Iowa DOT FHWA 2020 Safety Targets

August 2019

In January 2019, the Iowa DOT began the process of reviewing data to set performance targets for the five safety performance measures required by FHWA in 23 CFR 490 (also referred to as "PM1"). For the safety area, these targets are required to be five-year rolling averages and must be set annually. The five required measures are:

1. Number of fatalities
2. Rate of fatalities per 100 million vehicle miles traveled (VMT)
3. Number of serious injuries
4. Rate of serious injuries per 100 million VMT
5. Number of non-motorized fatalities and non-motorized serious injuries

These targets must be set as five-year rolling averages for 2016-2020, and are submitted as part of the State's Highway Safety Improvement Program (HSIP) annual report, due August 31, 2019. The first round of target setting for these measures occurred in 2017, and the same approach was used again in 2018 and 2019. Because of the relatively short-term nature of the targets, the methodology being utilized focuses on historical information and creates a forecast based on trends. The approach relies on the use of prediction intervals around the trend model forecast to inform a "risk-based" target setting method.

A prediction interval is defined as: "In statistical inference, specifically predictive inference, a prediction interval is an estimate of an interval in which future observations will fall, with a certain probability, given what has already been observed."[1] A prediction interval approach enables a focus on the acceptable risk of meeting, or failing to meet a target, which allows stakeholders at all levels of the organization to understand the targets in better context. Since 2017, the safety targets working group has annually evaluated several prediction intervals and continued to recommend a prediction interval of 75%, meaning that there would be 75% confidence that the actual number of fatalities and injuries would be lower than the targets. Management agreed with the use of a 75% confidence level, and it is being used again in 2019 for target setting.

For each measure, a time-series model was developed. An integrated moving average (IMA) model has been used since 2017. The following pages show the model's output and predictions at various confidence levels for each measure. This helps illustrate the level of risk associated with various confidence levels, as well as the fact that higher confidence levels lead to more conservative targets. The final page shows the 2016-2020 safety targets.

The safety data used in the forecast can be obtained from the Iowa Crash Analysis Tool (ICAT) and Motor Vehicle Division daily fatality count from the following websites.

ICAT: https://icat.iowadot.gov/
Fatality Report: https://www.iowadot.gov/mvd/stats/daily.pdf

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[1] https://en.wikipedia.org/wiki/Prediction_interval, 2019-May-02

