

What works in the prevention of accidents at work?

**Results of a systematic review of OHS
interventions**

**International Safety and Health Construction
Coordinators Organization (ISHCCO)**

Online, 17. Marts 2023

13.30 a.m. to 14.15

National Research Centre for the Working Environment Copenhagen, Denmark (NFA)

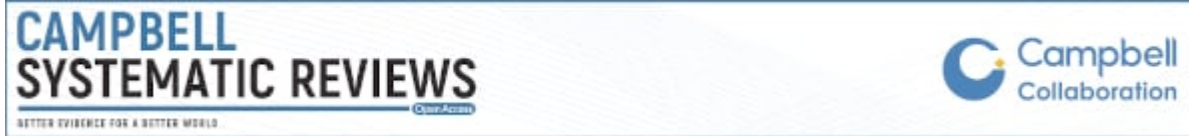
- The psychosocial working environment
- Musculoskeletal disorders and physical work load
- **Safety culture and Accidents**
- Chemical working environment, toxicology, nano safety and microbiology
- Interdisciplinary: Senior workers and young workers, and economic evaluations of interventions, R2P

About 164 employed at NFA



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Division for Safety Culture and Accident Research

SYSTEMATIC REVIEW / PUBLICATIONS



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SYSTEMATIC REVIEW

Safety interventions for the prevention of accidents at work: A systematic review

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Safety Interventions for the Prevention of Accidents at Work

Dyreborg J., Lipscomb H.J., Olsen O., Törner M., Nielsen K., Lund J., Kines P., Guldenmund F., Bengtson E., Gensby U., Rasmussen K., Zohar, D.

PROTOCOL

ID NO. SW2010-05

Protocol approval date: 10 March 2015



LYKKESFOREBYGGELSEN
DEN EKSISTERENDE
LIGE LITTERATUR OM
FORSKELLIGE TYPER
OREBYGGELSE
JLYKKER

FOR THE PREVENTION OF ACCIDENTS AT WORK)

an*, Pete Kines*, Angelika Dziekanska*,
th Bengtson*, Kurt Rasmussen*
enter for Arbejdsmiljø
egionshospitalet Herning

FORSKINGSCENTER



This research contributes to the fulfillment of the UN global goals



SYSTEMATIC REVIEW – STUDY SELECTION

Literature search: PubMed (1966), Embase (1980), CINAHL (1981), OSH ROM (NIOSHTIC 1977, HSELINE 1977, CIS-DOC 1974), PsycINFO (1806), EconLit (1969), Web of Science (1969) and ProQuest (1861), grey literature.

Identified references (assessed by two independent researchers)

- 60.466 references (total hits)
- 42.927 references (after removing duplets)
- 485 (after relevance screening)
- 194 studier (after quality assessment)
- 100 studier (Incl. RCT, CBA or ITS study designs)
- 120 safety interventions

Number of studies or safety interventions included, for each study design.

| Study design | Studies included | Safety interventions |
|--------------|------------------|----------------------|
| RCT | 16 | 20 |
| CBA | 30 | 43 |
| ITS | 54 | 57 |
| Total | 100 | 120 |

SYSTEMATIC REVIEW QUALITY ASSESSMENT

Pairs of reviewers independently extracted and coded data from the included studies.

| Levels of evidence | |
|-----------------------|--|
| Level | Definition |
| insufficient Evidence | If a safety intervention was only supported by one moderate quality study or any number of low quality studies |
| Limited evidence | At least one high-quality study or two studies of medium and/or high-quality, with consistent findings. |
| Moderate Evidence | at least two high-quality studies or three studies of medium and high-quality, with consistent findings |
| Strong evidence | A minimum of three studies with high-quality, and reporting consistent findings |
| Mixed evidence | If findings from medium and high-quality studies did not have consistent findings |

| | Random sequence generation (selection bias) | Allocation concealment (selection bias) | Equivalent groups | Blinding of participants and personnel (performance bias) | Blinding of outcome assessment (detection bias) | Statistical analysis (Detection Bias) | Incomplete outcome data (attrition bias) | Selective reporting (reporting bias) | Intervention fidelity | Intervention rationale | Other bias |
|-----------------------|---|---|-------------------|---|---|---------------------------------------|--|--------------------------------------|-----------------------|------------------------|------------|
| Adams 2013 | + | + | + | - | + | + | + | - | + | + | - |
| Cheng 2009 | - | - | ? | - | - | - | + | + | - | + | - |
| Daltroy 1997 | + | + | + | + | + | + | + | + | + | + | - |
| Gadomski 2006 | + | + | + | - | ? | + | + | + | ? | ? | ? |
| Hogg-Johnson 2012_HSA | + | - | + | + | + | + | ? | - | + | + | + |
| Hogg-Johnson 2012_MOL | + | + | + | + | + | + | + | + | + | + | + |
| Jensen_1997 | + | + | + | + | - | + | + | + | + | + | + |
| Jinnah 2014_Parent | + | + | - | - | + | + | - | + | + | + | + |
| Jinnah 2014_Staff | + | + | + | - | + | + | - | + | + | + | + |
| Kines 2013 | + | + | - | - | - | + | - | + | + | + | + |
| Morgan 2012 | + | + | + | + | + | + | - | + | - | + | - |
| Peek,Asa C 2004 | + | - | + | - | + | + | + | + | + | + | + |
| Prunet_2008_Activ | + | - | ? | - | - | + | + | + | + | + | + |
| Prunet_2008_Pass | + | - | ? | - | - | + | + | + | + | + | + |
| Rasmussen 2003 | + | + | + | - | + | + | + | + | + | + | - |
| Rautiainen 2004 | + | + | + | - | + | + | + | + | - | + | - |
| Srikrajang 2005 | ? | - | - | ? | ? | ? | + | + | + | + | - |
| van der Molen 2011_A | + | + | + | + | + | + | - | + | + | - | + |
| van der Molen 2011_B | + | + | + | - | + | + | - | + | - | - | - |
| Zohar 2002 | + | - | + | - | ? | ? | + | + | + | + | + |

SYSTEMATIC REVIEW QUALITY ASSESSMENT

Effect sizes / intervals

| Strength of effect | |
|---------------------------|---|
| Effektstørrelse | Effect intervals (reduced risk) *) |
| None | From 0 - 5% reduction in accidents |
| Little | From 5 til 25 % reduction in accidents |
| Moderate | From 25-45% reduction in accidents |
| Strong | From 45-65% reduction in accidents |
| Very strong | More than 65% reduction in accidents |
| Not estimable | Not estimable |

