Underground Mining Sector Root Cause Analysis Workshop Results and Next Steps

A focused approach to improving workplace health and safety

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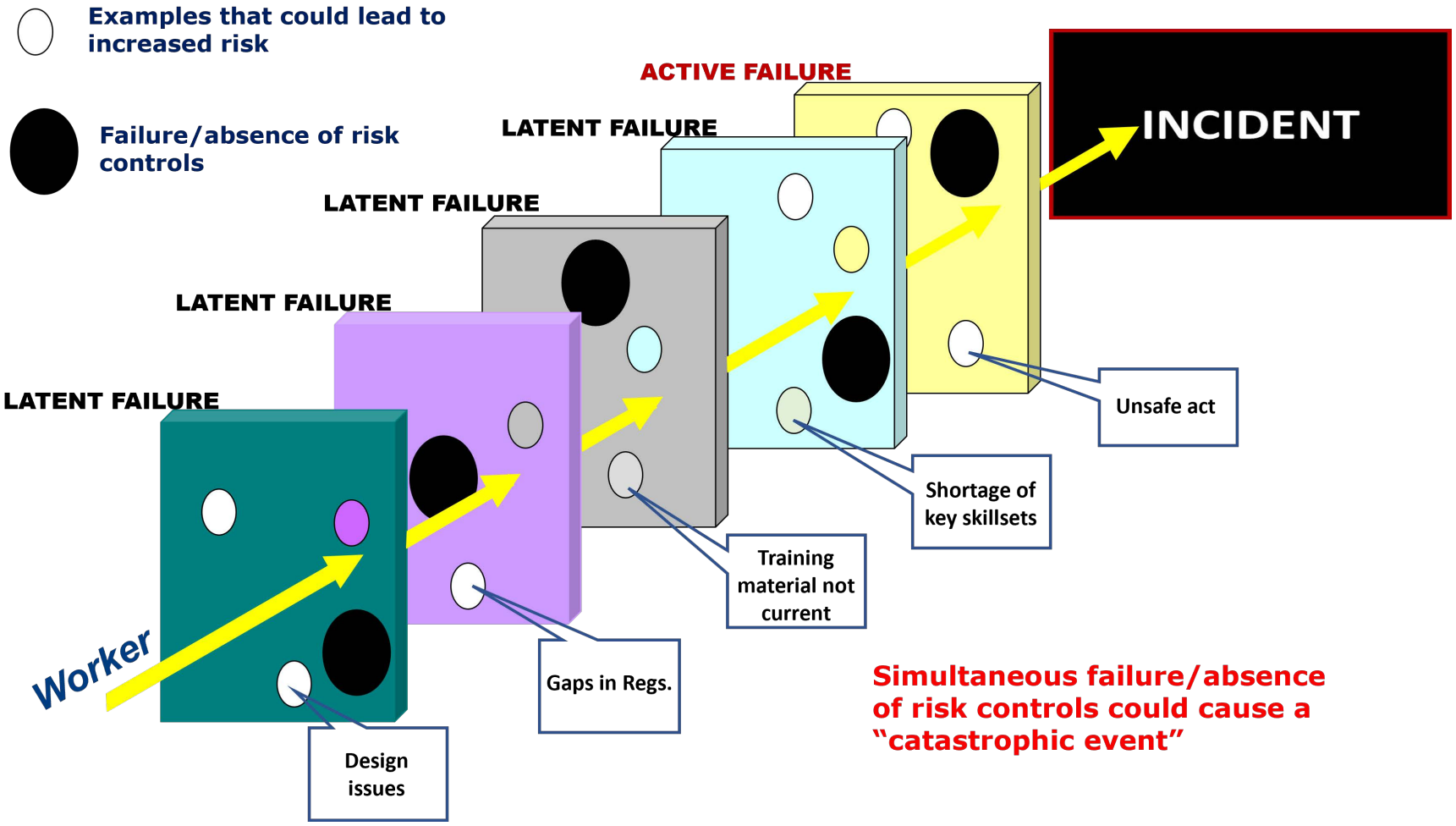
Table of contents

