To Trust or Not To Trust:

Factors that Influence Mineworkers' Trust in Proximity Detection Systems for Mobile Machines

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Holmes National Meeting and Training Seminar

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Virginia Beach, VA

Presentation Objectives:

- ❑ Discuss why appropriate trust in technology is important for mine safety
- ❑ Describe proximity detection systems (PDSs)
- ❑ Summarize the methods, results, and conclusions from the NIOSH study
- ❑ Provide recommendations

Presentation Agenda:

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How much do you trust technology?

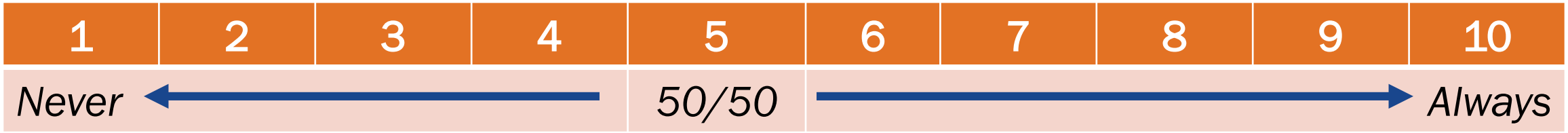
How much do you trust technology?

Not enough??

How much do you trust technology?

Too much??

How much do you trust _____?



Inappropriate trust has the potential to cause safety issues

Low Trust	Moderate Trust	High Trust
Disuse	**Appropriate use**	Misuse
Underutilization		Overreliance
Ignoring/Defeating		Improper monitoring

- Parasuraman & Riley, 1997

How much do mineworkers trust safety technology?

How much do mineworkers trust proximity detection systems for mobile machines (mobile PDSs)?

Pinning, crushing, and striking accidents involving equipment continue to be a major concern in the mining sector

1984-2013 preventable continuous mining machine injuries

- 238 nonfatal injuries
- 34 fatal injuries

1984-2014 preventable mobile equipment injuries

- 179 nonfatal injuries
- 42 fatal injuries

-*Mine Health and Safety Administration, 2015*

Underground coal mines adopted PDSs

1984-2014
- Over 400 nonfatal injuries
- Over 75 fatal injuries

2011
- MSHA proposed a rule requiring continuous mining machines to be equipped with PDSs.

2015
- MSHA published a rule requiring continuous mining machines to be equipped with PDSs (installation deadline: March 2018).

2015
- MSHA proposed a rule requiring mobile machines to be equipped with PDSs.

2017
- Continuous mining machine operator fatally injured after activating the emergency stop override function for the PDS.

2018
- SNL Energy Report documented stakeholder concerns related to the adoption and integration of PDSs in underground coal mines.

-Mine Health and Safety Administration, 2015
-Taylor, SNL Energy Report, 2018

Proximity detection systems could improve safety by reducing human-machine collisions

Proximity detection system (PDS) - an automated, collision avoidance technology designed to prevent machine-human collisions.

A PDS can be installed on:

- Continuous Mining Machines
- Mobile Machines
  - Coal hauling machines
    - Shuttle cars
    - Ram cars
  - Scoops

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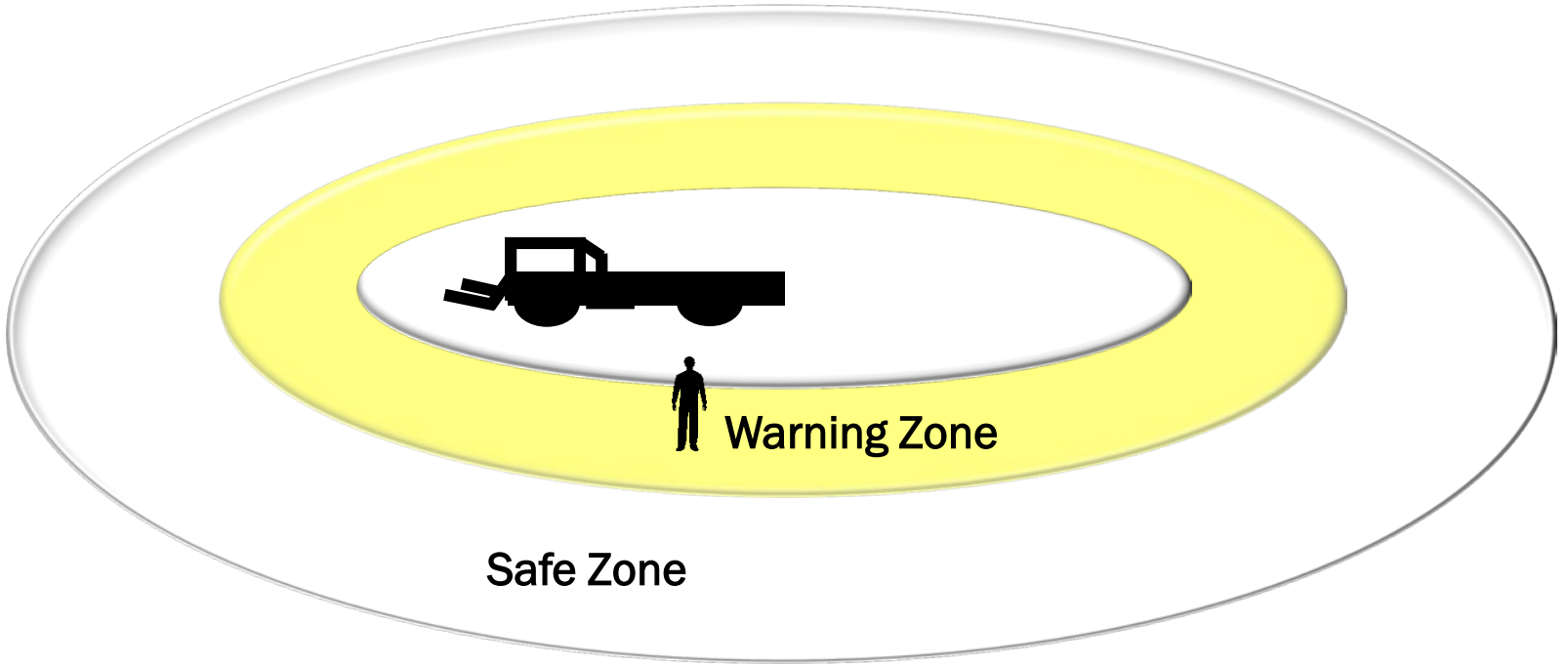
Proximity detection systems (PDSs) for mobile equipment help to protect mineworkers

