DEVELOPMENT OF SAFER TRENCHING OPERATIONS

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Outline of the presentation

- The need
- Scope of the project
- Work in progress
- Findings to date
- Planned project extensions

Acknowledgments

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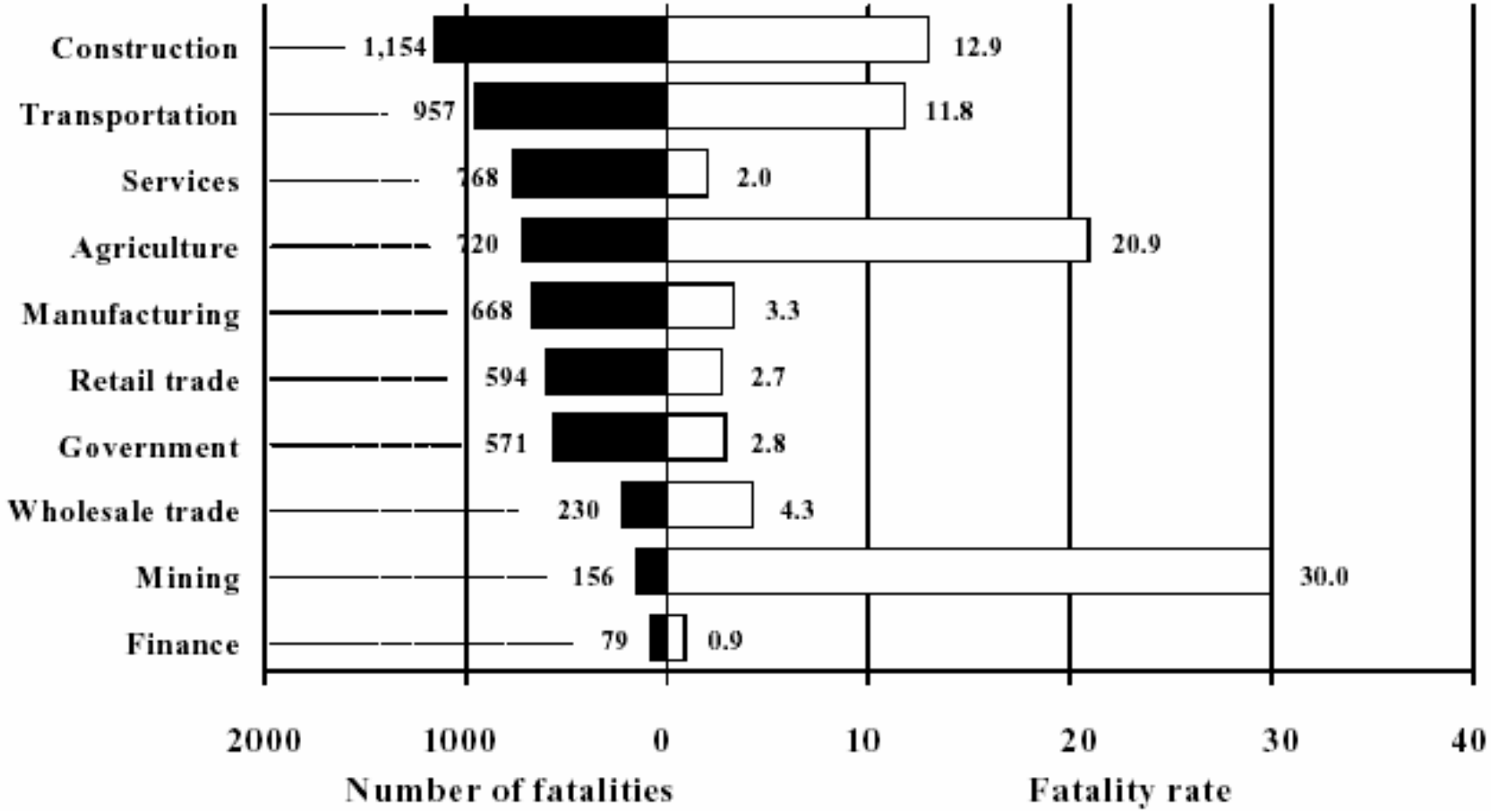
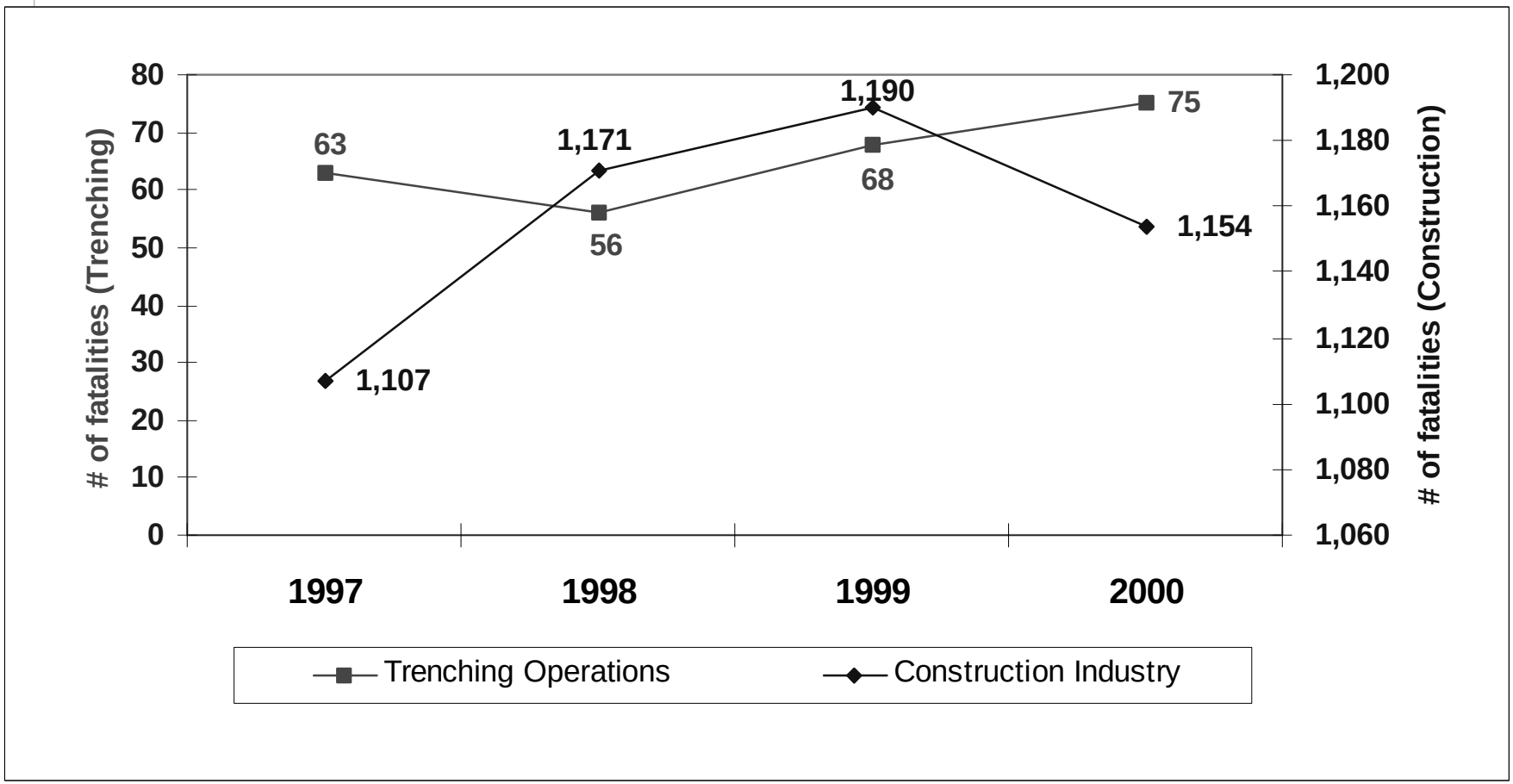
- Bowen Engineering - Indianapolis
- R.L. Turner - Indianapolis
- Graycor Construction Company - Chicago
- Turner Corporation - Cincinnati
- Frank Messer and Sons - Cincinnati
- Hunt Construction Company - Indianapolis
- Duke Construction - Indianapolis

