



Underground Mining Sector Root Cause Analysis Workshop Results and Next Steps

A focused approach to improving workplace health and safety

Sam Barbuto

Health and Safety Specialist

Robert Marin

Open Pit and Surface Plants Health and Safety Specialist

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1 888 730 7821 (Toll free Ontario)
workplacesafetynorth.ca



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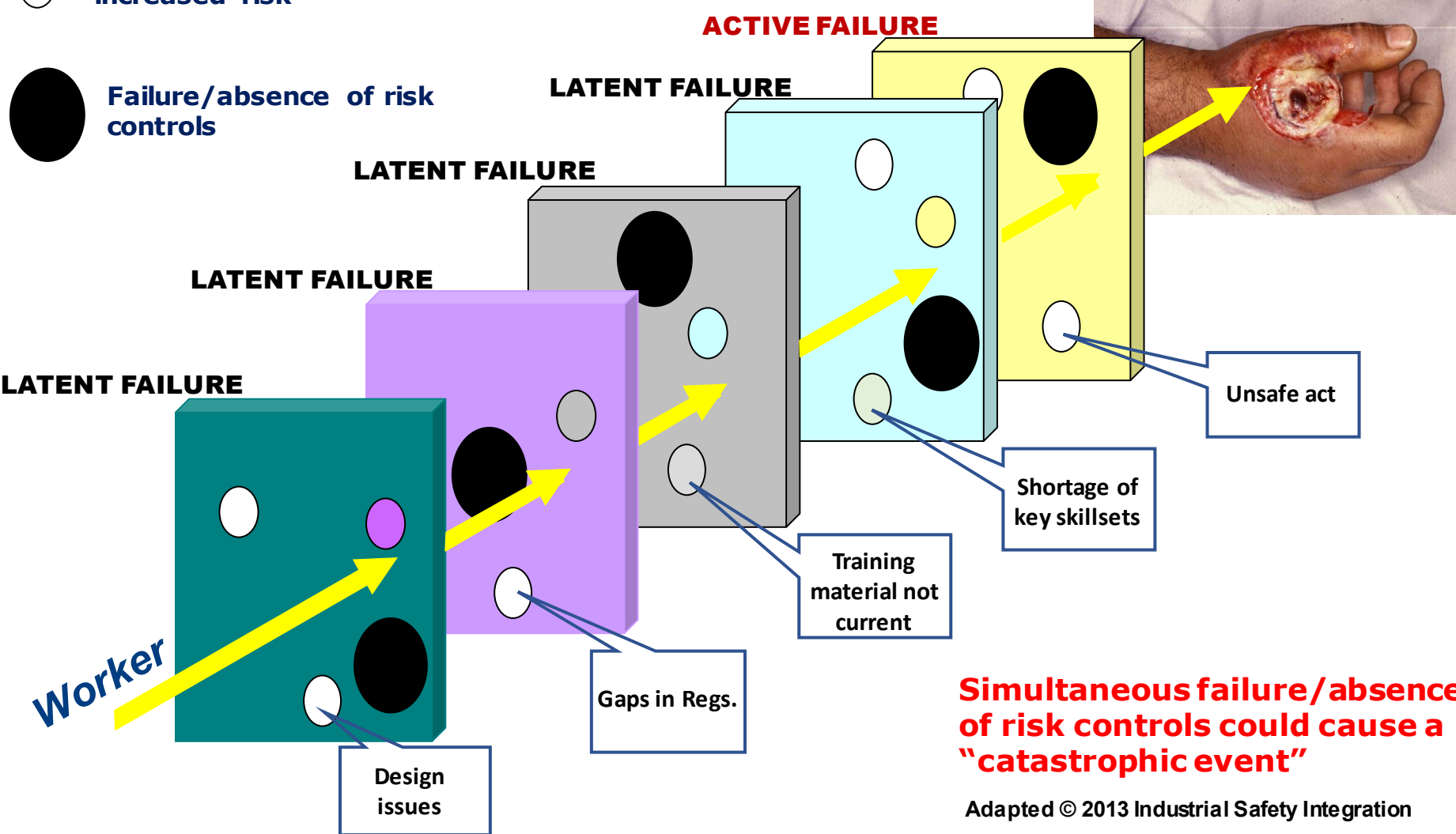
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Risk Assessment Project

