Proceedings of the 35th European Safety and Reliability & the 33rd Society for Risk Analysis Europe Conference
Edited by Eirik Bjorheim Abrahamsen, Terje Aven, Frederic Bouder, Roger Flage, Marja Ylönen
 Published by Research Publishing, Singapore.
doi: 10.3850/978-981-94-3281-3_ESREL-SRA-E2025-P8385-cd

Recommendations for a significant reduction in construction accidents in Norway

Stig Winge

SINTEF Digital, Norway. E-mail: stig.winge@sintef.no

Stine Skaufel Kilskar

SINTEF Digital, Norway. E-mail: stine.s.kilskar@sintef.no

Pål Brennhovd

SINTEF Digital, Norway. E-mail: paal.brennhovd.@sintef.no

Despite many preventive measures introduced to reduce accidents in the Norwegian construction industry the last decade, accident rates (fatal and non-fatal) have been relatively stable. The main purpose of this study was to identify and suggest key topics and recommendations to significantly reduce construction accidents in Norway. The material and methods were expert interviews, an expert workshop, and examination of various research, reports and documents. The research resulted in eight overall recommendations for reducing construction accidents on a national level: (1) more targeted measures towards incident concentrations, (2) improve risk-reduction practices, (3) integrate safety in all construction phases, (4) improve safety culture, leadership and participation, (5) improve safety competence among key actors, (6) coordinate guidance materials, (7) reduce time pressure and production pressure, and (8) strengthening the national organizing, coordination and financing of safety work. The results can be useful for other countries and industries aiming at reducing accidents on a national level.

Keywords: Safety, accidents, construction, occupational, accident prevention, safety recommendations.

1. Introduction

Key stakeholders in the Norwegian construction industry ask why accidents rates are relatively stable despite all the preventive measures introduced nationally the last decade. SINTEF Digital was hired by the Foundation for Regional Safety Representatives in Construction to identify recommendations for a significant reduction in construction accidents. This paper is based on the original report by Winge et al. (2024).

The first aim of the study was to identify key concentrations for prioritizations. "Incident concentration-analysis" (Kjellén and Albrechtsen, 2017) is an approach to identify clusters of incidents with common characteristics, e.g. accident types, deviations, barrier failures, time and place. Concentrations were grouped into characteristics of the incident, individuals, enterprises, time, place, and causal factors. More details on this analysis can be found in the original report (Winge et al., 2024). The results were largely in harmony with international results. Lingard and Wakefield (2019) conclude that (1) the activities and incidents that result in injuries are known, that (2) they are "remarkable similar", and that (3) this consistency indicates that strategies targeting these specific areas could significantly reduce accidents in construction. An important question then is why the accident rates are relatively high despite all we know. Our assessment is that there are some deeper troubles in the industry that hinder it from preventing these known main concentrations effectively. Hence, the main aim of this research was to identify key recommendations for increasing the construction industry's ability to prevent accidents more effectively.

2. Material and methods

This study is an inductive, exploratory case study triangulating results from (1) expert interviews, (2) an expert workshop, (3) relevant documents, and (4) various reports and research. A total of 14 interviews were conducted with a

total of 16 interviewees representing key stakeholders in construction: the authorities, clients, designers, contractors, industry associations, employee representatives, and three organizations working for safety in Norway, and representatives for organizations working with occupational safety on a national level in Sweden, Denmark, and the Netherlands. Some of the Norwegian interviewees represented more than one of the actors.

The interviews were conducted digitally, and lasted 1-1,5 hours. The interview guide was adapted to different roles, but mainly dealt with the same overarching topics: How to approach incident concentrations (both generic and on concrete concentrations), how to approach accidents in general, what works and what may not work so well in accident prevention, what can be done to improve approaches to accidents at the national level, focusing on synergies and collaboration, etc.

The workshop was a physical meeting after all other data had been gathered. Participants were experts representing key stakeholders. The aim of the workshop was to validate topics and recommendations, and to receive more qualitative data on the topics and recommendations. Before the workshop we had a longer list of topics and recommendations but had to narrow them down. We ended up with eight topics, some of which encompass multiple sub-topics. The list of topics and recommendations is not exhaustive.

