

Chapter 3

Estimate Mortality Rate by Using Kaplan-Meier Estimator among Accidental Data at Batu Pahat, Johor, Malaysia

Mohd Asrul Affendi Abdullah¹, Jessintha A/P Lai²

^{1,2} Faculty of Science, Technology and Human Development, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor Darul Takzim,
afendi@uthm.edu.my, jessinthalai@yahoo.com

Abstract. Road traffic accidents in Malaysia increase every year and are dangerous to everybody. So, the pattern of road traffic accident must be analyzed. Besides that, the mortality due road traffic accidents also increased every year. Therefore, the survival and mortality rate of the road traffic accident must be determined. In daily life, there are some peak times where accidents most frequently occur. Batu Pahat is one of the states in Malaysia that recorded the highest number of road traffic accidents every year. Rising of these incidents are often being associated with factors such as driving behaviors, driving perception, vehicle condition and others. In this study, Kaplan-Meier estimator will be used to find the survival and mortality rate. The Kaplan-Meier estimator can estimate time-to-event models with the existence of censored cases. For this study, the data of road traffic accidents will be obtained from Traffic Police Station at Batu Pahat, Johor. Based on the data analysis, the pattern of road traffic accidents at Batu Pahat was increased from year 2009 to 2011 and fluctuated from year 2012 to 2014. The highest mortality rate was in year 2009 while the lowest was in year 2013.

Keywords: *accidents, survival, mortality, censored, Kaplan-Meier*

1 Introduction

Road traffic accidents which are generally unintentional and avoidable are a common risk every day to life that can happen to almost everyone at anywhere. The problem of road traffic accident is increase then turn out to be a threat to public health and national development in many developing countries [1]. Worldwide, the number of people killed in road traffic accidents (RTA) every year is estimated to be almost 1.2 million, while the number of injured could be as high as 50 million [2]. Road traffic accidents are considered as one of the major causes of death and injuries in Malaysia [3]. Batu Pahat is categorized among the highest accident rates in Malaysia. Thus, while medical science has occupied the ravages of many diseases, accidents have become a new epidemic of public health importance that requires the same effort for control and prevention. Usually, people only concerned about the mortality rate among diseases but they are engrossed that mortality rate among accident also should be determine so that people will not underestimate about road accident [4]. This study focuses on the number of road accidents occurring in Batu Pahat. The targets of this study are any residents in Batu Pahat that involved in road accident. Road accident's data will be obtained from Traffic Police Station in Batu Pahat. The road accident's data that will be obtained are related to the time the accident occurred.

2 Kaplan-Meier Estimator

The standard nonparametric estimator of the survival function is the Kaplan-Meier (K-M) estimator, which is the product-limit estimator. This estimator comprise information from all the observation available, both censored and uncensored (*event times*), by consider survival to any point in times as series of step defined at the observed survival and censored times [6]. Survival function of road traffic accident is denoted by $S(t)$, gives the probability that people involved in road traffic accident survives longer than some specified time (t). Survival function gives the probability that the random variable (T) exceeds the specified time (t). This estimator is defined as:

$$\hat{S}(x) = \begin{cases} 1 & \text{if } t < t_1, \\ \prod_{t_i \leq t} \left[1 - \frac{d_i}{Y_i} \right] & \text{if } t_1 < t, \end{cases} \quad (1)$$

where t_1 denotes the first observed failure time, d_i represents the number of failures at time t , and Y_i denotes the number of individuals who have not experienced the event of interest, and have also not been censored, by time t . Based on equation (1), we notice that before the first failure happens, the survival probability is always 1. If failures occur, the Kaplan-Meier estimator of the survival function will decrease. Mortality rate is the hazard function in the survival analysis. The hazard function which is denoted by $h(t)$, shows the instantaneous potential per unit time for the event to occur, given that the individual has survived up to time t . The hazard function will focus on failing which is on the event of interest occurring. It is in contrast to the survival function which focuses on not failing. The equation of the hazard function is:

$$h(t) = \lim_{\Delta t \rightarrow 0} \frac{P(t \leq T < t + \Delta t | T \geq t)}{\Delta t} = \frac{f(t)}{S(t)} = \frac{d}{dt} S(t) \quad (2)$$

Censoring is when the total survival time or exact survival time for that subject cannot be accurately determined. This occurs when the subject drops out, lost to follow-up or when the study ends before the subject had the event of interest occur. Thus, censoring can occur within the study or terminally at the end [7].

