX       |
| Feb 2006   | 27174               | 238            | 0.88%    | X        |
| Oct 2006   | 29240               | -94            | -0.32%   | XI       |
| Feb 2007   | 29429               | -26            | -0.09%   | XII      |
| Oct 2007   | 31437               | -118           | -0.38%   | XIII     |
| Nov 2007   | 31368               | -127           | -0.41%   | XIV      |
| Jan 2008   | 29621               | 115            | 0.39%    | XV       |
| Feb 2008   | 31056               | 155            | 0.50%    | XVI      |
| Sep 2008   | 30012               | 81             | 0.27%    | XVII     |
| Oct 2008   | 31797               | -81            | -0.25%   | XVIII    |
| Feb 2009   | 31250               | 39             | 0.13%    | XIX      |
| Oct 2009   | 35075               | -98            | -0.28%   | XX       |
| Feb 2010   | 32268               | 220            | 0.68%    | XXI      |
| Sep 2010   | 35945               | -26            | -0.07%   | XXII     |
| Feb 2011   | 33727               | -34            | -0.10%   | XXIII    |
| Sep 2011   | 38447               | -15            | -0.04%   | XXIV     |
| Jan 2012   | 38314               | -44            | -0.11%   | XXV      |

Note: “-” indicates a decrease and “+” for an increase.

4. Discussion

Since the early years of road safety study, researchers have suggested the three E’s ways i.e. education, enforcement and engineering to improve the safety on the roads. In the review on enforcement effect road safety, Mohan in [4] summarised: (a) Most attempts at enforcing road traffic legislation will not have any lasting effects, either on road user behavior or on crashes unless the enforcement is continuous and widespread. This level of enforcement is expensive and difficult to sustain in most situations. (b) Imposing stricter penalties (in the form of higher fines or longer prison sentences) does not affect road-user behavior significantly and imposing stricter penalties also reduces the level of enforcement. (c) Increased normal, stationary speed enforcement is in most cases cost-effective. Automatic speed enforcement with cameras seems to be even more efficient. (d) There is no evidence proving mobile traffic enforcement with patrol cars is cost-effective.

An enforcement action corresponding to a policy implemented in Korea is believed to have taken place at the policy onset, suggesting an abrupt and instant (i.e. no time delay) effect [17]. More than 70% fatality reduction can be achievable in the U.S. within one decade by intensified enforcement and more appropriate safety device and limit laws [18]. Soole et al. in [5] investigated the impact of police speed enforcement methods on self-reported speeding behavior. Results indicate that marked patrol
vehicles parked on the side of the road were reported as the most effective on freeways (62.7%) and school zones (56.3%), but only somewhat effective on urban roads (49.4%). A literature review by [19] showed that by augmenting the enforcement, meaning more severe penalties and more frequent controls, in most cases the number of traffic accidents and violations will decrease, which will have a positive effect on increasing traffic safety levels.

In this study, the effect of the integrated enforcement operations was examined. Based on the forecasted number of accidents produced by the ARIMA and the intervention models developed, it can be seen that out of twenty five Ops Sikap carried out, fourteen Ops Sikap (56%) have successfully reduced the incidents. Ops Sikap VII that was conducted in November 2004 for the Eid festive has provided the highest reduction of the monthly accidents (0.7%). This is followed by Ops Sikap II in February 2002 that designated for CNY festive (0.6%). Ops Sikap XIV in November 2007 for the Deepavali festive ranked third in reducing the number of accidents (0.4%). Nevertheless, whether the reductions are significant or not, it cannot be provided as the data series used are the absolute number of accidents. Using the paired t-test shall provide a less accurate result since there are other variables that contribute to the change of number of accidents during the festive seasons i.e. the traffic exposure and major modes shift. If the exposure to the risks on the roads, for instance, the vehicle-kilometres travelled during the festive season increase substantially, the reduction forecasted by the models can be considered significant and vice-versa. At the moment, the comprehensive vehicle-kilometres travelled are still developed for the country. The modes shift is also critical as the risk of the modes is not similar from each other. Long distance travels are common during the festive seasons and thus the use of motorcycle decline, whereas this mode of transport is the predominant in Malaysia and considered as unsafe.

Previous studies, as such Abdul Rahmat et al. in [7] looked into the effectiveness of the Ops Bersepadu CNY 2007 in reducing the accident and fatality rates. They specified that for overall fatalities, the daily average death for 15 days before the enforcement operations was 15.1 but dropped to 13.8 during the operations. According to the report, the daily traffic volumes were counted at before and during the festive season on several federal road segments. The locations can be classified as suburban and rural areas. From the traffic data, there were significant increase of the traffic volumes, especially for car daily volumes, but not for motorcycle and lorry. Indeed, the percentage of motorcycles was 25% before the operations, dropping to 22% during the operations. Whilst, in Malaysia, motorcycle fatalities accounted for 60% of the total fatalities. Hence, the decline of fatalities during the enforcement operations may not be owing to the integrated operations, but effect of the lower volumes of motorcycle that lead to lower risk on the roads.

In addition, Mohd Fauzi et al. in [8] have conducted an evaluation on the enforcement operations during the Eid festive in 2007. The study has included the survey on the vehicle-kilometres travelled (vkt) to provide the rate of fatalities per vkt. Although the number of samples may be relatively few, it is a better technique to attain the effectiveness of the operations. They found that the rate of fatalities declined during the festive i.e. from 16.26 to 13.97 billion vkt. The vehicle-kilometres travelled during the festive season was higher about 4%. Nevertheless, they also noticed that the volume of motorcycles dropped about 3.6% during the festive season as compared with the working days just before the festive. Moreover, Jamilah et al. in [10] have further analysed on the Ops Bersepadu and focused on the effectiveness of the operations conducted for Eid festive in 2011. Among the main results, they found that the increase in the total number of accidents during the operations for Eid festive in 2011 is significant when compared to those of the operations for Eid 2010 and 2009. The higher numbers in the total accidents and total fatalities during operations for Eid 2011 are also significant as compared with the operations for CNY 2011. In short, there was a significant increase on the number of accidents during the festive season in 2011 as compared with the festive season of the previous years.

5. Conclusion
The models have shown that integrated enforcement operations called Ops Sikap conducted since in December 2001 have reduced the number of accidents during the festive seasons in many years. Out of twenty five Ops Sikap carried out, fourteen times (56%) have successfully reduced the accidents. The highest achievement was attained during the implementation of Ops Sikap VII that was conducted in November 2004 for the Eid festive. The operations have provided the reduction of the monthly accidents up to 0.7% as compared with the accidents if there were no such operations taken. With the assumption
that there was a substantial increase on the traffic volumes during the festive seasons, the reductions can be classified as significant. The recent Ops Sikap that conducted from 2010 to 2012 also provided a positive impact of road traffic safety as they have successfully brought down the number of accidents if compared with the “business as usual scenario.”

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