

Falske materialer i byggebransjen

Nina Eklo Kjesbu

Bygg- og miljøteknikk

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Hovedveileder: Ola Lædre, IBM

Norges teknisk-naturvitenskapelige universitet
Institutt for bygg- og miljøteknikk




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Byggebransjen er en industri som er utsatt for ulike typer kriminalitet. Mye tid og spalteplass har blitt viet til sosial og økonomisk kriminalitet, som sosial dumping og skatteunndragelse. Mindre har det blitt snakket om uredelighet rundt materialer og materialkvalitet. Denne oppgaven er en del av et prosjekt som ble startet i forbindelse med opprulling av andre typer kriminalitet i byggebransjen. Hensikten med prosjektet var å kartlegge mulighetsrommet for kriminell aktivitet i norsk byggebransje. I tillegg til generell kriminalitet har det i denne oppgaven blitt sett på forfalskede, uredelige og utilstrekkelige byggematerialer (heretter omtalt som falske materialer). Spesielt har materialet stål blitt undersøkt, der brudd på CE-merkingen og den tilhørende ytelseserklæringen har vært sett på som en indikasjon på at produktet kan være falskt. Gjennom litteratur- og dokumentstudier, en spørreundersøkelse, samt intervjuer med aktører i bransjen, har forekomsten av falske, lastbærende stålprodukter blitt undersøkt. Arbeidet har resultert i fire vitenskapelige artikler. Disse omhandler forskningen som er gjort på kriminalitet i byggebransjen generelt, samt forekomst, konsekvenser av og tiltak mot falske materialer. Det ble funnet flere eksempler på forekomst av falske stålmaterialer, hvorav også eksempler på lastbærende stålprodukter i konstruksjoner i Norge. Bransjen mener selv at dette skjer på grunn av at useriøse aktører enkelt kommer seg inn på markedet, blant annet på grunn av stort prispress. I tillegg er det en bransje som har en høy grad av tillitt. Man har en tendens til å stole på dokumentasjonen som kommer, uten å ta noen faktisk sjekk av kvaliteten. Intervjuobjektene hadde ulike forslag til tiltak mot falske stålmaterialer, hvorav de fleste allerede finnes. Verktøyene er altså i stor grad allerede tilgjengelige. Det anbefales derfor at man styrker oppfølgingen av eksisterende tiltak før man eventuelt innfører nye.

Stikkord:

1. Materialer
2. Stål
3. Kriminalitet
4. Byggebransjen


Nina Eklo Kjesbu

”... Stålet er sterkt og Gud er god, sier de...”

Forord

Denne masteroppgaven avslutter for meg studiet Bygg- og miljøteknikk ved NTNU. Arbeidet med masteroppgaven har hele veien vært et interessant prosjekt, og et tema jeg synes har vært spennende å jobbe med. I tillegg har det å skrive vitenskapelige artikler vært både lærerikt og utfordrende.

Dette er en oppgave som har strukket seg over lang tid. Først jobbet jeg med temaet kriminalitet i byggebransjen som forskningsassistent, deretter gjennom prosjektoppgave, og nå til slutt ble det temaet for masteroppgaven min. Noen av delene i denne oppgaven, blant annet noe metode, samt gjennomføringen av de tre første intervjuene, stammer fra prosjektoppgaven. Jeg vil takke Ola Lædre og Jardar Lohne for å ha gitt meg muligheten til å bli involvert i prosjektet på et så tidlig stadium.

Seriøse aktører i stålbransjen bruker enormt med tid og ressurser på å dokumentere og kvalitetssikre det de gjør. Samtidig er det andre som tar snarveier, eller selger forfalskede, uredelige eller utilstrekkelige materialer som om de var noe annet enn det de er. Det gjør at de kan prise seg ned, noe som nødvendigvis går utover de som ønsker å jobbe etter boka. I arbeidet med oppgaven har det kommet frem at det også finnes aktører som ønsker å gjøre ting riktig, men som får problemer i møtet med regler og forskrifter. Som ett av intervjuobjektene sa: ”Alle er egentlig veldig opptatt av å få luka ut de useriøse i bransjen... Så er det ikke alltid like lett å se at du er en av dem selv.”

Takk til intervjuobjektene for at de gav generøst med både tid og kunnskap til meg i sine allerede travle arbeidsdager. Jeg vil også takke dem for at de snakket åpenhertig med meg om et i utgangspunktet følsomt tema. En spesiell takk til Norsk Stålforbund som lot meg delta på ett av deres kurs. Igjen, takk til Ola Lædre og Jardar Lohne, og takk til Atle Engebø ved Institutt for Bygg- og Miljøteknikk på NTNU, for et svært godt samarbeid gjennom dette prosjektet. Spesielt takk til Ola for å ha vært en engasjert og god veileder gjennom prosjekt- og masteroppgave. Jeg vil også gi en takk til Andor Inge Kjesbu, Gustav Ramstad Gunnerud og Sander Hope Fiskvik for korrekturlesing og tilbakemeldinger på oppgaven.

Trondheim, 11. juni 2017


Nina Eklo Kjesbu

Sammendrag

Byggebransjen er, som mange andre bransjer, en industri som er utsatt for ulike typer kriminalitet. Mye tid og spalteplass har blitt viet til sosial og økonomisk kriminalitet, som sosial dumping og skatteunndragelse. Mindre har det vært snakket om uredelighet rundt materialer. Dette prosjektet ble startet i forbindelse med opprulling av andre typer kriminalitet i byggebransjen. Prosjektets formål var å kartlegge mulighetsrommet for kriminell aktivitet i norsk byggebransje. I denne masteroppgaven har det i tillegg blitt sett nærmere på lastbærende stålprodukter. Det viste seg at materialkvalitet, sertifikater og tilsyn er en komplisert prosess med mange ulike standarder og dokumentasjonskrav. I denne oppgaven har det blitt sett på forfalskede, uredelige og utilstrekkelige byggematerialer (heretter omtalt som falske materialer), der brudd på CE-merkingen og den tilhørende ytelseserklæringen har vært sett på som en indikasjon på at produktet kan være falskt. Gjennom en litteraturstudie omhandlende kriminalitet i byggebransjen, ett om bransjens karakteristikker, en spørreundersøkelse, samt intervjuer med 12 aktører, har forekomsten av og tiltak mot falske lastbærende stålprodukter blitt undersøkt. Relevante standarder, regler, lover og normer har fortløpende blitt studert og vurdert. Arbeidet har resultert i fire vitenskapelige artikler, hvorav tre konferanseartikler og en journalartikkel. Artikkene omhandler forskningen som er gjort på kriminalitet i byggebransjen generelt, samt forekomst, konsekvenser av og tiltak mot falske materialer. Det viser seg at det finnes flere tilfeller av falske stålmaterialer på norske byggeplasser. Av tilfellene som ble avdekket var det materialer brukt i bærende konstruksjoner i bygg i Norge. Bransjen mener selv at dette skjer på grunn av at useriøse aktører har en relativt enkel tilgang til bransjen generelt, og for stål er det spesielt prispresset som gjør at enkelte er tilbøyelige til å ta snarveier. Samtidig er det en bransje som har en høy grad av tillitt. Man har en tendens til å stole på dokumentasjonen som kommer, uten å ta noen faktisk sjekk av kvaliteten til materialene. Intervjuobjektene mente at en økt kontroll fra myndighetene ville være effektivt, samt flere reguleringer nasjonalt og internasjonalt. Det var en gjennomgående tendens at alle ønsket de useriøse aktørene ut. Det viste seg at mange av de foreslåtte tiltakene mot disse stålmaterialene allerede fantes i bransjen, men at de bare i en begrenset grad faktisk blir gjennomført. Dermed anbefales det å styrke oppfølgingen av eksisterende tiltak, heller enn å innføre ytterligere regler.

Denne masteroppgaven består av tre deler. 1) En prosessrapport som ønsker å belyse arbeidet som er gjort, 2) fire vitenskapelige artikler og 3) vedlegg.

Summary

The construction industry is subject to many types of criminal behavior. Much time and coverage has been devoted to social and economic crimes, such as social dumping and tax evasion. Fewer discussions have been around the topic of fraudulent materials. This project was started after several cases of criminal activity had been exposed in the industry. The purpose of the project was to map the opportunities for criminal activities in the Norwegian construction industry. This master thesis has, in addition to that, looked specifically at load bearing steel products. It turned out that material quality, certificates and inspections is a complicated process with many different standards and requirements for documentation. In this thesis, counterfeit, fraudulent and sub-standard (CFS) construction materials have been looked at, where a breach of the CE marking and the associated declaration of performance has been looked at as an indicator to a product being CFS. Through a literature review on crime in the construction industry, another on the characteristics of the industry, a survey and interviews with 12 actors in the industry, the occurrence of CFS load bearing steel products has been investigated. Relevant standards, rules and norms have been consecutively investigated. The work has resulted in four scientific papers, three of them being conference papers and one being a journal paper. The papers concern the research that has been done on crime in the construction industry in general, as well as the occurrence of, consequences from and countermeasures against CFS materials. It turns out that there have been several cases of CFS steel materials at Norwegian construction sites. Among the examples that were given was the use of CFS materials in load bearing constructions in buildings in Norway. The industry believes that this happens because of the industry being relatively easily accessible to dishonest actors, and for steel the price pressure is what makes it especially tempting to cut corners. Equally, it is an industry with a high degree of trust. The companies have a tendency to trust the documentation that arrives, without actually checking the quality of the materials. The interviewees believed that an increased inspection frequency from the government would be effective, in addition to more national and international regulations. It was an overall trend that everyone wanted the dishonest actors out. It turned out that many of the suggested countermeasures against these steel materials already exist in the industry, but that they are utilized only to a limited degree. Therefore, the recommendation is to strengthen the follow-up of the already existing countermeasures, rather than implementing additional rules.