Measure 1: Number of fatalities

Figure 1 shows the historical series (black line), the integrated moving average (IMA) model (red line), the model's forecast values (black dots), and a set of prediction interval (PI) bounds (blue lines). The blue lines shown in this figure correspond to the 75% confidence level used for targets. Table 1 shows the model's forecast of fatalities for 2019 and 2020 and the upper prediction interval value at different confidence levels.
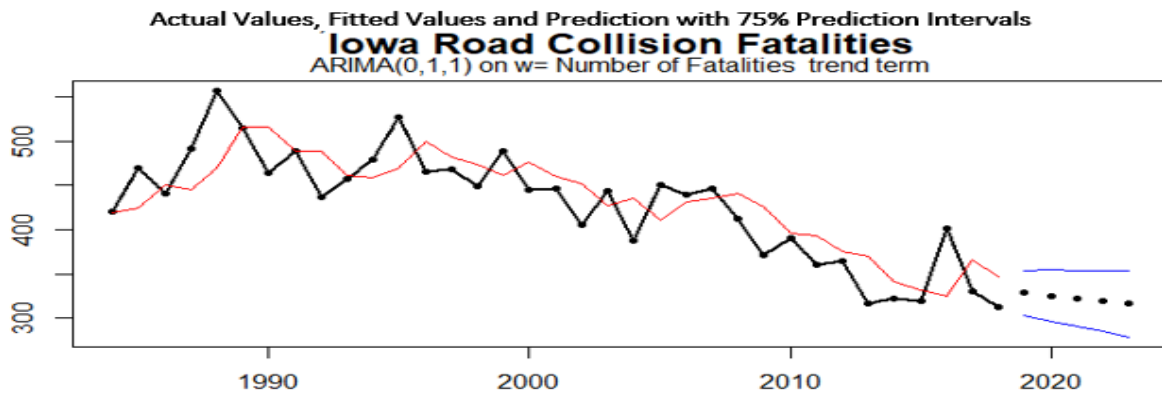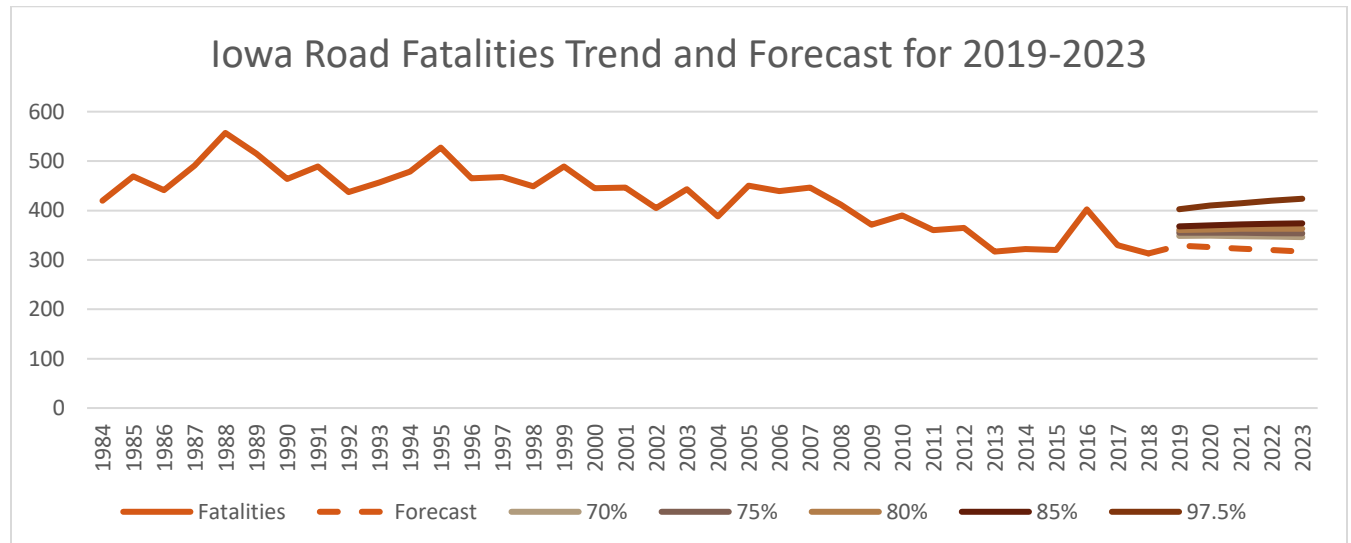
Figure 1: IMA model and forecast for annual fatalities

Table 1: Forecast road fatalities and upper prediction values at selected probability levels

Year	Forecast	70%	75%	80%	85%	97.5%
2019	329	349	354	360	368	403
2020	326	348	355	361	370	410

Figure 2: Fatalities trend and forecast, including prediction interval bounds

To be 75% confident of the 2020 target value, the five-year rolling average target for 2016-2020 would be set by averaging the forecast value of 329 fatalities for 2019 and the 75% PI value of 355 as the 2020 value along with the actual fatalities for 2016, 2017, and 2018. The five-year rolling average target for fatalities is presented in Table 7.

Measure 2: Fatalities per hundred million vehicle miles traveled

This measure is a rate conversion, using the forecast developed for Measure 1 and the estimated VMT for the forecast period. The forecast values of VMT were provided by the Systems Planning Bureau using their preferred methodology, linear ETS, which is an exponential smoothing approach. The linear ETS method provides the most reasonable results and adjusts for seasonality or fluctuations in the data. The annual VMT forecast by this method for 2020 is expected to be 35.1 billion (35,097,598,000).

Table 2: Fatality rate forecast at selected probability levels

Year	VMT forecast (x100M)	Forecast fatality rate	70%	75%	80%	85%	97.5%
2019	34,653.33	0.9494	1.0071	1.0215	1.0388	1.0619	1.1629
2020	35,097.59	0.9288	0.9915	1.0114	1.0285	1.0542	1.1681

To be 75% confident of the 2020 target value, the five-year rolling average target for 2016-2020 would be set by averaging the forecast value of 0.9494 fatalities per hundred million VMT for 2019 and the 75% PI value of 1.0114 for 2020 along with the actual fatality rates for 2016, 2017, and 2018. The five-year rolling average target for fatality rate is presented in Table 7.

Measure 3: Number of serious injuries

The figure below shows the historical series (black line), the model (red line), the model's forecast values (black dots), and a set of prediction interval bounds (blue lines) for the number of serious injuries resulting from collisions. In this case, due to a discontinuity between 2000 and 2001, the model is constructed using only data from 2001 and later.