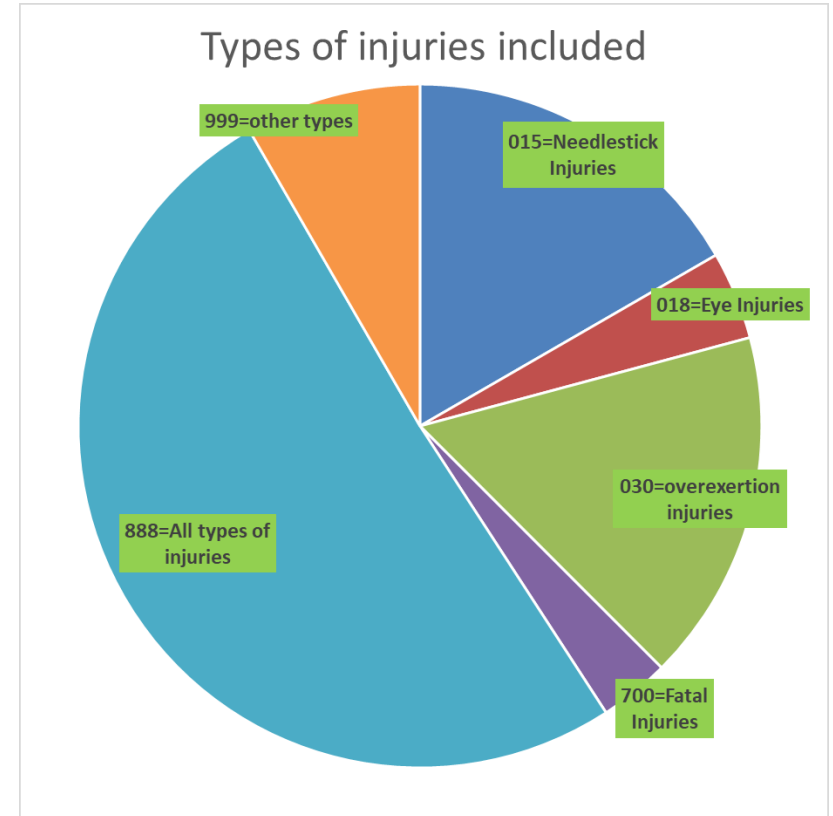
(*) ADJUSTED FROM MONSON 1990

- This is not part of the Campbell Collaboration standards, but is for dissemination purposes.
- Campbell Collaboration standards is just using point estimates and confidens intervals

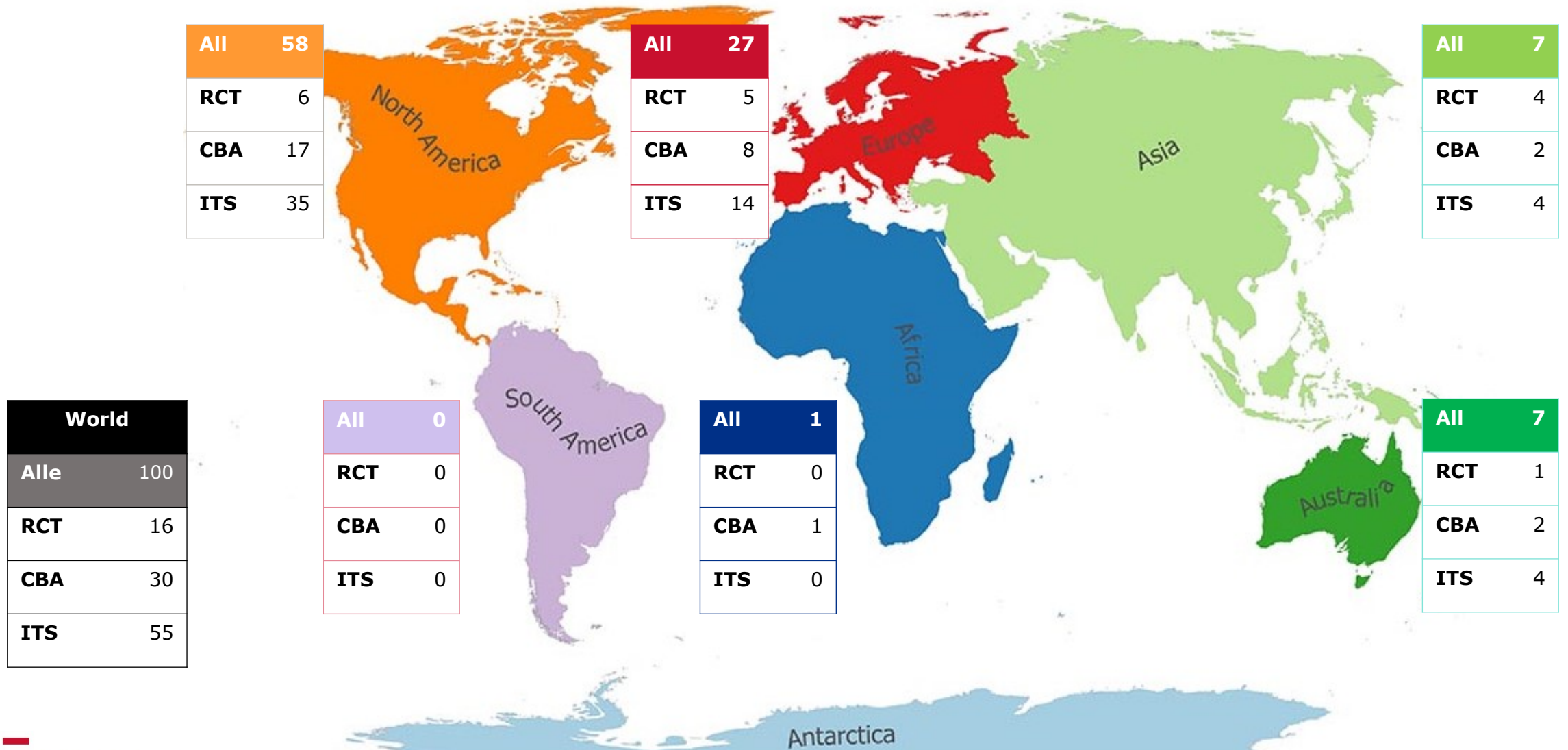
Proportion of studies by business activity and types of injuries

The proportion of safety interventions by business activity and study design

| Business activity | RCT | CBA | ITS | All |
|---|------|------|------|------|
| A - Agriculture, forestry and fishing | 25% | 9% | 9% | 12% |
| B - Mining and quarrying | 5% | 0% | 2% | 2% |
| C - Manufacturing | 25% | 19% | 16% | 18% |
| F - Construction | 5% | 5% | 12% | 8% |
| G - Wholesale and retail trade | 5% | 5% | 2% | 3% |
| H - Transporting and storage | 5% | 14% | 7% | 9% |
| N - Administrative and support service activities | 0% | 2% | 0% | 1% |
| O - Public administration and defence | 0% | 16% | 5% | 8% |
| Q - Human health and social work activities | 30% | 14% | 40% | 29% |
| All or mixed industries | 0% | 16% | 7% | 9% |
| All | 100% | 100% | 100% | 100% |



Number of studies spread across six continents



SYSTEMATIC REVIEW – Preventing accidents at work – what works?

OBJECTIVES:

- ❑ Evaluate effects of various types of safety interventions
- ❑ Identify effective components



What is a safety intervention?

Any attempt deliberately applied to promote safety and decrease the frequency or severity of accidents at work (Robson et al., 2001).

This includes also the initiatives that you implement in your industries or organisations.