Ending up with the eight recommendations was the result of the following steps: (1) The interviewees were asked for their opinion on important topics to reduce the number of accidents. (2) Based on a thematic analysis of the interviews and the other materials, 12 topics were identified by the researchers. (3) The 12 topics were presented to the participants of the workshop. The participants were divided into two groups who were asked to describe them in more detail and prioritize them. (4) The topics were further discussed and prioritized in plenary. (5) Based on the discussions in the workshop, the researchers reduced the list of topics from 12 to eight, and formulated recommendations based on the topics.

It is important to add that the prioritization process is also influenced by the researcher's assessments that have influenced the work in steps 2-5. There was a broad agreement on the eight topics among the participants.

Table 1. Interviews and workshop – key characteristics

Role	Inter-views (N)	Interviewees (N)	Participants workshop (N)
Authorities	1	2	1
Clients	2	2	2
Contractors	2	2	2
Design consultants	2	2	
Workers' organizations	2	2	2
National safety organizations	2	2	3
Interviewees from other countries	3	4	-
Tot	14	16	10

3. Topics and recommendations

Since publication of the report (Winge et al., 2024), we have presented the results in many settings and discussed the results with many actors. Based on this feedback we have elaborated some topics a little in this paper. It is important to note that the topics are connected and overlap. All recommendations apply to the whole construction industry, including authorities, employer organizations and labor organizations. The eight recommendations are summarized in Table 2.

Table 2. The eight recommendations summarized

N.	Recommendations
1	More targeted measures towards incident concentrations
2	Improve risk-reduction practices
3	Integrate safety in all construction phases
4	Improve safety culture, leadership and participation
5	Improve safety competence among key actors
6	Coordinate guidance materials
7	Reduce time pressure and production pressure
8	Strengthening top level commitment, organizing, coordination and financing

3.1. *More targeted measures towards incident concentrations*

This first recommendation is based on the incident concentration analysis mentioned above.

Many informants ask why the accident rate is stable despite all the efforts to reduce accidents in the last ten years. Our conclusion is that more targeted measures against concentration of risk factors nationally are necessary to achieve a significant reduction in accidents. A key actor for coordination of national accident prevention in construction is SfSBA (Cooperation for safety in construction) which is a partnership between key stakeholders in the Norwegian construction industry (clients, architects, designers, contractors, labor organizations and authorities).

We recommend that the industry and SfSBA significantly increase its efforts and work more targeted on prioritized incident concentrations and parts of the industry to achieve a significant reduction in accidents. Clear and measurable goals and sub-goals should be established, and strategies and measures must be implemented in priority areas that contribute most to achieving these goals. This assumes a more robust organizing and financing of SfSBA as described in chapter 3.8.

3.2.*Improve risk-reduction practices*

The development of risk reduction measures in the industry is mostly based on beliefs, and less on research evidence. In a comprehensive review of safety interventions for the prevention of accidents at work, Dyreborg et al. (2022) found that the relative effectiveness of workplace safety interventions is in accordance with the Public Health Hierarchy of Hazard Control. More specifically they found e.g. that (1) more effective interventions eliminate risk at the source of the hazard through engineering solutions or the separation of workers from hazards, (2) strong evidence supports greater effects being achieved with safety interventions directed toward the group or organizational level rather than at the individual level, (3) intensive group discussions are effective (4) multifaceted approaches combining intervention elements at the organizational level, or across levels, provide moderate to strong effects, particularly when engineering controls are included, (5) a focus on training workers to deal with dangerous tasks, for example, use of personal protective equipment, should be a last resort, exercised only when other more effective measures are not feasible, (6) occupational safety intervention efforts should foster safer work environments, tools, and conditions rather than focusing on how workers can mitigate the risks.

We recommend implementing measures to increase knowledge and practices on developing effective risk-reduction measures. The hierarchy of controls and the barrier approach should be familiar to and utilized by key roles industry actors. This is a demanding task. One important measure will be to increase the use of safety experts in key roles among the actors and projects, and to increase safety competence among leaders at alle levels. This is an issue in section 3.5.