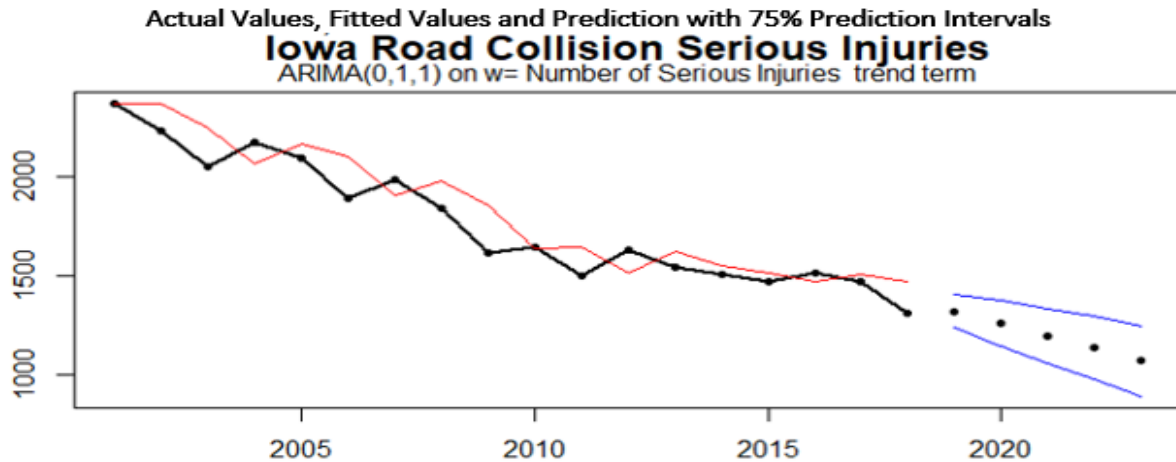*Figure 3: IMA model and forecast for serious injuries*

Actual Values, Fitted Values and Prediction with 75% Prediction Intervals
Iowa Road Collision Serious Injuries
ARIMA(0,1,1) on w= Number of Serious Injuries trend term

Table 3: Forecast road serious injuries and upper prediction values at selected probability levels

Year	Forecast	70%	75%	80%	85%	97.5%
2019	1,322	1,387	1,406	1,427	1,451	1,567
2020	1,258	1,348	1,374	1,402	1,436	1,593

Figure 4: Serious injuries trend and forecast, including prediction interval bounds
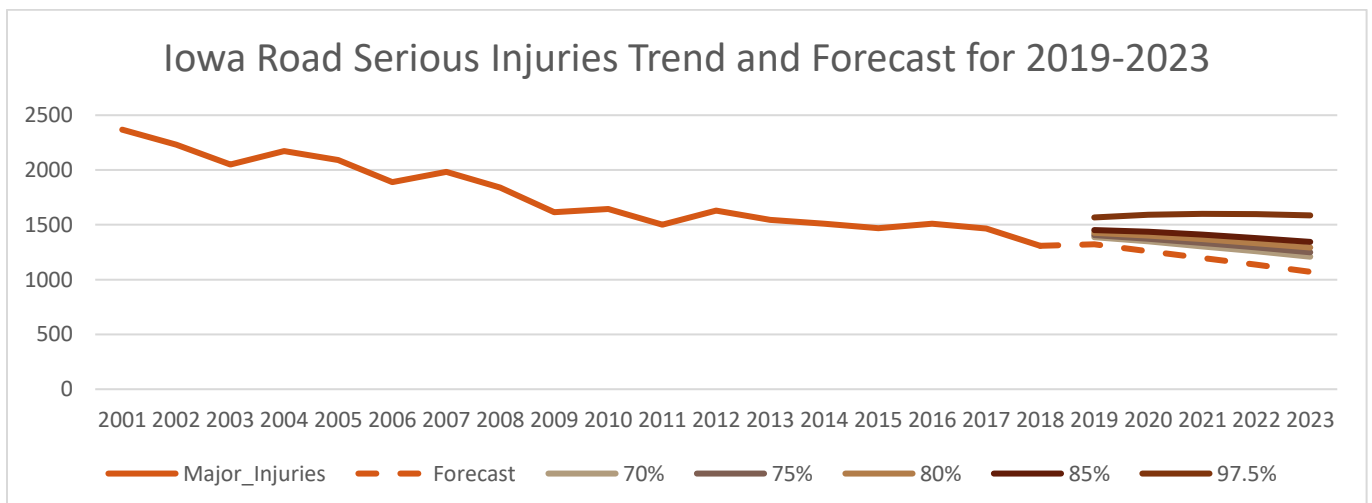
Iowa Road Serious Injuries Trend and Forecast for 2019-2023

To be 75% confident of the 2020 target value, the five-year rolling average target for 2016-2020 would be set by using the forecast value of 1,322 for 2019 and the 75% PI value of 1,374 for 2020 along with the actual serious injuries for 2016, 2017, and 2018. The five-year rolling average target for serious injuries is presented in Table 7.