This master thesis consists of three parts: 1) A process report that intends to show the process of the work, 2) four scientific papers and 3) appendices.

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Del A: Prosessrapport

1. Innledning

1.1 Introduksjon til oppgaven

Byggebransjen er en bransje utsatt for ulike typer kriminalitet, men det ser ut til at enkelte former for dette har blitt viet mer oppmerksomhet enn andre. Det er ikke uvanlig med artikler om sosial dumping, svart arbeid eller økonomisk kriminalitet i norske aviser. I mars 2017 skrev fagbladet Byggeindustrien at 11 kriminelle nettverk hadde blitt avdekket i bransjen av a-krim-senteret, som består av Skatt øst, Arbeidstilsynet, Politiet, kemneren, Tolletaten og NAV. (Byggeindustrien, 2017). Avisen Aftenposten hadde i 2014 og 2015 en artikkelserie om Grå økonomi, deriblant artikler om malingsbransjen i Oslo. (En link til samlesiden med disse artiklene finnes i bibliografien). Der var det også økonomiske og sosiale aspekter som stod i fokus. Denne oppgaven snur blikket og ser på andre typer kriminalitet i bransjen.

Bakgrunnen for denne masteroppgaven er at forfatteren startet som forskningsassistent ved daværende institutt for bygg, anlegg og transport i 2015. Dette var i forbindelse med et da nystartet prosjekt initiert av NTNU og Prosjekt Norge, blant annet i samarbeid med norsk politi. Prosjektet, som fortsatt pågår og som denne masteroppgaven er en del av, omhandler kartlegging av mulighetsrom for kriminell adferd i norsk BAE-næring (Prosjekt Norge , u.d.). Dette arbeidet ble også videreført i etterkant av forskningsassistentjobben gjennom prosjektoppgave og denne masteroppgaven.

Noe av ideen bak prosjektet var å undersøke om kriminalitet i byggebransjen også foregikk, eller kunne foregå, på flere områder, blant annet innenfor materialer. Når man velger materialer til et byggeprosjekt gjør man dette på bakgrunn av flere ting, blant annet materialenes karakteristikk og egenskaper, pris og miljø. Dersom et materiale viser seg å ha andre egenskaper enn forutsatt, vil dette kunne ha konsekvenser for materialets ytelse i byggverket. Samtidig hadde Construction Industry Institute (Minchin, et al., 2014) akkurat kommet ut med en rapport om forfalskede materialer. Til sammen ga dette ideen om å se på et mulig juks innenfor materialer.

Falske materialer er samlebetegnelsen på forfalskede, uredelige og utilstrekkelige materialer. På engelsk brukes gjerne forkortelsen CFS (counterfeit, fraudulent and sub-standard), mens forkortelsen FUU kan brukes på norsk. Engebø et al. (2017) definerer de tre som følger:

1. Forfalskede materialer: Ulovlig bruk av åndsverk
2. Uredelige materialer: Falsk dokumentasjon, kan ha kvalitetsavvik
3. Utilstrekkelige materialer: Har kvalitetsavvik, kan ha falsk dokumentasjon

Disse definisjonene har også blitt brukt i denne oppgaven.

Arbeidet med dette prosjektet startet med å se på hva slags forskning som har blitt gjort på kriminalitet i byggebransjen generelt. Videre gikk arbeidet inn mot falske materialer, og hva

som kunne bli konsekvensene ved bruk av disse. Etter hvert snevret tematikken seg inn mot stål, og tilfeller av falske stålmaterialer i Norge ble undersøkt. Til slutt ble ulike mottiltak mot bruk av disse materialene sett på. Dette arbeidet har altså strukket seg fra forskningsassistentperioden og videre til denne masteroppgaven.

1.2 Problemstillinger

Til sammen har arbeidet beskrevet i introduksjonen resultert i fire vitenskapelige artikler. Problemstillingene varierer mellom artiklene som har blitt skrevet, men alle omhandler kriminalitet i byggebransjen. For å lette henvisningene til artiklene i teksten blir de heretter omtalt med romertallene som følger i tabell 1.

Tabell 1 Artikler skrevet i forbindelse med dette prosjektet.

Artikkelnummer:	Tittel:
I	Crime in Construction
II	Perceived consequences of counterfeit, fraudulent and sub-standard construction materials
III	Counterfeit, fraudulent and sub-standard materials: The case of steel in Norway
IV	Countering counterfeit, fraudulent and sub-standard materials in construction

I artikkel I ble følgende forskningsspørsmål stilt:

- 1) *What research has been carried out on crime in the AEC-industry?*
- 2) *How are different topics within this field of research covered respectively?*
- 3) *What are the most important gaps in the research on crime in the AEC-industry?*

I artikkel II, omhandlende forfalskede materialer, ble følgende forskningsspørsmål stilt relatert til bruken av disse materialene:

- 1) *What are the consequences of CFSS-materials for the industry?*
- 2) *What are the consequences of CFSS materials for the construction process?*
- 3) *What are the consequences of CFSS materials for the final product?*

I artikkel III ble fokuset spisset inn mot stål, og følgende forskningsspørsmål stilt:

- 1) *Do CFS steel products exist in the Norwegian construction industry?*
- 2) *Which key characteristics of the construction industry make it especially vulnerable to these materials?*

I artikkel IV, som er en fortsettelse av forskningsartikkel III, ble følgende forskningsspørsmål stilt:

Which countermeasures can be undertaken to mitigate CFS steel materials in the Norwegian construction industry?

Undertegnede har vært medforfatter for artikkel I og II, og førsteforfatter for artikkel III og IV. På grunn av dette er det artikkel III og IV som vil bli omtalt i størst detalj i denne prosessrapporten. Arbeidsfordelingen mellom forfatterne er beskrevet i kapittel 2.3.

1.3 Avgrensninger

Kriminalitet i en hel bransje er et stort tema, det samme er materialomfanget. Derfor har det blitt gjort flere klare avgrensninger.

I artikkel III og IV har undersøkelsene, som nevnt, blitt avgrenset til å omhandle kun lastbærende stålmaterialer. Dette for å redusere omfanget, da en undersøkelse omhandlende alle typer materialer hadde blitt svært omfattende. I artikkel III er forskningsspørsmål 1 i tillegg begrenset til å se på hvorvidt det finnes falske materialer i byggebransjen eller ikke, det er ikke gjort forsøk på å kvantifisere fenomenet.

En viktig definisjon og avgrensning har vært definisjonen av falske byggevarer. Hvordan kan man definere om et materiale er falskt eller ikke?

I artikkel III og IV defineres falskt stål som stålprodukter som ikke tilfredsstillers ytelsen erklært i CE-merkingen og den tilhørende ytelseserklæringen. Dette ble gjort fordi det var viktig å ha et skille på hva som er et falskt materiale og ikke. CE-merking og ytelseserklæring ble valgt som mål på dette fordi dette er obligatorisk dokumentasjon for produkter som er dekket av en harmonisert europeisk standard. Lastbærende stålprodukter er dekket av en slik standard. Direktoratet for byggkvalitet (DiBK) stadfester i Byggevareforordningen artikkel ni punkt to at ”CE-merkingen skal etterfølges av de siste to sifrene i det årstallet da den først ble påført, produsentens navn og registrerte adresse, eller et identifikasjonsmerke som gjør det mulig å identifisere produsentens navn og adresse enkelt og tydelig, produkttypens entydige identifikasjonskode, ytelseserklæringens referansenummer og nivået eller klassen for den angitte ytelse, henvisning til den anvendte harmoniserte tekniske spesifisering, eventuelt det tekniske kontrollorgans identifikasjonsnummer og den tilsiktede bruken som fastsatt i samsvar med den anvendte harmoniserte tekniske spesifisering.” (Direktoratet for byggkvalitet, 2016)

Med andre ord sier CE-merkingen og den tilhørende ytelseserklæringen noe om hvilken kvalitet man kan forvente av produktet, samt hvilken harmonisert standard det er produsert etter. Det er derfor samsvar med CE-merkingen og ytelseserklæringen har blitt valgt som mål på om et materiale er falskt eller ikke. Om andre krav og standarder ikke har blitt tilfredsstillt har altså ikke blitt hensyntatt i arbeidet med stålproduktene. Man kunne kanskje ha valgt en enda bredere definisjon, men denne dokumentasjonen er godt kjent blant aktørene i stålindustrien, og dermed enkel å forklare for intervjuobjekter og kilder. Det er også viktig å merke seg at CE-merkingen ikke sier noe om hvorvidt produktet er godkjent for bruken det er

anskaffet for. For eksempel kan et CE-merket produkt ha alle dokumenter i orden, men det hjelper ikke dersom produktet ikke er egnet for den bruken bestilleren ønsker.