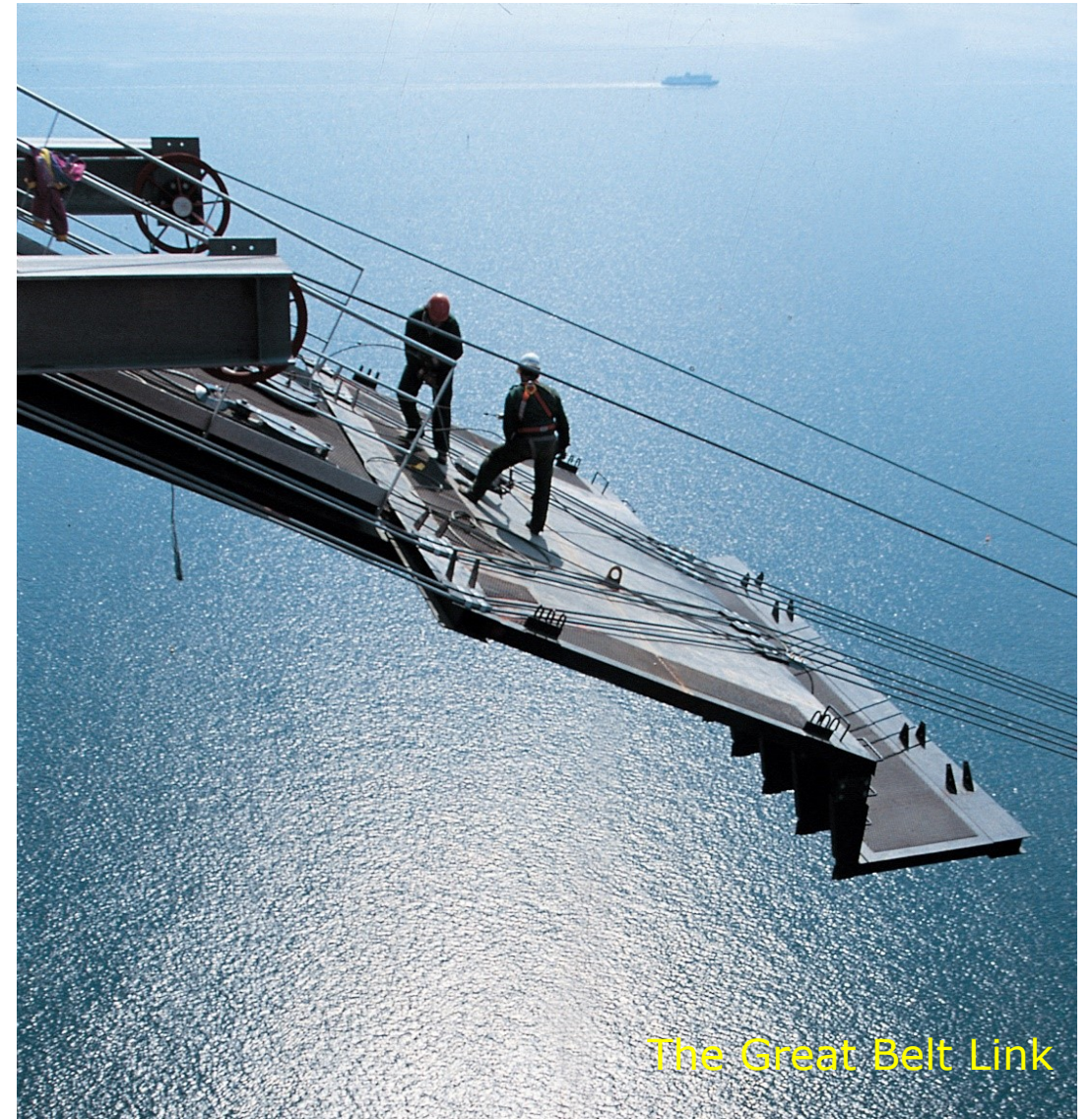
WHAT TYPES OF SAFETY MEASURES DO WE HAVE IN THE TOOLBOX?

Attitude modification:



This may be achieved by means of information and persuasive messages in campaigns, leaflets, booklets, films, posters, direct mail, guidelines, by teaching or various counseling approaches. (Lund & Aarø, 2004).

Attitude modification mainly explains behaviour in terms of internal mental states and cognitive processes (e.g., knowledge-attitudes-behaviour).



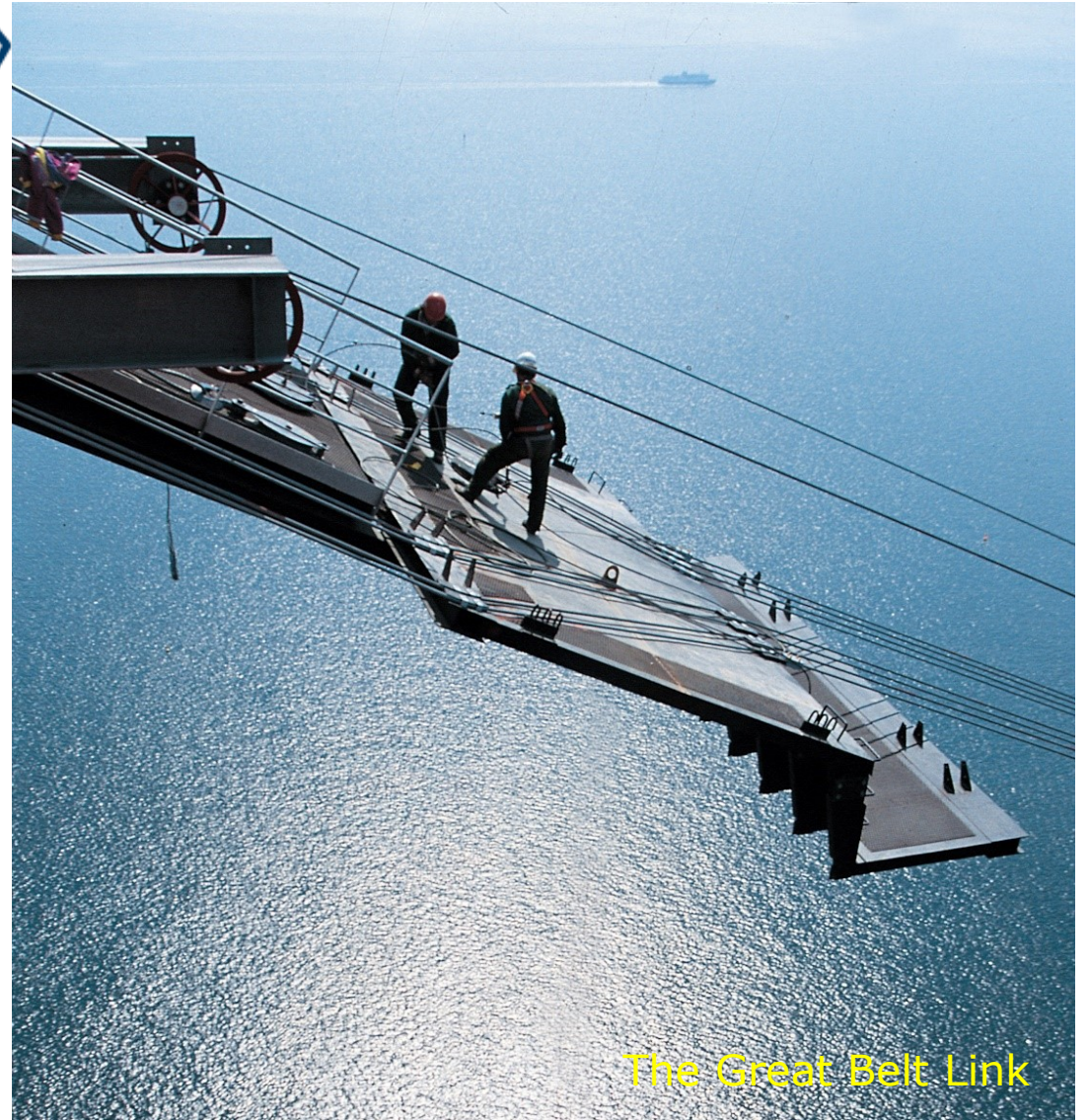
The Great Belt Link

Behavior based approach

The so-called '*Stick & Carrot*'-method'. Is about changing behavior through influence from the environment, e.g. using incentives for safe behavior ('carrot') or punishment ('stick') for unwanted behavior (Luthans & Kreitner, 1985).