Measure 4: Serious injury rate per hundred million vehicle miles traveled

This measure is a rate conversion, using the forecast developed for Measure 3 and the estimated VMT for the forecast period. The forecast values of VMT were provided by the Systems Planning Bureau using their preferred methodology, linear ETS, which is an exponential smoothing approach. The linear ETS method provides the most reasonable results and adjusts for seasonality or fluctuations in the data. The annual VMT forecast by this method for 2020 is expected to be 35.1 billion (35,097,598,000).

Table 4: Serious injury rate forecast at selected probability levels

Year	VMT forecast (x100M)	Forecast serious injury rate	70%	75%	80%	85%	97.5%
2019	34,653.33	3.8149	4.0025	4.0573	4.1179	4.1871	4.5219
2020	35,097.59	3.5842	3.8407	3.9147	3.9945	4.0914	4.5387

To be 75% confident of the 2020 target value, the five-year rolling average target for 2016-2020 would be set by averaging the forecast value of 3.8149 serious injuries per hundred million VMT for 2019 and the 75% PI value of 3.9147 for 2020 along with the actual serious injury rates for 2016, 2017, and 2018. The five-year rolling average target for serious injury rate is presented in Table 7.

Measure 5: Number of non-motorized fatalities & serious injuries

The figure below shows the historical series (black line), the model (red line), the model's forecast values (black dots), and a set of prediction interval bounds (blue lines) for the number of non-motorized fatalities and serious injuries resulting from collisions with a vehicle. The model is constructed using all available data from 2009 and later.

Figure 5: IMA model and forecast for annual non-motorized fatalities and serious injuries
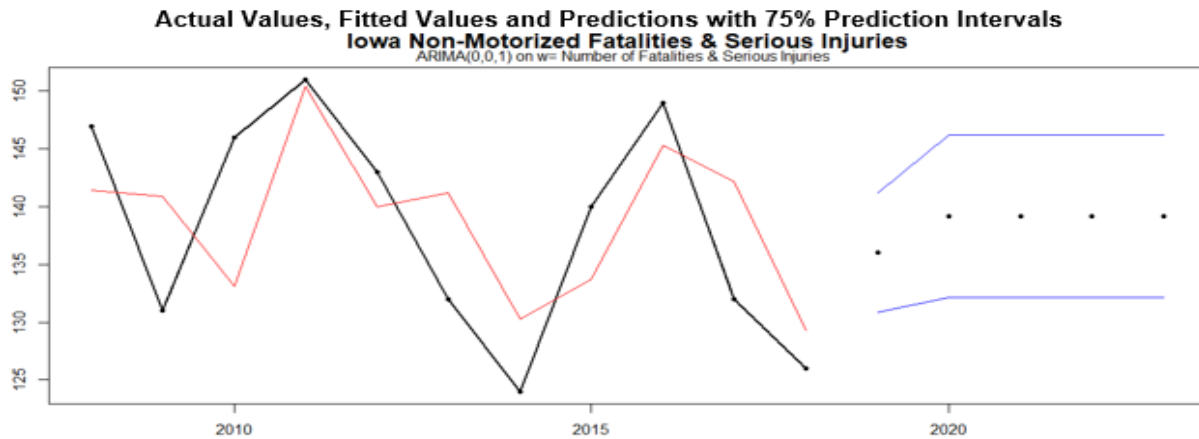

Actual Values, Fitted Values and Predictions with 75% Prediction Intervals
Iowa Non-Motorized Fatalities & Serious Injuries
ARIMA(0,0,1) on w= Number of Fatalities & Serious Injuries

Table 5: Forecast non-motorized fatalities and serious injuries, and upper prediction values at selected probability levels

Year	Forecast	70%	75%	80%	85%	97.5%
2019	136	140	142	143	144	152
2020	140	145	147	148	150	160

Figure 6: Non-motorized fatalities and serious injuries trend and forecast, including prediction interval bounds