Context of the problem



Fatality rate = #of fatalities / 100,000 workers

Context of the problem



Fatalities in the construction industry Vs Fatalities in trenching operations (1997 – 2000)

A typical trenching operation..

No means of egress

Overhead load

Mobile Equipment

Spoil distance

No Protective System

Loose rock/soil

The Need

- Fatalities in trenching operations:

  1997: 69
  2000: 82

- Most deaths in trenching operations are from cave-ins

Source: Job Safety and Health Fall 1999

Scope of the project

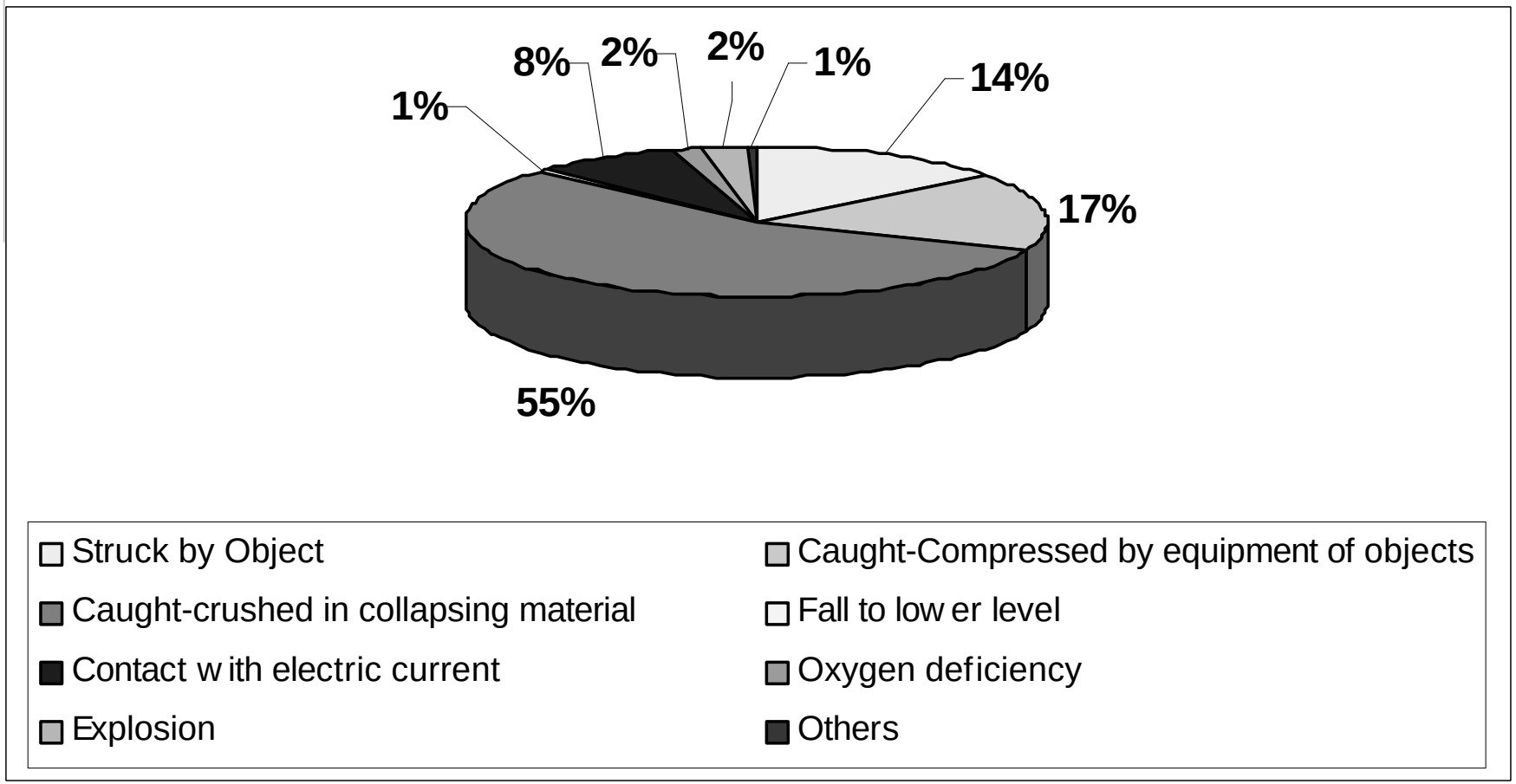
- Analyze the causes of accidents in trenching operations
- Establish an information database on work risk factors associated with trenching operations
- Develop strategies to prevent and reduce injuries in trenching operations

