The response time is a crucial element of Emergency Medical Services (EMS). However, there are neither federal nor state (specifically Michigan) data available to regulate EMS response times, and standards are being set by individual vendors or local organizations. Investigation into response time performance measures may lead to further discoveries, innovations, and potentially better practices to improve existing systems used by EMS. Leading to quicker access to care for the end users (crash victims) and potentially saving numerous human lives.

### Parameters Affecting Response Time
- **Sprawling of Cities**
- **Rural & Urban Classification**
- **Workplace and vehicle location**
- **Transport location**
- **Urban vs rural**

### Strategies for Reducing Response Time
- **Vehicle availability in crash area**
- **No. of severe crashes & EMS response vehicles**
- **Response time to further discoveries, innovations, and potentially identify best practices to improve local organizations.**
- **Investigation into response time performance measures**

### Introduction

The goodness-of-fit results suggest that the 3-Parameter Lognormal distribution is one of the most suitable distributions for future predictive modeling. The 3-Parameter Lognormal distribution was identified as the highest ranking distribution based on the Anderson Darling test, however distributions such as Pearson IV (9), Inverse Gaussian, and others also presented plausible fits and may be considered in future modeling studies.

### Rural & Urban Classification

- **Number of Agencies per County from 83 Counties**
- **Geographic classification was determined by population density**
- **Urban: populations greater than or equal to 50,000 residents**
- **Rural: populations less than 50,000 residents**

### 3-Parameter Lognormal Model

The goodness-of-fit results suggest that the 3-Parameter Lognormal distribution is one of the most suitable distributions for future predictive modeling. The 3-Parameter Lognormal distribution was identified as the highest ranking distribution based on the Anderson Darling test, however distributions such as Pearson IV (9), Inverse Gaussian, and others also presented plausible fits and may be considered in future modeling studies.

### Probability Distribution Function

\[
 f(x) = \exp\left(-\frac{1}{\sigma} \left(\frac{\ln(x) - \mu}{\sigma}\right)^2 \right)
\]

### Cumulative Distribution Function

\[
 F(x) = \exp\left(-\frac{1}{a} \left(\frac{\ln(x) - \mu}{a}\right)^2 \right)
\]

Where the three parameters \(\mu, \sigma, a\) and \(\nu\) contribute to the location, scale, and threshold properties of the distribution, respectively. It is understood to be the Laplace Integral and the mathematical constant for computational purposes.

### Fitted Data: 3-Parameter Lognormal Model

<table>
<thead>
<tr>
<th>Region</th>
<th>Fitted Mean (minutes)</th>
<th>Fitted Standard Deviation (minutes)</th>
<th>Time Interval</th>
<th>Time Interval</th>
<th>Time Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>9.26</td>
<td>3.23</td>
<td>(3.06, 11.38)</td>
<td>(2.24, 23.65)</td>
<td>(1.93, 30.49)</td>
</tr>
<tr>
<td>Urban</td>
<td>5.96</td>
<td>2.35</td>
<td>(3.55, 10.88)</td>
<td>(2.35, 20.81)</td>
<td>(1.77, 40.98)</td>
</tr>
<tr>
<td>Rural</td>
<td>14.90</td>
<td>4.94</td>
<td>(9.44, 16.82)</td>
<td>(3.03, 31.11)</td>
<td>(2.08, 49.90)</td>
</tr>
</tbody>
</table>

### Application of Fitted Response Time Distribution

- **Evaluate and compare EMS agency performances: response times to fall within the 68%, 95%, or 99.7% intervals.**
- **3-Parameter Lognormal Distribution classifications can be evaluated and adjusted as more data is collected.**
- **The PDF and CDF can be used to predict and summarize response times.**
- **Use the distributions and simulation models to test changes in protocols or the routing and location of agency vehicles.**
- **Without additional information, models for prediction will be extremely rudimentary and have very low power for prediction.**
- **Combine current data fields with additional data from other sources, higher powered prediction models could be developed to provide means for EMS performance evaluation and for response time improvements.**
- **Lognormal and normal distributions can be used to summarize response times.**
- **Follow-up studies can be conducted.**
- **A complementary approach to future modeling of this data is big data analytics.**

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### References

5. Ong et al. (7)
7. Ong et al. (7)