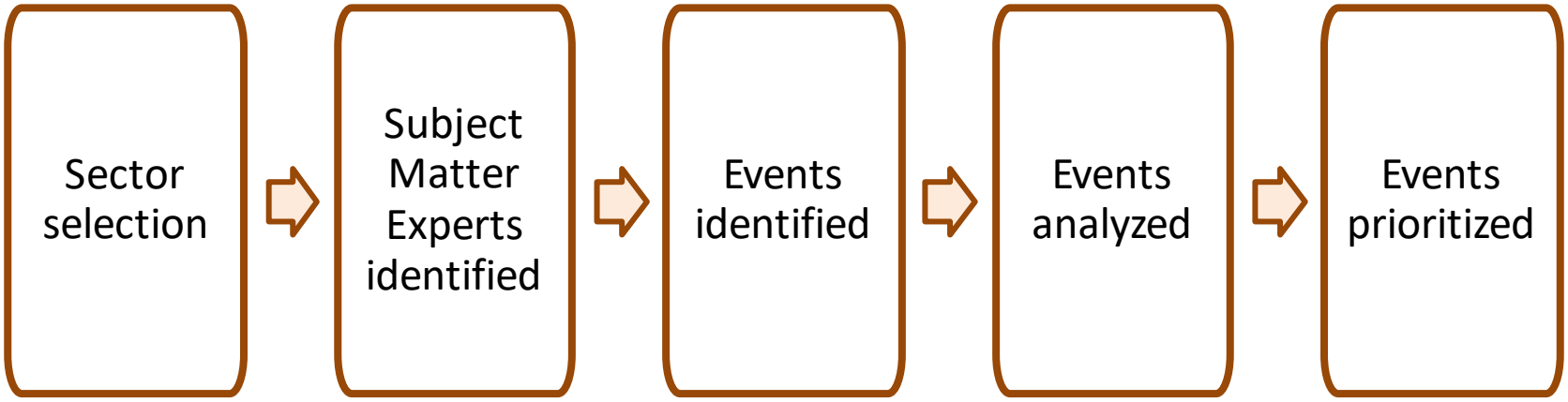
Risk Assessment Project
Background: Reason's model of accident causation
Workshop: A Tripartite and Collective Process
Risk Assessment Workshop Results: Top 10 risk categories
Top Underground Mining Sector Risk Categories
Analysis of Top 10 Risk Events – Contributing Factors
Infographic: Top 10 Health and Safety Risks in Underground Mines 2023
Root Cause Analysis Workshop Participants
Root Cause Analysis Risk Statement defined
Fishbone Diagram and Method
Fishbone Results by Category
Top Primary Causal Factors
Infographic: Top 10 Causes of Collisions in Underground Mines
List of Solutions and Controls for the Top Primary Root Causes
  Next Steps: What should we focus on immediately?
  Next Steps: Proactive efforts of the Mining Legislative Review Committee (MLRC)

Risk Assessment Project



Simultaneous failure/absence of risk controls could cause a "catastrophic event"

Workshop: A tripartite and collective process



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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:

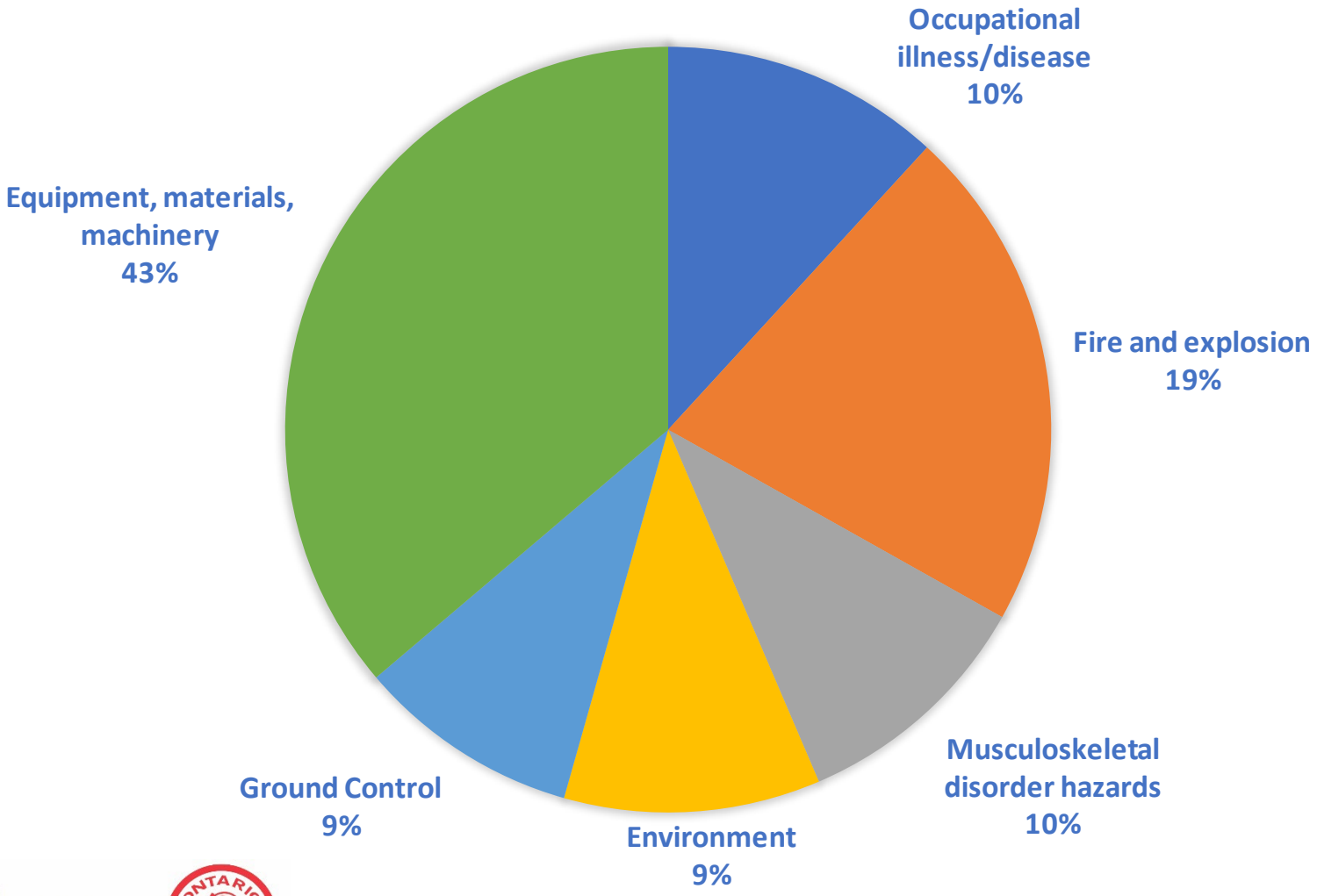
- Only industry experts ranked the risks
- Process was NOT about consensus (although results demonstrate a significant degree of convergence)

