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Accident types and barrier failures in the construction industry

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ABSTRACT

The paper identifies frequent accident types in the construction industry, characterises the accident sequence, and identifies barrier failures for the most frequent accident types. 176 accidents in the Norwegian construction industry investigated by the Norwegian Labour Inspection Authority in 2015 are analysed. The most frequent accident types include: fall from roof, floor or platform; contact with falling objects; fall from scaffold; and contact with moving parts of a machine. A comparison of the study sample to other injury samples, showed that the distribution of accident types varied regarding severity and different construction types. This can be explained by differences in work type, hazard, and energy type and energy amount. An analysis of barrier failures showed that many accidents are explained by the lack of physical barrier elements. The results indicate that there is significant potential for accident prevention in the construction industry by systematic barrier management.

1. Introduction

The construction industry in Norway has one of the highest numbers of fatal injuries and incident rates compared with other industries. The average incidence rate for fatalities during 2012–2016 was 4.1 per 100,000 employees (Labour Inspection Authority, 2017). An increase in the annual number of fatalities, and some major, dramatic accidents, led to an initiative from stakeholders in the Norwegian construction industry to establish a tripartite cooperation with a vision-zero-approach. The cooperation expressed a need for further knowledge on frequent accident types and their causal factors. Clients and contractors produce injury statistics for their projects and hence have an overview of the less severe injuries. However, they rarely experience severe accidents themselves. As a result, none of the actors in the industry have a significant number of cases of severe accident types and their barrier failures.

The purpose of this study is (1) to identify frequent accident types and (2) to analyse barrier failures to establish a knowledge base for prioritising and developing preventive measures in the construction industry. Producing relevant knowledge about accidents is problematic as the national data on accidents and injuries (like other countries), does not '… generally permit detailed analysis of causes beyond the identification of the mechanism and agency of injury' (Cooke and Lingard, 2011, p. 279). The main study sample in this research consists of 176 severe construction accidents investigated by the Norwegian Labour Inspection Authority (LIA) in 2015. This paper is limited to studying mainly proximate causes and incident types. Contributing factors in the organisation are not addressed.

There exist some statistics and studies showing distribution of incident types. However, it is problematic to compare the different studies and statistics since there are different categories used for describing accidents, e.g. 'deviations', 'cause', 'accident/injury types' and 'central events'. However, 'fall from height' dominates in most studies and statistics. Other frequent 'accident types' are falling/collapsing objects, moving vehicles, moving machine parts, and electricity. In Europe (EU28), 782 fatal construction accidents were registered in 2014 (Eurostat, 2017). The most frequent 'deviations' were: fall of persons (26%); breakage/fall/collapse, etc. of material agent (20%); and loss of control of machines, equipment, tools, etc. (19%) (Eurostat, 2017). The distribution of 'deviations' for non-fatal accidents was somewhat different. In a study of deaths from injuries among construction workers in North Carolina 1988–1994, Lipscomb et al. (2000) found that work related deaths were most often 'caused by' motor vehicles (21%), falls (mostly roofs and scaffolds) (20%), machinery (15%), electrocutions (14%), and falling objects (10%). In a Dutch study of 'accident types' in the construction industry, Ale et al. (2008) found that the most frequent 'accident types' were fall from height (roof, floor, platform), contact with falling/collapsing objects, fall from ladder, fall from scaffold, and contact with moving parts of a fixed machine. Both the statistics from Eurostat (2017) and Ale et al. (2008) show differences in the distributions of fatal vs. non-fatal accidents. Based on a review of construction safety literature using mortality data, Swuste et al. (2012) concluded that the most frequent 'central events' were: falling from height; contact with falling or collapsing objects;

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Table 1
Overview of samples of injuries in the Norwegian construction industry.

Sample name	Description	Data period	Injuries in the sample	Number injuries per year	Estimated average severity (order)
'Main study sample'	Accidents investigated by the LIA in 2015	2015	184 (176 accidents)	–	Medium/high (2)
'Fatal'	Fatal injuries	2000–2014	131	10 (average 2012–2016)	High (1)
'Inspection'	Injuries reported to the LIA	2011–2016	1758	293 (average 2011–2016)	Medium (3)
'Insurance'	Injuries (insurance claims) reported to the Labour and Welfare Administration (LWA)	2015	1783	1783	Medium (4)
'Survey'	Labour force survey (LFS) 2013	2013	41	9000–10,000	Low (5)

contact with electricity; contact with moving machinery parts; falling from a moving platform; contact with hoisted, hanging, swinging objects; hit by vehicle; squeezed between or against something; and contact with objects thrown from machine.

