Shiftwork, Fatigue, and Safety Performance in the Mining Industry

WSN Mining Health and Safety Conference
April 7th, 2016
Overall goal: *Achieve Sustainable Improvement of Safety Performance*

**Shiftwork and Fatigue Study**
- **Objective:** Investigate the impact of fatigue on productivity, incident rates, incident types, and existing dependencies and correlations between incidents and shift structure, camp conditions, worker experience, age, etc.
- **Scope:** Three gold mines in Timmins, Ontario and one site in Yukon.

**Safety Climate Study**
- **Objective:** Uncover current attitudes of the workers in the mining sector toward safety initiatives, labour safety training, risk aversion, peer impacts, and safety outcome.
- **Scope:** Three gold mines in Timmins. Collected 197 self administered questionnaires.
Fatigue Study: Research Methodology

• Collected Production, Hours, and Incident details for four Dumas mining sites.
• Data included: daily production, daily hours, incident type, date, time, shift, day in rotation, etc.
• Conducted in-person visits and interviews with Site Superintendents, Supervisors, Safety Personnel, and select workers for all four mines.
• Conducted additional safety surveys at one site (extension of previous project)
• Designed and conducted a pilot “fatigue-specific” survey at one site.
• Data Analysis:
  • Investigated the impact of fatigue on incidents based on Dumas data.
  • Analyzed the impact of fatigue based on survey statistics.
Scope & Projects Involved

In-town Mines

Project 1
Ontario

Project 2
Ontario

Camp Mines

Project 3
Ontario

Project 4
Yukon
Incidents by Time through Rotation

**Project 1**

- Frequency
  - 1/4: 20
  - 1/2: 26
  - 3/4: 32 (↑ 40%)
  - 1: 45

**Project 3**

- Frequency
  - 1/4: 19
  - 1/2: 30
  - 3/4: 23
  - 1: 29 (↑ 58%)

**Project 2**

- Frequency
  - 1/4: 16
  - 1/2: 21
  - 3/4: 26 (↑ 58%)
  - 1: 41

**Project 4**

- Frequency
  - 1/4: 21
  - 1/2: 26
  - 3/4: 16 (↑ 31%)
  - 1: 21
Incidents by Experience (Months with Dumas)

- **Project 1**
  - Months with the Company:
    - 12: 49
    - 24: 13
    - 36: 11
    - 48: 6
    - 60: 6
    - 72: 5
    - 84: 5
    - 96: 4
    - More: 7

- **Project 2**
  - Months with the Company:
    - 12: 45
    - 24: 17
    - 36: 13
    - 48: 10
    - 60: 10
    - 72: 5
    - More: 6

- **Project 3**
  - Months with the Company:
    - 12: 83
    - 24: 11
    - 36: 9
    - 48: 1
    - More: 2

- **Project 4**
  - Months with the Company:
    - 12: 63
    - 24: 5
    - 36: 4
    - 48: 8
    - More: 5
Incidents by Experience with Dumas

Worked for Dumas up to:
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years

Project 1
- 48%
- 13%
- 10%
- 5%
- 5%
- 5%
- 3%
- 4%
- 4%

Project 2
- 43%
- 9%
- 16%
- 12%
- 9%
- 9%
- 5%
- 4%
- 2%

Project 3
- 79%
- 10%
- 8%
- 1%
- 2%

Project 4
- 74%
- 9%
- 6%
- 5%
- 6%
Time of Day

Project 1

Project 3

Project 2

Project 4

Hour in Shift

Frequency

Day Shift

Night Shift
Incidents by Shift

Project 1

- Day Shift: 71%
- Night Shift: 29%

Project 2

- Day Shift: 71%
- Night Shift: 29%

Project 3

- Day Shift: 53%
- Night Shift: 47%

Project 4

- Day Shift: 67%
- Night Shift: 33%
Incidents by Type

Project 1
- Eqpt/Prpt Damage: 34%
- RO: 52%
- FA: 8%
- RWI: 12%
- Near Miss: 1%
- LTI: 1%
- MTI: 4%

Project 2
- Eqpt/Prpt Damage: 11%
- RO: 51%
- FA: 6%
- RWI: 21%
- Near Miss: 8%
- LTI: 3%
- MTI: 3%