When a worker is in an established warning (yellow) zone or stop (red) zone…

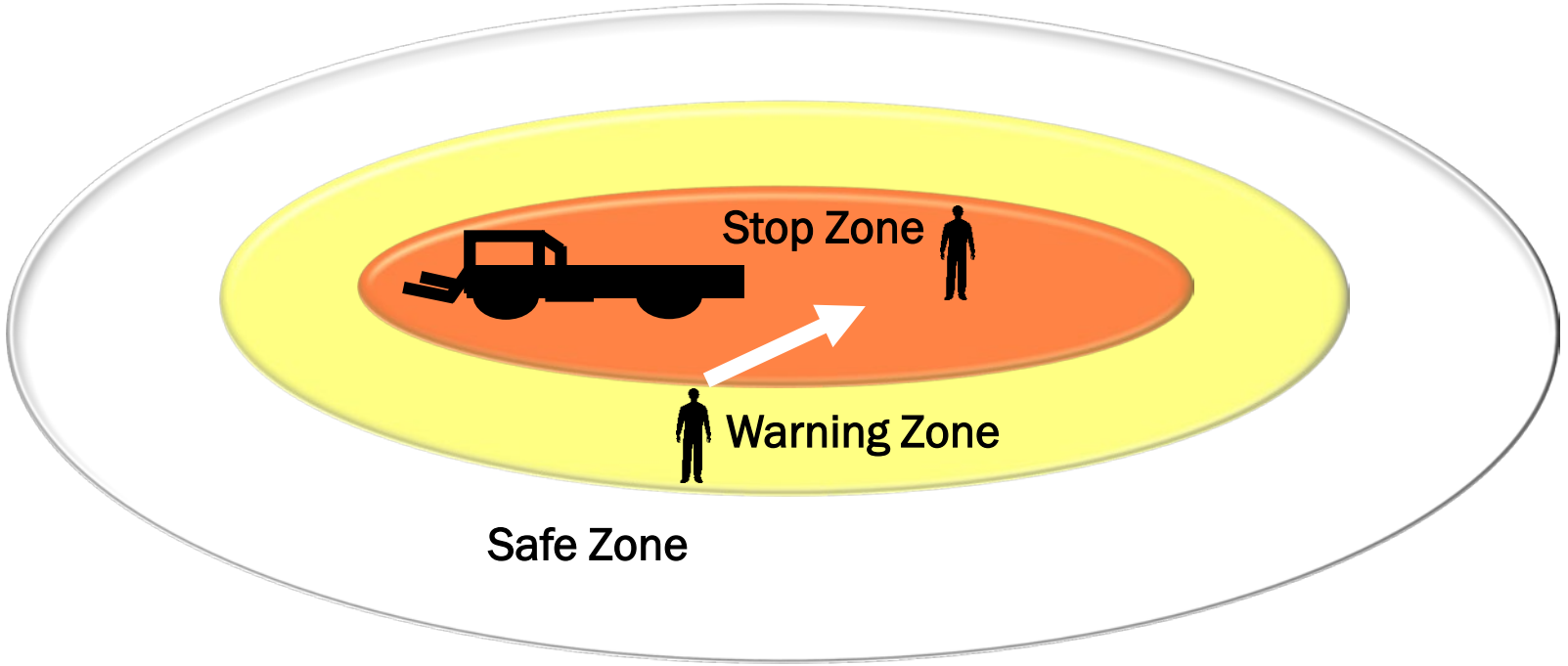
- Worker is alerted by their miner wearable component (MWC)



Proximity detection systems (PDSs) for mobile equipment help to protect mineworkers

When a worker is in an established warning (yellow) zone or stop (red) zone…

- Worker is alerted by their MWC
- Mobile machine is slowed or disabled



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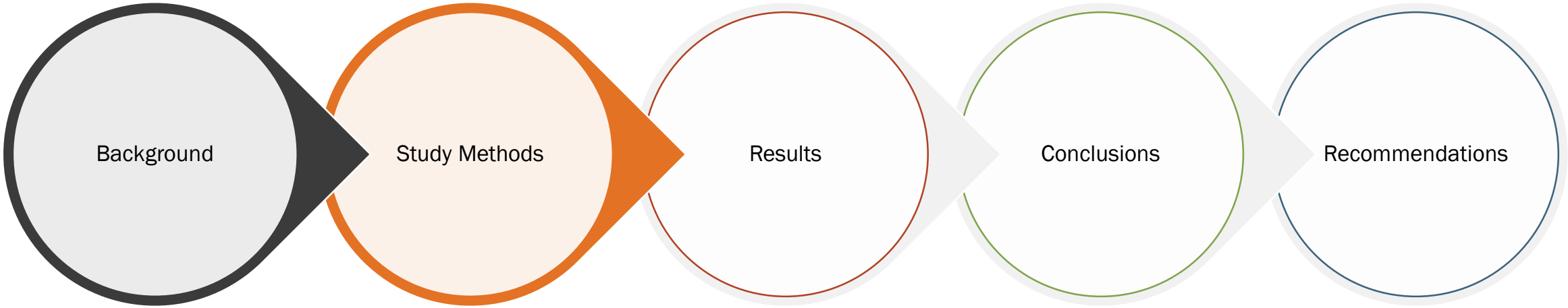


Study methods and research questions

Study Methods:

- Mixed-methods study (i.e., qualitative and quantitative)
- 7 Underground coal mines
- 208 mineworkers

Research Questions:

- How are mineworkers' trained on mobile PDSs?
- What factors influence mineworkers' trust in mobile PDSs?

For this study, trust in a mobile PDS is…

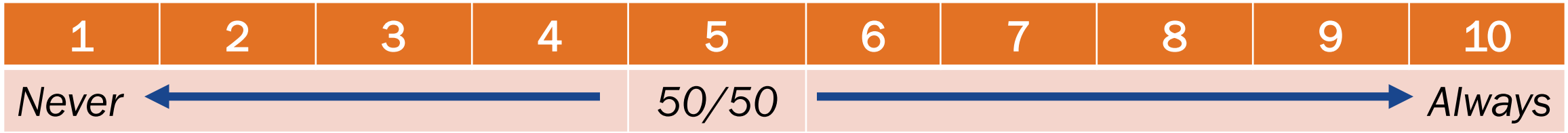
a worker's "confidence in the system's ability to prevent collisions while not exposing them to additional risk."