En annen viktig avgrensning har vært å ikke undersøke årsakene til at produktene er falske. Feil på et produkt kan for eksempel skyldes produksjonsfeil, men det kan også være bevisst juks. Det er i denne oppgaven ikke gjort noe forsøk på å skille mellom disse, da det ville ha krevd store undersøkelser rundt hvert tilfelle.

1.4 Oversettelse

Mye av informasjonsinnsamlingen har foregått på norsk, for eksempel intervjuene. I tillegg har mange av kildene vært på norsk. Da de vitenskapelige artiklene er sendt til internasjonale konferanser var det nødvendig med en del oversettelse av både sitater fra kilder og ord/uttrykk til engelsk. Når det gjelder oversettelse av sitatene har dette blitt gjort rimelig ordrett, men med en tanke om å beholde intensjonen i det informantene sa. Det har med andre ord også blitt vektlagt at sitatene skal være lesbare. Når det gjelder ord/uttrykk har mange av disse vært en del av offentlige dokumenter eller lover. En del av ordene har blitt funnet i ordlister tilknyttet dokumentene, for eksempel ordlista som ligger ved Plan- og bygningsloven (Kommunal- og moderniseringsdepartementet, 2010). I tabell 2 finnes eksempler på uttrykk som har blitt oversatt gjennom dette arbeidet, enten direkte eller ved hjelp av ordlister.

Tabell 2 Eksempler på uttrykk som har blitt oversatt i arbeidet med artiklene

Norsk	Engelsk
Plan- og bygningsloven	Plan and Building Act
Ferdigattest	Certificate of Completion
Ytelseserklæring	Declaration of Performance
Norsk Standard	Norwegian Standard
Direktoratet for byggkvalitet	The Directorate for Building Quality

1.5 Layout

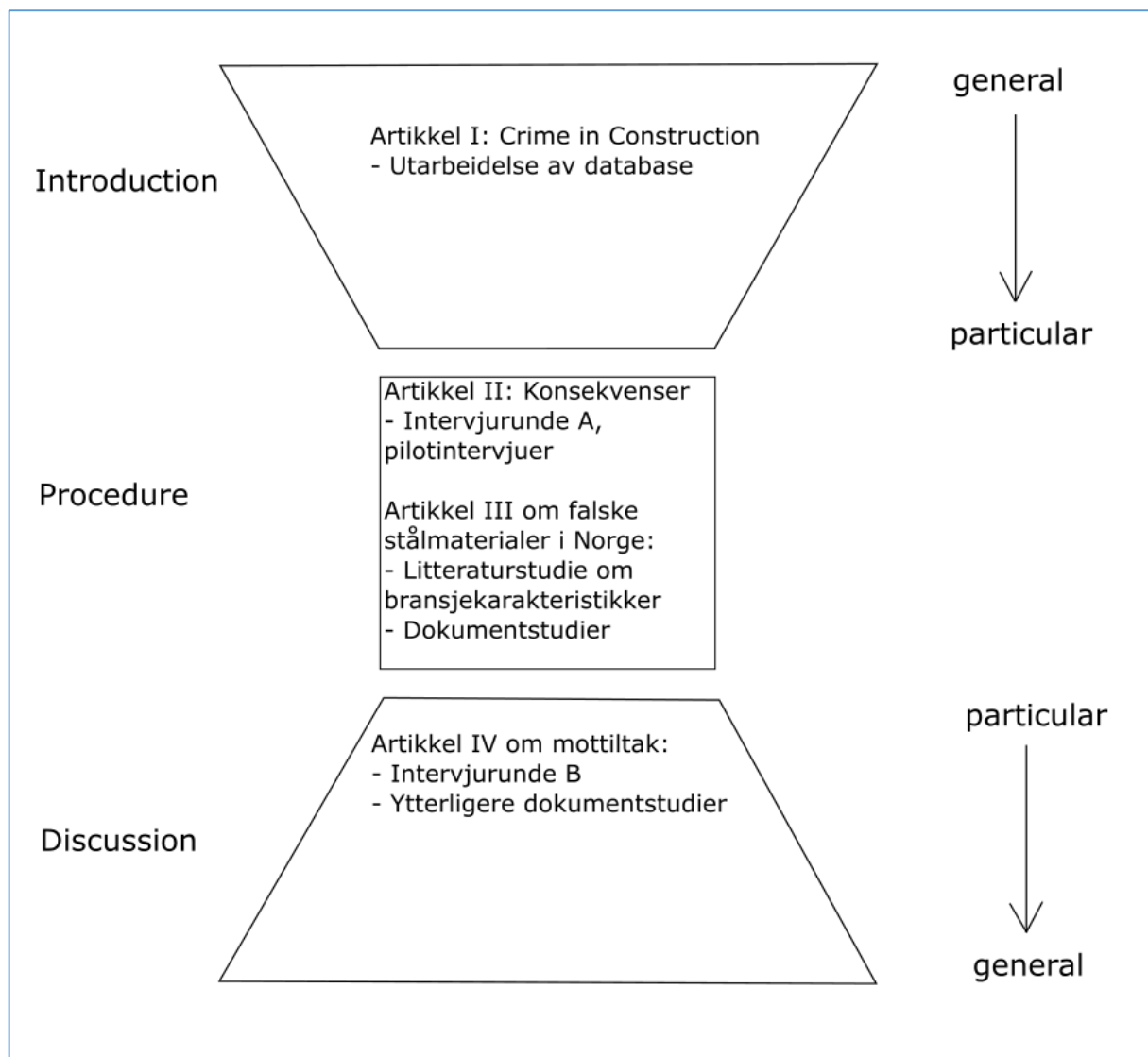
Layouten i denne oppgaven varierer noe, da oppsettene til konferanseartiklene er laget etter instruksjoner fra de respektive konferansene. Derfor vil layouten i disse være ulik oppsettet i denne prosessrapporten. For å sikre lesbarhet i den trykte versjonen av denne masteroppgaven, har fontstørrelsen blitt økt noe for artikkel IV. Denne vil endres tilbake igjen før endelig innsending. Se forøvrig kapittel 2.3.

2. Metode

2.1 Overordnet metode

Det har vært viktig å ha en overordnet metode gjennom hele arbeidet, da prosjektet har bestått av flere ulike deler som har pågått over ulike tidsrom.

Swales (1990) viser hvordan Hill et al. fremstiller den overordnede organiseringen av en forskningsartikkel. Dette vises som en introduksjon som er generell, som videre beveger seg mot en mer spesialisert del, som videre går ut til en generell del. Hvordan de ulike elementene i denne oppgaven fordeler seg kan bli sett i figur 1, som er basert på figuren Swales presenterer i boka "Genre Analysis: English in Academic and Research Settings" (Swales, 1990). Merk at dataene samlet inn også har blitt brukt videre nedover i prosessen.



Figur 1 Overordnet metode og utvikling i arbeidet ført inn i figuren Swales (1990) presenterer fra Hill et. al.

Tidlig i prosjektet var perspektivet bredt, og det var kriminalitet i byggebransjen som var fokuset, slik det er presentert i artikkel I. Fokuset lå på å finne ut så mye som mulig av relevant informasjon knyttet til kriminalitet i byggebransjen. Det ble ikke skilt mellom ulike typer kriminalitet, for eksempel materialkriminalitet og arbeidslivskriminalitet.

I arbeidet med artikkel II om konsekvenser var fokuset fortsatt relativt bredt, men det ble sentrert rundt materialer.

I artikkel III ble fokuset videre snevret inn, og det var da lastbærende stålprodukter som kom i fokus. Arbeidet med artikkel IV var fortsatt rettet mot stål, men det ble også litt bredere da det ble gått bort fra å diskutere enkelte falske stålprodukter. I stedet omfavner artikkelen tiltak mot falske stålmaterialer generelt.

Parallelt med dette har også undersøkelsene blitt gjort smalere. I utgangspunktet ble det gjort en studie på alt av kriminalitet i byggebransjen, og også i noen grad relevante artikler fra andre bransjer. Så ble en survey gjort, spesifikt rettet mot byggebransjen, men fortsatt ikke rettet direkte mot stålbransjen. Dette ble derimot gjort under intervjuene, som ble rettet direkte mot aktører i stålbransjen, eller de som kunne antas å ha god kunnskap om denne.

2.2 Undersøkelser og intervjuer

2.2.1 Database

I forbindelse med at forfatteren av denne masteroppgaven jobbet som forskningsassistent, ble en database utarbeidet i 2015/2016. Databasen ble opprettet i forbindelse med en litteraturstudie som da ble gjennomført. Den ble utarbeidet gjennom en rekke søkeord i ulike databaser, både norske og internasjonale. Det ble forsøkt å bruke generelle søkeord, men noen ganger ble det så mange resultater at det var nødvendig med en innsnevring. Typisk var dette å legge til "construction" for å få færre, men mer relevante treff. Arbeidet bestod i å lese gjennom titlene på artiklene som kom opp, og eventuelt se på sammendraget for de artiklene som virket interessante. Ved å ikke lese alle sammendragene mister man muligens noen resultater, men det hadde vært svært tidkrevende å komme gjennom så mange treff dersom hvert enkelt skulle undersøkes nøyere. En grovsortering basert på navn på artiklene var derfor nødvendig. Antallet treff varierte fra 0 til flere millioner. Det ble vurdert som dårlig tidsbruk å gå gjennom alt i de tilfellene der antall søk oversteg 3-400. Her ble da de første sidene gjennomgått for å finne relevante treff, eventuelt ble det i stedet søkt etter samme frase med "construction" etterpå for å se om dette minket antallet søkeord noe.