Project 3
- Eqpt/Prpt Damage: 32%
- RO: 31%
- FA: 15%
- RWI: 8%
- Near Miss: 12%
- LTI: 1%
- MTI: 1%

Project 4
- Eqpt/Prpt Damage: 49%
- RO: 19%
- FA: 9%
- RWI: 15%
- Near Miss: 8%
- LTI: 1%
- MTI: 1%

[Graphs and Pie Charts showing percentages for each category across projects]
Incidents by Trade

Project 1

- Operator: 50%
- Miner: 37%
- Mechanic: 6%
- Construction: 2%
- Electrician: 1%
- Supervisor: 1%
- Not Identified: 4%

Project 2

- Operator: 34%
- Miner: 43%
- Mechanic: 8%
- Construction: 3%
- Electrician: 1%
- Supervisor: 1%
- Not Identified: 7%

Project 3

- Operator: 41%
- Miner: 40%
- Mechanic: 7%
- Construction: 1%
- Electrician: 11%
- Supervisor: 1%
- Not Identified: 1%

Project 4

- Operator: 45%
- Miner: 23%
- Mechanic: 16%
- Construction: 5%
- Electrician: 1%
- Supervisor: 1%
- Not Identified: 4%
Survey Results

1. On average, workers take 2-3 breaks for more than 5 minutes (including lunch)
2. On average, workers drink 3-4 cups of coffee/tea during a shift
3. 51% of workers smoke for an average of 14 cigarettes a shift!
4. 30% of workers consume energy drinks, between 1-2 per shift.
5. 20% don’t sleep well at all at camp.
6. 46% have trouble sleeping on the camp bed
7. 51% complaint about lack of AC and noise at camp
8. On average, workers sleep 6.4 hrs at camp and 7.6 hours at home
9. Most tiring shift mostly due to lack of sleep and camp conditions.
Conclusions

• On all four sites, the number of incident increases as the rotation duration progress (by as much as 58% from one quarter rotation to the next)
• Day/Shift consistently shows higher incident rates than night shifts (by as much as 145%)
• On average about 42% of all incidents are caused by Operators and 31% are caused by Miners
• In non-camp mines, about 44% of all incidents are caused by workers in their first year of employment.
• In camp mines, about 76% of all incidents are caused by workers in their first year of employment!
Safety Climate refers to the perceptions that employees share about their working environments (Zohar 1980).

1) Improved work behaviors of compliance.
2) Reduction in injury severity and frequency.
People have different attitudes when facing problems.

1. Not aware

2. Avoid

3. Improve
Research Target

Was based on a group of workers working on three project sites:
- The study gathered 200 surveys

Workforce make-up:
- Supervisor 13.3%
- Journeyman 80.4%
- Apprentice 6.3%
Mobile workers on mining sites:
  - Workers that moved between employers and/or projects within a three year time period.

**No. of employers in the past 3 years**

- \( \geq 3 \): 23%
- 1-2: 77%

**Mobility (No. of projects in the past 3 years)**

- 3: 56%
- 4-12: 23%
- 1-2: 21%
Three parts are measured:

- Workforce demographics
- Attitudes toward safety
- Safety incidents

### General Information:

1. Gender: (circle) Male Female
2. Age: ________
3. What is your trade? ________________________________________
4. How long have you worked in mining? ________ YEARS
5. How long have you worked for this employer? ________ YEARS

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Certain</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I worry about safety all the time I would not get my job done</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I cannot avoid taking risks in my job</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidents will happen no matter what I do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I can't do anything to improve safety in my workplace</td>
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<tr>
<td>I always wear the protective equipment or clothing required on my job</td>
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<tr>
<td>I do not use equipment that I feel is unsafe</td>
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<tr>
<td>If I find some safety issues in my job, I will not continue the work</td>
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<tr>
<td>until the problem is fixed</td>
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<tr>
<td>I inform management of any potential hazards I notice on the job</td>
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<tr>
<td>I know what procedures to follow if a worker is injured on my shift</td>
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</tr>
<tr>
<td>I would know what to do if an emergency occurred on my shift</td>
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</table>
Attitudes Toward Safety

Positive Attitudes

• Conscientiousness
• Safety consciousness
• Job safety
• Co-worker safety
• Supervisor safety
• Management safety
• Safety program & policies
• Job involvement

Negative Attitudes

• Fatalism
• Role overload
• Work pressure
• Interpersonal conflict at work

The attitudinal questions were scored from 1 (strongly disagree) to 5 (strongly agree).
Fatalism

A worker’s view on the randomness or uncontrollability of incidents.