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 *"What could keep you up at night?"*
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



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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**	• 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**	• Autonomous equipment • Specialized explosives • Inadequate preventative maintenance programs	Injury to worker, damage to equipment, loss of process
3	**Occupational disease**	• 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**	• Inexperienced workforce • Inadequate planning and supervision • Worker shortage contributes to overloading personnel	Injury to a worker, long-term effects of injury
5	**Ground Control**	• 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

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

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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

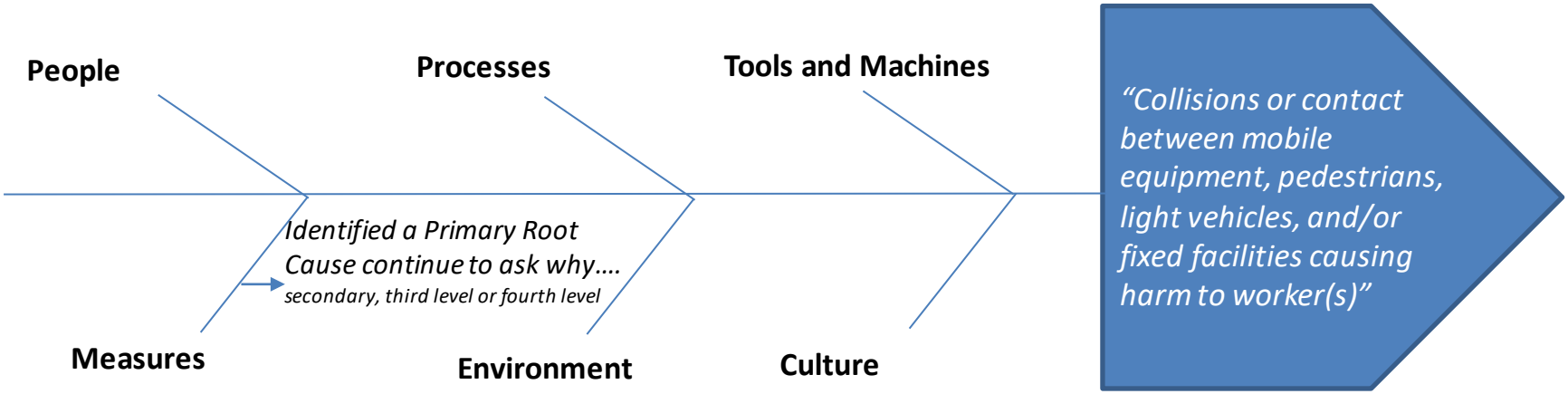
WORKSHOP PARTICIPANTS		
#	Name	Company/Representative
11	Harsim Kalsi	Ministry of Labour, Immigration, Training & Skills Development
12	Sujoy Dey	Ministry of Labour, Immigration, Training & Skills Development
13	Sam Barbuto	Workplace Safety North: Facilitator
14	Robert Marin	Workplace Safety North: Facilitator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