I tillegg ble også noen av forfatterne videre undersøkt, fordi de virket å ha mye stoff som var relevant for prosjektet. Dette gjaldt for eksempel forfatterne R.E. Minchin og Colin Williams, som hadde skrevet flere aktuelle artikler.

19 søkefraser ble brukt. Disse ble utarbeidet under prosjektmøter, og ble valgt for å gi et så bredt spekter av relevante treff som mulig. De 19 var: illegal workforce, immigrant workers

construction, immigrant workers, social dumping, tax evasion construction, tax deviation+construction, undeclared work, workforce exploitation, counterfeit materials, counterfeit materials construction, wage dumping, bribes construction, falske materialer, sosial dumping, HSE illegal work, HSE crime, construction accidents illegal work.

Det ble søkt i ni databaser. Disse var; Web of science, Scopus, Google Scholar, Engineering Village, ASCE Library, Oria, ASCE Civil Engineering Database, Research gate. Databasen er grunnlaget for artikkel I, men den er også brukt som en del av det teoretiske grunnlaget i de påfølgende artiklene.

2.2.2 Spørreundersøkelse

For å nå byggebransjen spesifikt, ble aktører som jobber innenfor denne bransjen gjenstand for spørsmål gjennom en spørreundersøkelse i 2016. Spørreundersøkelsen ble utformet basert på en lignende undersøkelse gjennomført av det amerikanske Construction Industry Institute (Minchin, et al., 2014), og oversatt og administrert av undertegnede. Siden den skulle brukes opp mot den norske bransjen, måtte den på enkelte områder tilpasses denne, blant annet med norske navn på aktører i prosjektene.

Totalt ble det gjennomført to runder med spørreundersøkelsen. I den første runden ble 33 mulige respondenter kontaktet, og i den andre runden ble ytterligere 44 kontaktet. Det ble sendt ut påminnelser per epost underveis. Totalt var det 20 personer som svarte, noe som gir en svarprosent på 26 %. Det er vanskelig å vite hvorfor ikke flere svarte, men i og med at det er et ukjent tema for mange kan en slik undersøkelse ha vært vanskelig å prioritere i en hektisk hverdag.

Spørreundersøkelsen bestod totalt av 50 spørsmål, og det var ikke obligatorisk å besvare alle spørsmålene. Dette er noe som det i ettertid kunne ha vært lurt å vurdere, da det er en svakhet ved undersøkelsen at selv om 20 personer besvarte undersøkelsen, var det ikke alle som svarte på alle spørsmålene. Det kan være at enkelte ikke syntes alle spørsmålene var relevante for dem, eller at de syntes 50 spørsmål var for mye å komme gjennom

Data fra spørreundersøkelsen ble benyttet i artikkel III og IV. Spørsmålene til spørreundersøkelsen ligger vedlagt som vedlegg 1.

2.2.3 Litteraturstudie

Det ble gjennomført en strukturert og systematisk litteraturstudie rundt karakteristikker ved byggebransjen, i forbindelse med artikkel III. Her ble 7 databaser gjennomgått med 7 søkeord for å finne kilder rundt hva som karakteriserer byggebransjen. Matrisen for søkene er gitt i tabell 3. Tallene angir antall treff for hvert søk, noe som ble logget underveis.

Som man kan se, ble det undersøkt to færre databaser i dette søket, sammenlignet med da databasen i 2.2.1 ble utviklet. Årsaken til dette var at ASCE Civil Engineering Database og

Research gate gav svært få treff i første runde, og at de treffene som var relevante i stor grad også fantes i de andre databasene. Det ble med andre ord gjort for å begrense arbeidet noe.

Tabell 3 Databaser og treff fra litteraturstudien om karakterstikker ved byggebransjen.

	D1: Engineering Village	D2: ASCE Library	D3: Web of Science	D4: ORIA (Bibsys)	D5: Scopus	D6: DIVA	D7: Google Scholar
Characteristic* AND construction	192 251	42 279	33 758	1 812 542	68 586	935	4 090 000
Construction AND production AND characteristic*	19 522	25 109	2 037	61 620	4.310	135	4 850 000
Construction AND project* AND characteristic*	14 251	27 071	3 701	885 121	940	217	4 620 000
Nature* AND construction AND (industry OR project*)	9870	18.886	2 496	11.988	5.629	924	3 560 000
Egenskap* AND (byggebransjen OR byggeindustrien)	0	0	0	22	0	5630	839
Karakteristikk* AND (byggebransjen OR byggeindustrien)	0	0	0	2	0	44	1170
Kjennetegn AND (byggebransjen OR byggeindustrien)	0	0	0	12	0	28	535

Etter at en liste med relevante treff ble utformet, ble noen av disse kildene analysert etter VIKOs regler for kildekritikk, som er presentert i kapittel 2.2.6.

2.2.4 Dokumentstudier

I tillegg har mye informasjon blitt funnet ved behov underveis, der relevante kilder har blitt undersøkt for å skaffe spesifikk informasjon rundt konkrete temaer. Blant annet har nettsidene til Direktoratet for Byggkvalitet blitt brukt, da disse har mye spesifikk informasjon om regler knyttet til produktdokumentasjon, blant annet det som omtales som DOK – forskrift om dokumentasjon av byggevarer. Spesielt har også Norsk Stålforbund sine nettsider blitt flittig brukt, da disse har mye relevant informasjon om stålprodukter, også på norsk. Etter å ha deltatt på kurset ”Hva skal kontrolleres på byggeplass?” høsten 2017 fikk undertegnede også tilsendt presentasjonene fra dette kurset. Disse har også blitt brukt som kilder, og titlene er vist i tabell 4 på neste side. Disse kildene omhandler lastbærende stålmaterialer, og har dermed vært svært relevante for oppgaven.

Tabell 4 Presentasjoner fra Norsk Stålforbund

Presentasjoner fra kurs i regi av Norsk stålforbund	Forfatter
Innføring I NS-EN 1090 del 1 og del 2	Kjetil Myhre
Krav til utførelse på byggeplass	Kjetil Myhre

2.2.5 Intervjuer

Etter at databasen hadde blitt opprettet, spørreundersøkelsen gjennomført og litteraturstudien ferdigstilt, ble undersøkelsene videreført gjennom intervjuer. For å undersøke fenomenet rundt stål videre ble 12 personer som jobbet i byggebransjen intervjuet. Ikke alle jobbet i stålbransjen, men de hadde stillinger der de jobbet med lignende problemstillinger, eller hadde kompetanse om lignende tilfeller innen andre materialer.

I tidligfasen av dette arbeidet ble tabell 5 utformet som et verktøy for å velge intervjuobjekter. Her ble ulike aktører i bransjen listet opp, samt deres perspektiv. Bakgrunnen for dette var et ønske om å inkludere flest mulig aktører og perspektiv i intervjuene, uten å miste dybden og fokuset på stål.

Tabell 5 Skisserte mulige intervjuobjekter i tidligfasen

Rolle	Perspektiv
Produsent	Produsent av stålprodukter
Leverandør	Leverandør av stålprodukter
Sertifiseringsfirmaer	Kunnskap om sertifikater og om andre sertifiseringsenheter
Entreprenører	Kunnskap om utførelse, innkjøp, bestillinger med videre
Prosjekteiere	Finansierer prosjektet
Akademikere	Akademikere innen stålprodukter, som professorer, PhD etc.

Høsten 2016 ble tre personer intervjuet i intervjurunde A (pilotrunde gjennom prosjektoppgave), mens det våren 2017 ble intervjuet ni personer i intervjurunde B. Det som manglet i tabellen over, og i ettertid viste seg svært interessant å inkludere, var intervjuobjekter fra norske myndigheter og kontrollenheter. Dette ble gjort i runde B.

Som intervjuform ble det valgt å gjennomføre semi-strukturerte dybdeintervjuer. Yin (2009) beskriver følgende styrker og svakheter ved dybdeintervju:

Styrker:

- Targeted – focuses directly on case study topics
- Insightful – provides perceived causal inferences and explanations

Svakheter:

- Bias due to poorly articulated questions
- Response bias

- Inaccuracies due to poor recall
- Reflexivity – interviewee gives what interviewer wants to hear

(Yin, 2009)

Yin (2009) skriver også følgende om case study dybdeintervjuer: *“You can ask key respondents about the facts of a matter, as well as their opinion about events. In some situations, you may even ask the interviewee to propose her or his own insights into certain occurrences, and may use such propositions as the basis for further inquiry”* (Yin, 2009)

Det Yin beskriver over har vært svært berikende for prosjektet. Å kunne spørre respondentene om deres egen mening og forslag har vært svært viktig, da disse har årevis med erfaring fra en bransje som forfatteren ikke i utgangspunktet kjenner så godt. Derfor har denne måten å jobbe på vært svært god for dette prosjektet. I tillegg har de kunnet foreslå andre personer å snakke med, noe som har vært svært nyttig med tanke på å lokalisere flere respondenter. At intervjuobjektene kan tenkes å gi det svaret som de tror intervjueren ønsker, er selvfølgelig alltid en risiko. Dette har blitt forsøkt dempet ved at intervjueren presiserte at de som svarte kun trengte å svare på spørsmålene de følte var relevante for dem. Alle de som svarte hadde mange års erfaring fra stålbransjen, og flere av dem ønsket gjerne å komme med synspunkter rundt spørsmål som ikke nødvendigvis berørte dem direkte.