3.3.*Integrate safety in all construction phases*

Construction projects are divided into phases, e.g. (1) feasibility study and concept development, (2) design and planning, (3) construction, and (4) delivery, use and maintenance. Traditionally, safety management has focused primarily on the construction phase, and little attention has been paid to early phases. Problems in later project phases are often found in processes and decisions at the front-end of projects (Williams & Samset, 2012). Behm (2005) found that 42% of construction fatalities were linked to design, Gambatese et al. (2008) found a significant link between design and the incident in 71% of fatalities, while Driscoll et al. (2008) found that 44% of construction fatalities were related to design.

The background for the EU Directive 92/57/EEC, was to ensure the safety and health of workers on construction sites through planning, coordination, and a chain of responsibility. A key principle for sustainability and safety management in construction projects is to manage risk as early in the project's life cycle as possible (Kjellén & Albrechtsen, 2017; Lingard & Wakefield, 2019). There are however significant challenges in practical implementation of safety in design (Lingard and Wakefield, 2019) and planning in early phases. A key challenge is the inadequate dialogue, cooperation and coordination between the client, designer and principal contractor (Winge et al., 2024).

We recommend implementing measures to improve the quality and integration of safety in planning and design processes across various parts the industry. This work should, among other things, be built on research and

recommendations described above and in Winge et al. (2024).

3.4.*Improve safety culture, leadership and participation*

Most informants underlined the importance of improving safety culture, leadership and participation to reduce accidents in the industry. There is no widely accepted definition of safety culture, and some argue for the elimination of safety culture from "the safety science lexicon" (Sherratt et al., 2025, p. 8). Reason (1997, p. 194) argues that safety culture is an organizational culture in which "safety is an over-riding priority". Hopkins (2019) argues that the most concrete and useful definition of safety culture is the collective practices of the group — "the way we do things around here" (Schein, 1992). There is also no consensus on how to *change safety culture* to improve safety (Dyreborg et al., 2022). Schein (1992) (referred by Hopkins, 2018) argues that leaders create cultures by what they systematically pay attention to, e.g. what they comment on, measure, control, reward and in other ways systematically deal with it. Hopkins (2018) argues for two ways to influence safety culture – structure and leadership. Leaders create structures that will in turn institutionalize a certain kind of organizational culture (ibid.). These structures reflect the priorities of top leaders. Hopkins (2019) concludes that structure and power are more effective ways to influence culture than via educational programs and attitude campaigns such as "hearts & minds".

Norway, Sweden and Denmark are societally and regulatory relatively similar countries. Nielsen et al. (2023) identified possible "cultural factors" responsible for Sweden having far better injury rates in construction than Denmark. The results indicated that the six factors investigated (cooperation, perceived organizational support, organizational citizenship behavior, planning, safety motivation, and long-term orientation) was generally higher in Sweden. The results indicate the relevance of "safety culture" in construction.

We recommend implementing measures to improve safety culture, leadership, and participation in construction. The project should assess how to effectively and practically improve "safety culture" in construction by e.g. leadership, structural measure, participation and other measures.

3.5.*Improve safety competence among key actors*

There are many types of competence at different levels necessary for safe production in construction. Safety-relevant competence is acquired through education, formal training, courses, and through practice and dialogue in everyday working life. Many informants assert that the latter is most important, and many state that the problem is that courses focus on quantity, and little on quality. Forthermore, much attention is directed at safety-competence among workers at the sharp end, and little on managers, leaders, safety-personnel and coordinators. It is important to underline that safety and safety management are disciplines with education in specific tools and methods like risk assessment, barrier management, accident investigations, safety audits etc. Many people in the construction industry have this type of competence, and they can be involved more in planning, project management and safety management.

We recommend implementing measures to identify the biggest deficiencies in safety competence in the industry, and what is needed to improve safety competence of key groups and roles.

3.6.*Coordinate guidance materials*

There are many useful guidelines and instructions related to safety in the construction industry located at various websites. Examples are guidelines about safety and working on roofs, trench work, safety plans, concrete pumping, prefabricated installation, design, planning and engineering, blasting, geotechnics, construction machinery, and tunnel work. Informants point out that it can be difficult to find available materials located at different sites, that some materials overlap, and that some actors are keen to have their own guidelines that emphasize slightly different things. There is a potential for coordinating the production of such material to avoid overlapping and make it more coherent.

This is both a governance and a technological challenge. We recommend that a

work group represented by key actors is given the task of suggesting technological solutions and how this work should be organized. The aim should be to coordinate the production and publication of guidance materials, and that most of it is located at a user-friendly website that is made known in the industry.