-Swanson & Bellanca, forthcoming

Mineworkers were asked the following questions

1. How did you learn to use mobile PDS? (qualitative)

2. How confident are you that the system will prevent a collision? (quantitative)



Four of the mines had PDS A and three had PDS B

Mine	PDS	Mining Method	UG Workers	Hours *(annual)*	Tons of Coal *(annual)*	Haulage	Scoop
A	A	Longwall	598	1,586,445	12,123,618	Partial	Partial
B	A	Longwall	481	1,391,106	5,352,731	Partial	Partial
C	A	Longwall	595	1,438,550	9,180,468	None	None
D	B	Room and Pillar	162	381,890	2,498,918	Partial	None
E	A	Longwall	225	547,314	4,805,028	Partial	None
F	B	Longwall	201	619,954	5,327,442	Full	None
G	B	Room and Pillar	266	557,959	1,462,854	Partial	None

*UG = Underground; *National Fatal Incidence Rate = 0.024; **NFDL = Non-Fatal Days Lost; National NFDL Incidence Rate = 3.66*
Source: MSHA, Mine Data Retrieval System

Most of the mines were longwall mines

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The mines ranged from 162 to 598 employees

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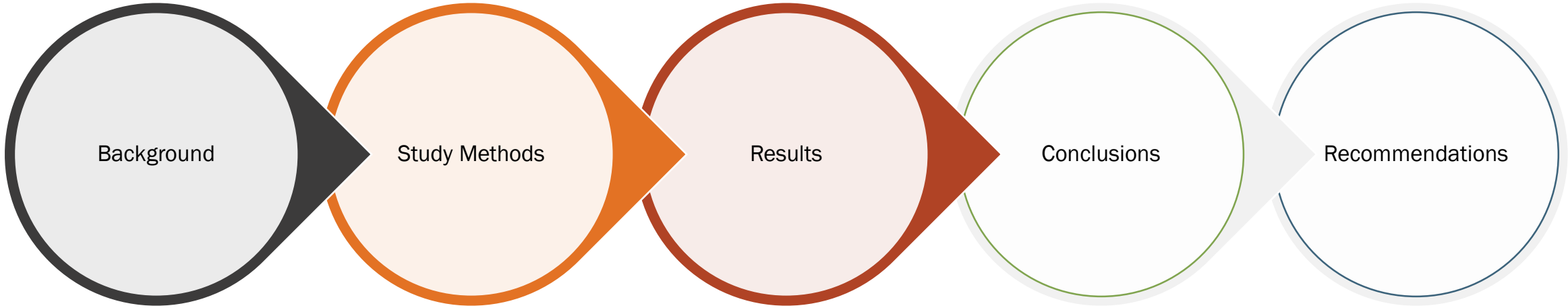
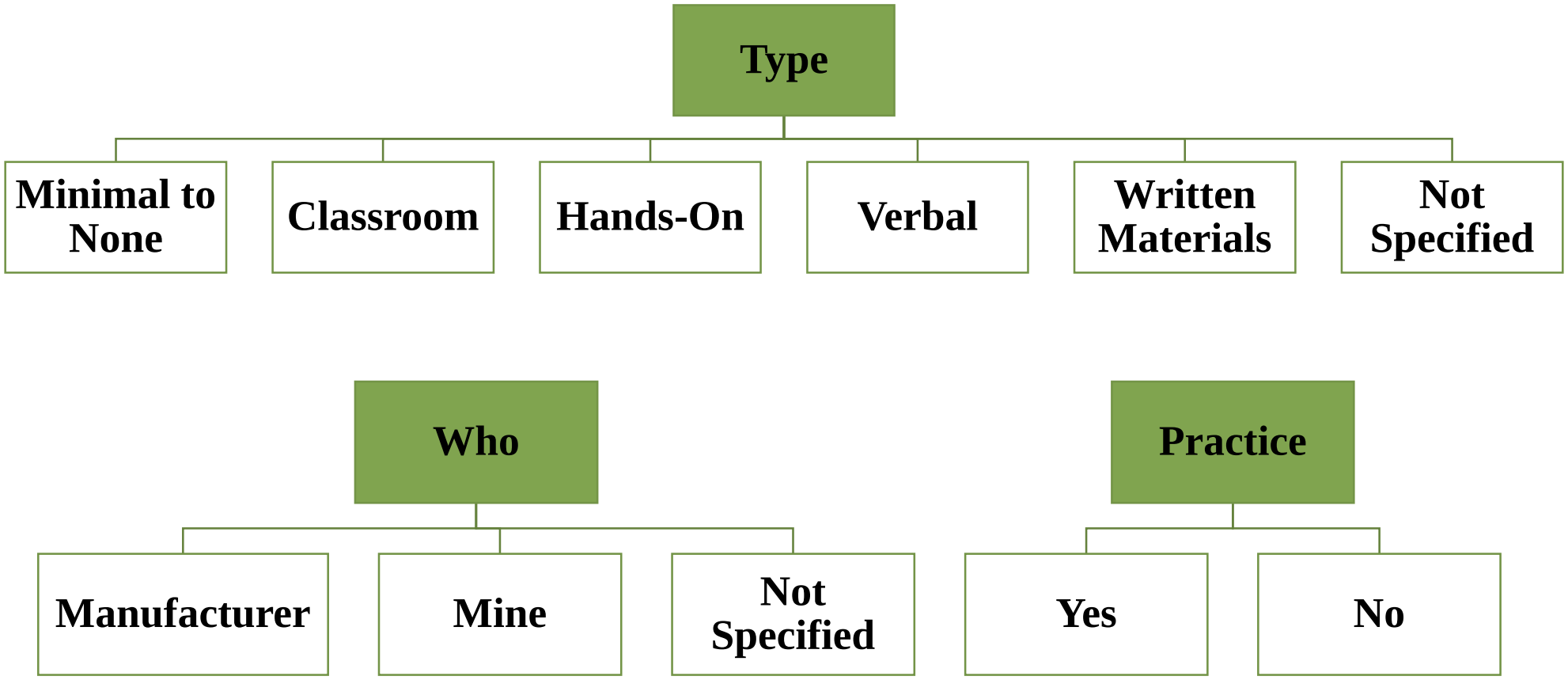
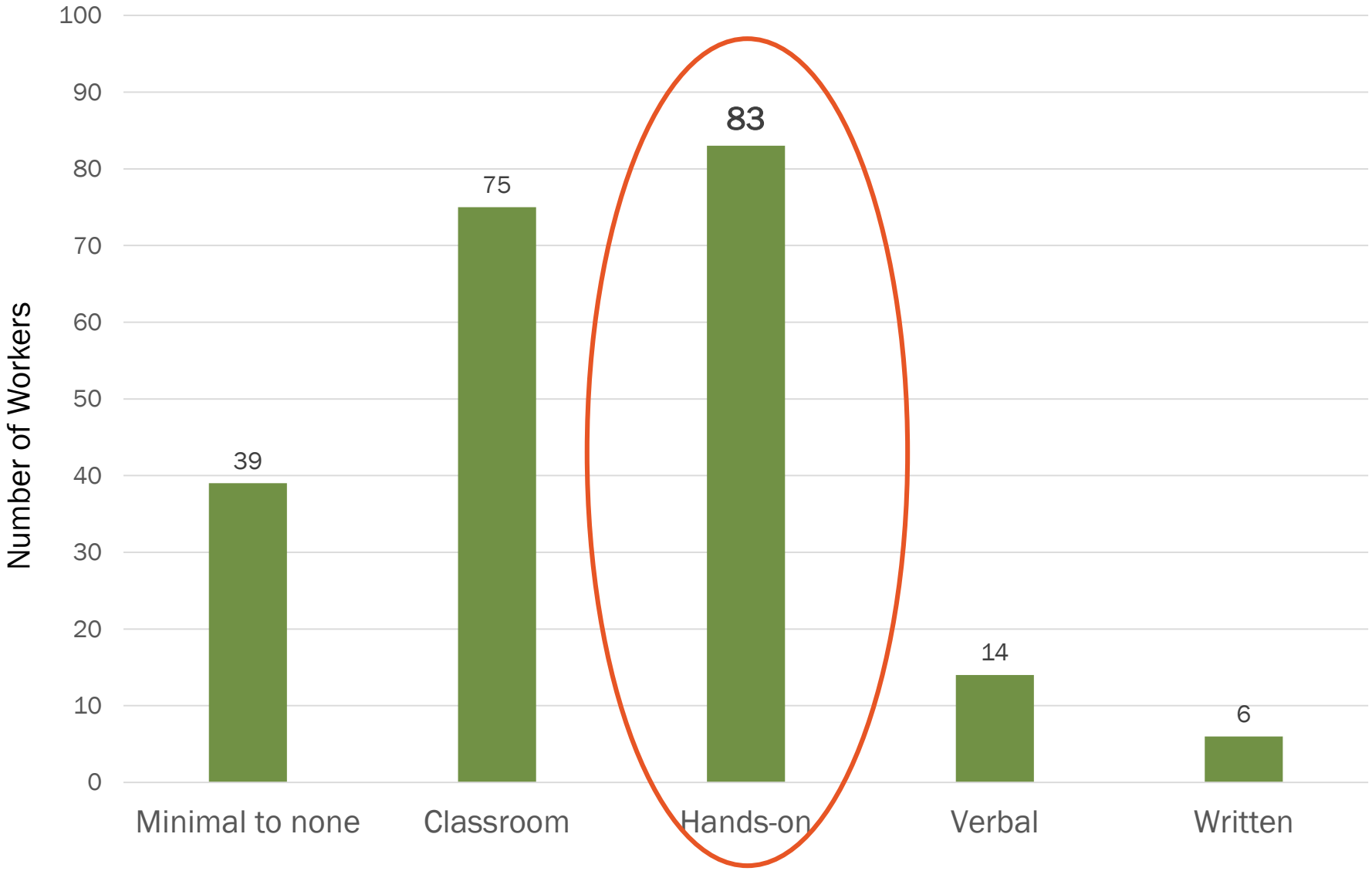