De tre første intervjuobjektene ble intervjuet i en pilotrunde som ble gjennomført høsten 2016 (runde A), mens de resterende 9 ble intervjuet våren 2017. De 12 hadde på intervjutidspunktene stillinger som følger av tabell 6, som finnes på neste side.

Tabell 6 Faktiske intervjuobjekter runde A og B

ID	Stilling
A1	Senioransatt hos en stålbygger
A2	Innkjøper hos en entreprenørbedrift
A3	Senioransatt hos et sertifiseringsfirma
B1	Senioransatt hos et konsulentfirma
B2	Senioransatt hos en stålgrossist
B3	Senioransatt hos kommunal myndighet
B4	Senioransatt hos kommunal myndighet
B5	Senioransatt hos nasjonal myndighet
B6	Senioransatt hos nasjonal myndighet
B7	Senioransatt hos en stålgrossist
B8	Senioransatt hos et konsulentfirma
B9	Daglig leder/byggingeniør

I tillegg til de som ble intervjuet ble ytterligere tre personer spurt om å delta. Disse hadde ikke mulighet til å la seg intervjuer, eller ønsket ikke dette. Dette betød selvfølgelig at ønskede respondenter ikke ble med på intervjuene. Samtidig anbefalte samtlige av disse andre å prate med, slik at deres perspektiv ble ivaretatt likevel. Alle de spurte ble valgt på bakgrunn av sitt

arbeid eller sin antatte kompetanse gjennom å inneha sentrale stillinger i bransjen. Det var også et viktig poeng å sikre en god spredning i intervjuene, slik at intervjuobjektene dekket en så stor del av stålbransjen, samt tilknyttede funksjoner, som mulig. Ett perspektiv som ikke ble tatt inn var prosjekteierperspektivet, noe som kanskje hadde vært lurt sett i ettertid. Likevel sikret utvalget av aktører et godt fokus på materialperspektivet, og de hadde også kunnskaper om prosjekteierrollen, slik at dette ble ivarettatt til noen grad.

I utgangspunktet skulle alle intervjuene være individuelle, men etter ønske og initiativ fra intervjuobjektene selv ble det gjennomført tre gruppeintervjuer. Det var to intervjuer som ble gjennomført med to personer, disse var B3 og B4, samt B5 og B6. I tillegg var det ett intervju som bestod av tre personer, dette var B7, B8 og B9. Dette var altså ikke intensjonen i utgangspunktet, men opplevelsen ble at gruppeintervjuene ofte medførte at de som ble intervjuet sammen kom på løsninger eller eksempler. I tillegg kunne de også til tider stille hverandre spørsmål om ting de ikke husket, eller elementer de mente var relevante.

Før intervjuene ble det utarbeidet en felles intervjuguide, som ble sendt ut til intervjuobjektene sammen med informasjon om arbeidet med prosjektet (vedlegg 2). Dette ble gjort for å sikre at alle intervjuene ble gjennomført etter samme rammeverk. Intervjuguiden ble laget i samarbeid med Atle Engebø, Ola Lædre og Jardar Lohne, som også er på forfatterlistene til samtlige av artiklene i del B. Denne intervjuguiden ble i utgangspunktet utarbeidet i forkant av runde A, men da denne viste seg å fungere godt til formålet ble den ikke endret i intervjurunde B. Dette var også viktig for å sikre at det også på tvers av runde A og B var et så likt rammeverk som mulig rundt intervjuene. Her fikk intervjuobjektene også informasjon om at det kom til å bli gjort opptak, og de hadde anledning til å reservere seg mot dette. Ingen reserverte seg mot å bli tatt opp.

Tre av de som stilte opp ble med på intervjuene etter initiativ fra andre intervjuobjekter, noe som førte til at disse ikke fikk tilsendt intervjuguiden før intervjuet fant sted. De fikk derimot utdelt intervjuguiden ved intervjustart, og anledning til å sette seg inn i denne. De ble også informerte om at opptak ble satt i gang. Disse fikk nok en noe dårligere mulighet til å sette seg inn i intervjuguiden, men de kunne samtidig stille oppklaringsspørsmål underveis dersom de syntes noen av spørsmålene var uklare.

Før praten rundt spørsmålene startet ble alle spurt om de kunne fortelle litt om sin bakgrunn, og litt mer om hva deres selskap eller avdeling arbeidet med. Dette ble gjort for at intervjueren skulle få et inntrykk av hvem personene var, samt at det her ofte kom opp informasjon som kunne brukes for å stille oppfølgingsspørsmål senere i intervjuet.

I etterkant av intervjuene ble samtlige lydopptak transkribert. Deler av lydopptakene ble gått gjennom flere ganger, for å sikre så korrekt transkribering som mulig. Etter dette ble samtlige av de spurte tilsendt den transkriberte teksten for godkjenning og eventuelt ytterligere kommentarer. Der gruppeintervju ble gjennomført, ble hele teksten sendt til alle deltagerne på gruppeintervjuet. Det ble brukt fargekoder for å vise hvem som hadde sagt hva, slik at intervjuobjektene enkelt kunne identifisere egne sitater under gjennomgangen. Her var det

noe rom for feil, da det ved svært korte kommentarer kunne være vanskelig å høre hvem det var som snakket. Likevel ble det ansett som hensiktsmessig, da det gjorde at intervjuobjektene kunne fokusere mer på egne sitater under gjennomgangen av tekstene, som var på mellom 6 og 28 sider.

På grunn av temaets natur, har alle som stilte opp på intervju blitt anonymiserte, både i denne prosessrapporten og i de vitenskapelige artiklene. En utfordring rundt intervjuene var å beholde anonymiteten til intervjuobjektene i en bransje som er relativt liten. På grunn av dette er alle henvisninger til steder, saker etc. som kan virke avslørende på identiteten til de som gav opplysningene fjernet i sitatene.

2.2.6 Kildekritikk

Kildekritikk har hele tiden hatt et stort fokus i arbeidet. Ved litteraturstudier og dokumentstudier har TONE-prinsippet for kildekritikk vært svært nyttige. TONE-prinsippet, som blant annet benyttes av VIKO (NTNU, 2015) og NDLA (Nyborg & Kaspersen, 2012), går ut på å vurdere fire elementer ved kilden. De fire er:

- Troverdighet
- Objektivitet
- Nøyaktighet
- Egnethet

Disse elementene var spesielt gode å benytte seg av under litteraturstudien, men også under dokumentstudiene ble de benyttet.

Ved intervjuene har det også vært svært viktig å ikke tro blindt på alt det respondentene har svart. Ikke all informasjonen fra slike intervjuer er mulig å ettergå i ettertid, fordi svarene i stor grad har vært basert på interne rutiner, kontrollsystemer eller egen erfaring. Fordelen har vært at stålbransjen ikke er så stor, og at mange av de som har blitt intervjuet dermed har fortalt om den samme bransjen. På denne måten har det vært mulig å se fellestrekk mellom det de ulike har forklart.

Det har også vært viktig å vurdere muligheten for at eksemplene på falske stålmaterialer som intervjuobjektene har kommet opp med har vært de samme, med andre ord at ulike aktører har forklart seg om samme sak. Noen ganger har det vært åpenbart at sakene er forskjellige, for eksempel ved at stålproduktene var ulike, mens andre ganger har det vært mer tvil. Å spørre om mer informasjon rundt stålproduktene har vært løsningen på dette. For å beskytte anonymiteten til de som har stilt opp, har det ikke blitt stilt oppfølgingsspørsmål som har kunnet avsløre identiteten til andre respondenter.

Ett eksempel på falske stålmaterialer er ikke tatt med i oversiktstabellen i kapittel 4.2, fordi det ganske sikkert er det samme tilfellet som det en av de andre respondentene forklarte seg om.

2.3 Arbeidsfordeling mellom forfatterne

I dette kapittelet forklares arbeidsfordelingen mellom forfatterne på de ulike artiklene. Da dette er en mer subjektiv gjenfortelling, har undertegnede valgt å bruke jeg-form ved forklaring om eget arbeid.

2.3.1 I arbeidet med artikkel I Crime in Construction

Fem forfattere arbeidet med denne artikkelen; Jardar Lohne, undertegnede, Atle Engebø, Brendan Young og Ola Lædre. Hovedsakelig er det Jardar Lohne som har stått for utarbeidelsen av artikkelen. Jeg var medforfatter, og mitt største bidrag var å utarbeide databasen som artikkelen er basert på. I tillegg bidro jeg med gjennomlesning og kommentarer i skriveprosessen. Deler av metoderapporten og trendanalysen jeg skrev i forbindelse med utarbeidelsen av databasen er også brukt som grunnlag for teksten.

2.3.2 I arbeidet med artikkel II Consequences from use of counterfeit, fraudulent and sub-standard construction materials

Fire forfattere arbeidet med denne artikkelen. Jeg var medforfatter, og bidro med datainnsamling til artikkelen gjennom intervjuer med A. I tillegg bidro jeg med gjennomlesning og kommentarer. Selve skrivingen av artikkelen er det Atle Engebø som har stått for, med innspill fra undertegnede, Ola Lædre og Jardar Lohne.