Work in progress

- Analysis of historical data from BLS, OSHA and NIOSH
- Interviews with safety directors
- Review of successful safety practices implemented by construction companies
- Analysis of the chain of events leading to trenching accidents

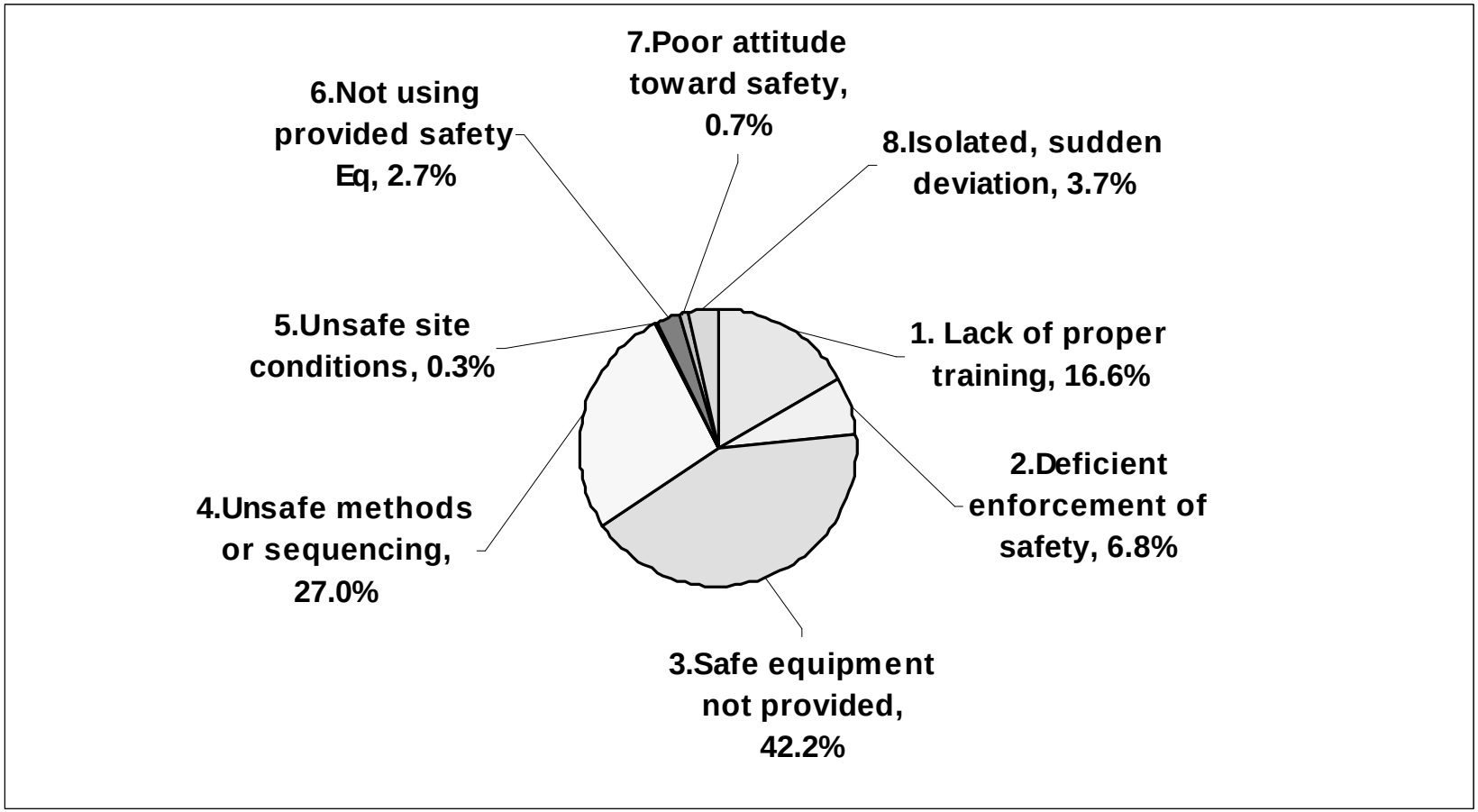
Data Analysis

Causes of trench-related fatalities (OSHA 1997-2001)
Type of Accident Model (Hinze 1998)