The construction industry is not homogenous, which also implies that incident types and barrier failures can vary regarding the type of project (e.g. building, infrastructure, refurbishment), project phase and project size and complexity. Research has demonstrated that causal factors differ in different settings, for instance between countries (Cameron et al., 2008; Spangenberg et al., 2003), and construction project features (Manu et al., 2010).

The framework used in this analysis is based on three elements that are basic in many accident causation models, namely hazards, barriers/defences and loss (e.g. Haddon, 1980; Reason et al., 2006). The analysis focuses on proximate factors in the accident sequence. Distal, organisational factors are not covered in this paper.

2. Study samples

The main study sample consists of 176 construction accidents investigated by the Norwegian LIA in 2015. This sample gives sufficient descriptions of the accident sequence as well as a sufficient number of recent accidents. The study sample is limited to accidents investigated by the LIA for one year. In 2015, LIA carried out investigations of 189 construction accidents, involving 210 companies. Seven of the 189 accidents were excluded from the sample since they did not take place during construction work or at constructions sites, and six accidents were excluded due to lack of sufficient information about the accident. Hence, the main study sample is 176 accidents involving 184 injured persons, of which 4 were fatalities.

According to the Norwegian Work Environment Act, occupational accidents that have led to fatal- or severe injuries must be notified to the police and the LIA. Severe injury here means any harm, (physical or mental), that results in permanent or prolonged incapacitation. There is guidance on LIA's website describing nine characteristics that indicate severe injury, e.g. injuries to head, skeleton, internal organs, loss of body part, poisoning, unconsciousness, metabolism/frost injury, hypothermia, and injuries that lead to hospitalisation (Labour Inspection Authority, 2017). When the LIA is notified of an accident, the LIA decide whether to complete an investigation based on assessments of potential severity and available inspectors. These are the criteria for selecting accidents for the main study sample:

(1) At least one construction company involved
(2) Happened during construction work
(3) Inspected by the LIA in 2015

Most construction accident statistics do not include workers employed by non-construction companies that are injured in construction accidents, e.g. temporary employment agencies. Criteria 1 and 2 ensure that these workers are included.

One investigated accident can contain many documents and normally consists of the notification of the accident, accident reports from the LIA and the company, and other letters between the LIA and companies. When an accident is reported by mail or phone to the LIA, a checklist is used to collect information about the accident to decide whether an investigation is going to be carried out. During the investigation, the inspectors use another checklist to investigate if there have been any violations of the law and to collect information about the course of events. After the investigation, the inspectors produce an investigation report that in most cases includes a description of the accident sequence, causal factors, and violations of the law when identified. In most cases, the investigated company is decreed to produce an accident investigation report and a plan including measures to prevent similar accidents.

The amount of information on the accidents varies significantly. Some cases have only one document while others have 50. Some cases are sparsely described and six accidents were excluded due to lack of sufficient information. Other accidents have rich descriptions and are investigated by professional accident investigators.

This research includes all data collected from the reporting of the accident and the whole process related to the investigation. Four analysts were engaged in finding relevant documents and extracting relevant qualitative information from the accidents into a word document consisting of 84,000 words. Central issues were assessed and organised in variables in an Excel document.

2.1. Samples compared to the main study sample

The main study sample is compared to four other samples of construction injuries representing different degrees of severity (Table 1). The aim of the comparison is to assess representativeness of the study sample and relations between accident severity and distribution of accident types.

The official number of employees in the Norwegian construction industry in 2015 was 206,000 and the average number of fatalities per 100,000 employees in the 2012–2016 period was 4.1 fatalities. It is likely, however, that the level of injuries in construction is underestimated since staffing agencies or subcontractors that are not construction companies employ many of the injured workers.

The main study sample is described above. The 'fatal' sample is fatal injuries reported to the LIA by the employer, police or health services (Table 1). Sometimes the LIA captures fatalities via media or other sources. It is estimated that the fatal injuries represent nearly 100% of the fatal construction injuries. The 'inspection' sample is injuries reported to the LIA and is similar to the main study sample. One difference is that the 'inspection' sample includes *all injuries reported to the LIA* 2011–2016, while the study sample only includes reported injuries that were investigated in 2015. Another difference is that the 'inspection' sample includes only employees in construction companies, while the main study sample also includes employees in non-construction companies (e.g. hired workers) injured during construction work. The level of underreporting is unknown. The 'insurance' sample is occupational injuries that lead to medical treatment or lead to work disability reportable to the Labour and Welfare Administration (LWA). These are the public injury statistics in Norway. The injury notification forms,