2.3.3 I arbeidet med artikkel III Counterfeit, fraudulent and sub-standard materials: The case of steel in Norway

Fire forfattere arbeidet med denne artikkelen. Jeg var førsteforfatter og hadde således hovedansvar for datainnsamlingen, skrivearbeidet og innsending til konferanse. De andre forfatterne bidro spesielt med tilbakemeldinger på innhold og fremstilling av resultater og diskusjon, samt med innspill til nyttige kilder. Layouten på artikkelen er laget etter retningslinjer fra konferansen IGLC. Etter innsending til IGLC kom artikkelen tilbake med kommentarer fra to reviewere. Disse kommentarene har også ført til noen endringer i artikkelen, og disse var det spesielt Jardar Lohne og jeg som jobbet med å imøtekomme. Jeg vil også stå for arbeidet med å forberede presentasjon av denne til IGLC-konferansen 10-12. Juli 2017.

2.3.4 I arbeidet med artikkel IV Countering Counterfeit, Fraudulent and Sub-standard Materials in Construction

Fire forfattere arbeidet med denne artikkelen. Jeg var førsteforfatter med hovedansvar for datainnsamling og skriving. Metodekapittelet ble jobbet med under et skrivekurs i regi av Jardar Lohne. Layouten til artikkelen er laget med templatene til IPMA 2017, slik kravet er fra konferansen. Som nevnt i kapittel 1.5 er fontstørrelsen økt noe for å sikre lesbarhet.

I forbindelse med besøk fra Dr. Glenn Ballard ved UC Berkeley i april 2017 fikk jeg svært gode innspill til denne artikkelen. Utgangspunktet for møtet var artikkel III, men i hovedsak var det artikkel IV som ble diskutert. Blant annet kom ideen om å presentere mottiltakene som skjold på en tidslinje fra ham. På dette møtet deltok også Atle Engebø og Ola Lædre.

2.3.5 I arbeidet med denne rapporten

Jeg har stått for hele utarbeidelsen av prosessrapporten. I tillegg har Ola Lædre bistått i arbeidet med utformingen av rapporten, og vært til stor hjelp i forbindelse med kommentarer til innhold.

2.3.6 Annet arbeid

Alt annet arbeid i forbindelse med masteroppgaven er det jeg som har stått for. Dette inkluderer for eksempel alle intervjuer og datainnsamling.

3. Publiseringsstatus

De ulike artiklene har i skrivende stund status som følger:

I. Crime in construction

Status: Avventer videre revisjon før den blir sendt inn til International Journal of Construction Engineering and Management

II. Perceived consequences of counterfeit, fraudulent and sub-standard construction materials

Status: Har blitt akseptert av Creative Construction 2017-konferansen i Primošten, Kroatia.

III. Counterfeit, fraudulent and sub-standard materials: The case of steel in Norway

Status: Har blitt akseptert av LC3/IGLC 2017- konferansen i Heraklion, Hellas, under temaet Supply Chain Management and Prefabrication

IV. Countering counterfeit, fraudulent and sub-standard materials in construction

Status: Avventer godkjenning til IPMA 2017-konferansen i Astana, Kazakhstan under temaet Global challenges, trends and models for the development of organizational competence in PM.

To av artiklene er altså godkjent til konferanser. En av artiklene er sendt inn til en konferanse og avventer godkjenning, mens journalartikkelen avventer videre revisjon før den blir sendt inn til et vitenskapelig tidsskrift.

Selv om noen av artiklene allerede er godkjente, kan det likevel forekomme endringer i samtlige. Ved fremtidig bruk av artiklene bør man benytte seg av den publiserte versjonen og ikke av versjonene som ligger inn under del B i denne masteroppgaven.

4. Ubenyttede data og arbeid

Totalt har det blitt samlet inn mye informasjon til denne masteroppgaven. Til sammen ble det transkribert 115 sider med tekst fra intervjuene, og det var naturligvis ikke plass til å ta inn samtlige elementer. Dessuten ble den første artikkelen skrevet på grunnlag av pilotintervjuene samt surveyen, slik at det var flere momenter som kom fram i de senere intervjuene som også kunne ha passet inn i den første artikkelen.

4.1 Eksempler på falske stålmaterialer

Ulike tilfeller av forfalskede, uredelige og utilstrekkelige stålprodukter ble diskutert i intervjuene. Enkelte av hendelsene og tilfellene hadde intervjuobjektene selv opplevd, mens andre hadde de kun hørt om, men fra det de anså som troverdige kilder. Ikke alle tilfellene er beskrevet i artiklene, da artikkel III var basert på pilotstudien (altså bare de tre første intervjuene). Under følger en oversikt over alle tilfellene som ble diskutert i intervjuene. Noen av disse ble diskutert i artikkel III, men tabellen kan gjerne benyttes til senere arbeid. Som nevnt i kapittelet om kildekritikk, er ett tilfelle fra intervjuene tatt bort, da det ganske sikkert allerede hadde blitt omtalt av en av de andre respondentene.

Tabell 7 Tilfeller av falske stålmaterialer som kom opp under intervjuene

Tilfelle	Feil	Opprinnelsesland
Stål til konstruksjon av industribygg	Manglende dokumentasjon	Kina
Søylar	Feil sveisetykkelse	Øst-Europa
Plater	Feil deklarasjon av innhold, dermed feil sveisbarhet	Kina
Stål til byggeprosjekt	Kom ikke frem, ble etter hvert byttet ut med stål fra en norsk stålbygger	Egypt
Søyle til byggeprosjekt	Produsent hadde ikke rett til å CE-merke.	Kina
Stål til byggeprosjekt	Kvaliteten var lavere enn kvaliteten beskrevet i dokumentasjonen.	Utenlandsk, ikke spesifisert fra hvor i intervju
Bjelker og søylar ment for bærende konstruksjoner i bygg	Feil karboninnhold deklarerert i dokumentasjonen	Kina
Stål til bærende konstruksjon, men ikke til en kritisk del	Kvalitet ikke i henhold til dokumentasjonen	Kina

4.2 Sammenligning med andre bransjer

Ved siden av konkrete eksempler på produkter, kom det også frem flere interessante momenter som havnet litt utenfor temaene i artiklene. Ett av disse var sammenligning av byggebransjen og oljebransjen. Det er godt kjent i Norge at oljebransjen krever mye dokumentasjon, noe det også ble fortalt om av informantene i denne oppgaven. De fortalte også om ulike sertifikater som kreves i disse bransjene, der oljebransjen har strengere kontroll av materialene. Dette temaet er også en del av den ubenyttede teorien, da det i forbindelse med undersøkelser om sertifikater for byggebransjen også dukket opp en del informasjon om sertifikater for oljebransjen

4.3 HMS, etikk og økonomi

Det var også flere av intervjuobjektene som i forbindelse med intervjuene snakket om mangelfullt fokus på helse, miljø og sikkerhet (HMS) hos det de mener er useriøse stålprodusenter. Enkelte nevnte også de etiske utfordringene ved å velge en produsent eller en leverandør som ikke er opptatt av disse temaene. Dette har det ikke blitt lagt noe vekt på i dette arbeidet.

I arbeidet dukket det også opp informasjon om at Norsk stålforbund skulle holde et infomøte om momssvindel på stål fra baltiske land. Dette var det også noen av intervjuobjektene som nevnte. Igjen er dette svært interessant, men det faller noe utenfor oppgavens tema.

Økonomisk kriminalitet innenfor materialbransjen har det ikke blitt sett noe særlig på i denne oppgaven.

4.4 Andre materialer

Flere av de spurte kom også med eksempler på andre typer materialer enn lastbærende stål. Dette inkluderer produkter som branndører, vinduer, fasadeelementer, bolter og skruer. Selv om dette var interessante eksempler på falske materialer, samt at det viser at dette foregår på flere områder, har det ikke blitt viet noe særlig oppmerksomhet, da det ikke har vært så relevant for stålartiklene. Dette er også beskrevet i kapittelet om avgrensninger.

5. anbefaling om videre arbeid

Etter arbeidet med denne masteroppgaven, er det flere interessante retninger å gå videre i. Denne siste og mest spissede delen av denne oppgaven har i stor grad vært begrenset til lastbærende stålmaterialer. En kvantifisering av fenomenet falske stålmaterialer hadde vært en spennende retning å gå videre. Da kan man undersøke hvor i verdikjeden det vil være mest nødvendig å sette inn mottiltak. Her kan også en sammenligning med hvilke kontrolltiltak oljebransjen har inkluderes. Som nevnt har denne oppgaven ikke sett noe på om de falske materialene har kommet som følge av bevisst juks eller slurv. En videre undersøkelse av slike tilfeller kan med fordel gjøre et slikt skille. Det er forskjell på aktører som ønsker å jukse og aktører som ønsker å gjøre ting riktig, men som ikke får det til.

Definisjonen av hva som er falske materialer har vært et viktig punkt i denne oppgaven. CE-merkingen og den tilhørende ytelseserklæringen har her blitt valgt som mål på dette. Videre arbeid må gjerne inkludere å se på andre måter å avgjøre om et materialer er falskt eller ikke.

Det hadde også vært interessant å se like spisset på andre typer materialer, for eksempel aluminiumsprodukter eller betong, for å undersøke om dette også foregår i forbindelse med andre typer materialer. I tillegg hadde det også vært spennende å se om materialkriminalitet også kan assosieres med forekomst av andre typer kriminalitet, for eksempel skatteunndragelse, miljøkriminalitet og illegalt arbeid.