3.7.*Reduce time pressure and production pressure*

Production pressure and time pressure exist in construction most of the time. The challenge is to prevent it from creating unacceptable unsafe conditions and situations. Many informants experience that time pressure and production pressure are major contributors to many accidents and necessary to address to reduce accidents significantly.

Production pressure and time pressure are also recurring topics in the research literature. In a comprehensive literature study of safety factors in construction, Mohammadi et al. (2018) found that production pressure (workload, overburdening, fatigue, burnout, work pace, working hours, overtime, and delays) was a significant factor. Mullen (2004) observed that insufficient time and resources created pressure from managers and co-workers to prioritize performance over safety, resulting in unsafe practices. Hasle et al. (2023) found that health, safety, and environment (HSE) performance on construction sites is strongly influenced by cost-reduction, but often even more by time constraints caused by optimistic planning. These descriptions are largely in line with what informants in this research expressed.

High production pressure and time pressure can arise from many factors at various phases. Time pressure and production pressure can result from circumstances at all phases of a project. Much can be influenced during the early phases, as described in chapter 3.3. Although challenging to address at a national level, production and time pressures are such critical factors for safety in the industry that they must be addressed to significantly reduce accidents.

We recommend initiating a project to explore how these pressures can be reduced across the industry. The work should adopt a systemic approach and consider contributing factors to production and time pressures at different phases and organizational levels. These include regulations, inspections, audits, guidance, planning competence, project design and management, contract forms, collaboration models, communication and cooperation, project schedules, incentives, safety culture, etc.

3.8.*Strengthening top level commitment, organizing, coordination, and financing*

This paper has presented seven key topics and recommendations, as described in the previous chapters, for improving safety in the industry. This eighth recommendation – strengthening top level commitment, organizing, coordination, and financing – is necessary for initiating and implementing the other recommendations.

There is broad agreement among stakeholders that, given its constraints regarding funding etc., SfSBA has functioned well and is built on solid principles. SfSBA is established and operated by all key stakeholders. SfSBA should continue but be further developed. However, to significantly reduce accident rates, the national organizing, coordination and financing by key stakeholders and through SfSBA must be strengthened.

The top level of authorities, clients and contractors must take more responsibility. Drawing inspiration from the Danish model of political agreements and tripartite collaboration can enhance commitment, financing and coordination. Consideration should be given to funding the collaboration through state funds, membership fees etc.

The authorities, both as a regulator and client, have the most influence on safety in construction. Public construction projects often face considerable time and production pressures, contributing to accidents as described in chapter 3.7. Authorities and public clients should put more effort into ensuring that such pressures do not compromise safety. Public clients significantly impact construction safety through building roads, railways, airports, power generation and supply, public buildings etc. By leading by example, public clients can make a significant contribution to improving safety standards and results. This requires more commitment among the public clients and the political level governing the public clients.

To significantly reduce accidents, we recommend that safety is more anchored at the top levels of the industry's key actors to improve organizing, coordination and financing. Political agreements and tripartite cooperation should be

considered to enhance commitment and financing.

4. Discussion

Key stakeholders in the Norwegian construction industry ask why accident rates are relatively stable despite all preventive measures introduced the last decade. Lingard and Wakefield (2019) conclude that the activities and incidents that result in injuries in construction are known, which is also the situation in Norway. An important question then is why accident rates are relatively high despite all we know about accidents. Our conclusion is that there are some deeper troubles in the industry that hinder it from preventing known concentrations effectively.

Hence, the main aim of this research was to identify key topics and recommendations for increasing the construction industry's ability to prevent accidents more effectively. Our general answer is that we believe that the industry and central stakeholders underestimate what is necessary when it comes to both the quantity and quality of preventive strategies and measures. We also believe that sustained, long-term efforts involving the key stakeholders at the national level are essential. It is essential to create strong national organizational frameworks for this work, anchored at the highest levels of the various stakeholders. Therefore, recommendation number eight – strengthening top level commitment, organizing, coordination, and financing – is key to achieve long term results.

There are some limitations in this research. Before the workshop we had a longer list of topics and recommendations but had to prioritize a few topics. We ended up with eight topics, some of which encompass multiple sub-topics. The list of topics and recommendations is not exhaustive. The prioritization of the eight topics is heavily based on the researcher's assessment of triangulation of data.