3 Data Source

The secondary data was obtained from Traffic Police Station of BatuPahat, Johor. This study considered accident data for six year period from 2009 to 2014. The data obtained was a time to event data. The data were according to the number of accidents occurred at specific time. The time period were recorded for every two hours start from the midnight which was at twelve midnight. The number of road traffic accidents and the number of people killed in road traffic accidents were used as the response variable and the other variables such as the time the road traffic accident was occurred and the time people were killed by road accident as the explanatory variable.

There were 43503 road accidents cases that occurred in BatuPahat from 2009 to 2014 which killed 982 people. This shows that on the average, 7,250 road accidents occurred every year and 163 lives are lost through these accidents. Table 1 shows the total number of road traffic accidents that occurred from year 2009 to 2014.

Table 1. Total number of road traffic accidents occurred at Batu Pahat and numbers of people killed by road traffic accident from year 2012 to 2014

Year	Number of accidents	Number of people killed
2009	6597	168
2010	7113	163
2011	7438	173
2012	7398	169
2013	7511	153
2014	7446	156

Based on Table 1, the numbers of road traffic accidents were increased from year 2009 to 2011. There were 6597 cases of road traffic accident in year 2009 and increased to 7113 cases in year 2010 then 7438 cases in year 2011. However, the number of road traffic accident occurred in Batu Pahat were slightly decreased in year 2012 from year 2011 with only 7398 cases then increased to 7511 cases in year 2013. In year 2014, there were 7446 cases of road traffic accidents. A total of 168 people died due to road traffic accident in year 2009 but there was a small decreased in the number of deaths caused by road traffic accidents in year 2010 which was only 163 people were killed. The highest numbers of deaths were in year 2011 which 173 person were killed in road traffic accident. In year 2014, the numbers of death due to road traffic accidents were increased. A total of 156 people die in year 2014.

4 Results and Discussion

Fig. 1 below show the total number of road traffic accidents that occurred at BatuPahat from year 2009 to 2014. There were total numbers of road traffic accidents from year 2009 to 2014 represented by the graph below.

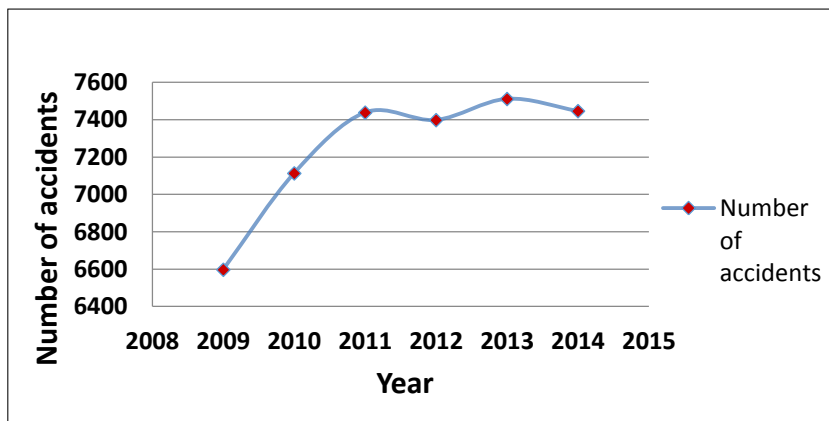


Fig. 1. Line graph of the number of road traffic accidents at Batu Pahat from year 2009 to 2014