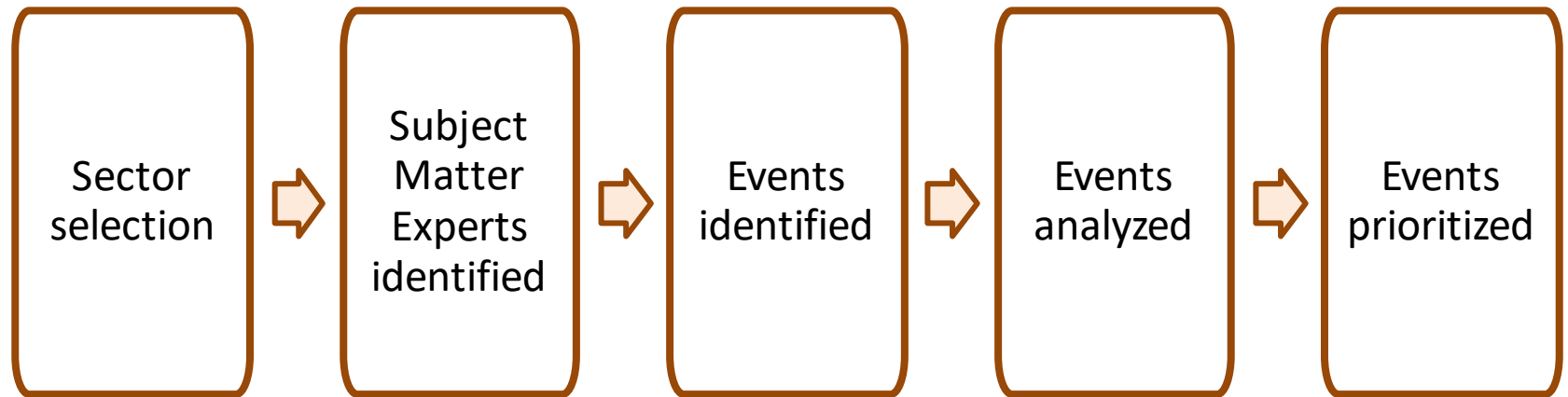
○ Examples that could lead to increased risk

● Failure/absence of risk controls



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Workshop: A tripartite and collective process



Workshop: A Tripartite and Collective Process

Workshop process was open, transparent, and collaborative:

- Ensured perspectives/viewpoints were heard
- Responses were respected, not freely edited
- Final list shared with participants before workshop
- Workshop results reviewed/validated by participants

Finding acceptable solutions that all members can support:

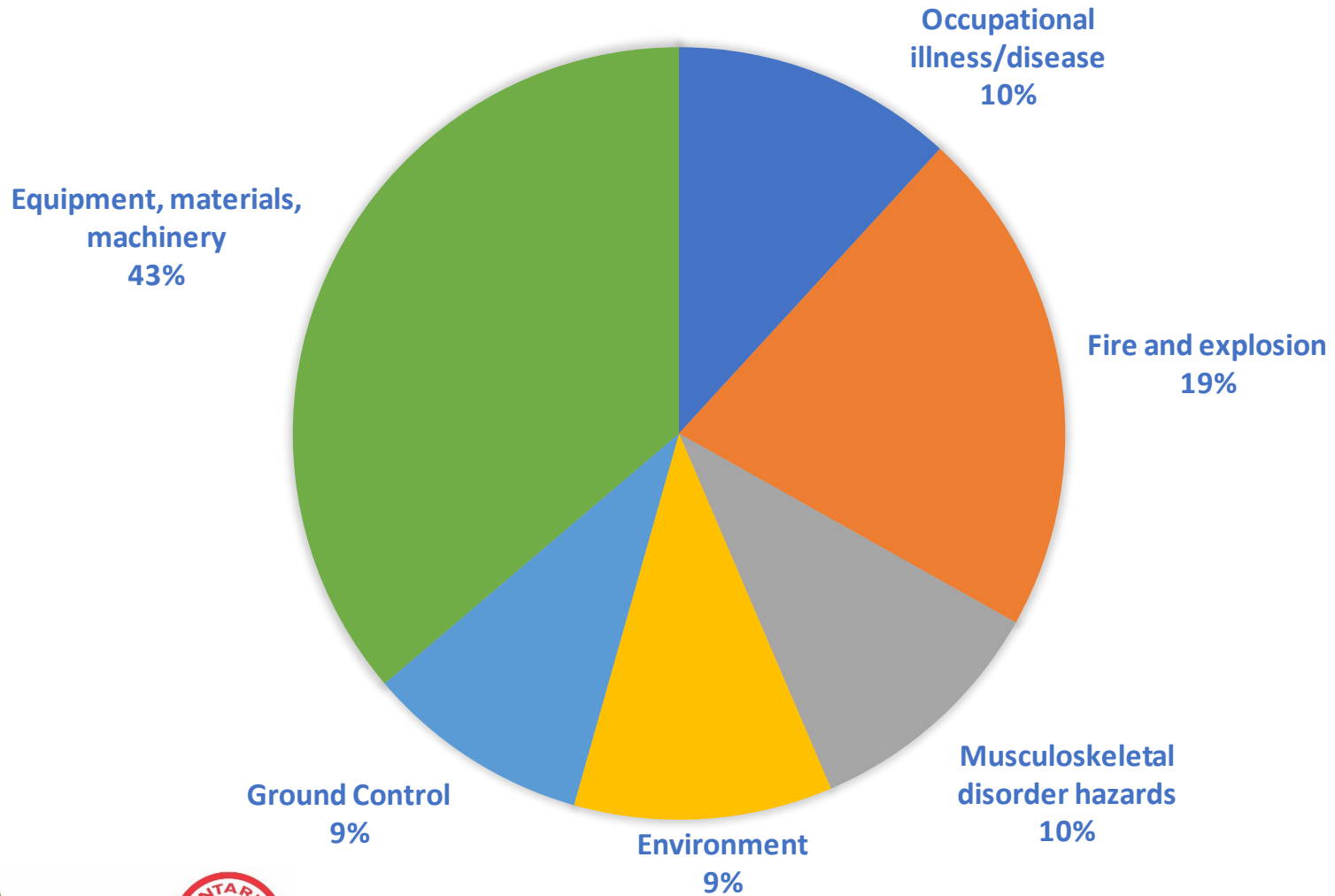
- Only industry experts ranked the risks
- Process was NOT about consensus (although results demonstrate a significant degree of convergence)