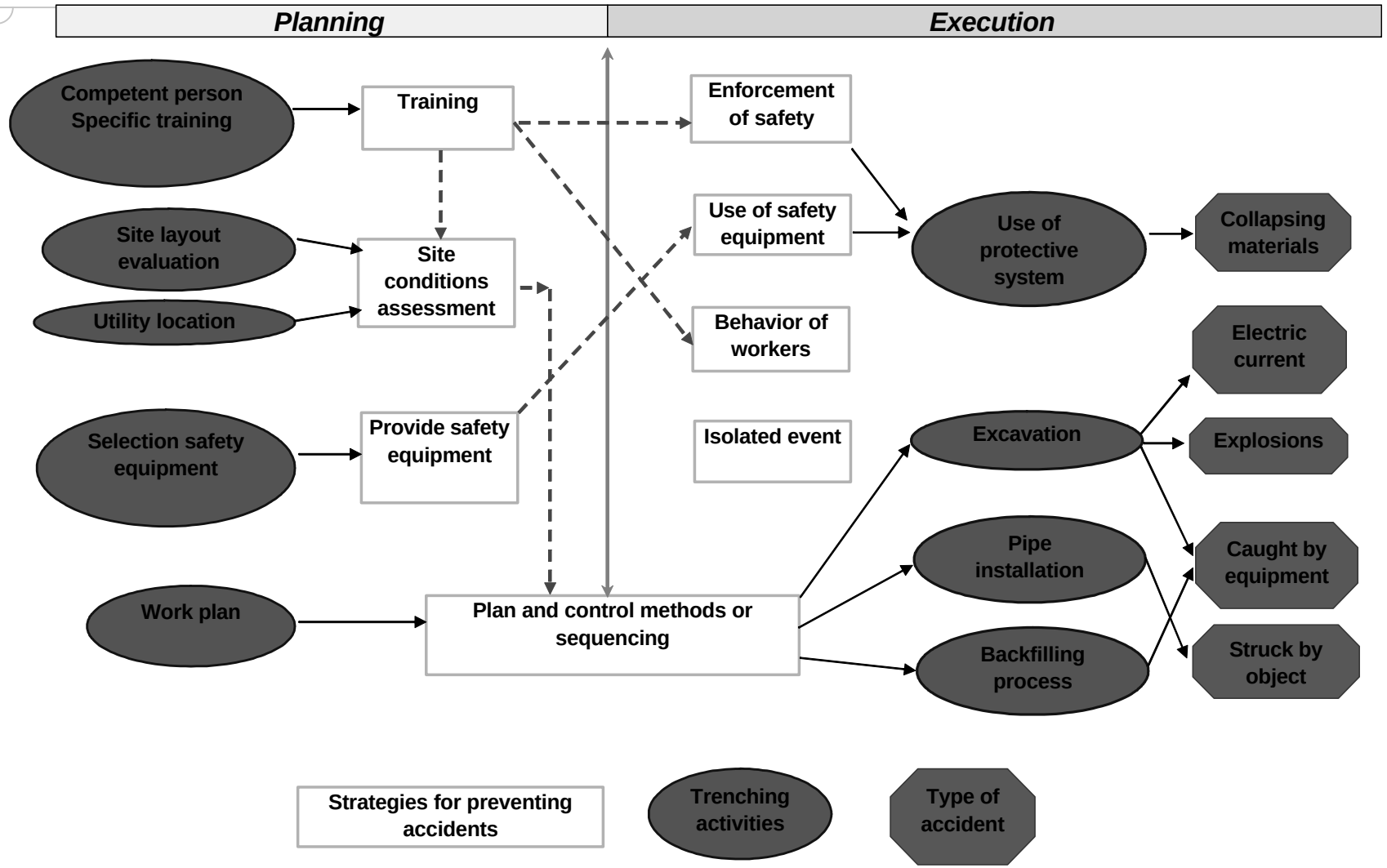


Data Analysis

Causes of trench-related fatalities (OSHA 1997-2001)
Human Causes Model (Toole 2002)



Chain of events



Interviews with construction practitioners

- 16 interviews (11 companies)
- Objective: Identify the existing gaps between the strategies adopted by the construction industry and the strategies required to prevent trenching accidents
- 2 groups of questions:
  - Type of accident
  - Strategies to prevent accidents (Resources allocated to prevent trenching fatalities)
- Multiple comparison of strategies

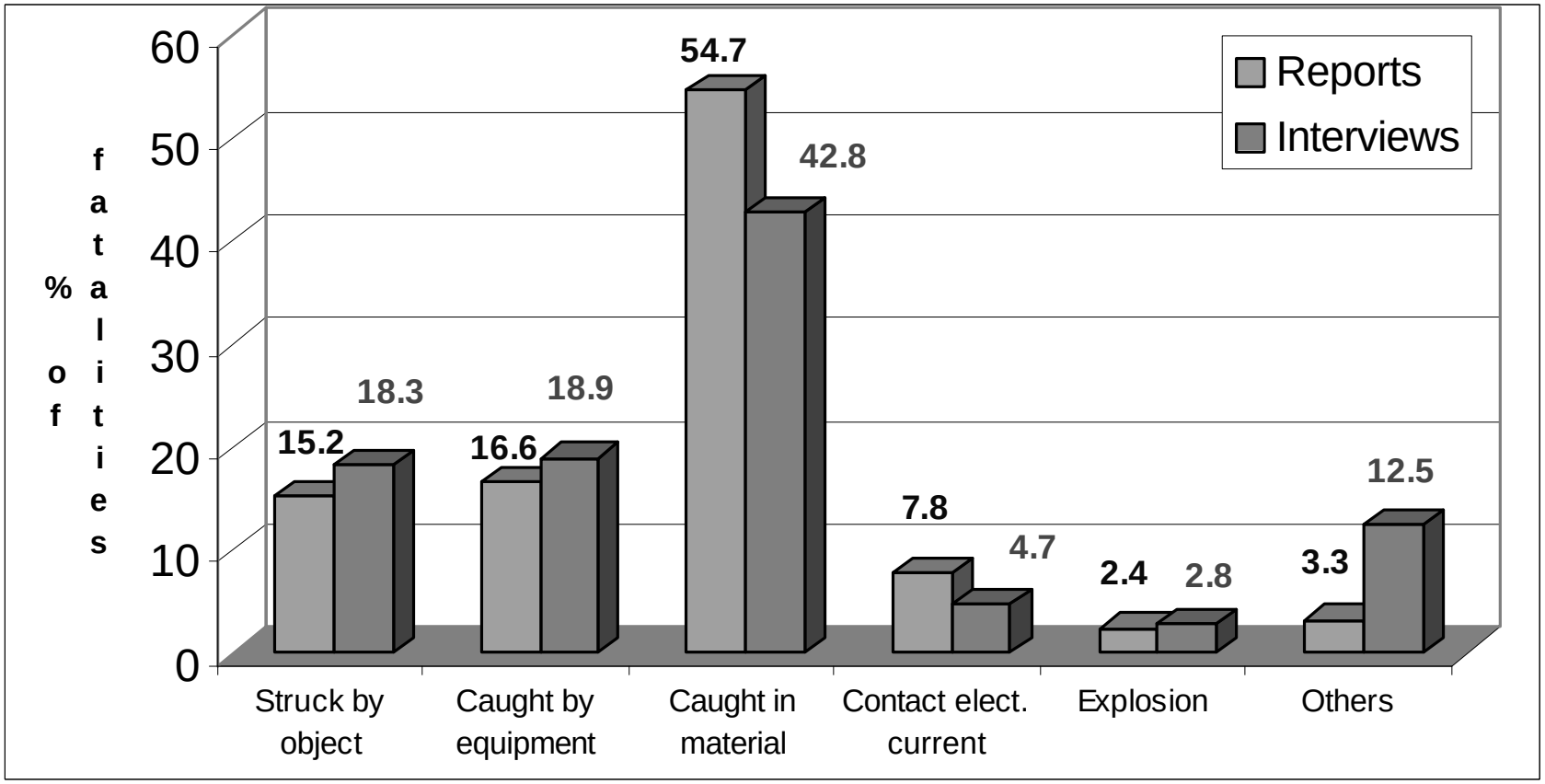
Interviews with construction practitioners