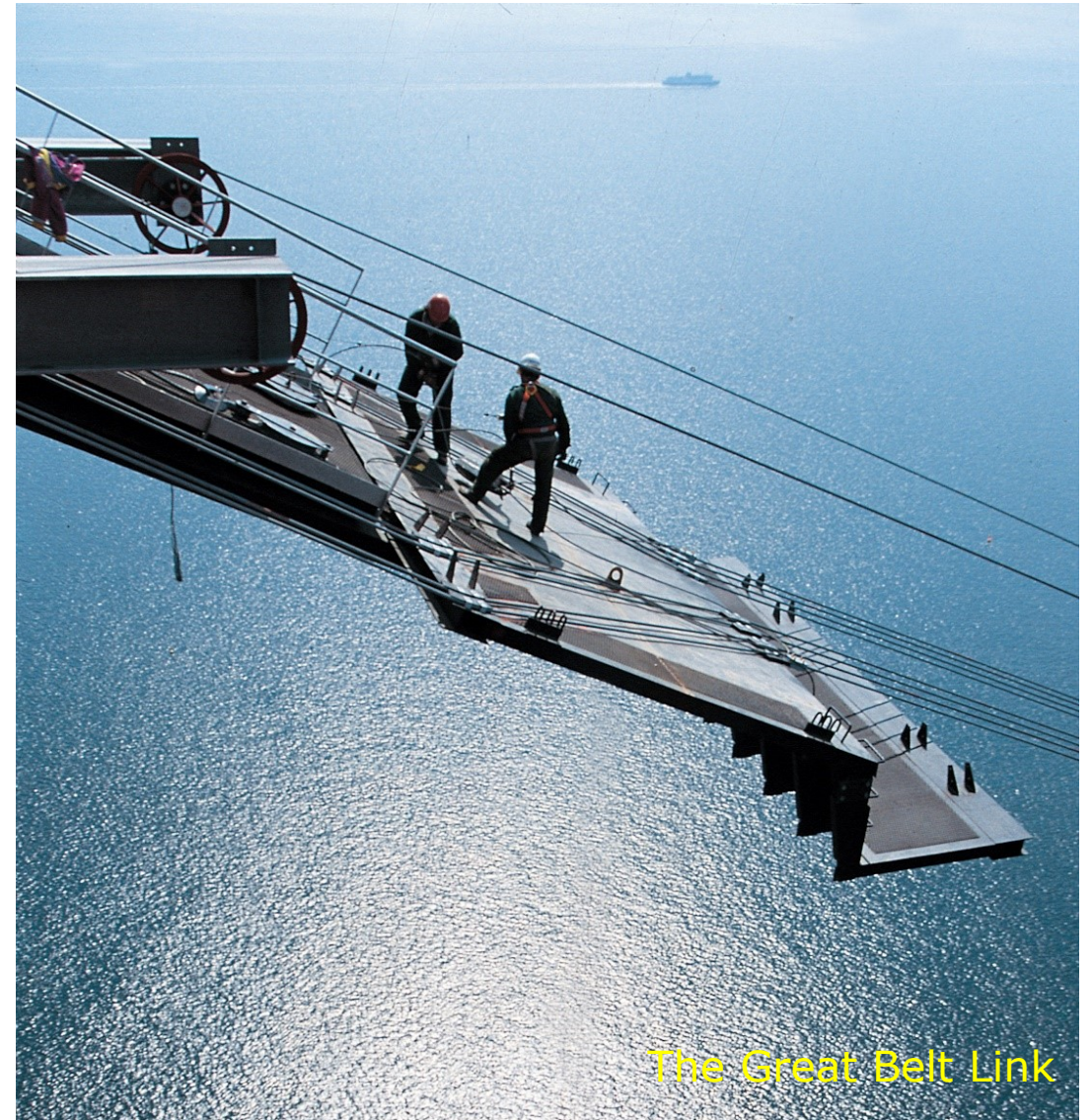
This approach originates from B. F. Skinner (1969), who proposed that a desired behavior (e.g. a safe work practice) is conditioned by certain incentives or consequences of action. This conditionality is formulated as the Antecedent-Behavior-Consequence (A-B-C)



Fysiologiske tiltag

The physiological approaches are usually directed at individual workers, and are intended to increase workers' mobility and agility by use of various training methods.

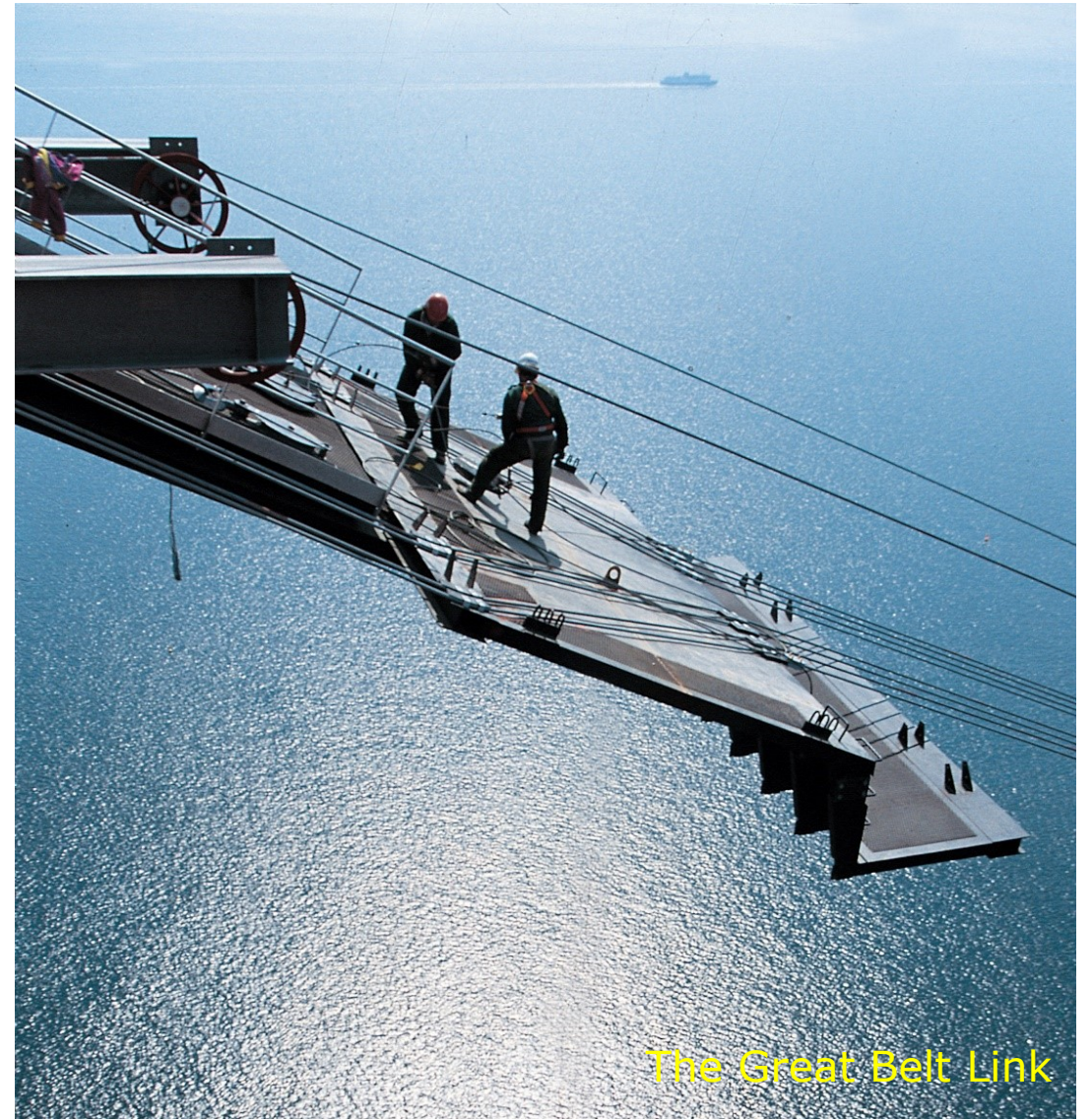
The underlying assumption of these training methods is that a stronger or more flexible body can better withstand loads and thus avoid a potential accidental injury.



Safety climate

This approach is aimed at changing the shared perceptions among managers and employees in an organization, or in a group, to influence the relative priority of safety adopted in the organization or in the group (Zohar, 2010).

