RELATIONSHIP OF WINTER ROAD WEATHER MONITORING TO WINTER DRIVING CRASH STATISTICS

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1. **ABSTRACT:**

The deployment of Road Weather Information Systems (RWIS) using state of the art non-invasive pavement sensors together with the atmospheric sensors has advanced the capabilities of the Idaho Transportation Department (ITD) maintenance crews to better plan their winter storm response, both in treatment chemical selection and application timing. The results of the winter maintenance activities are now measured through a Winter Performance Measurement program that evaluates how well each maintenance crew is doing with regards to achieving and maintaining safe grip roads during and after storm events.

The results of this recent focus towards data driven maintenance operations has revolutionized the level of service ITD provides its customers in terms of year round safety and mobility. ITD has developed a quantitative data collection procedure to measure the effectiveness of the RWIS and Winter Performance Measure program in improving safety, which was evaluated through a benefit/cost study.

This paper compares winter driving crash statistics on road segments prior to the deployment of RWIS sites to crash statistics after winter road condition data became available through RWIS deployment and then calculates a benefit/cost metric. For the study period (2010-2013) the benefit/cost is 22, which concludes that strategically deployed RWIS sites and proper utilization of the data easily justifies the investment in infrastructure and operations.

For the 3-year study period and the highway segments being analyzed, winter driving fatalities dropped from 5 in the baseline season to 1 in the second season to zero in the third season.
2. BACKGROUND

There have been several studies performed that examine the benefits of various aspects of winter operations, including (a), (b), and (c).

In each of these studies the researchers developed and used mathematical models to estimate the benefits of the tool or maintenance practice. Instead of developing a mathematical model for calculating estimated benefits and costs for the three year study period, this paper used crash data extracted from the Idaho statewide crash report database to calculate the benefits of avoided crashes, and collected associated deployment and operations costs for the Road Weather Information Systems (RWIS) sites in the study area.

Over the past five years the Idaho Transportation Department (ITD) has invested over $15 Million in expanding and modernizing its RWIS network at strategic locations statewide. Noninvasive pavement sensors have been included at nearly every site that report pavement temperature, layer type (water, ice, snow), layer thickness, and “grip” (the coefficient of friction). The current RWIS inventory statewide is 125 sites with an additional new site under construction. ITD has developed a winter performance management program to quantify how well the maintenance crews are maintaining safe roads during and after winter storm events. The winter performance measures track the success of the road treatments, and the percentage of time the grip measurement was maintained in the safe driving range (grip >0.6) when the road surface temperature was below freezing and precipitation is present. ITD asserts that the measured grip value is the most useful indicator of the condition and safety of the road surface during winter weather conditions.

This deployment of winter performance reporting RWIS sites has enabled the following improvements to occur that all can contribute to safety:

- Treatment timing
- Material selection
- Scenario review and critique
- Performance Measurement-Mobility Index
- Higher quality road condition traveler information
- Automated road condition and alerts reporting on 511 traveler information websites

3. STUDY

ITD wanted to analyze the relationship of utilizing the winter road condition data to winter driving crash statistics to determine what the benefit/cost is for deploying RWIS sites. A study was begun in 2014 that covered winter driving seasons starting in the fall of 2010 and examined the new deployments of RWIS sites (33 total, 2011 and 2012) and the crash statistics associated with this group. See map of RWIS locations below in Figure 1.
The bases for this study were the following:

1. The seasonal winter storm frequency and severity was not significantly different during the 3 year study window.
2. Data sets consist of reported winter driving crashes.
3. Traffic volumes were constant or slightly increasing during the study period.
4. Benefits are the avoided societal costs represented by crash reductions. During the study period (2010-2013) the statewide winter operational costs decreased in succeeding years, however these savings were not included in the benefit/cost calculation.
5. The global average cost per crash is calculated using NHTSA values for serious injury and fatality crashes plus Idaho law enforcement estimated property damage values, covering 674 recorded crashes on the highway segments studied.
6. A grip value < 0.6 determines winter driving conditions (post RWIS deployment).
7. Winter driving conditions for pre-RWIS deployment locations based on crash report causes noted by law enforcement officers.
8. Each of the 33 RWIS sites has associated segments of highway that it represents. A total of 885 lane miles are associated with the 33 RWIS sites. Only winter driving condition crashes reported on these segments are counted in the calculations.

The approach used in analyzing the road condition data and crash data is to annualize the benefits and costs as follows:
Crash Reduction (CR) = Crash totals (before data) – Crash totals (after data)

Benefits = CR x average cost of crash

The average cost of a winter driving crash is $72,700 based on 674 reported crashes involving fatalities, serious injury, and property damage.

Costs = annualized capital and operating costs of RWIS network

Costs = \( \sum \text{capital}/n + \text{annual network operating cost} \)

Where \( n \) is the service life of an RWIS site, which is assumed to average 10 years.

The average capital cost per site is $125,000, covering design and construction.

The RWIS site operating costs average $5,500 per year and cover repair, maintenance, communications, and data management.

Therefore the annual operating cost per site is $18,000.

Note that benefits and costs are calculated using constant 2014 dollars.

### TABLE 1  RWIS Inventory by Winter Season

<table>
<thead>
<tr>
<th>Season</th>
<th>RWIS Sites Deployed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
<td>Pre-deployment season (Baseline)</td>
<td>0</td>
</tr>
<tr>
<td>2011-2012</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>2012-2013</td>
<td>24</td>
<td>33</td>
</tr>
</tbody>
</table>

4. RESULTS

The reported winter driving crash events for the highway segments associated with the 33 RWIS sites are shown on Chart 1, and the corresponding calculated societal costs avoided are shown on Chart 2. The 2010-2011 season is the baseline for crash statistics and used to compare results from the next two succeeding years as 9 RWIS sites were deployed in 2011 and then 24 RWIS sites added in 2012.
Table 2 shows the capital and operating costs for the two RWIS Groups.

**Table 2**  RWIS Capital and Operating Costs ($)

<table>
<thead>
<tr>
<th>RWIS Site Group</th>
<th>Capital 2011-2012</th>
<th>Operating 2011-2012</th>
<th>Capital 2012-2013</th>
<th>Operating 2012-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>112,500</td>
<td>49,500</td>
<td>112,500</td>
<td>49,500</td>
</tr>
<tr>
<td>24</td>
<td>0</td>
<td>0</td>
<td>300,000</td>
<td>132,000</td>
</tr>
<tr>
<td>Totals</td>
<td>112,500</td>
<td>49,500</td>
<td>412,500</td>
<td>181,500</td>
</tr>
</tbody>
</table>
Table 3 shows the calculated benefit/cost for the two year span.

<table>
<thead>
<tr>
<th>TABLE 3 Benefit/Cost for the Two Winter Seasons</th>
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</thead>
<tbody>
<tr>
<td>Season</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>2011-2012</td>
</tr>
<tr>
<td>2012-2013</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>

The crash reduction trend is also reflected in fatality statistics for the highway segments considered in this study as shown in Table 4.

<table>
<thead>
<tr>
<th>TABLE 4 Highway Fatalities During Winter Driving Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
</tr>
<tr>
<td>Fatalities</td>
</tr>
</tbody>
</table>

5. CONCLUSIONS

The Idaho Transportation Department has concluded that the capital and operating investments in strategically placed RWIS sites and proper utilization of the observation data is easily justified by the societal benefits in significant reductions in winter driving crashes and fatalities.

Also, the safety improvements experienced are the result of improved winter maintenance operations and better and more comprehensive winter traveler information, both of which are enabled by the availability of road weather observation data.

6. REFERENCES