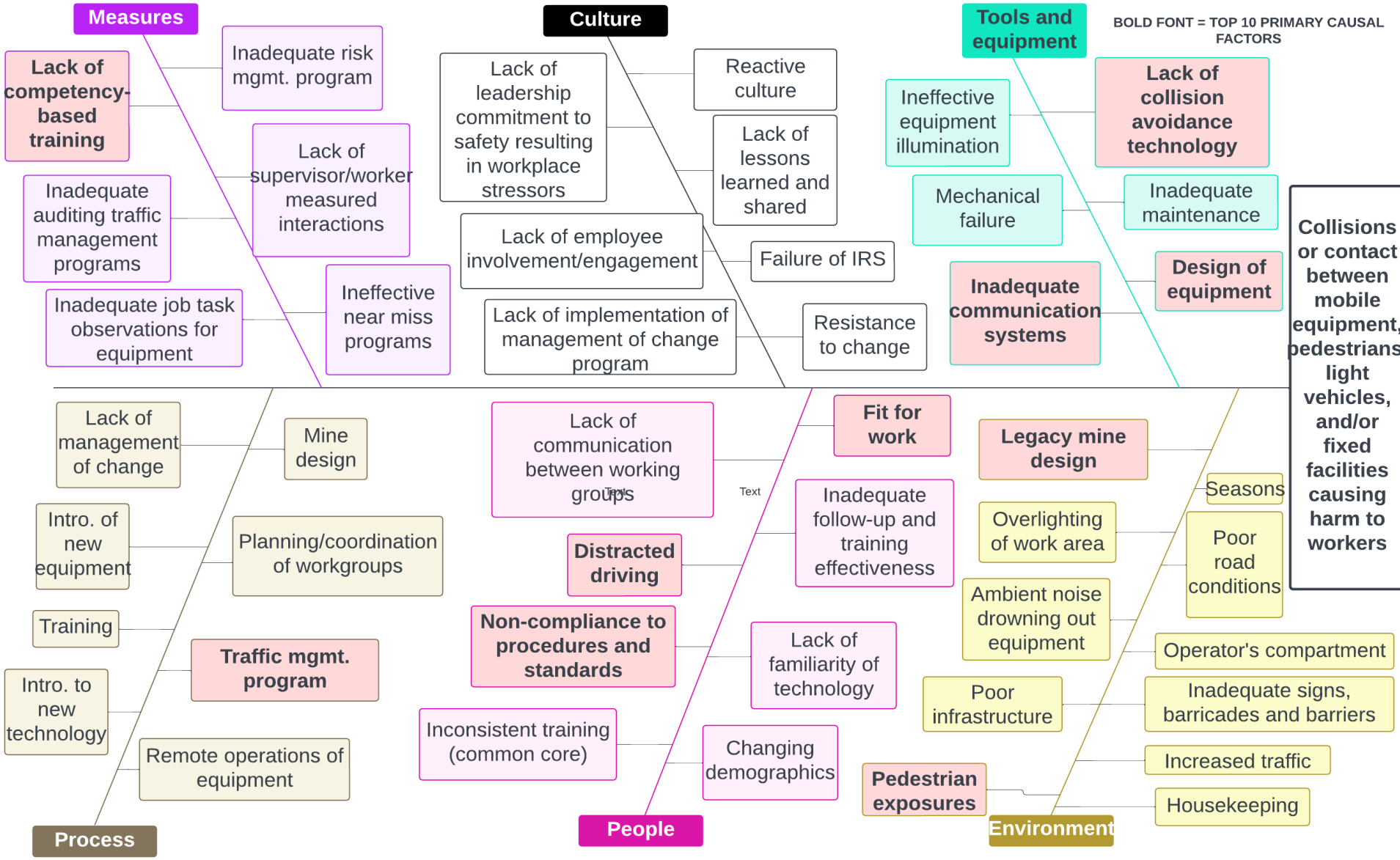
Root Cause Analysis: Risk Statement

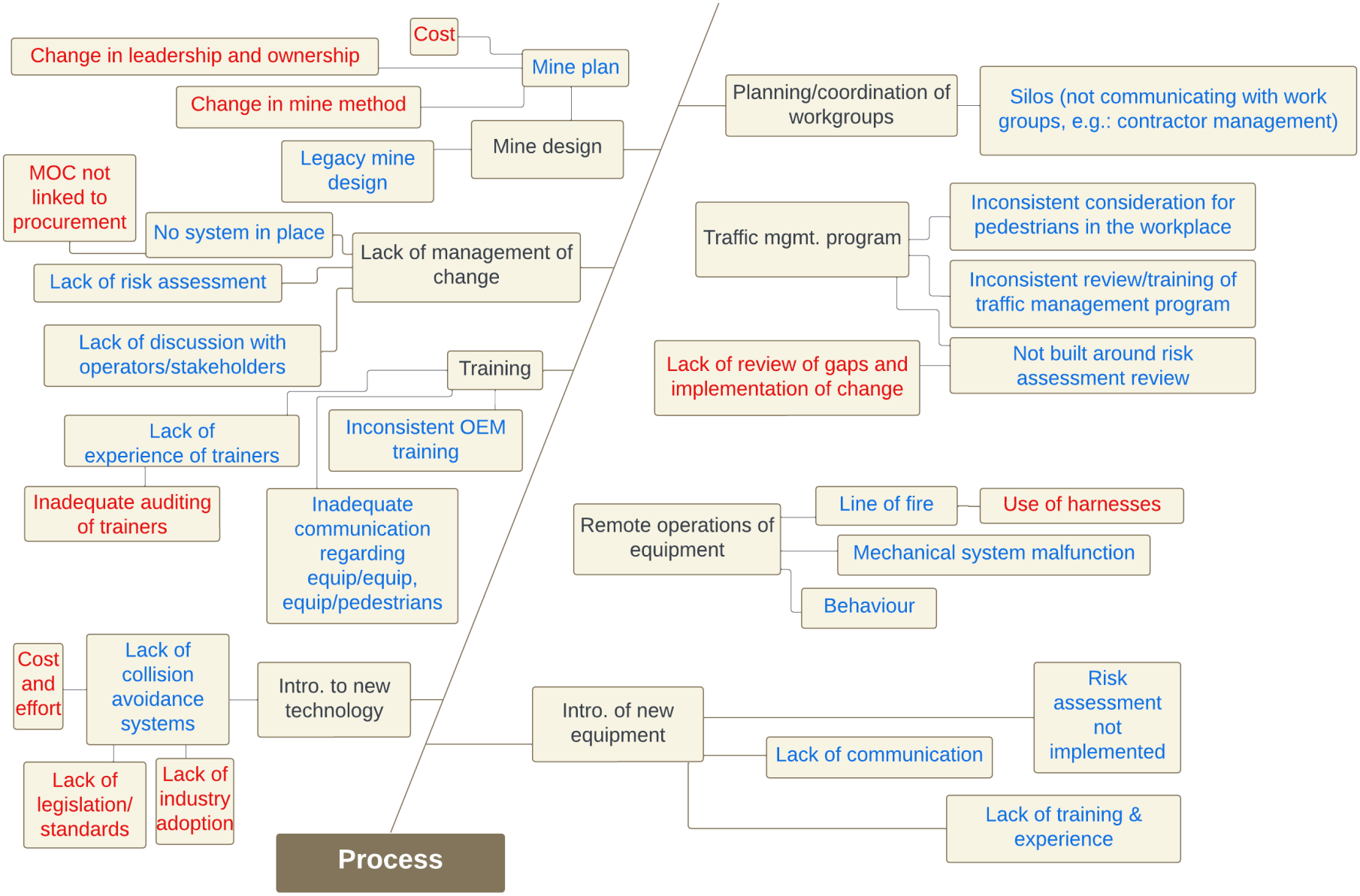
Based on risk assessment results and further analysis, the Root Cause Analysis working group confirmed and developed the following risk statement using the **"Fishbone"** approach addressing