We are talking about a good safety climate in the construction industry, when managers and employees give high priority to the adopted safety standards, even when things are busy!



Organizational level approaches

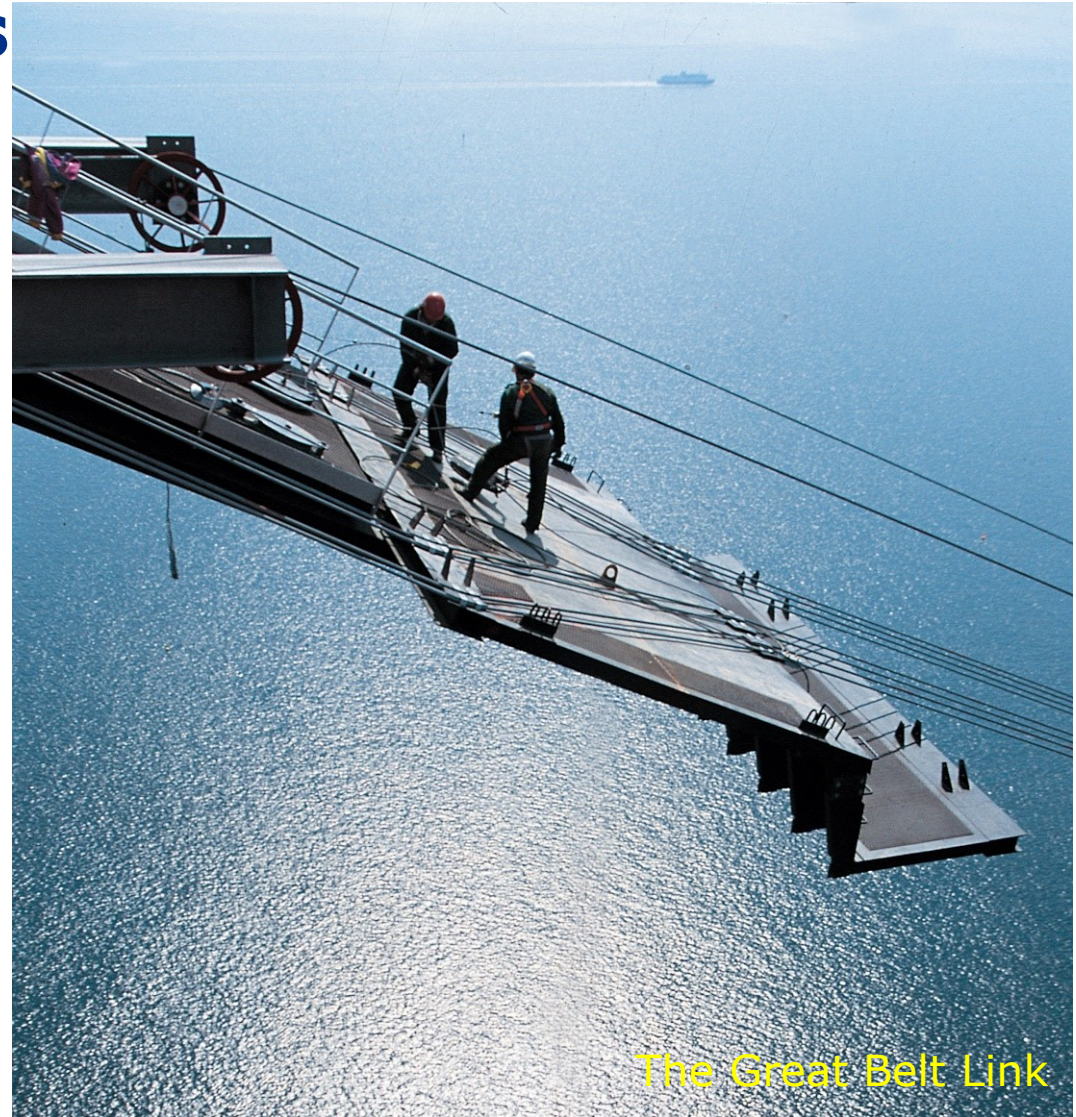
Organizational level efforts, such as improved design, work organization, policies, procedures, and strengthening of the systematic work environment efforts, etc.



Technical measures, such as machine shielding, fall protection, elimination of hazardous substances or materials.

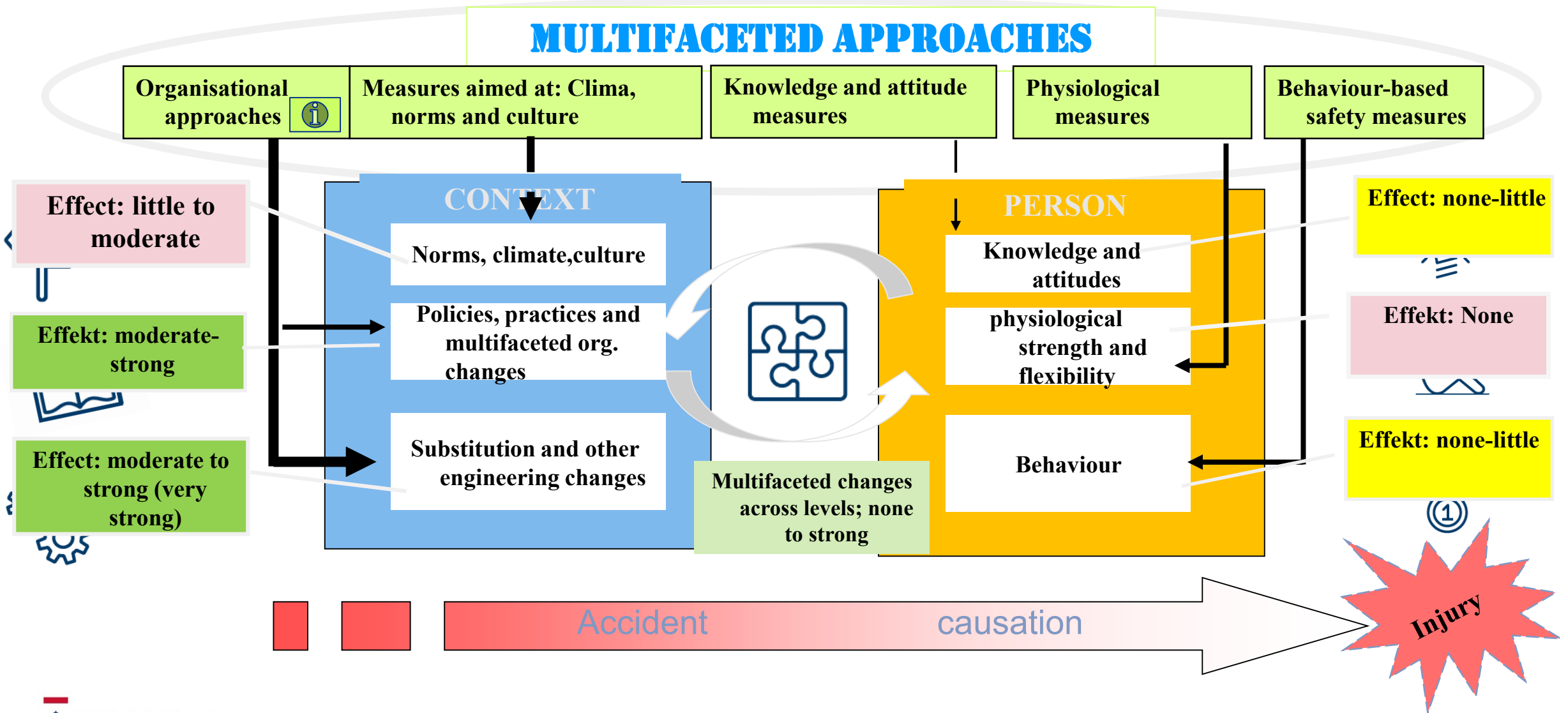


Multifaceted measures integrate two or more types of measures in the prevention of occupational accidents.