Fig. 1 showed that the pattern of number of road traffic accidents at Batu Pahat from year 2009 to 2014. Road traffic accidents cases were increased from year 2009 to 2011. The number of road traffic accidents increased from 6597 in year 2009 to 7113 (year 2010) and to 7438 (year 2011). In year 2012, the pattern of road traffic accident was reversed and reduced to 7398 cases. Start from year 2012, the pattern of road traffic accidents was fluctuated until year 2014. The numbers of road traffic accidents were increased in year 2013 with 7511 cases and lessened to 7446 in year 2014.

The survival rate and mortality rate of the road traffic accidents occurred at Batu Pahat was obtained from the Kaplan- Meier estimator of survival analysis. The road accident data were analyzed by using SPSS software. In this study, number of people killed in road traffic accident was classified as the event of interest. Meanwhile, the number of people who were not killed was considered as censored event. The start time for the event was at 00.00 A.M while the end time was at 22.00 P.M.

Table 2. Cumulative survival rate of road traffic accidents from year 2009 to 2014

Year	Survival rate
2009	0.911
2010	0.928
2011	0.919
2012	0.920
2013	0.937
2014	0.923

Table 3. Cumulative mortality rate of road traffic accidents from year 2009 to 2014

Year	Mortality rate
2009	0.089
2010	0.072
2011	0.081
2012	0.080
2013	0.063
2014	0.077

Table 2 showed the survival rate of road traffic accidents from year 2009 to 2014. Based on this table, the highest survival rate was in year 2013 which is 0.937 (93.7%). In year 2013, people involved in road traffic accidents have higher probability to survive than the other five years, followed by year 2010 with second highest survival rate. The survival rate for year 2010 was 0.928 (92.8%), 0.919 (91.9%) for year 2011, 0.920 (92.0%) for year 2012 and 0.923 (92.3%) for year 2014. The lowest survival rate was in year 2009 which is 0.911 (91.1%).

Based on **Table 3**, the highest cumulative mortality rate was in year 2009 with the value of 0.089 (8.90%). This showed that a lot of people were killed by road traffic accidents in year 2009. The cumulative mortality rate of road traffic accidents in year 2010 was 0.072 (7.20%), 0.081 (8.10%) for year 2011 which was the second highest mortality rate among six years, 0.08 (8%) for year 2012, 0.063 (6.30%) for year 2013 and 0.077 (7.70%) for year 2014. The lowest cumulative mortality rate was in year 2013 which mean less people were killed in road traffic accidents in this year.