Risk Assessment Workshop Results:

Top 10 risk categories based on highest risk within that category

Rank	Category	Event (Situation/Condition) that could result in Injury or Illness OR <i>“What could keep you up at night?”</i>
1	Equipment, materials, machinery	Interaction with mobile equipment – equipment collision with other equipment (large vs small) – traffic control
2	Equipment, materials, machinery	Interaction with mobile equipment and pedestrian
3	Fire and explosion	Adoption of new technology: battery electric vehicle fires – battery electric vehicle overheats, catches fire, or explodes underground (injuring operators, miners and/or mine rescue personnel)
4	Musculoskeletal Disorder Hazards	Worker suffers manual handling or repetitive strain injury
5	Ground Control	Ground control failure causing injury
6	Occupational illness/disease	Exposure to airborne substances
7	Equipment, materials, machinery	Interaction with mobile equipment – collision with infrastructure (conveyors, towers, etc.)
8	Equipment, materials, machinery	Inadvertent contact with stored energy
9	Occupational illness/disease	Hearing loss
10	Fire and explosion	Major fire underground from mobile equipment

Top Underground Mining Sector Risk Categories



Analysis of Top 10 Risk Events

Contributing factors and undesired outcomes identified in the following overall ranking/categories (three factors per top five)

Rank	Risk Category	Contributing Factor	Result
1	Equipment, materials, machinery	<ul style="list-style-type: none"> • Larger equipment with reduced sightlines • Brighter ambient lighting and equipment headlights washing out lights of oncoming vehicles • Lack of collision avoidance technology 	Collision with people and other equipment
2	Fire and explosion	<ul style="list-style-type: none"> • Autonomous equipment • Specialized explosives • Inadequate preventative maintenance programs 	Injury to worker, damage to equipment, loss of process
3	Occupational disease	<ul style="list-style-type: none"> • Lack of or inadequate engineering or ventilation plan • Mobile equipment in disrepair • Inconsistent diesel emissions testing 	Injury to worker, long-term effects resulting in occupational disease
4	MSDs	<ul style="list-style-type: none"> • Inexperienced workforce • Inadequate planning and supervision • Worker shortage contributes to overloading personnel 	Injury to a worker, long-term effects of injury
5	Ground Control	<ul style="list-style-type: none"> • Mining at depth • Mining in high-stress ground • Changes in mining plan with improper risk review 	Injury to a worker, damage to equipment, loss of process

Top 10 Health and Safety Risks in Underground Mines

Interaction with mobile equipment is top risk

As identified by workers, supervisors, and employers in the Ontario mining industry through a Ministry of Labour, Immigration, Training and Skills Development-facilitated risk assessment workshop in partnership with Workplace Safety North.