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

Fishbone Diagram




Measures
Lack of competency-based training
Inadequate risk mgmt. program
Lack of supervisor/worker measured interactions
Inadequate auditing traffic management programs
Inadequate job task observations for equipment
Ineffective near miss programs
Culture
Lack of leadership commitment to safety resulting in workplace stressors
Reactive culture
Lack of lessons learned and shared
Lack of employee involvement/engagement
Failure of IRS
Lack of implementation of management of change program
Resistance to change
Tools and equipment
BOLD FONT = TOP 10 PRIMARY CAUSAL FACTORS
Ineffective equipment illumination
Lack of collision avoidance technology
Mechanical failure
Inadequate maintenance
Design of equipment
Inadequate communication systems
Collisions or contact between mobile equipment, pedestrians light vehicles, and/or fixed facilities causing harm to workers
Process
Lack of management of change
Mine design
Intro. of new equipment
Planning/coordination of workgroups
Training
Traffic mgmt. program
Intro. to new technology
Remote operations of equipment
People
Lack of communication between working groups
Text
Text
Fit for work
Inadequate follow-up and training effectiveness
Distracted driving
Non-compliance to procedures and standards
Lack of familiarity of technology
Inconsistent training (common core)
Changing demographics
Environment
Legacy mine design
Seasons
Overlighting of work area
Poor road conditions
Ambient noise drowning out equipment
Operator's compartment
Poor infrastructure
Inadequate signs, barricades and barriers
Pedestrian exposures
Increased traffic
Housekeeping



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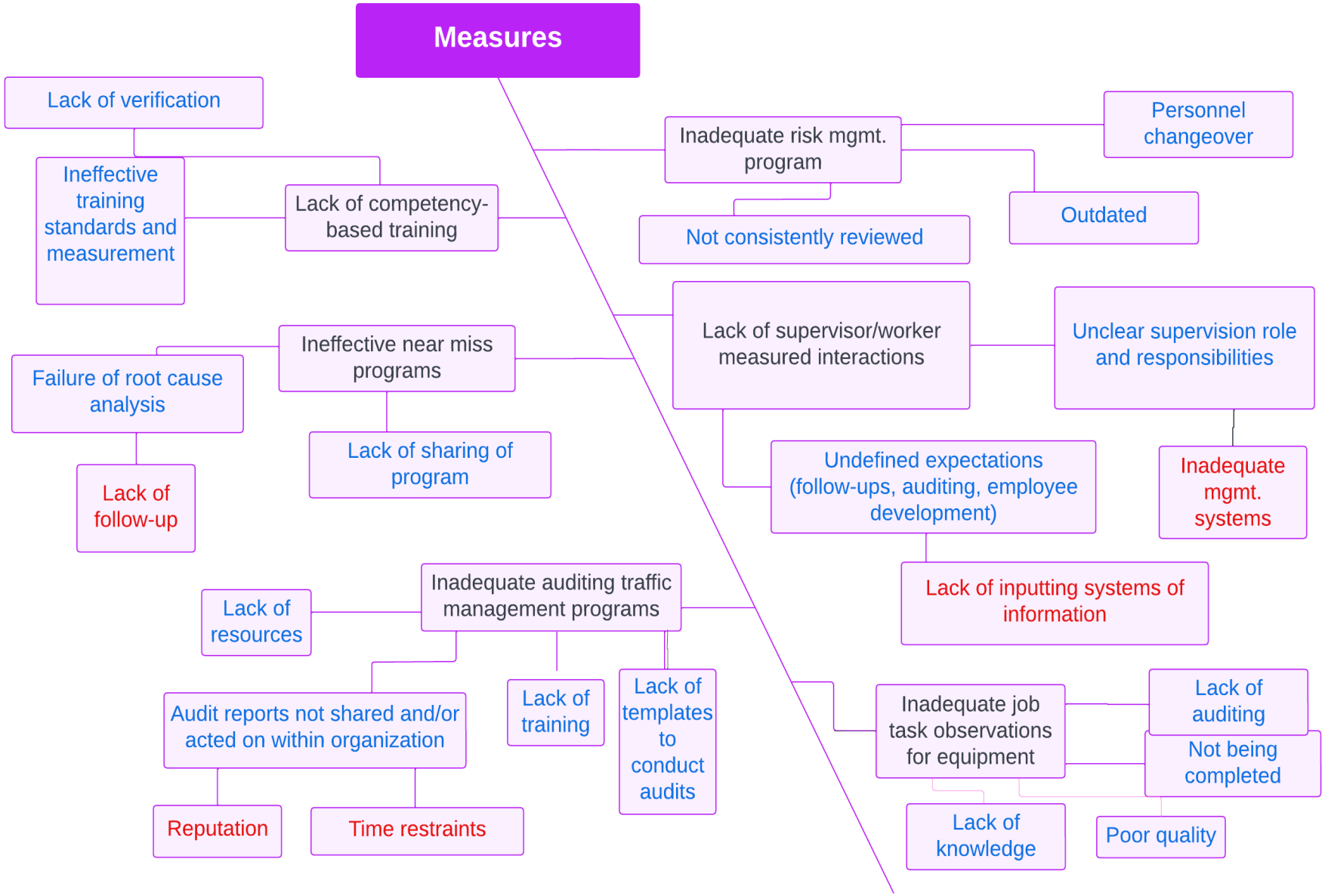