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Del B: Vitenskapelige artikler

Artikkel I: Crime in Construction

Crime in the AEC-industry: a scoping literature review

Lohne, Jardar; Kjesbu, Nina Eklo; Engebø, Atle; Young, Brendan; Lædre, Ola

Keywords: Crime; AEC-industry; literature review; Materials; Organisation; HSE

Abstract

The characteristics of the Architecture, Engineering and Construction (AEC) industry seem to facilitate and permit the embedding of criminal actors and activities leading to the prevalence of crime in the AEC-industry. Crime in the AEC-industry is acknowledged as a problem that needs addressing. This is not, however, well reflected by the amount of literature covering this issue. This paper reports on a scoping literature review on crime in the AEC-industry. It highlights that research in this area has only recently begun to take off. The paper explores how the literature covers the topics of organisation, materials, and health, safety and environment (HSE) issues. The research highlights that these topics are not covered evenly and that some, namely material and HSE issues, are lagging behind. This study aids practitioners by highlighting the extent of these issues in the industry. It also provides a number of departure points that can be used by academics for further research.

Introduction

Engineering, being one of the classical professions, is a profession with an obligation to society and the common good (Brante, 2013). Yet despite this, one of the largest engineering industries is riddled with issues. The adversarial nature of the Architecture, Engineering and Construction (AEC) industry is well documented throughout the research literature. For instance, the HM Government (UK) committee “Construction 2025” (2013) underlines that the “*vertical integration in the supply chain [of the AEC-industry] is low and [that] there is a*

high reliance on sub-contracting". Equally, the committee maintains how the "[l]ow entry cost and low capital required enables small firms to access the market and promotes competition in the sector". In general, the "[h]igh degree of fragmentation relative to other sectors and countries which impacts on levels of collaboration, innovation and ability to access foreign markets". These characteristics particular to the industry of a structural nature seem to drive much of the adversarial state of affairs witnessed. More grave, however, than open conflict and litigations is that the characteristics of the industry seem to permit the embedding of criminal actors and activities in construction projects. This insight constitutes the starting point of this study.

This paper reports on a scoping literature review on crime in the AEC-industry. Surprisingly few studies have been undertaken in this field of research. As pointed out by Kankaanranta and Muttillainen (2010: 417-429), concerning their study of economic crime in the Finnish construction industry, "internationally there are only a few studies focusing on the construction industry, even if it is one of the core areas of grey economy due to the high level of subcontracting.". It seems, then, that the area is of utmost interest for research – but sparingly researched.

One pilot review, which preceded the more comprehensive study, did not reveal any comprehensive literature reviews on phenomena. The reviews that were found were typically characterised by being limited to the specific fields of interest presented in research publications on specific phenomena. In addition, the literature was found to be of a heterogeneous nature, both concerning their thematic focal points and the methodological approaches chosen. The research strategy chosen consequently aimed at identifying all relevant literature, irrespective of study design.

This is in line with the prescription of Levac et al. (2010), recommending, in the case of scoping studies, the combination of a broad purpose of the enquiry with clearly articulated research questions. Consequently, the present study has ambitioned to examine existing literature on crime within the construction industry according to the following research questions:

- What research has been carried out on crime in the AEC-industry?
- How are different topics within this field of research covered respectively?
- What are the most important gaps in the research on crime in AEC-industry?

The concept of crime in the AEC-industry and limitations to the analysis

Despite being a word that everyone is familiar with, “crime” does not have a universally accepted definition (Farmer, 2008). According to the analysis of the material presented here, no widely accepted definition for crime in the AEC-industry could be identified either.

No clear-cut borders to related phenomena can be outlined; much criminal activity in the industry seems, at first hand, not to be construction specific (such as drug use); elements of the organisation of the industry do, however, point towards certain phenomena occurring more often here than in other industries. The Chartered Institute of Building (CIOB), in their study 2009 study used quite a broad view of crime in the AEC-industry and included the following themes into their list of phenomena (CIOB, 2009):

- | | | |
|----------------|-------------------------------|--------------------------|
| • Theft | • Racketeering | • Kidnap |
| • Vandalism | • Illegal drug dealing or use | • Illegal waste disposal |
| • Arson | • Health & safety neglect | • Identity theft |
| • Fraud | • Forced labour | • Data loss/theft |
| • Bribery | • Illegal working | • Handling stolen goods |
| • Intimidation | | |
| • Assault | | |

For reasons further outlined below, it was chosen not to include such a broad view of crime in this research. The intention was to limit the analysis to as industry-specific themes as possible. For example, phenomena such as kidnapping and identify theft were not considered to be industry-specific themes in this case. In addition, the CIOB list do not include relevant phenomena such as the use of counterfeit materials.

The work presented in this paper has been financed through the research project “Kartlegging av mulighetsrom for kriminalitet i byggenæringen” (Mapping of the potential for criminal activity in the AEC-industry), supported by the industry-research within Project Norway¹. The work undertaken by this project has been carried out according to the topics of “organisation”, “materials” and “HSE-neglect”. Therefore, for the purposes of this study, it was decided in a pragmatic manner sort the results according to these three topics. However, it was also decided to include publications that address all, or none specifically (provided they were still relevant to the main theme), of these categories. Thus, the findings are organised according to four topics: 1) Materials, 2) Organisation, 3) HSE-neglect and 4) Other.

Methodology

As commented by Arksey and O'Malley (2005), scoping studies have so far received little attention in the literature (2005:19). As described by Mays et al. (2001) scoping studies “*aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available, and can be undertaken as stand-alone projects in their own right, especially where an area is complex or has not been reviewed comprehensively before*” (2001:194). Based on this definition, Arksey and O'Malley identify four common reasons for undertaking a scope study, notably 1) to examine the extent, range and nature of research

¹ <http://www.prosjektnorge.no/>

activity, 2) to determine the value of undertaking a full systematic review, 3) to summarize and disseminate research findings, and 4) to identify research gaps in the existing literature (2005:21). It is mainly the first and the fourth of these reasons for undertaking a scoping study that has motivated the research reported here. The ambition has thus not been to describe the research findings in detail, but rather to map the field of study in order to visualise the range and volume of material available. The limited examination of existing research within the field of study, in addition to the heterogeneity of the research, motivates this approach as a useful way of mapping the field of study. In addition, the broad approach permits for identifying important gaps in the literature.

Arksey and O'Malley (2005) propose a six-stage methodological framework notably: 1) identifying the research question, 2) searching for relevant studies, 3) selecting studies, 4) charting the data, 5) collating, summarizing and reporting the results, and 6) consulting with stakeholders to inform or validate study findings. The present study differs from this approach in that stages 2 and 3 were undertaken together in an iterative process – the results from searches tended to influence the judgement of the relevance of studies and vice versa. Equally, stage 4 was included in an extended stage 1, where the particular interests of the authors respectively determined the chartering of the data to a certain extent.

As commented by Levac et al. (2010), “*scoping studies differ from systematic reviews because authors do not typically assess the quality of included studies*”. This might be considered a significant disadvantage, however, as is further underlined by Levac et al. (2010:1), “*scoping studies may be particularly relevant with disciplines with emerging evidence*”, such as is the case, with research on crime in the AEC-industry. As the field of research must be considered immature, “*scoping studies are ideal because researchers can incorporate a range of study designs in both published and grey literature*” and “*address questions beyond those related to intervention effectiveness*”. (*ibid.*)

The initial research reported in this paper was undertaken during the period of February-September, 2015. Nine databases were scrutinized. A total of 171 individual searches were carried out, resulting in 330 unique registrations of research papers. Furthermore, a second updating search was conducted in the period of March-April 2017. The aim of the second search was to update the findings to include the time-period of 2015-2016. This resulting in an extension of unique registrations from 330 to 376 publications.

Databases

The following internationally oriented search portals and databases were utilised for the search (as included in the matrix):

- Web of Science
- Scopus
- Google Scholar (GS)
- Engineering Village
(www.engineeringvillage.com)
(including Compendex, GeoRef og
InSpec.)
- American Society of Civil
Engineers (Minchin et al.) Library
- Oria (Norwegian library database)
- ASCE Civil Engineering Database
- Research Gate
- DIVA (Digitala Vetenskapliga
Arkivet)

In addition, specifically recommended papers from the database of the Construction Industry Institute (CII) were included in the analysis. The general news archive of Europol² was equally examined. Finally, the Norwegian databases BIBSYS and Retriever were scrutinised in order to provide an overview over research carried out within the Norwegian context. It should be noted that twenty of the twenty-four articles from Norway were published in the Norwegian language only.

² www.europol.europa.eu

Search words

The following search words and continuations of these constituted the bulk of the search undertaken:

- Illegal workforce
- Immigrant workers construction
- Immigrant workers
- Social dumping
- Tax evasion
- Tax deviation + Construction
- Undeclared work
- Workforce exploitation
- Counterfeit materials
- Counterfeit materials + construction
- Wage dumping
- HSE illegal work
- HSE crime construction accidents illegal work
- Falske materialer (“counterfeit materials” Norwegian databases searches only)
- Sosial dumping (“Social dumping” Norwegian databases searches only).