Profile of the companies interviewed

I.D.	Company	Role in the company	Volume of construction (US$)	Volume of trenching (US$)	% of Trenching	Type of Company
1	Company 1	Safety Director	140,000,000	21,000,000	15%	General Contractor
2	Company 1	Project Manager	140,000,000	21,000,000	15%	General Contractor
3	Company 1	Superintendent	140,000,000	21,000,000	15%	General Contractor
4	Company 2	Risk Manager	600,000,000	75,000,000	13%	C.M.
5	Company 2	Project Manager	600,000,000	75,000,000	13%	C.M.
6	Company 3	Safety Officer	2,000,000	400,000	20%	Subcontractor
7	Company 4	Superintendent	80,000,000	8,000,000	10%	General Contractor
8	Company 5	Foremen	100,000,000	50,000,000	50%	Subcontractor
9	Company 6	Safety Director	2,100,000,000	30,000,000	1.4%	C.M.
10	Company 6	Project manager	2,100,000,000	30,000,000	1.4%	C.M.
11	Company 7	Safety Director	40,000,000	2,000,000	5%	General Contractor
12	Company 7	Project Manager	40,000,000	2,000,000	5%	General Contractor
13	Company 8	Superintendent	45,000,000	4,500,000.0	10%	General Contractor
14	Company 9	Superintendent	13,000,000	1,950,000	15%	Subcontractor
15	Company 10	Superintendent	20,000,000	7,000,000	35%	General Contractor
16	Company 11	Foremen	75,000,000	45,000,000	60%	Subcontractor