1. Interaction with mobile equipment - collision with other equipment (large vs small) - traffic control



6. Exposure to airborne hazardous substances



2. Interaction with mobile equipment and pedestrian



7. Interaction with mobile equipment - collision with infrastructure (conveyors, towers, etc.)



3. Adoption of new technology: Battery electric vehicle fires or explosions injure workers or mine rescue personnel



8. Inadvertent contact with stored energy



4. Worker suffers manual handling or repetitive strain injury



9. Hearing loss



5. Ground control failure causing injury



10. Major fire underground from mobile equipment

For more information, please contact your WSN Health and Safety Specialist or visit workplacesafetynorth.ca

Risk assessment infographic showing top 10 health and safety risks underground mines

Root Cause Analysis Workshop: Participants

SUBJECT MATTER EXPERTS

#	Name	Company/Representative
1	Craig Allair	Vale
2	Nav Gill	KGHM
3	Rick Legree	Barrick
4	Herb Watkins	KGHM
5	Richard Claveau	Newmont
6	Chris Betsill	Redpath
7	Loye Halteman	Barrick
8	Jake Hughes	Technica
9	Bruno Fortin	Vale
10	Darren Raymond	Compass Minerals

WORKSHOP PARTICIPANTS

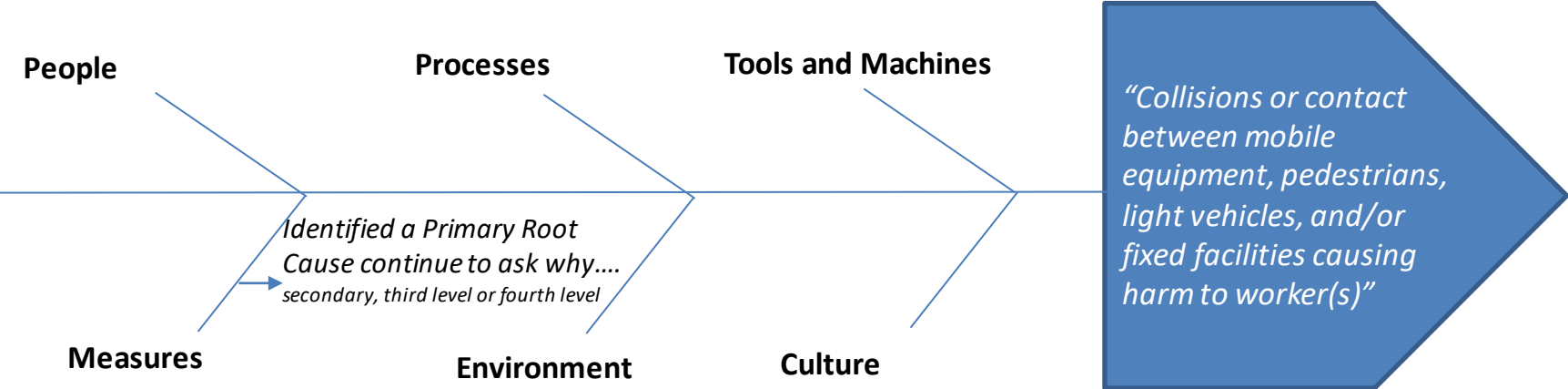
#	Name	Company/Representative
11	Harsim Kalsi	Ministry of Labour, Immigration, Training & Skills Development
12	Sujoy Dey	Ministry of Labour, Immigration, Training & Skills Development
13	Sam Barbuto	Workplace Safety North: Facilitator
14	Robert Marin	Workplace Safety North: Facilitator
15	Tom Welton	Workplace Safety North: Director
16	Tricia Valentim	Workplace Safety North: Tech Support
17	Tiana Larocque	Workplace Safety North: Tech Support