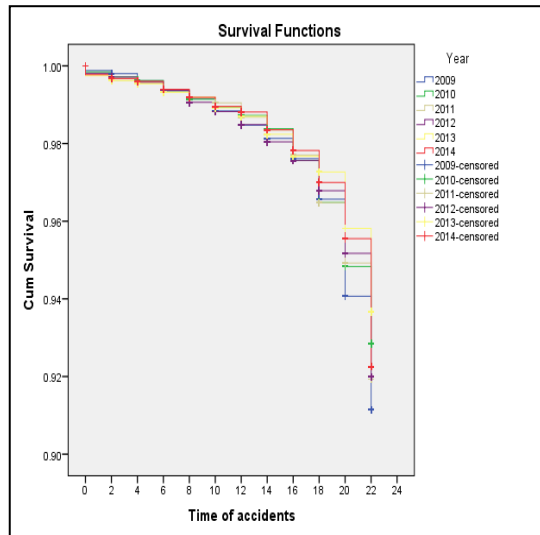


Fig. 2. Survival curved of road traffic accidents from year 2009 to 2014

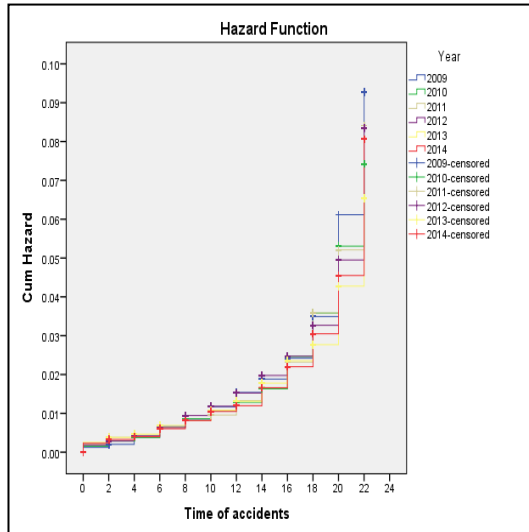


Fig. 3. Hazard curved of road traffic accidents from year 2009 to 2014

Fig. 2 showed the survival curve of road traffic accidents from year 2009 to 2014. Based on this figure, the survival rates were approximately same for every time period. The survival rates were decreased over time so that the survival curve was curved down. However, the probabilities of surviving were high for every year from 2009 to 2014. The lowest survival rate was in year 2009.

Fig. 3 showed the hazard curve of road traffic accidents from year 2009 to 2014. Based on this figure, the hazard rates (mortality rate) for every time period were almost the same. The cumulative hazard rate increased over time so that the hazard curve was curved up. At time 00.00A.M to 08.00A.M, the cumulative hazard rates were almost same for year 2009 to 2014. However, at time 20.00P.M to 22.00P.M, more people killed in road traffic accident for year 2009 than the other five years.

5 Conclusions

Based on the road traffic accidents data which were analysed, the total of 43503 cases of road traffic accidents had occurred and 982 people were killed from year 2009 to 2014. This showed that a lot of road traffic accidents occurred at Batu Pahat so that the authorities should take appropriate actions to reduce and prevent this problem. Road traffic accidents had slowly become the leading cause of death in Malaysia.

The pattern of road traffic accidents at Batu Pahat was increased from year 2009 to 2011 and then from year 2012 to 2014, the pattern was fluctuated. The lowest numbers of road traffic accidents were in year 2009 with 6597 cases and year 2013 had recorded the highest number of road traffic accidents which is 7511 cases. Based on the pattern of road traffic accidents that occurred in year 2009 to 2014, mostly, the numbers of road traffic accidents were increased over years, and just reduce in small quantity for a certain year. So, road traffic accident is still a matter to be considered and prioritized to save people's life.

The survival and mortality rate were obtained so that the curve for survival and mortality rate was plotted. The highest survival rate was in year 2013 and the lowest survival rate was in year 2009. Therefore, for the mortality rate, the highest was in year 2009 and the lowest mortality rate was in year 2013.

References

1. Deus,D.K.(2006). Risk Factors and Road Traffic Accidents in Tanzania: A Case Study of Kibaha District.
2. Deepak,S., Singh,U.S. and Mukhere,S.(2011).A study on road traffic accidents in Anand-Gujarat.
3. Fairoos,W. and Zakiyatussariroh,W.(2005).Modelling Malaysian Road Accident Deaths: An Econometric Approach.
4. Che Zakaria,N.A.(2010). Road Safety Level: A Case Study of Major Road Linked Terengganu and Kuantan Town, pp. 1-3.
5. Lu,P.H.(2011).Customer Satisfaction towards Retailer.
6. Hosmer,D.W., Lemeshow,S. and May,S.(2008).Applied Survival Analysis: Regression Modelling of Time-to-Event Data, Willey Series in Probability and Statistics, Second Edition.
7. Rich,J.T., Gail,M.J., Neely, Paniello,R.C., Courtney,C.J., Voelker, Phil,D., Nussenbaum,B. and Wang,E.W.(2010). A Practical Guide to Understanding Kaplan-Meier Curves, Department of Otolaryngology-Head and Neck Surgery, Washington University School of Medicine.