Safety is not controllable

Fatalism decreases with increasing job tenure

Fatalism  Safety Incidents
One’s awareness of safety issues in the workplace.

Safety Consciousness decreases with increasing mobility.

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=3</td>
<td></td>
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</tbody>
</table>
A worker’s belief that there is excessive pressure to complete work faster.

**Work Pressure**

**Safety Incidents**

**Work pressure**

- Yes: 20.8%
- No: 79.2%
Supervisor Safety

The worker’s perception about their supervisor’s safety practices.

Supervisors' efforts on safety practices

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>96.9%</td>
<td>3.1%</td>
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</table>

Supervisor Safety

Safety Incidents
A worker’s perception about the effectiveness of safety programs and policies in workplace.

Safety program effective and clear?

- Yes: 95.8%
- No: 4.2%

Safety Program

Safety Incidents
Interpersonal conflict at work is the degree to which respondents get along with others at work.

![Graph showing Interpersonal conflicts]

- **Interpersonal Conflicts**
- **Safety Incidents**
Job involvement is one’s beliefs regarding the importance of their work in their life.
Worker vs. Supervisor

Conscientiousness
Safety consciousness
Job safety
Coworker safety
Supervisor safety
Management safety
Safety program
Job involvement

Strongly Agree
Agree
Uncertain
Disagree
Strongly disagree

Worker
Supervisor
Worker vs. Supervisor (cont.)

**Fatalism**

- **Worker**:
  - Strongly disagree: Low
  - Disagree: Moderate
  - Uncertain: High
  - Agree: Low
  - Strongly agree: Very low

- **Supervisor**:
  - Strongly disagree: Very high
  - Disagree: High
  - Uncertain: Low
  - Agree: Very low
  - Strongly agree: Low

**Role overload**

- **Worker**:
  - Strongly disagree: Low
  - Disagree: Moderate
  - Uncertain: High
  - Agree: Low
  - Strongly agree: Very low

- **Supervisor**:
  - Strongly disagree: Very high
  - Disagree: High
  - Uncertain: Low
  - Agree: Very low
  - Strongly agree: Low

**Work pressure**

- **Worker**:
  - Strongly disagree: Low
  - Disagree: Moderate
  - Uncertain: High
  - Agree: Low
  - Strongly agree: Very low

- **Supervisor**:
  - Strongly disagree: Very high
  - Disagree: High
  - Uncertain: Low
  - Agree: Very low
  - Strongly agree: Low

**Interpersonal conflicts**

- **Worker**:
  - Strongly disagree: Low
  - Disagree: Moderate
  - Uncertain: High
  - Agree: Low
  - Strongly agree: Very low

- **Supervisor**:
  - Strongly disagree: Very high
  - Disagree: High
  - Uncertain: Low
  - Agree: Very low
  - Strongly agree: Low
Conclusion

Based on the responses by the workers, a positive safety climate on the three sites was found:

- 90% have control over safety.
- 95% are aware of relevant safety issues.
- 96% believed that safety programs are useful and clear.
- 79% believed that they have sufficient time to plan their work.
- 72% believed that their job contains risks, which indicates a high awareness of safety issues.
- Even though there was a level high mobility, workers felt safe due to management's leadership and approach to safety and the matured safety programs implemented at their workplace.
Recommendations

The following are Dumas’ recommendations:

1. Apply continuous improvement ideas to enhance the safety culture of Dumas.
2. Implement programs to focus on the high frequency areas (first month/year of employment).
3. Promote mental and physical health of workers.
4. Reduce quantity and intensity of incidents by reducing worker fatigue.
Discussion – Potential Future Projects

- Process Mapping
- Modelling & Simulations
- Optimization & Applications

Forward Mining
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... it is our responsibility to return them safely.