This research can be useful for other countries and industries aiming at reducing accidents on a national level. Safety science mainly operates on an enterprise level, while this research focuses on the national level of the construction industry. There is need for more research on "safety management" on a national level coordinating authorities, industry actors, labor organizations, employers' organizations etc. to coordinate their efforts. Both case studies and comparative studies are important. Comparative studies can compare safety results and safety practice to identify factors that can explain differences in safety results. For example, several studies (e.g., Nielsen et al., 2023) have identified possible factors explaining why Sweden have considerably lower injury rates in construction than Denmark. More safety management research on national level in construction, other industries, and other areas would be valuable.

Acknowledgements

This paper is based upon a research report (Winge et al., 2024) funded by the Foundation for Regional Safety Representatives in Construction[a]. We would like to extend our thanks to the Foundation, which was crucial for the completion of this research. Additionally, we are grateful to all the interviewees for their willingness to participate and share their valuable insights. Their contributions have been instrumental in shaping the outcomes of this study.

References

Behm, M. (2005), "Linking construction fatalities to the design for construction safety concept", *Safety Science*, Vol. 43, No.8, pp.589-611

Driscoll, T. R., Harrison, J. E., Bradley, C., & Newson, R. S. (2008). The role of design issues in work-related fatal injury in Australia. *Journal of Safety Research*, *39*(2), 209-214.

Dyreborg, J., Lipscomb, H. J., Nielsen, K., Törner, M., Rasmussen, K., Frydendall, K. B., & Kines, P. (2022). Safety interventions for the prevention of accidents at work: A systematic review. *Campbell systematic reviews*, *18*(2), e1234

Gambatese, J. A., Behm, M., & Rajendran, S. (2008). Design's role in construction accident causality and prevention: Perspectives from an expert panel. *Safety science*, *46*(4), 675-691.

Hasle, P., Öhler, W., Pagell, M., Uhrenholdt Madsen, C., Limborg, H. J., Ramioul, M.,& Dupont, V. (2023). Improving OSH through supply chains: market-based initiatives in the agri-food and construction industries: Summary. *Report*.

Hopkins, A. (2018). The use and abuse of "culture". *Safety cultures, safety models: Taking stock and moving forward*, 35-45.

[a] Fondsstyret for regionale verneombud i bygge- og anleggsbransjen: https://rvofond.no/ba)

Hopkins, A. (2019) Organising for Safety. How Structure Creates Culture. CCH Press, Sydney (2019).

Kjellén, U., Albrechtsen, E. (2017). Prevention of accidents and unwanted occurrences: Theory, methods, and tools in safety management. CRC Press.

Lingard, H. and Wakefield, M. (2019) *Integrating work health and safety into construction project management*. USA: Wiley-Blackwell.

Mohammadi, A., Tavakolan, M., & Khosravi, Y. (2018). Factors influencing safety performance on construction projects: A review. Safety science, 109, 382-397.

Mullen, J. (2004). Investigating factors that influence individual safety behavior at work. *Journal of safety research*, *35*(3), 275-285.

Nielsen, K. J., Törner, M., Pousette, A., & Grill, M. (2023). National culture and occupational safety–a comparison of worker-level factors impacting safety for Danish and Swedish construction workers. *Construction Management and Economics*, *41*(6), 445-456.

Reason, J. (1997). Managing the Risks of Organizational Accidents. Ashgate publishing, Surrey.

Schein, E. H. (1992). *Organizational culture and leadership* (2nd ed.). Jossey-Bass.

Sherratt, F., Szabo, E., & Hallowell, M. R. (2025). Seeking a scientific and pragmatic approach to safety culture in the North American construction industry. *Safety Science*, *181*, 106658.

Williams, T., & Samset, K. (Eds.). (2012). *Project governance: Getting investments right*. Springer.

Winge, S. & Kilskar, S.S, Brennhovd, P. (2024). Incident concentrations in The Norwegian Construction Industry: Mapping and Recommendations to Improve Common Safety Work (In Norwegian: Gjengangere i bygg og anlegg – Kartlegging og anbefalinger for å løfte det felles sikkerhetsarbeidet). Report. SINTEF.