Root Cause Analysis: Risk Statement

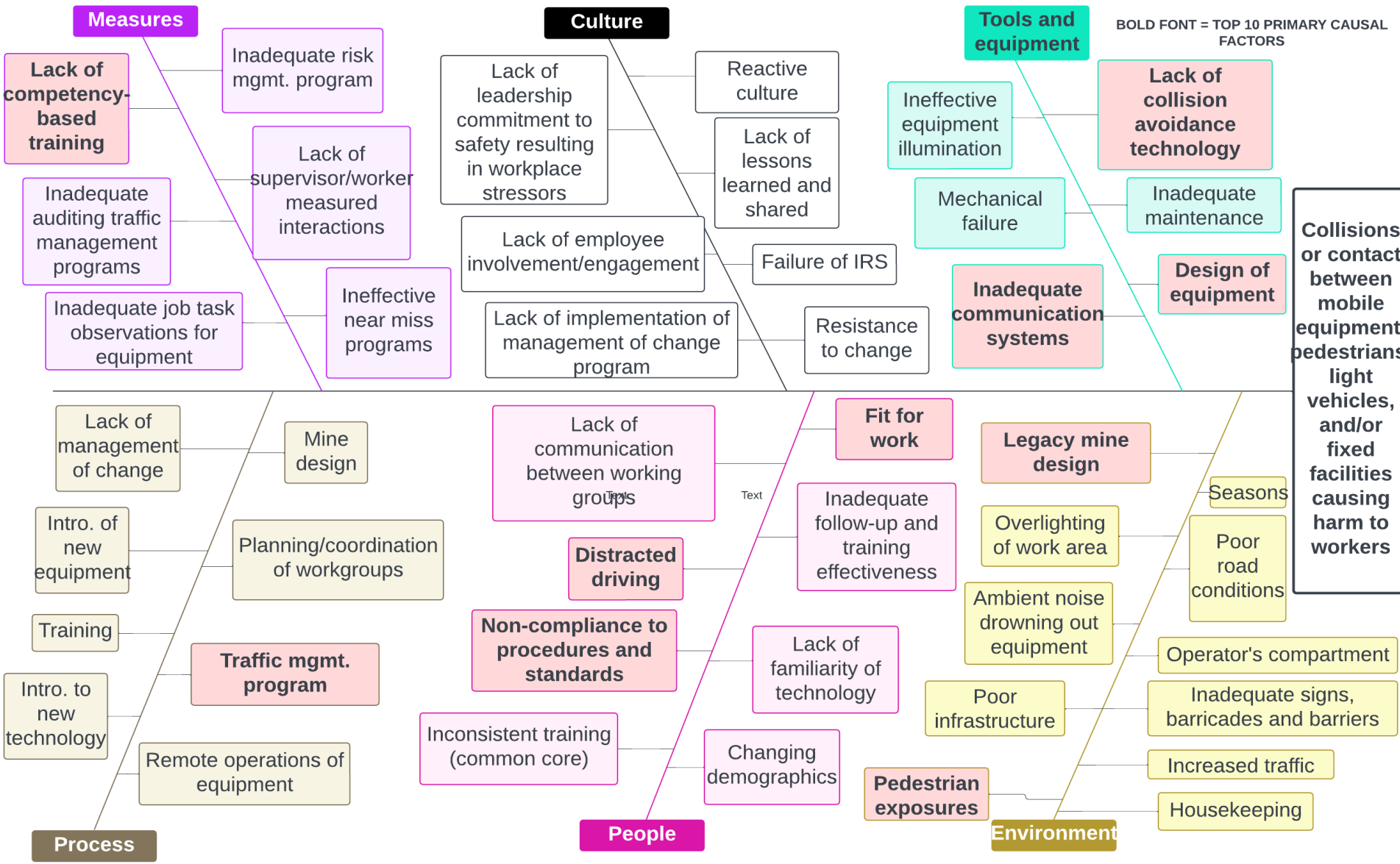
Based on risk assessment results and further analysis, the Root Cause Analysis working group confirmed and developed the following risk statement using the “**Fishbone**” approach addressing