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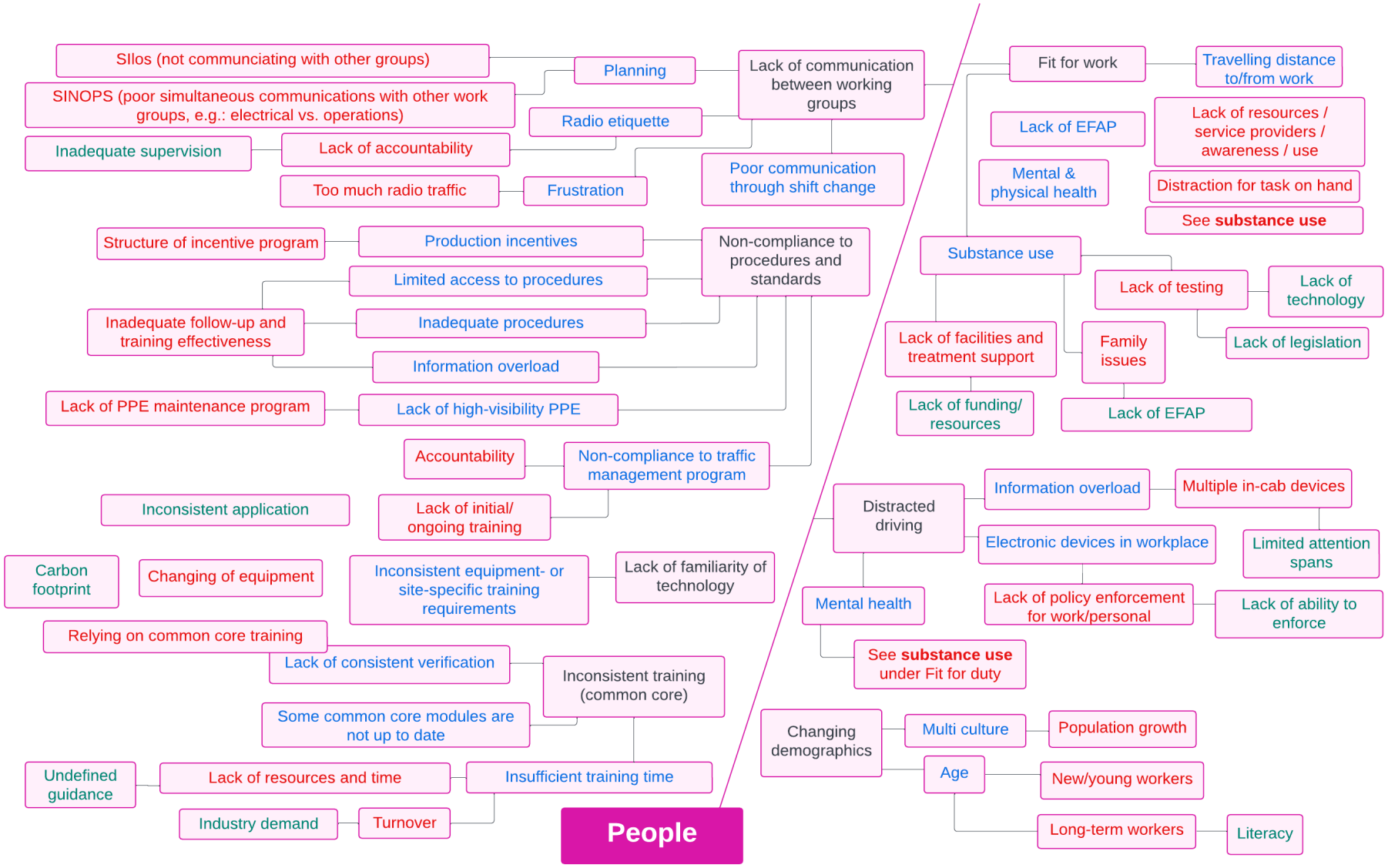