Iowa Road Non-Motorized Fatalities and Serious Injuries Trend and Forecast for 2019-2023
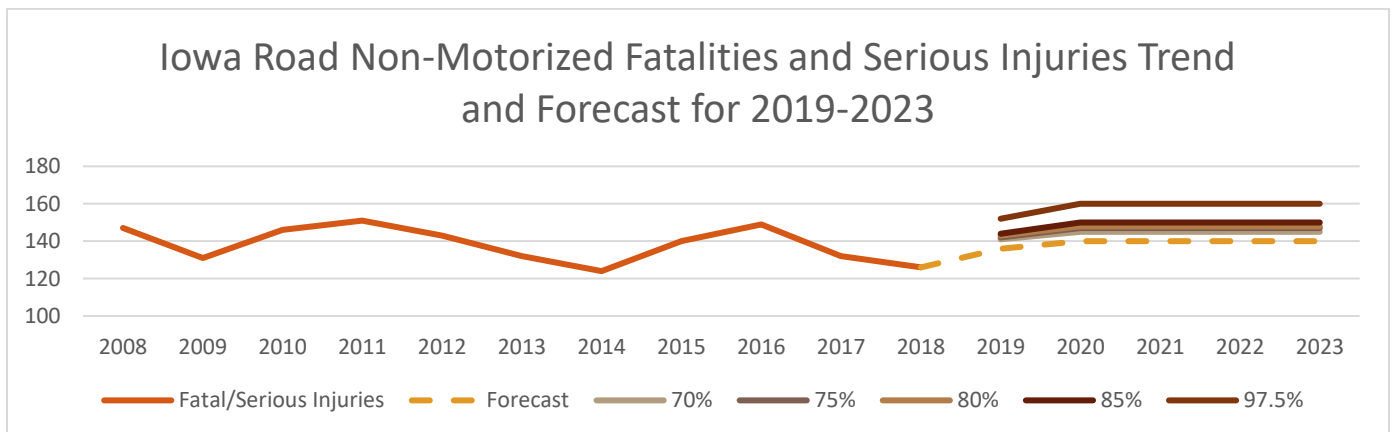
To be 75% confident of the 2020 target value, the five-year rolling average target for 2016-2020 would be set by using the forecast value of 136 for 2019 and the 75% PI value of 147 for 2020 along with the actual non-motorized fatalities and serious injuries for 2016, 2017, and 2018. The five-year rolling average target for non-motorized fatalities and serious injuries is presented in Table 7.

Iowa DOT 2016-2020 safety targets

While the preceding forecasts were developed for each year, the targets are required to be set as five-year rolling averages, as crashes are subject to significant year-to-year variability. The following table gives the actual numbers of fatalities, serious injuries, non-motorized injuries and fatalities, and the vehicle miles traveled (VMT, in millions) for each respective year, which are the basis for the five-year rolling averages presented in Table 7.

Table 6: Annual data summary

Year	Fatalities	Serious injuries	Non-motorized injuries and fatalities	VMT (millions)
2011	360	1,501	151	31,411
2012	365	1,629	143	31,581
2013	317	1,545	132	31,542
2014	322	1,509	124	32,332
2015	320	1,470	140	33,109
2016	402	1,510	149	33,263
2017	328	1,458	132	33,751
2018	313	1,308	126	34,209

Table 7 shows the historical and predicted five-year rolling averages for the five targets. The highlighted numbers represent Iowa's 2016-2020 safety targets.

Table 7: 5-year rolling average actuals and 2020 targets

Five-Year Rolling Averages					
Year	Fatalities	Serious injuries	Non-motorized injuries and fatalities	Fatalities per hundred million VMT	Serious injuries per hundred million VMT
2004-08	427.1	1,995.2	Data not available	Data not available	Data not available
2005-09	423.6	1,883.4			
2006-10	411.6	1,794.2			
2007-11	395.8	1,716.6			
2008-12	379.6	1,646.1	143.6		
2009-13	360.6	1,586.8	140.6		
2010-14	350.8	1,565.6	139.2		
2011-15	336.8	1,530.8	138.1	1.053	4.785
2012-16	345.2	1,532.6	137.6	1.067	4.735
2013-17	338.2	1,498.4	135.4	1.027	4.568
2014-18	337.4	1,499.1	134.2	1.046	4.497
Forecast 75% prediction interval value					
2015-19	343.8	1,432.2	137.8	1.017	4.237
2016-20 targets	**345.8**	**1,396.2**	**138.1**	**1.011**	**4.083**