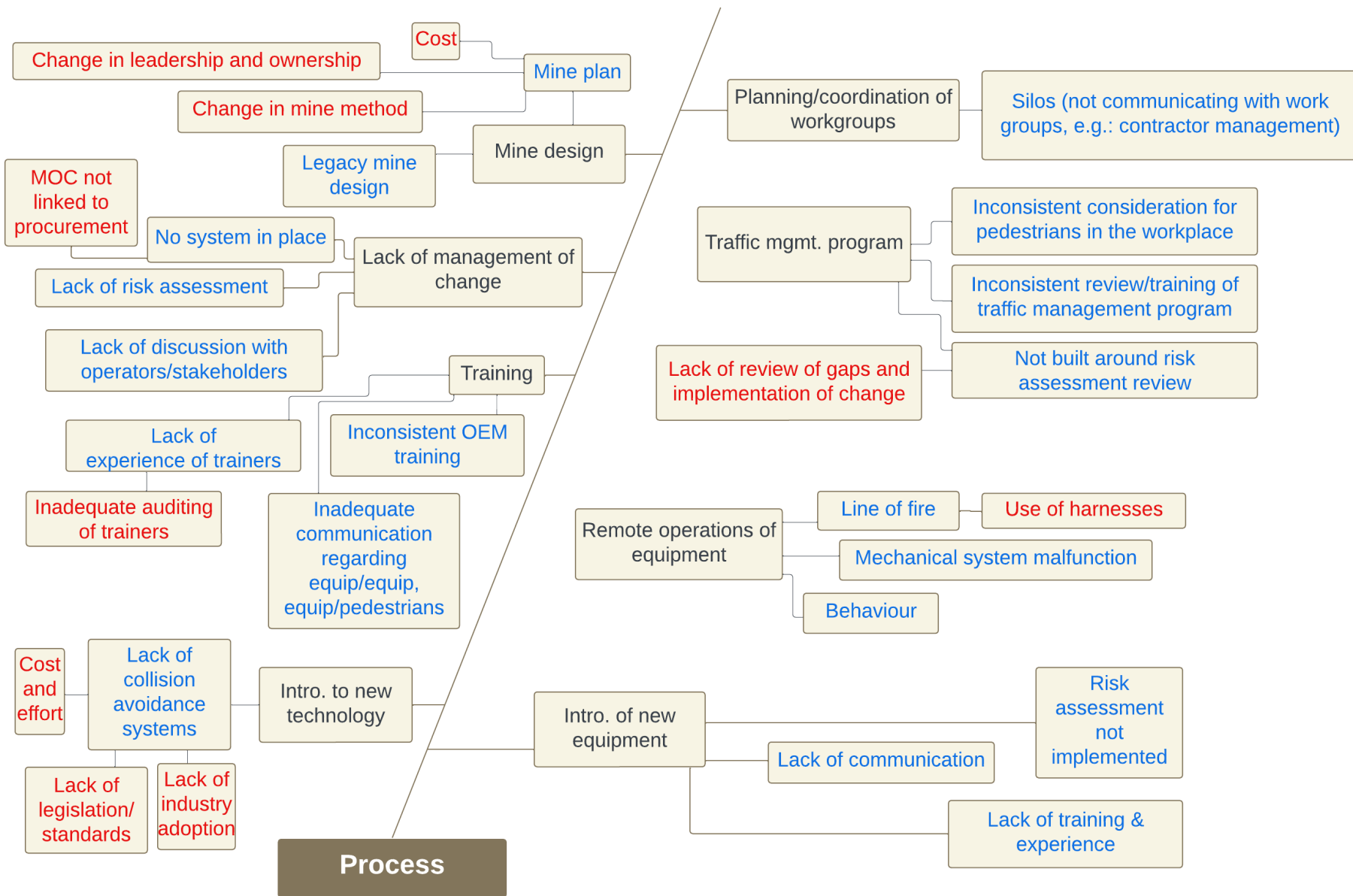
“Collisions or contact between mobile equipment, pedestrians, light vehicles, and/or fixed facilities causing harm to worker(s).”