The Great Belt Link

What works in accident prevention? OVERVIEW



Summary of approaches

- *Overall, we only found a weak link between individual level approaches and reducing accidents at work. It seems that knowledge, attitudes or incentives, are overruled by the social or organisational practices at the workplace.*
- *We found limited evidence for a little to moderate effect of leader-based safety climate improvement and no effect of goal setting and feedback at group or organizational level.*



Summary of approaches

- *This review shows that safety interventions combining group or organizational level components provide moderate evidence of a strong effect at medium-term follow-up, and limited evidence of moderate effect at long-term follow-up*
- *This review found that engineering controls overall provide moderate to strong effects on reducing accidents at work. Strong effects were in particular seen in cases where the safety intervention works independently of human decision making or work practices, or where the risks were “designed out.”*



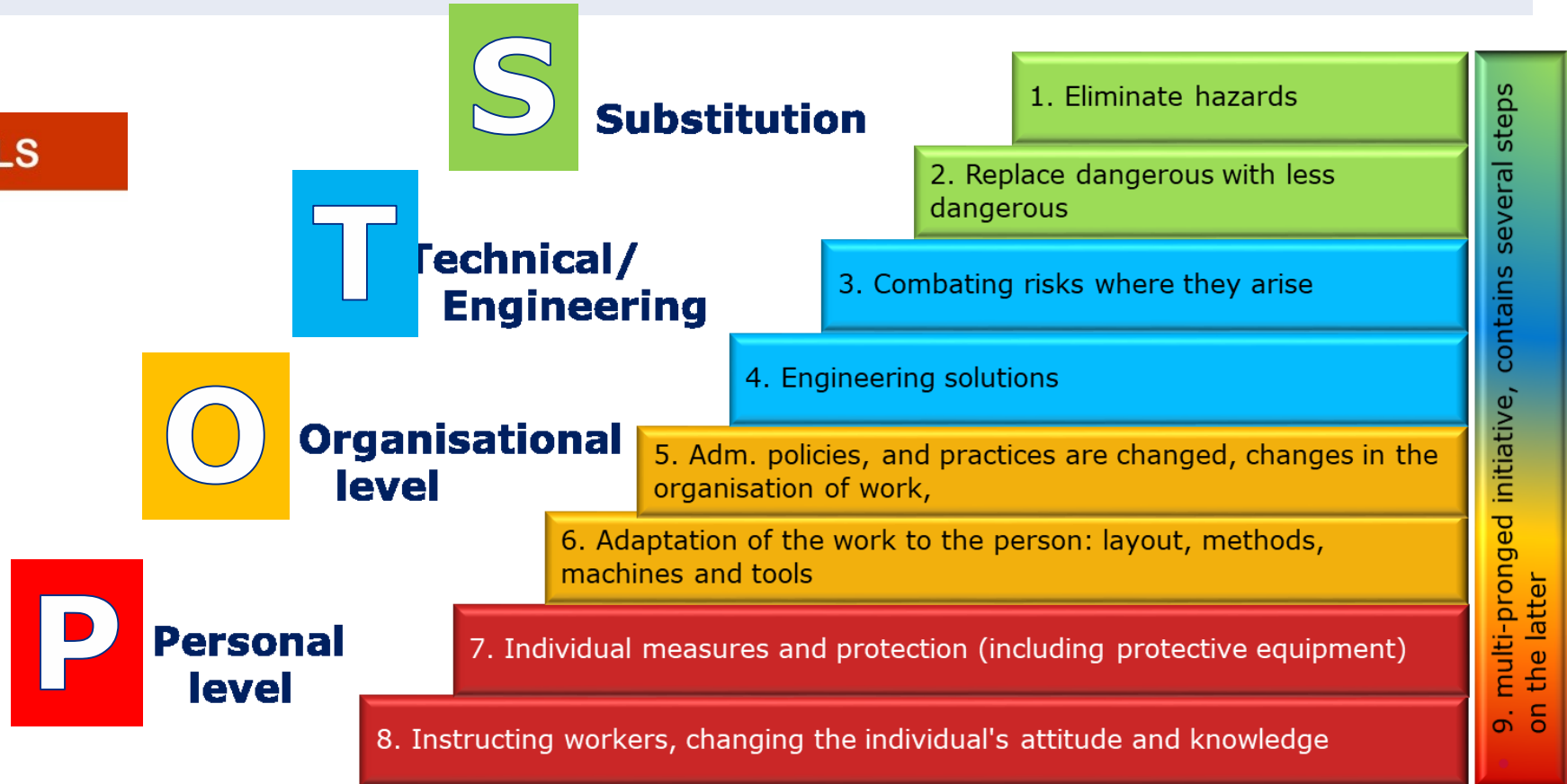
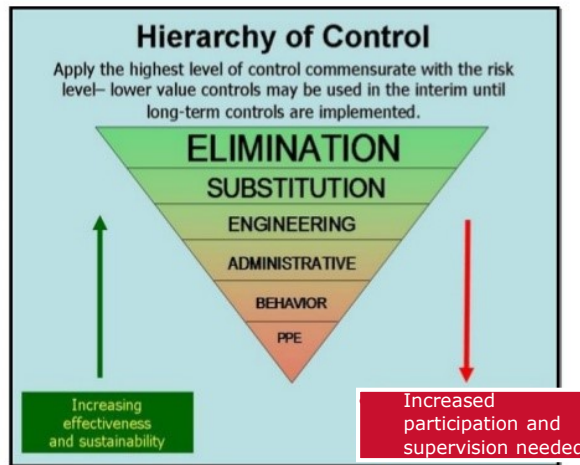
Prevention of accidents

Important principles in workplace prevention efforts

SIPAW results support the hierarchy of hazard controls
And the S.T.O.P. principle.