How are mineworkers trained on mobile PDSs?



Most mineworkers described receiving hands-on training



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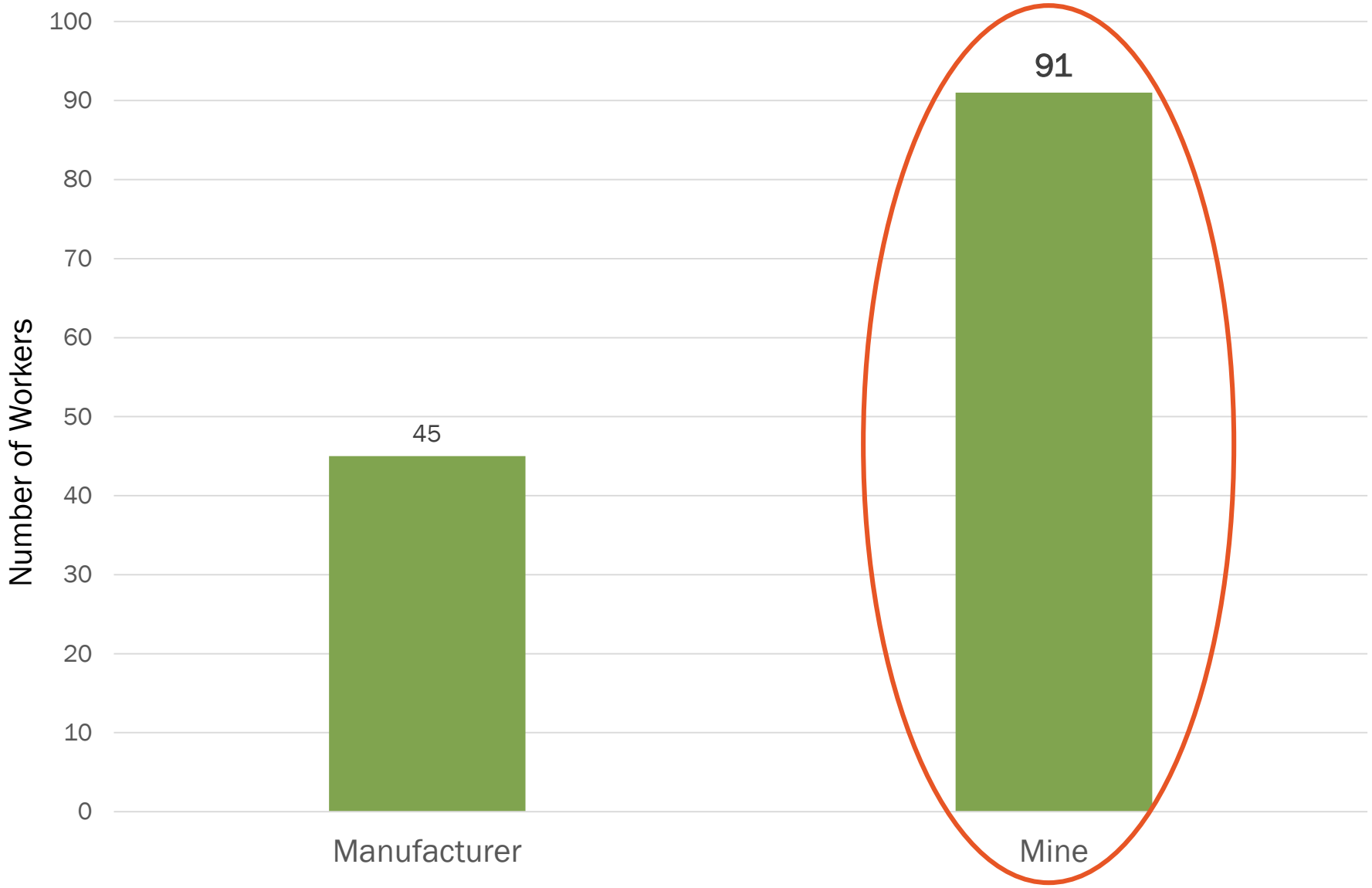
Training

