Investigating differential risk factors through comparison of coal fatalities in Australia, China, India, South Africa and the United States of America

Dr Jill Harris
Analysis of global coal mining fatalities

Benefits of collecting and analysing safety data (e.g. fatalities, injuries, high potential incidents):

- Identify prevalence of incidences
- Better understand the causes of safety failures
- Monitor the effectiveness of past and current safety interventions
- Communicate performance (e.g. corporate, industry reports)
- To guide health and safety strategy (i.e. continual improvement, design advances)
- Alert industry to “lessons learnt“
- Encourage vigilance
Global coal mining fatalities

• How do broad organisational, societal, economic, legislative or environmental conditions affect safety performance in coal mining?

• The objective of this study is to undertake a comparative analysis of coal mining fatalities across different countries; to provide a foundation of information for a more informed debate on safety management priorities for coal mining

• To determine if the hazards identified in the RISKGATE body of knowledge could be used to categorise safety data in Australia as well as that of other key mining countries
Overview of methodology

- Access narratives of coal mining fatalities in five countries (2006-2010)
- Classify each narrative according to 16 common coal mining hazards (RISKGATE)
- Checks to reduce coding errors
- Compilation of data
- Normalisation across countries
  a. Total hours worked per year
  b. Production (metric tonne, raw)

### Method

<table>
<thead>
<tr>
<th>Country</th>
<th>Source of narratives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>MISHC database compiled by David Cliff</td>
</tr>
<tr>
<td>China</td>
<td>State Administration of Work Safety of China</td>
</tr>
<tr>
<td>India</td>
<td>Directorate General of Mines Safety, Ministry of Labour &amp; Employment, Government of India</td>
</tr>
<tr>
<td>South Africa</td>
<td>Chamber of Mines of South Africa</td>
</tr>
<tr>
<td>US</td>
<td>Mines Safety &amp; Health Administration (MSHA) website, “Fatalgrams”</td>
</tr>
</tbody>
</table>

Frequency Rate = \( \frac{\text{number of fatalities}}{\text{1,000,000 metric tonnes}} \) / \( \text{total number of worker hours} \)
Example of fatality narratives

- **Australia**
- **China**
- **India**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/01/2010</td>
<td>Coal Mine</td>
<td>0</td>
</tr>
</tbody>
</table>

Additional text in Chinese:

"为安全副矿长、1名大工、2名小工。

2010年1月15日16时30分，山西省晋中市灵石煤矿有限公司二采区皮带运输大巷在维修清理过程中发生顶板冒落并出现透水，造成4人被困（当班6人，其中2人脱险）。"
Results: Total coal mining fatalities (2006 to 2010)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total number of fatalities</th>
<th>Total coal production (per million metric tonne)</th>
<th>Total number of hours worked (per million hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>9</td>
<td>2487.6</td>
<td>437.2</td>
</tr>
<tr>
<td>China</td>
<td>4712</td>
<td>13556.5</td>
<td>N/A</td>
</tr>
<tr>
<td>India</td>
<td>519</td>
<td>2578.3</td>
<td>4840.4</td>
</tr>
<tr>
<td>South Africa</td>
<td>85</td>
<td>1252.9</td>
<td>694.1</td>
</tr>
<tr>
<td>US</td>
<td>177</td>
<td>5119</td>
<td>832.6</td>
</tr>
</tbody>
</table>

China: 2006-2010 - 3,550 people missing (not included as fatalities)
Fatal Injury Frequency Rates (Production)

China

Poor safety record, but rapidly improving

Reasons for improvement?
• Reduction in the number of small unregulated mines
• Increase in larger mines – mechanisation & improved safety practice
• Increasing enforcement

FIFR (production) weaknesses
• Fails to take into account the size of the workforce or
• length of time at work (overtime, length of shift)
Fatal injury frequency rates (hours worked)

High safety performance of Australia

**Environmental (geotech?)**

**Organisational Technical Legislative Societal**

<table>
<thead>
<tr>
<th>Country</th>
<th>Surface</th>
<th>Underground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aus</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>India</td>
<td>0.10</td>
<td>0.11</td>
</tr>
<tr>
<td>SA</td>
<td>0.09</td>
<td>0.21</td>
</tr>
<tr>
<td>US</td>
<td>0.14</td>
<td>0.27</td>
</tr>
</tbody>
</table>

**Upper Big Branch explosion 29 died**

Underground mining more dangerous

Similar safety outcomes
Hazards causing fatalities

Top three hazards causing coal mining fatalities (2006-2010)

<table>
<thead>
<tr>
<th>Country</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Collisions (3)</td>
<td>Isolation - mechanical (2)</td>
<td>Strata (1), Tyres (1), Isolation Hydraulic (1), Slips/trips/falls (1)</td>
</tr>
<tr>
<td>China</td>
<td>Explosions (1619)</td>
<td>Inrush (715)</td>
<td>Strata (616)</td>
</tr>
<tr>
<td>India</td>
<td>Collisions (170)</td>
<td>Strata (120)</td>
<td>Isolation - mechanical (70)</td>
</tr>
<tr>
<td>South Africa</td>
<td>Collisions (30)</td>
<td>Strata (22)</td>
<td>Isolation - mechanical (16)</td>
</tr>
<tr>
<td>US</td>
<td>Explosions (49)</td>
<td>Collisions (26)</td>
<td>Strata (26)</td>
</tr>
</tbody>
</table>

- Australia had only 1 death as a result of a major hazard, but they cause many deaths in other countries
- Collisions may not cause multiple deaths, but it does cause many deaths
Australian coal mining safety performance

Key Aspects to Australian Mining OHS Legislations

- **Risk Management**
  - Major Hazards Management Plans

- **Duty of Care**
  - Employer
  - Employee

- **Stakeholder Involvement**
  - Workplace plays an inherent role in implementing OHS management
Coal mining fatalities in Australian (1991-2010)

Qualitative changes over 2 decades

- Change in the types of hazards that were causing most deaths
- 2001-2010: 0 multiple death accidents; no deaths from explosions, inrush, outburst; strata deaths dropped from 13 to 5

Quantitative & qualitative change in analyses of coal mining fatalities in Australia
Conclusion

- Australia’s very good safety performance (fatalities)
  - Underground is more dangerous than surface coal mining in US and South Africa, but not in Australia
  - Major hazards continue to cause most deaths in China and the US; but not in Australia, India and South Africa
- Risk-based legislation may be driving the improvement in Australian coal mines
- Across countries there is evidence of a maturity or journey model in regard to managing hazards
Project team

- Philipp Kirsch
- Meng Shi
- Jirui Li
- David Cliff
- Ankita Gagrani
- Anand Krishna
- Ahmad Tabish
- Deepanshu Arora
- Kishore Kothandaraman