Fishbone Diagram

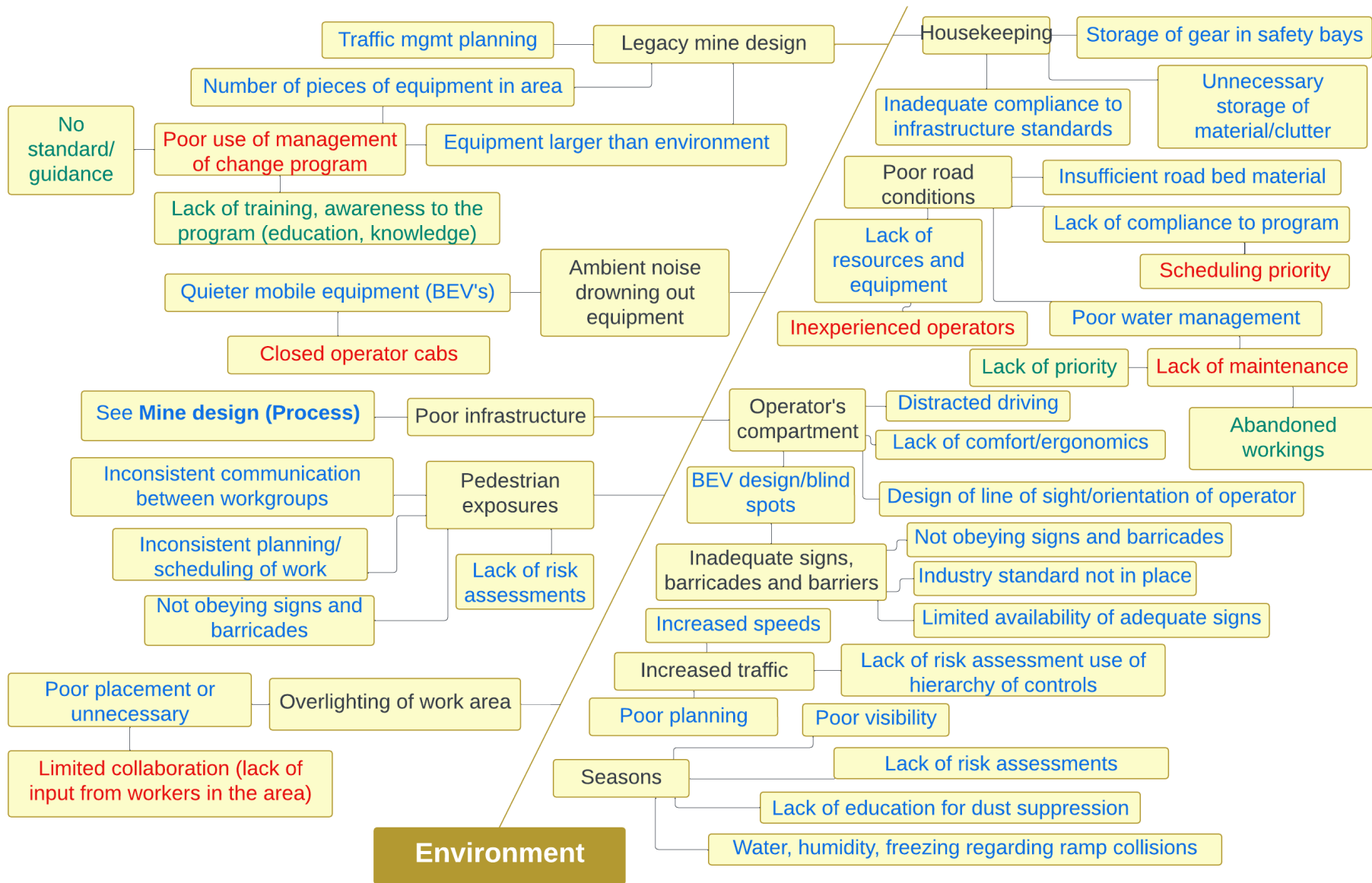


BOLD FONT = TOP 10 PRIMARY CAUSAL FACTORS



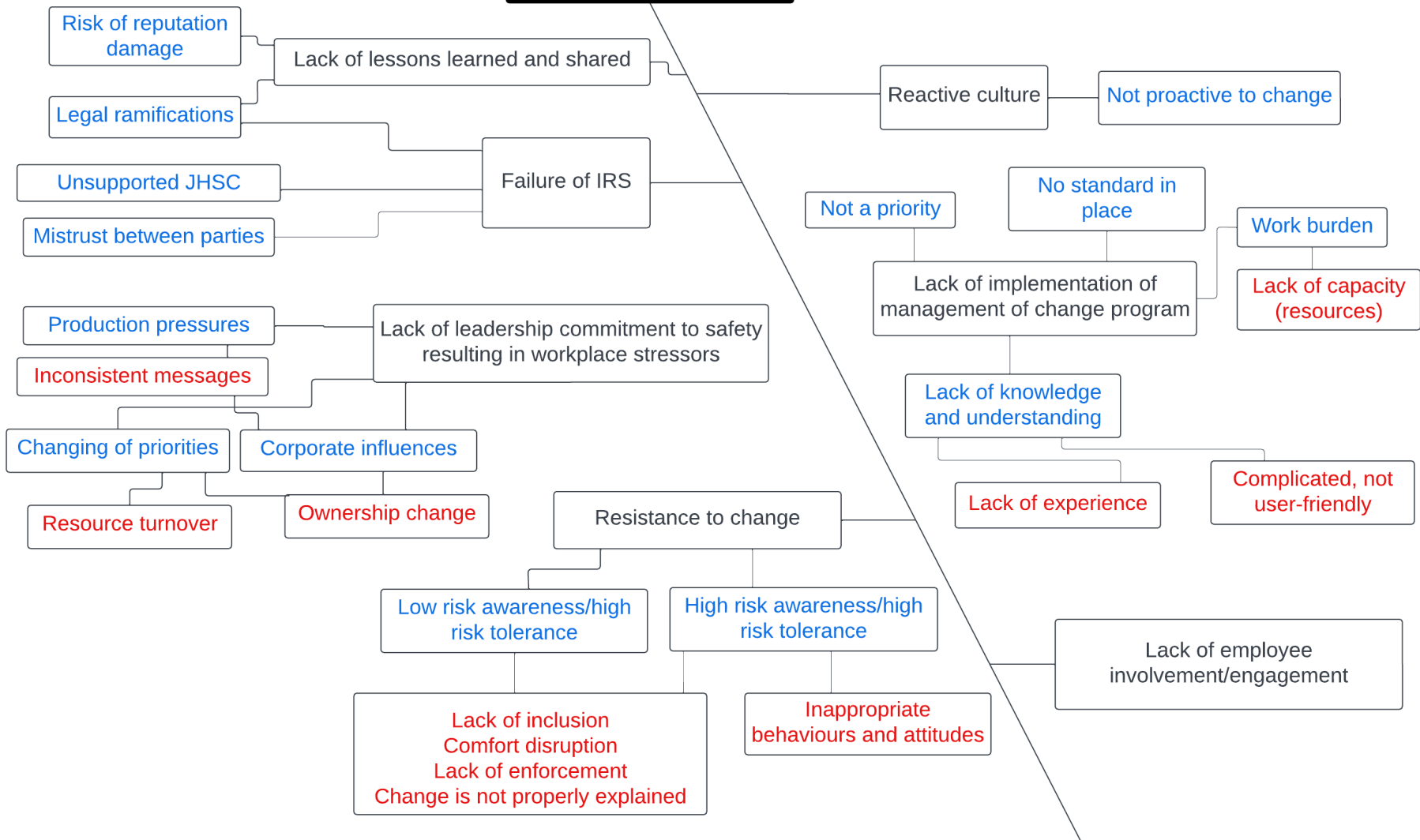


Black – Primary Causal Factor
 Blue – Secondary Causal Factor
 Red – Tertiary Causal Factor
 Green – Quaternary Causal Factor



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Culture



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 Green – Quaternary Causal Factor

Top Primary Causal Factors

Ranking	Category	Primary Root-Cause
1	Tools and Equipment	Design of equipment
2	Environment	Historic mine workings mismatched with modern equipment
3	People	Non-compliance to procedures and standards
4	Process	Ineffective traffic management program
5	Tools and Equipment	Inadequate communication systems
6	Tools and Equipment	Lack of confidence in collision avoidance technology
7	Environment	Pedestrian exposures to mobile equipment
8	People	Distracted driving
9	People	Fit for work
10	Measures	Ineffective assessment of training competencies

Top 10 Causes of Collisions in Underground Mines

Worker injury can be severe or fatal

As identified by workers, supervisors, and employers in the Ontario mining industry through a root cause analysis workshop in partnership with Workplace Safety North.



1. Design of equipment



6. Lack of confidence in collision avoidance technology



2. Older mine workings don't match modern equipment



7. Pedestrian exposure to mobile equipment



3. Non-compliance to procedures and standards



8. Distracted driving



4. Ineffective traffic management program



9. Mental and physical health (fit for duty)



5. Inadequate communication systems



10. Ineffective assessment of training competencies

For more information, please contact your WSN Health and Safety Specialist or visit workplacesafetynorth.ca

Root cause analysis infographic showing top 10 primary causes of collisions in underground mines

List of Solutions and Controls for the Top Primary Root Causes