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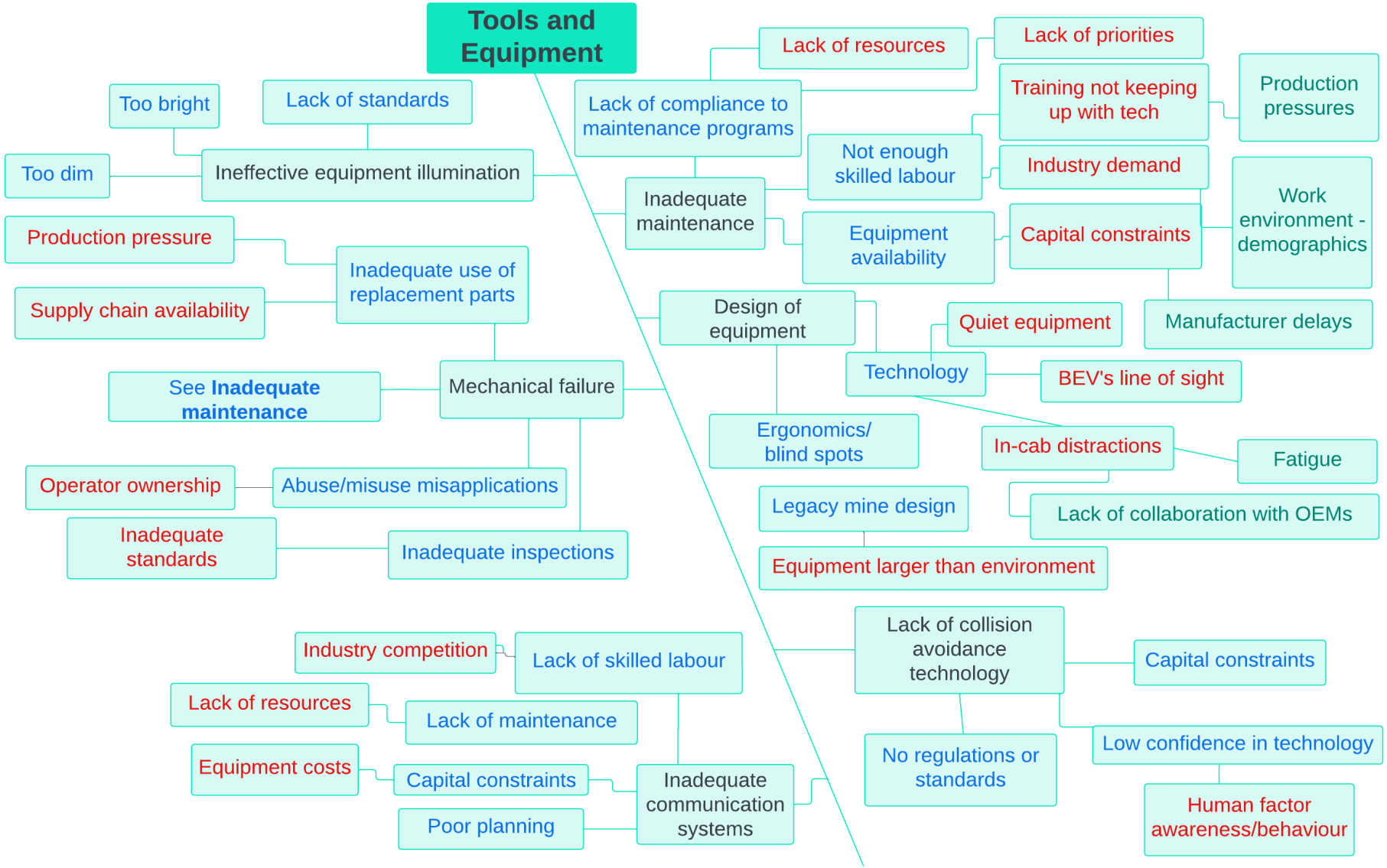

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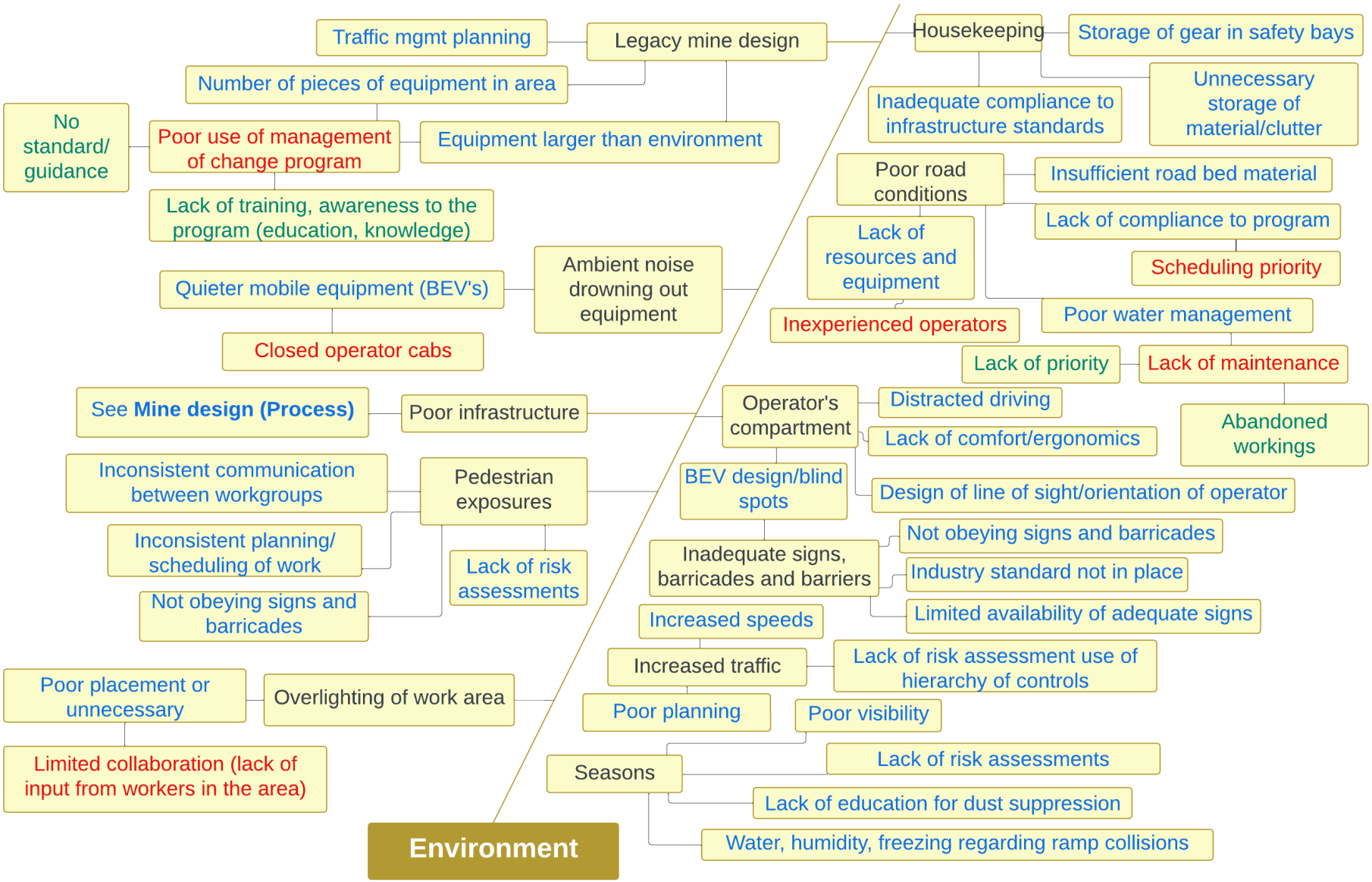