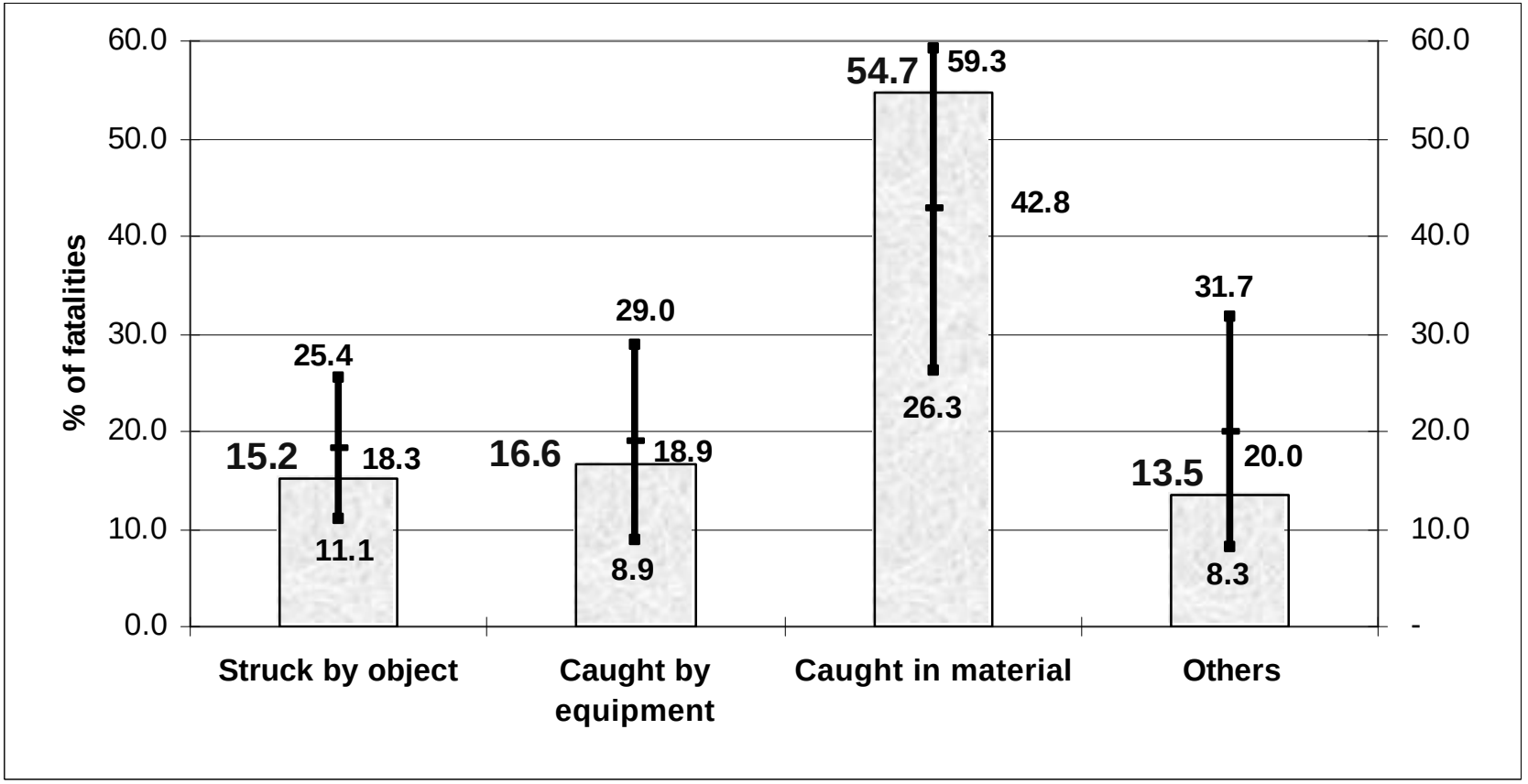
Results of the interviews

Type of Accident Model



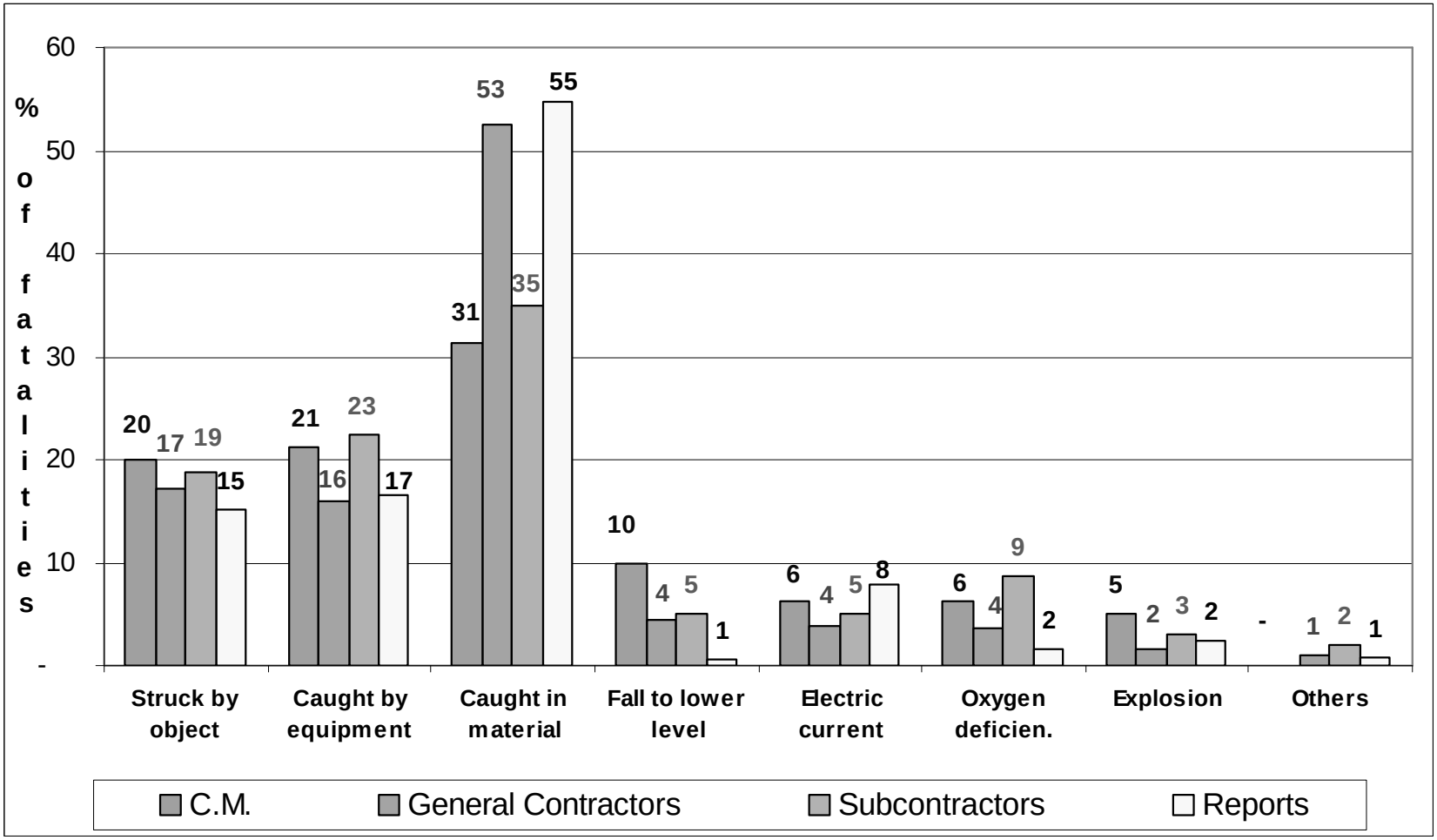
Results of the interviews

Type of Accident Model – Bonferroni method



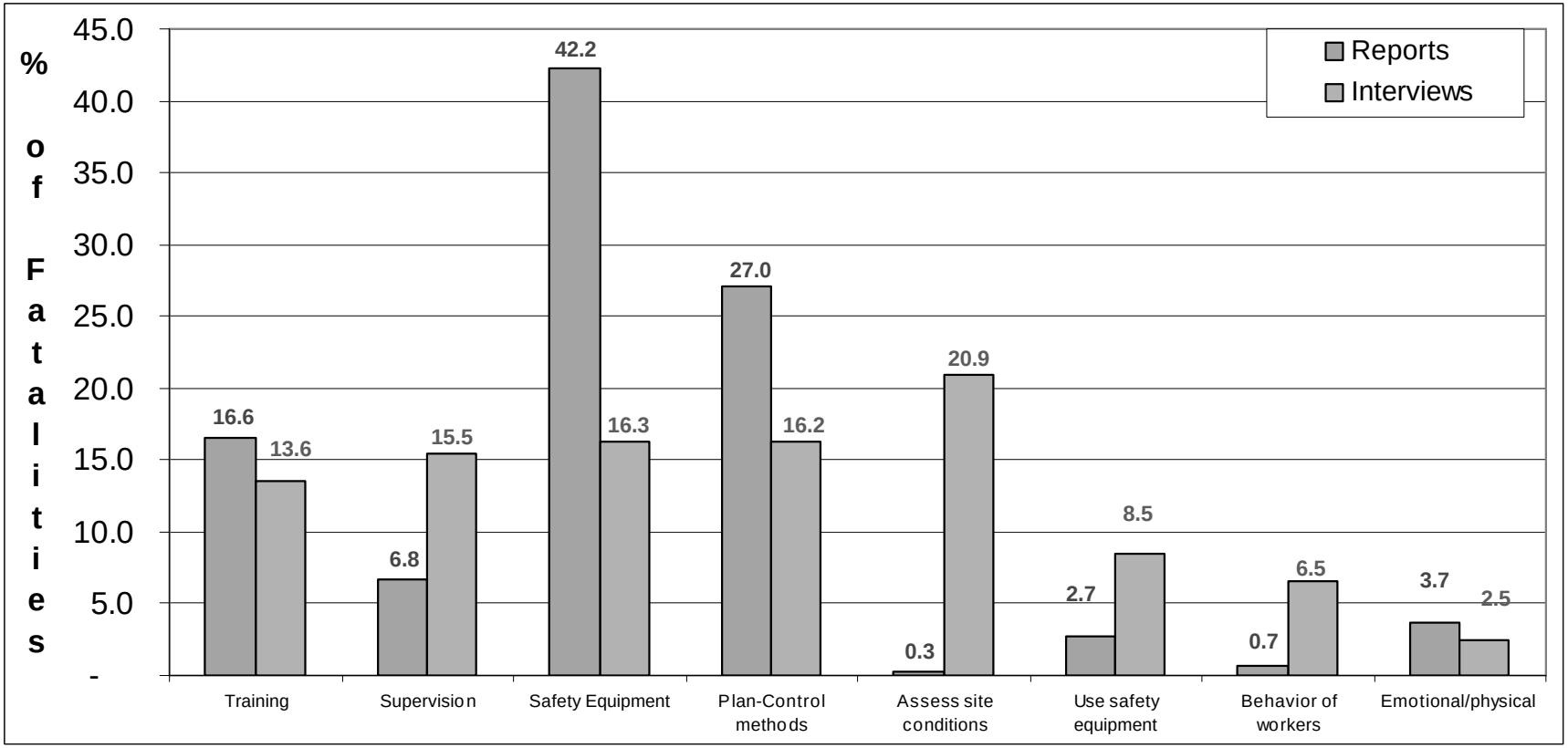
Results of the interviews

Type of Accident Model – Type of company



Results of the interviews

Behavioral Causes Model

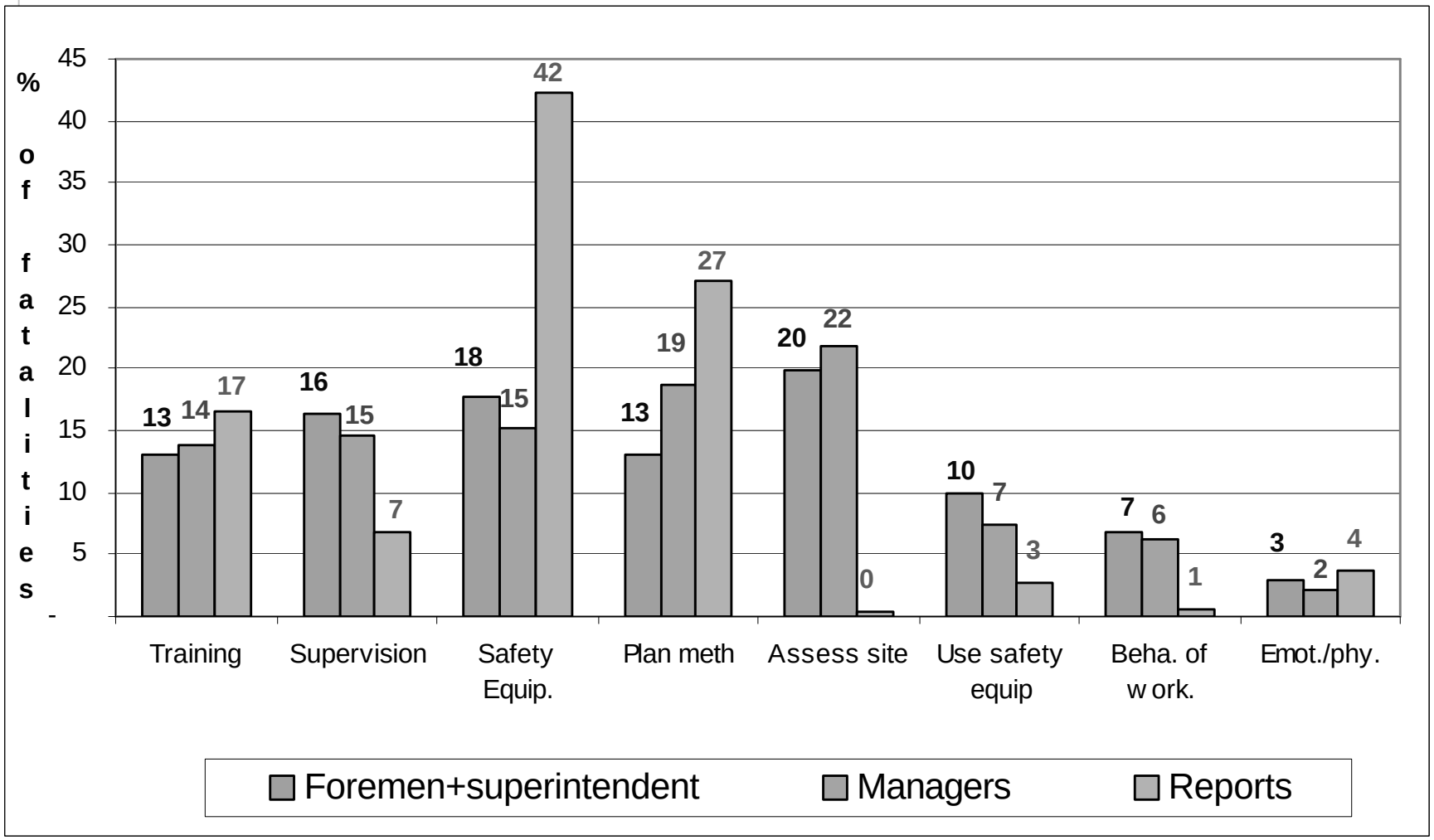


Results of the interviews

Behavioral Causes Model - Bonferroni method

Results of the interviews

Behavioral Causes Model – Role in the company



Successful safety practices

Practice	Construction phase	Participants
Safety planning meetings	Planning	Design team, subcontractors, project engineers, foremen, a representative of the owner, insurance company, and contractor's safety officer
Daily safety meetings	Execution	Foremen, subcontractors
Safety training General safety training Specific safety training	 Planning Execution	 Engineers, foremen, workers Subcontractors
Incentive programs	Execution	Engineers, foremen, subcontractors, administrative personnel
Top management support	Execution	Top management, project engineers
Owner's role	Planning Execution	Representative of the owner
Accounting practices	Execution	Project engineers, financial division
Increasing accountability of workers	Execution	Project engineers, foremen, workers
Control of minor accidents	Execution	Project engineers, foremen

Successful safety practices

- Planning meetings:
  - Overall safety planning meeting
  - Daily safety meetings
- Training:
  - General training (use of Personal Protective Equipment)
  - Specific training in trenching operations
- Incentive programs:
  - Project basis
  - Worker basis
  - Behavior basis
- Top management support

Successful safety practices

- Increased involvement by owner
  - Safety as a major factor in awarding contracts