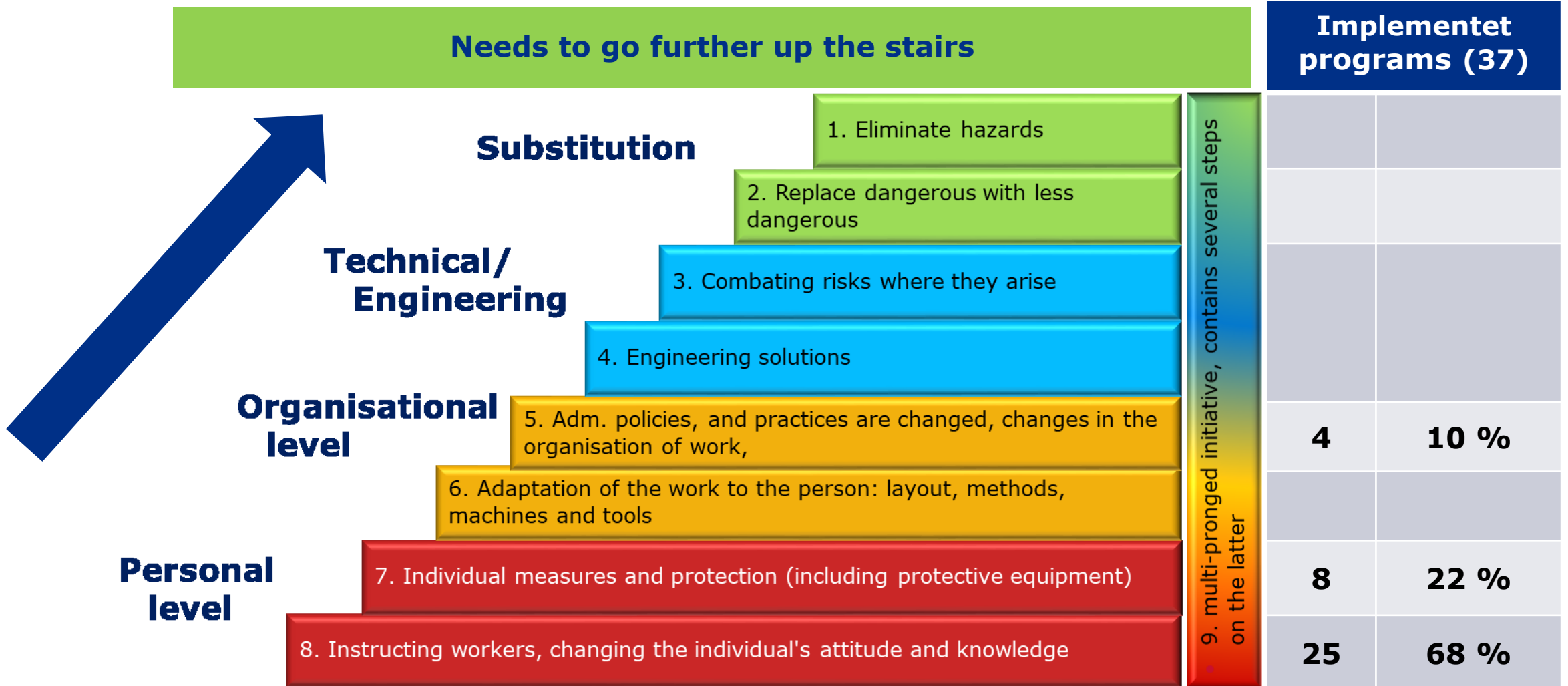
HIERARCHY OF CONTROLS



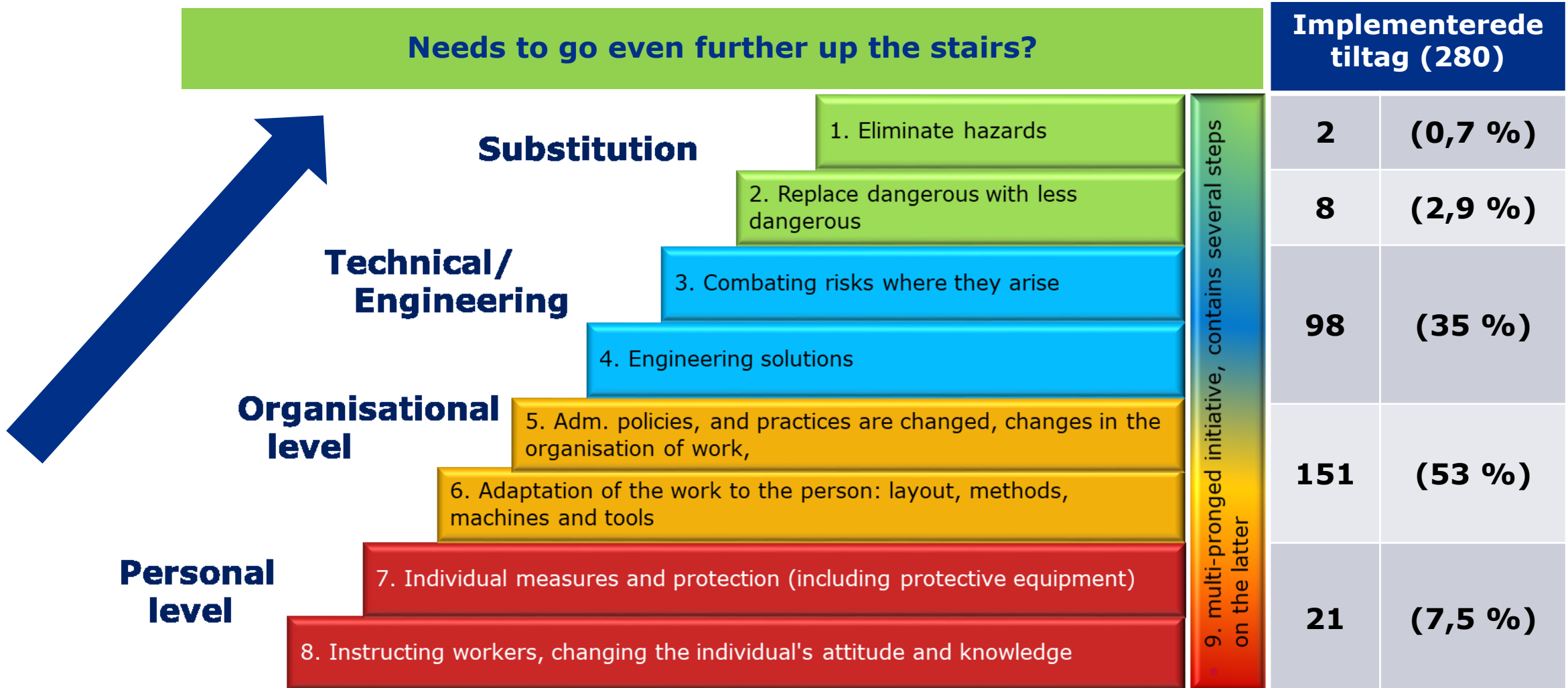
Hierarchy of hazard control OR the prevention ladder



37 prevention programs in Building industry – effective?



Safety coordinators in Building industry - effective approaches?



SYSTEMATIC REVIEW – Legislation and enforcement

Table 5.3: Summary of narrative analyses of safety interventions directed at group or organisational level, *not included* in meta-analysis, by quality assessment, level of evidence and evaluated strength of effect.

| Number of safety interventions | Quality assessment | | | Total | Level of evidence | Strength of Effect |
|---|--------------------|------------------|-------------|-------|------------------------------------|------------------------------------|
| | high quality | moderate quality | low quality | | RCT, CBA and serial measures (ITS) | RCT, CBA and serial measures (ITS) |
| Type of safety intervention and follow-up periods | | | | | | |
| 2.1.0. Climate, norms or culture modifications: | | | | | | |
| 2.1.1 Goal setting and FB at group or org. level | | | | | | |
| 2=Short-term (-12 months) | | 2 | 5 | 7 | Limited | None |
| 2.1.7 Leadershipbased safety interventions | | | | | | |
| 2=Short-term (-12 months) | 1 | 2 | 1 | 4 | Limited | Little to moderate |
| 2.2.0. Structural modifications: | | | | | | |
| 2.2.1 Legislative changes | | | | | | |
| 4=Long-term (36- month) | 3 | 2 | 4 | 9 | Limited | Little to moderate |
| 2.2.2 Economic incentives | | | | | | |
| 3=Medium-term (12-36 months) | 2 | | | 2 | Limited | Little to moderate |
| 4=Long-term (36- month) | 1 | | | 1 | Limited | <i>Not estimable</i> |
| 2.2.3 Soft regulation | | | | | | |
| 3=Medium-term (12-36 months) | 1 | 2 | | 3 | Limited | None |
| 4=Long-term (36- month) | | | | 2 | Limited | None |
| 2.2.4 Engineering controls | | | | | | |
| 2=Short-term (-12 months) | 3 | 3 | 5 | 11 | insufficient | Moderate |
| 3=Medium-term (12-36 months) | | | 1 | 1 | Strong | Moderate |
| 4=Long-term (36- month) | 3 | 1 | 1 | 5 | Limited | Little |
| 2.2.5 Administrative controls | | | | | | |
| 2=Short-term (-12 months) | | 1 | 1 | 2 | Insufficient | <i>Not estimable</i> |
| 3=Medium-term (12-36 months) | | | 1 | 1 | Insufficient | <i>Not estimable</i> |
| 2.2.7 Enforcement of laws and regulations | | | | | | |
| 4=Long-term (36- month) | 1 | 2 | 3 | 6 | Moderate | None to little |
| 2.2.8 Social marketing and other approaches | | | | | | |
| 4=Long-term (36- month) | | | 1 | 1 | Insufficient | Very strong |

Legislation →

Enforcement →

SYSTEMATIC REVIEW – Legislation and enforcement

Table 5.4: Summary of meta-analysis for a subset of structural safety interventions, directed at the organisational level, by type of safety intervention, quality assessment, level of evidence and strength of effect.