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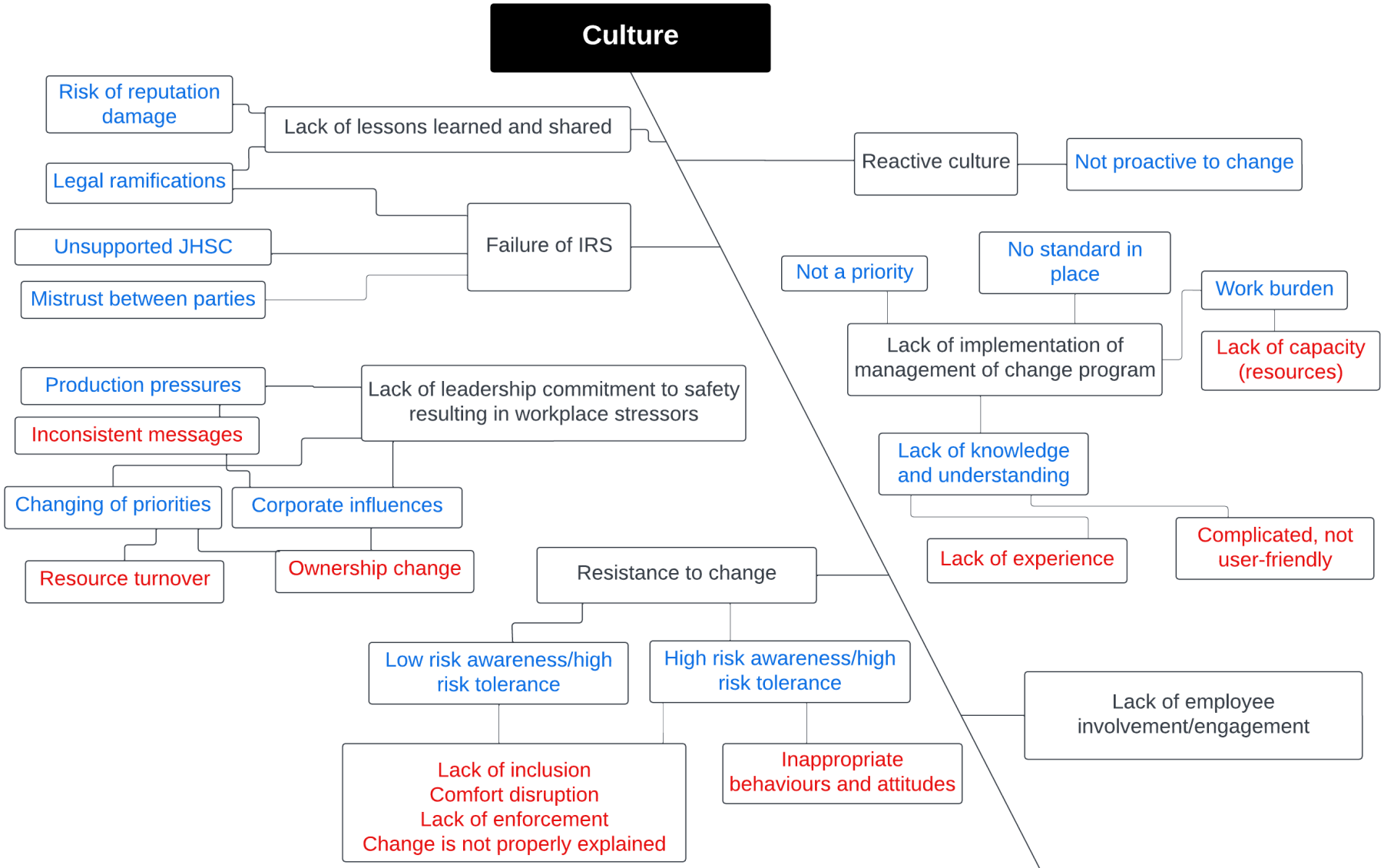

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Top Primary Causal Factors

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

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?

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