Most mineworkers reported receiving training from the mine



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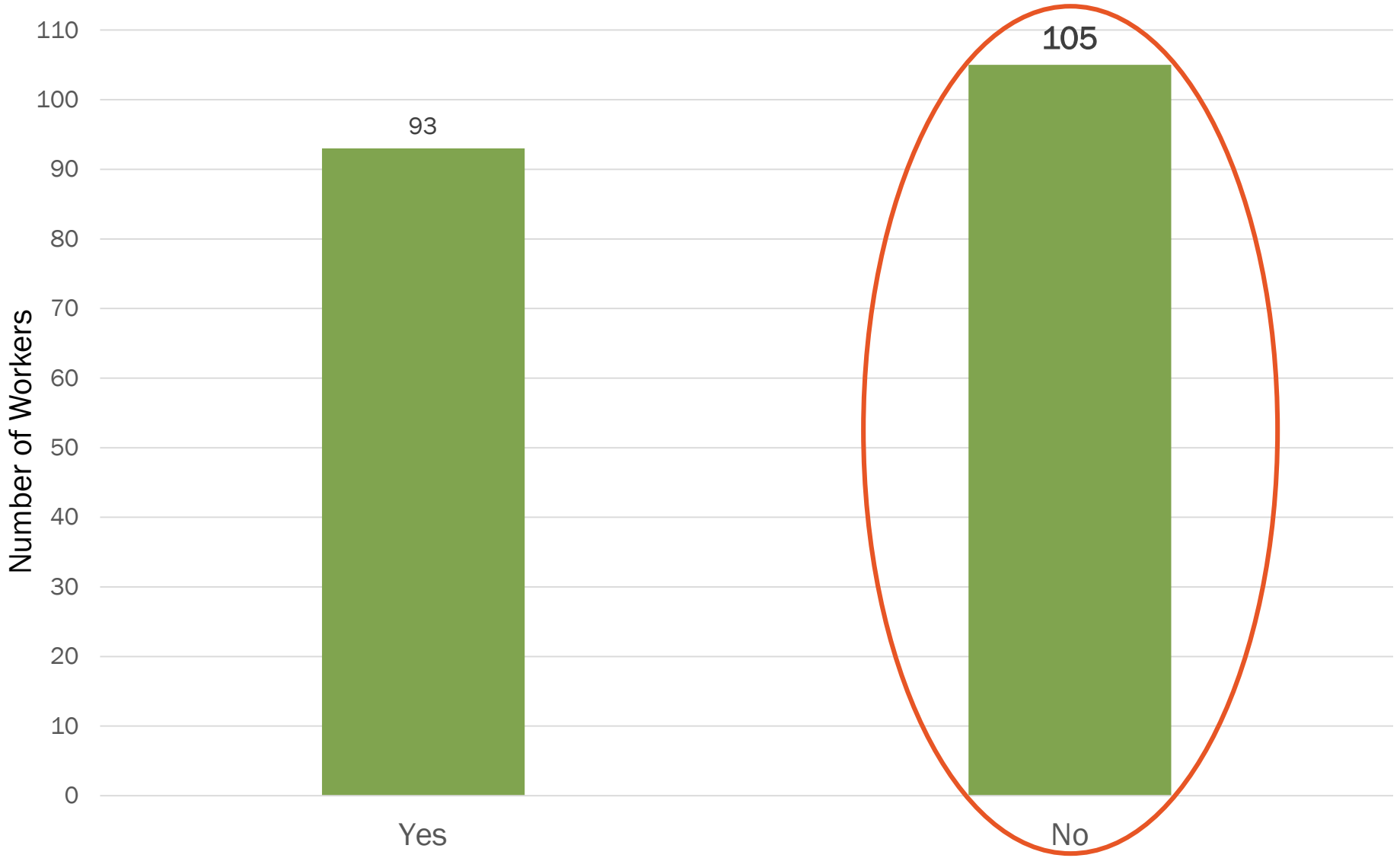
Training

Most mineworkers did not learn through practice



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Training

What factors influence workers' trust in mobile PDSs?

Training	Mine	Age	Experience	System Make
• Hands-on training and step-by-step guides[1]	• Cultural[2] • Organizational[3]	• Older adults and overreliance[4] • Young adults and mistrust[5]	• System experience increases trust[6] • Experience decreased trust[7]	• Performance differences may influence trust[7]

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Training did not have a significant influence on trust.