- Accounting practices
  - Charge the indirect and direct costs of the accident directly to the cost of the project
- Control of minor accidents
  - Accident prevention
  - Higher level of commitment from the management
- Increasing accountability of workers
  - Need for workers to accept responsibility for their own actions

Summary of research findings - I

- 64% of the fatalities occurred in trenches less than 3 m (10 ft) deep, and 98% of the fatalities occurred in trenches less than 6.1 m (20 ft) deep.
- 72% of the fatalities occurred in projects costing under US$ 1 million.
- 36% of the fatalities occurred in projects with fewer than 10 workers AND costs under US$ 250,000.
- 63% of the fatalities in occurred in projects with fewer than 10 workers on site.

Summary of research findings - II

- The major causes of fatalities can be addressed by the existing OSHA standards.
- The construction industry has a clear understanding of the different types of accidents involved in trenching operations.
- The construction industry does not consider a single strategy as most important to prevent trenching accidents.
- The construction industry has implemented strategies to prevent accidents, but the focus is not necessarily on the major strategies based on the Behavioral Causes Model

Recommendations for future work

- Quantitative analysis
  - It is necessary to evaluate the cost/benefit ratio for the identified safety strategies
  - It is important to do an in-depth analysis of small construction companies involved in trenching operations.
- Qualitative analysis
  - Analysis of the workers' behavior in trenching operations. "*Tough guy culture*"

Dissemination of findings

- Publications:
  - Arboleda, C., Abraham, D. M., Wirahadikusumah, R. and Irizarry, J. (2002). Trench-Related Fatalities in Construction: An Analysis of Fatality Assessment and Control Evaluation (FACE) records. *First International Conference on Construction in the 21st Century (CITC2002) - Challenges and Opportunities in Management and Technology*. Miami, Florida, April 25-26, 2002, pp. 277-282.
  - Lew, J., Abraham, D., Wirahadikusumah, R., Irizarry, J. and Arboleda, C. (2002) Excavation and Trenching Safety: Existing Standards and Challenges, *Third International Conference on Implementation of Safety and Health on Construction Sites – One Country – Two Systems*, Hong Kong SAR and Beijing, China, May 8-17, 2002, 103-109.
  - Irizarry, J., Abraham, D. M., Wirahadikusumah, R., and Arboleda, C. (2002). Analysis of Safety Issues in Trenching Operations. *CIB W-65 - Tenth International Symposium - Construction Innovation and Global Competitiveness*, Cincinnati, OH, September 9-13, 2002, pp 1133-1144.
  - Arboleda, C. and Abraham, D. M. (2003). Fatalities in Trenching Operations – Analysis using Models of Accident Causation. *ASCE Journal of Construction Engineering and Management* (to appear).
  - Abraham, D., Lew, J., Irizarry, J., Arboleda, C., and Wirahadikusumah, R. (2003). Trenching Accidents and Fatalities: Identifying Causes and Implementing Changes. *Safety and Health on Construction Sites*. SPONS Publications. (to appear).

Planned project extensions

- Evaluating the relationship between safety and productivity in steel erection (special emphasis on the new safety standards in steel erection)
- Using new technologies to overcome the challenges in safety inspections
- Evaluation of the cost/benefit ratio for the identified safety strategies
- Assessment injury rates among women and minority workers in construction operations
- Analysis of the workers' behavior - "Tough guy culture" in trenching operations

Thank You

Questions?