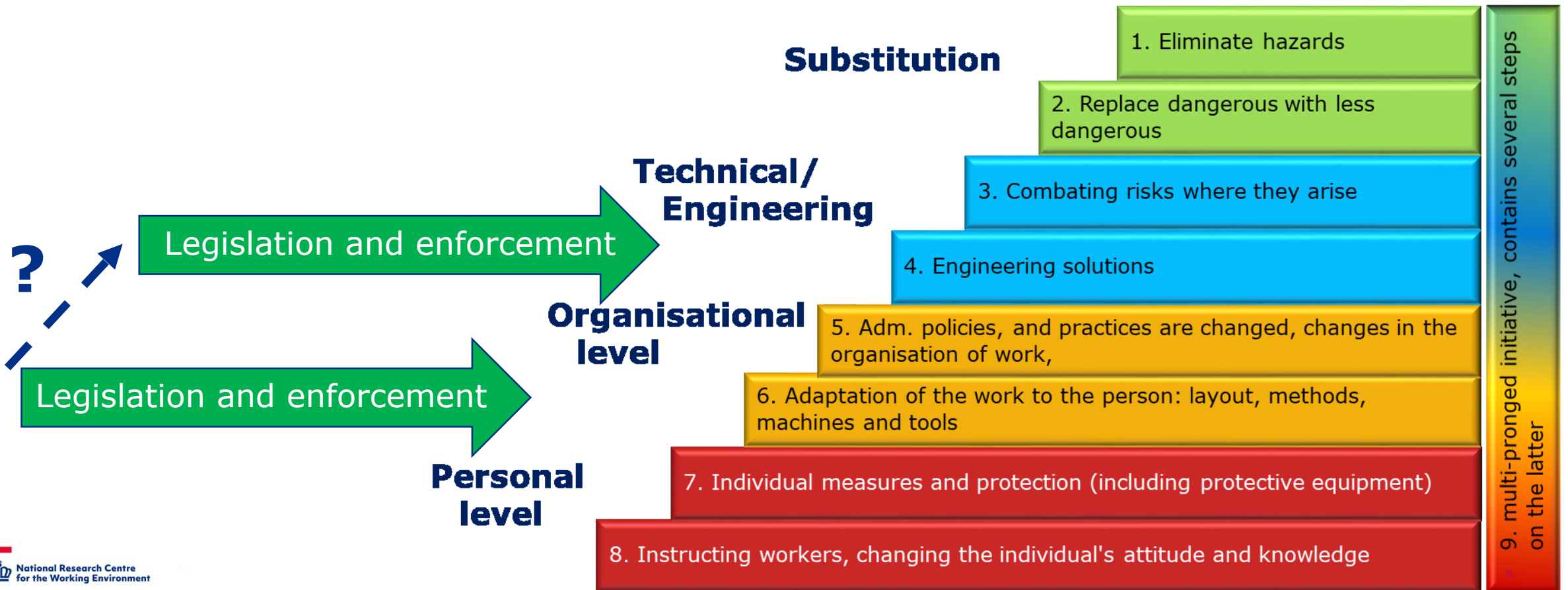
| Number of safety interventions | Quality assessment | | | Total | Level of evidence | Strength of effect | Meta-analysis (injury outcomes) | | I ² RCT/CBA |
|---|--------------------|------------------|-------------|-------|-------------------|-----------------------|---------------------------------|----------------------|---------------------------|
| | high quality | moderate quality | low quality | | RCT and CBA | RCT and CBA | RCT | CBA | |
| 2.2.0.: Structural safety interventions: | | | | | | | | | |
| 2.2.4 Engineering controls | 4 | 2 | | 6 | | | | | |
| 1=Post-test | 1 | | | 1 | Limited | Strong to very strong | OR 0.33 [0.21, 0.51] | | NA |
| 2=Short-term (-12 months) | 3 | | | 3 | Strong | Moderate | OR 0.72 [0.29, 1.83] | OR 0.28 [0.10, 0.75] | NA/70% |
| 3=Medium-term (12-36 months) | | 1 | | 1 | insufficient | Strong | | OR 0.44 [0.26, 0.74] | NA |
| 4=Long-term (36- month) | | 1 | | 1 | insufficient | Very strong | | OR 0.27 [0.14, 0.52] | NA |
| 2.2.7 Enforcement of laws and regulations | 7 | | 4 | 11 | | | | | |
| 2=Short-term (-12 months) | 1 | | | 1 | Limited | Little | | OR 0.86 [0.77, 0.95] | NA |
| 3=Medium-term (12-36 months) | 2 | | 4 | 6 | Moderate | None to little | OR 0.99 [0.89, 1.10] | OR 0.95 [0.93, 0.97] | NA/0% |
| 4=Long-term (36- month) | 4 | | | 4 | Strong | Little | | OR 0.96 [0.93, 0.98] | 0% |
| 2.2.7 Enforcement of laws w/penalties | 2 | | | 2 | | | | | |
| 3=Medium-term (12-36 months) | 2 | | | 2 | Moderate | None to little | | OR 0.95 [0.92, 0.98] | 0% |



Eksternal measures

Legislation and enforcement

Measures can also be external in the form of legislation, supervision, 'soft law' (political agreements, certification, activities and action plans at branch level, etc.), which encourage companies to take steps or concrete actions to improve the working environment.



Thank you!

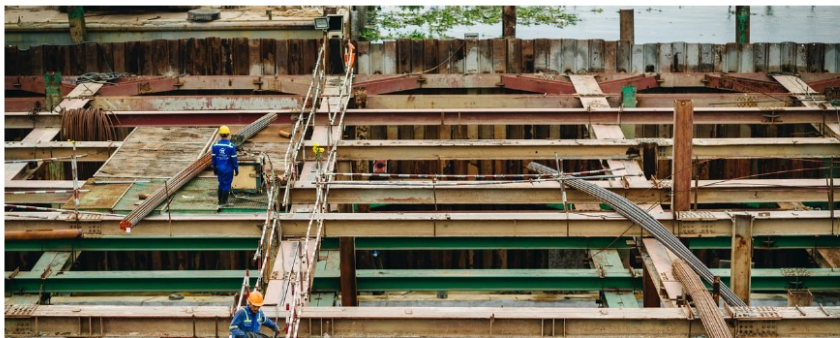
- Thanks to co-authors:
- [Hester Johnstone Lipscomb](#), [Kent Nielsen](#), [Marianne Törner](#), [Kurt Rasmussen](#), [Karen Bo Frydendall](#), [Hans Bay](#), [Ulrik Gensby](#), [Elizabeth Bengtsen](#), [Frank Guldenmund](#), [Pete Kines](#)

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Campbell Systematic Reviews, June 2022, Wiley
DOI: 10.1002/cl2.1234

Target the organization before the individual, when preventing accidents at work



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LATEST RESEARCH

Campbell Collaboration

Plain Language Summary
Social Welfare 2022

Occupational safety interventions directed at the group or organisational level are more effective in preventing accidents than individual-level measures

Occupational safety interventions directed at the group or organisational level are more effective at improving safety and behaviour and reducing accidents at work than interventions directed solely at the individual level.

Multifaceted measures are particularly effective when they include elimination, substitution or other engineering controls. Safety regulation and enforcement contribute to the prevention of accidents at work, but with lesser effect.

Thank you for your attention!



Contact: Johnny Dyreborg
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