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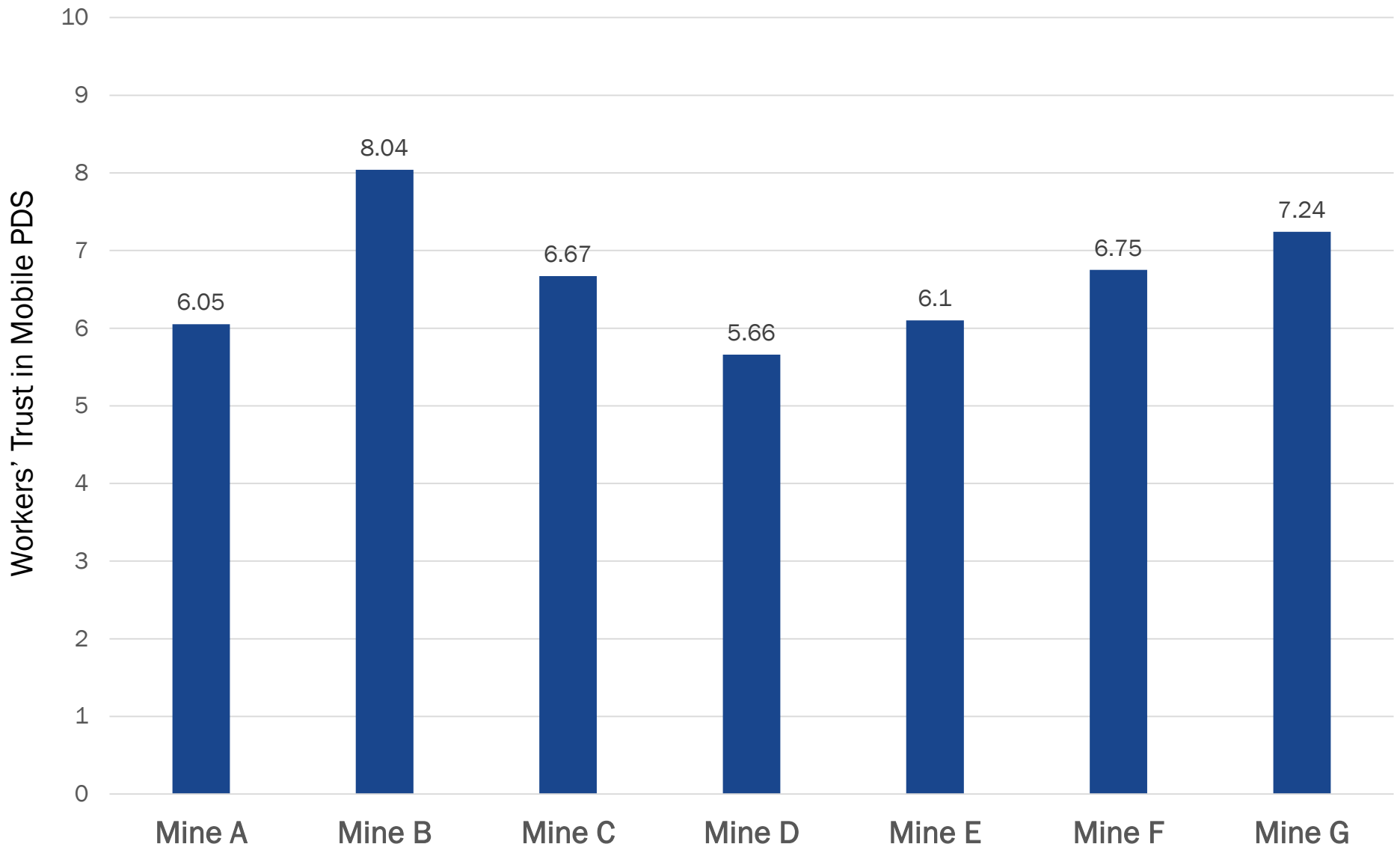
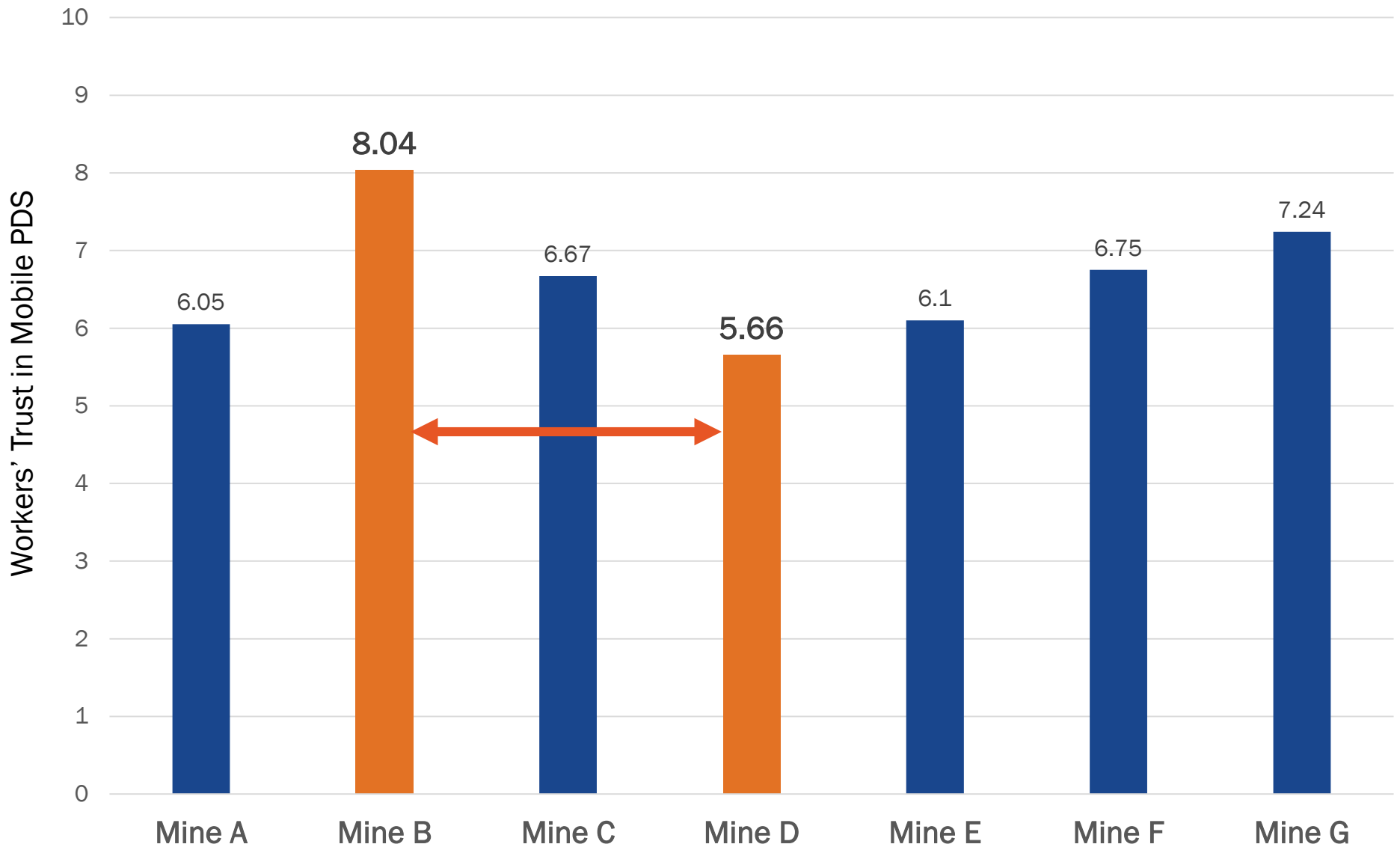
Averages in workers' trust ranged from about 5 to 8 out of 10