Note:

- Scope of this exercise does not include assessment of listed controls.
- List provides information on specific controls and/or activities that support a control.
- Control performance should be **specific, measurable, observable, and auditable**

Next Steps: What should we focus on immediately?

Based on controls identified for the Top Primary Causal Factors, it would be beneficial, as a start, to focus right away on the following systemic weaknesses:

Ranking	Category	Primary Root-Cause
1	Tools and Equipment	Design of equipment
2	Environment	Historic mine workings mismatched with modern equipment
3	People	Non-compliance to procedures and standards
4	Process	Ineffective traffic management program
5	Tools and Equipment	Inadequate communication systems
6	Tools and Equipment	Lack of confidence in collision avoidance technology
7	Environment	Pedestrian exposures to mobile equipment
8	People	Distracted driving
9	People	Fit for work
10	Measures	Ineffective assessment of training competencies

Next Steps: Proactive efforts of the Mining Legislative Review Committee (MLRC)

- The following results will be shared with the Mining Legislative Review Committee (MLRC), and the Provincial Mining Tripartite Committee (MTC) for consideration in the development of future health and safety related supports and direction for the mining sector.
- The workshops identified primary causal factors and specific controls will assist in the establishment and in supplementing:
 - Industry leading practices
 - Knowledge of legislation and standards
 - Future development of supervisor common core training

Thank you for helping make workplaces safer

Questions?

Workshop Contacts

Sam Barbuto

Health and Safety Specialist

SamBarbuto@workplacesafetynorth.ca

Robert Marin

Open Pit and Surface Plants Health and
Safety Specialist

RobertMarin@workplacesafetynorth.ca



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