Mine

Statistical differences were found between Mine B and Mine D



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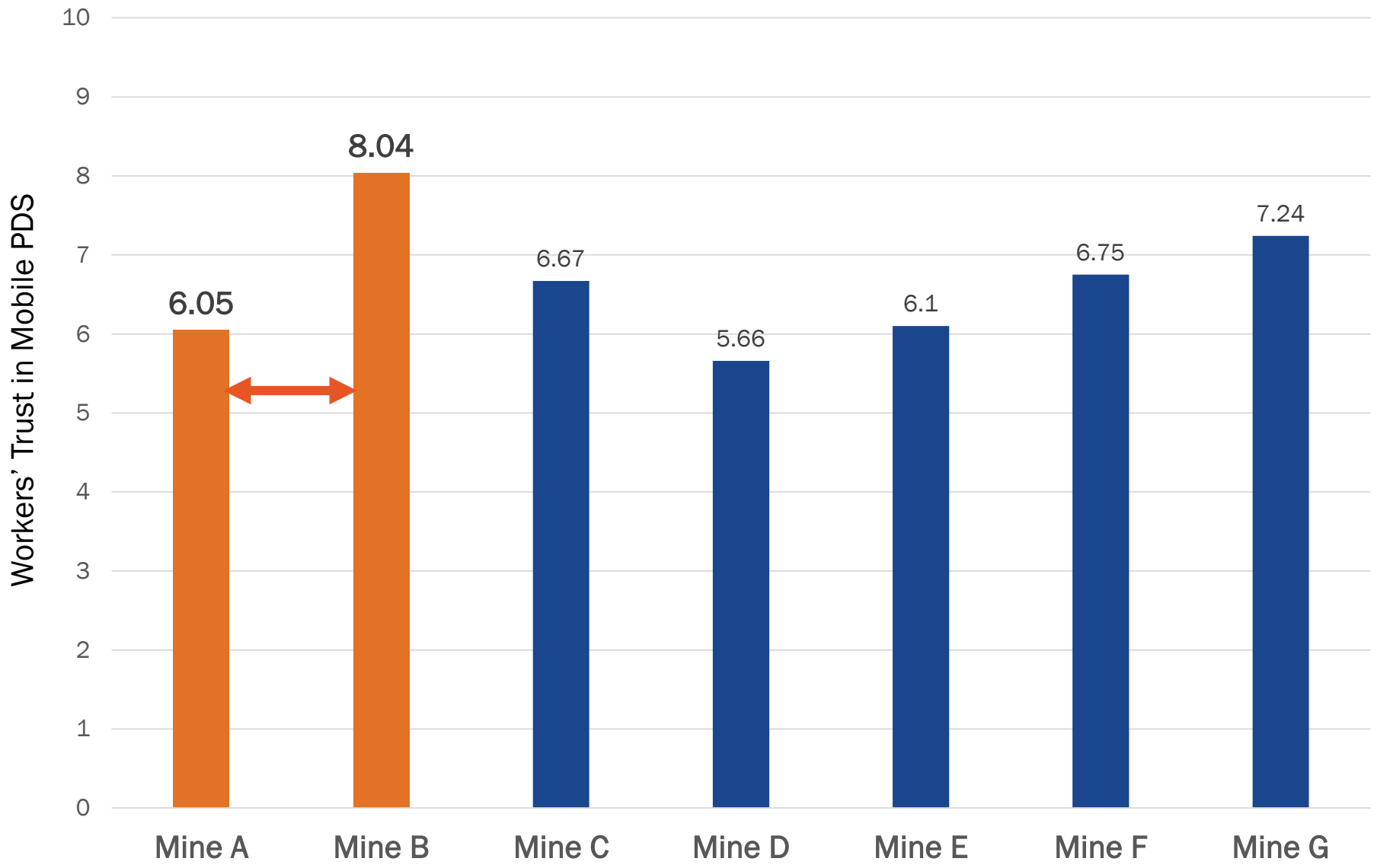

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Average trust ratings of the age groups were similar to the overall average

	Workers (N)	Workers' Trust (Mean)	Workers' Trust (SD)
19-29 years	43	6.53	2.76
30-49 years	112	6.42	2.32
50-69 years	47	6.98	2.32
All workers	***202***	***6.57***	***2.42***

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Age did not have a significant influence on trust.

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Average trust ratings for the experience groups were between 6 and 7

Mining Experience	Worker (N)	Workers' Trust (Mean)	Workers' Trust (SD)
0-5 years	44	6.16	2.44
6-10 years	69	6.68	2.56
11-20 years	54	6.22	2.39
21-30 years	12	7.25	1.77
31 or more years	24	7.29	2.51
All Workers	***203***	***6.55***	***2.45***

Experience

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Experience did not have a significant influence on trust.

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Average trust ratings for system make were around the overall average

Mobile PDS	Workers (N)	Workers' Trust (Mean)	Workers' Trust (SD)
System A	128	6.44	2.31
System B	80	6.73	2.64
All Workers	*208*	*6.57*	*2.44*

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System make did not have a significant influence on trust.

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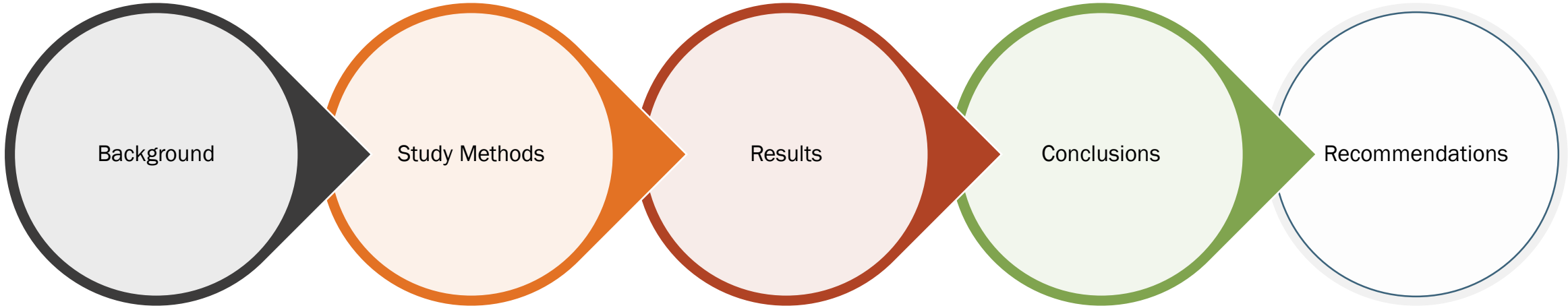

Mine of employment was the only significant factor

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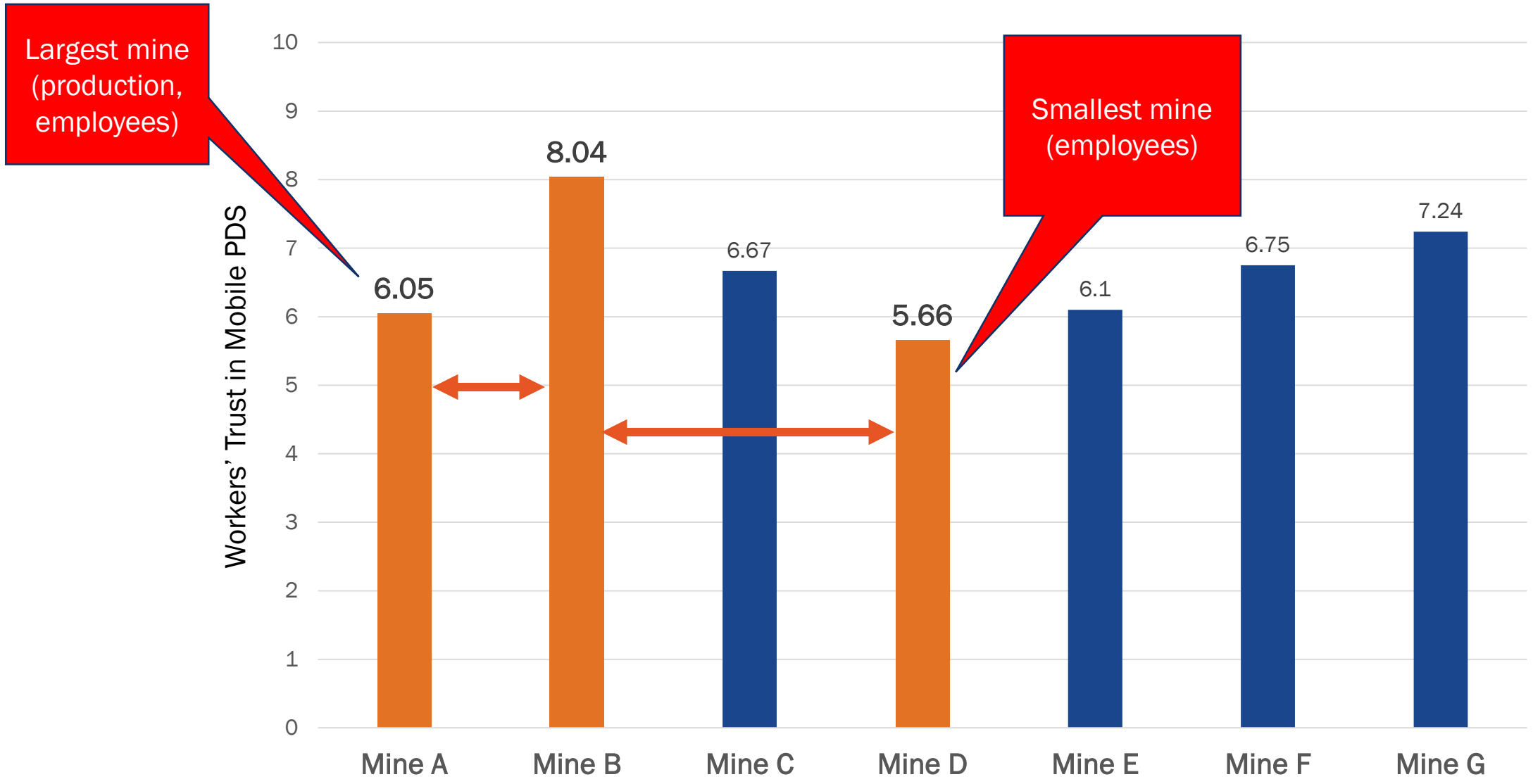
Mine culture could have influenced the results

- Variations in employee workloads and work practices
  - High task loads lead to excessive trust

-Biros, Daly, & Gunsch, 2004

The largest and smallest mine had lower trust ratings



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Mine culture could have influenced the results

- Social norms or the attitudes and values of others
  - One employee can shape the trust perceptions of others

    -Workman, 2005
  - The initial presentation of the system can influence trust

    -de Vries & Midden, 2003

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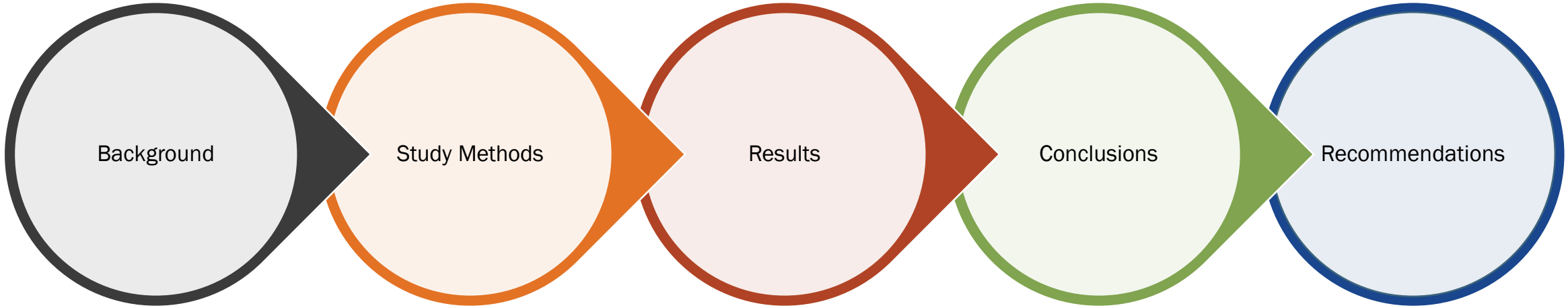

Recommendations

- Address behaviors that may indicate inappropriate trust
  - Ignoring alarms or alerts
  - Defeating the system
  - Deterioration of awareness or skills

- Consider how workloads may be influencing workers' trust
  - Adjust workloads during implementation

- Select supervisors with appropriate trust and a knowledge of the system to lead implementation and training efforts
  - Identify leaders with understanding of system strengths and weaknesses

Feel free to contact me with any questions

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