The number of hits varied from zero to several million. A thorough analysis of the hits surpassing an amount of 3-400 according to relevance was considered wasteful, and the analysis therefore stopped there. As a follow-up, several authors whose names showed up frequently in the searches were individually searched for in order to map their full contribution to the field. In addition, the reference lists of the key articles were scrutinised to pick up any articles that were missed using the previous methods according to the procedure outlined by Ellis (1993).

Categories such as *stealing*, *kidnapping*, *illegal waste disposal* and *identity theft* are excluded from the material research. In addition, this study is limited by the fact that the literature search was conducted only on papers published in English or Norwegian, thus excluding a potentially large number of publications published in other languages. The authors acknowledge the productivity of Colin C. Williams and his co-authors and recognise their contributions to this field. However, a complete citation of all of this work will skew the

findings. Therefore, we have limited the findings to just include a handful of key publications from C.C Williams that were perceived to be the most relevant.

Findings

By plotting the number of publications per year for the identified literature, a clear trend can be identified, as seen in Figure 1. The plot shows that there were relatively few publications per year from 1980 until 2004. From 2004 onwards, there has been a significant increase in the number of publications related to crime in the AEC-industry. One probable source for the increase in research interest is the fact that China’s economy has experienced considerable growth over the last years and in 2005 its economy surpassed that of both the UK and France (Garnaut and Song, 2006). Contributing to this growth was the increase in China’s materials and manufacturing industry.

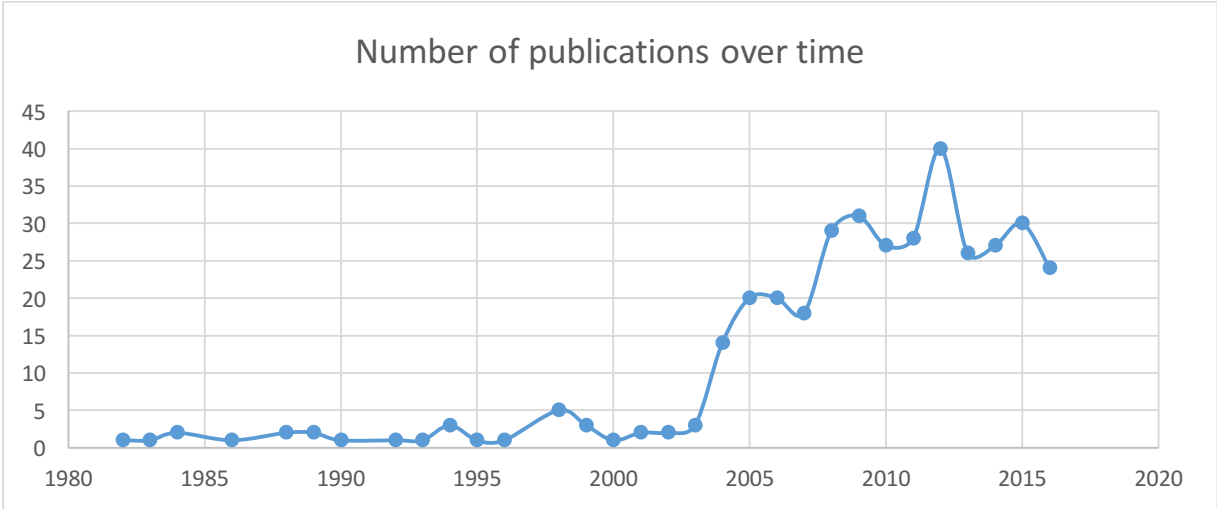


Figure 1 - Number of Publications over Time (from 1980 to the end of the research period)

Another probable contributing factor to this trend could be due to the large expansion of the European Union (EU) that occurred in 2004, when an additional ten countries joined

(Commission, 2016). Seven of the ten countries were Eastern European countries, countries then characterised by significantly lower salary levels and a higher degree of unemployment.

Additional causes for the increasing trend in the number of publications covering this issue probably include globalisation and the increasing flow of workers and immigrants in general.

Classification of results

The results are categorised according to four topics, notably 1. Materials, 2. Organisation, 3. HSE and 4. Other. Concerning the topic of “Materials”, the heterogeneity of the material needs to be taken note of. The magnitude and importance of the AEC-industry renders it, almost by definition, difficult to differentiate between phenomena lying within its boundaries and those lying on the outside. Ambitioning to include research on piracy/counterfeiting in adjacent industries, some papers were included into the material that are not solely confined to the AEC-industry.

The category of “Organisation” covers papers on illegal or unreported work and clandestine work-related immigration, and crime-related subjects within this field of enquiry.

The category “HSE” includes papers directly covering themes like dangerous work conditions caused and accident-prone criminal manners of dodgy organising work or accidents.

The category “Other” includes both papers that do not fit well into an individual category and papers equally fitted to all. In this category, articles from Europol are well represented, as they tend to cover crime-related subjects of a more general nature.

In addition to this categorisation, the material was classified according to a 1/0 scale, where category 1 denoted articles directly/mainly covered the construction industry, while category 0 contained articles whose reference to the industry was partial. This selection was carried out according to the discretion of the authors, in order to prepare the grounds for a potential

systematic review of the research field. In total, 376 of the publications identified were found to be of sufficient pertinence to the AEC-industry to be included in this analysis, 254 according to the category 0 and 122 in category 1.

General overview of the findings according to the topics

Figure 2 illustrates the distribution of the publications identified and classified by industry. As can be seen, the number of publications specifically addressing the AEC-industry is limited when compared with the publications that only partially concern the industry.

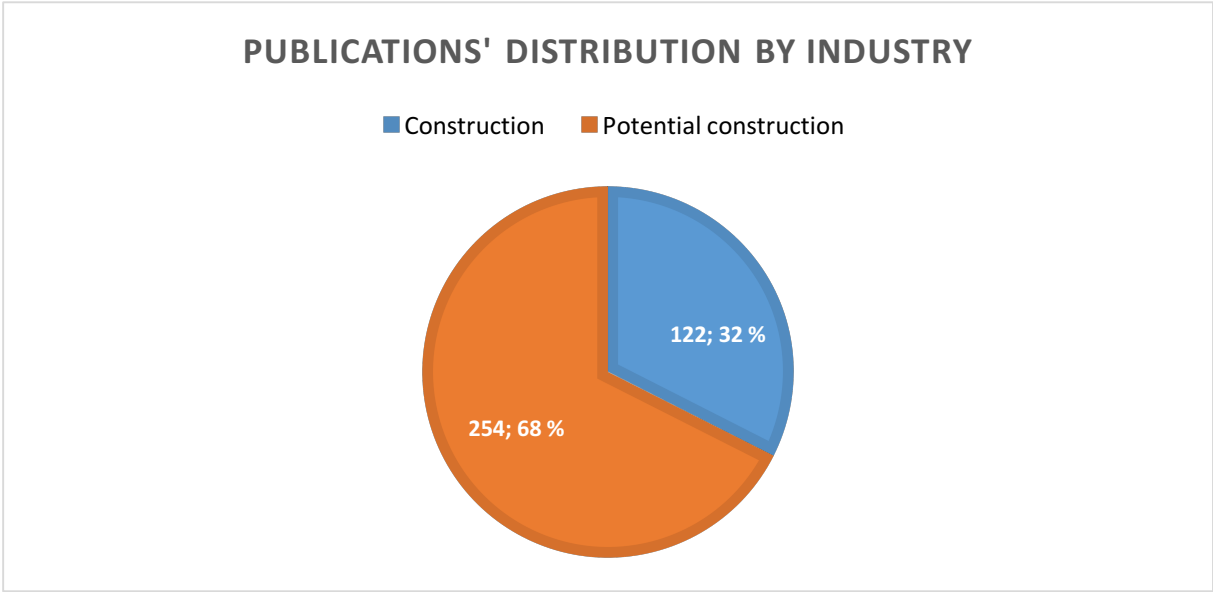


Figure 2 - Distribution of publications identified and classified by industry

Figure 3 and 4 provide an overview over the results according to the topic of the material. As can be observed, by far the most important topic explored in the publications identified is

“Organisation”. The number of publications concerned with HSE-neglect were, on the other hand, surprisingly low.

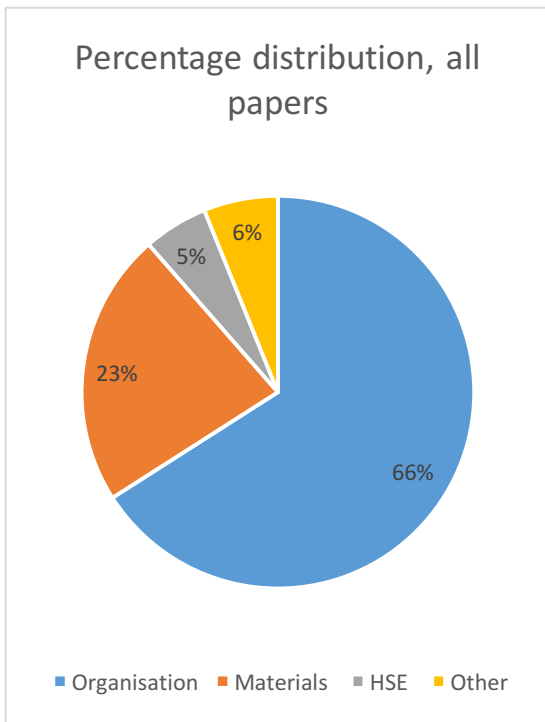


Figure 3 Classification of results

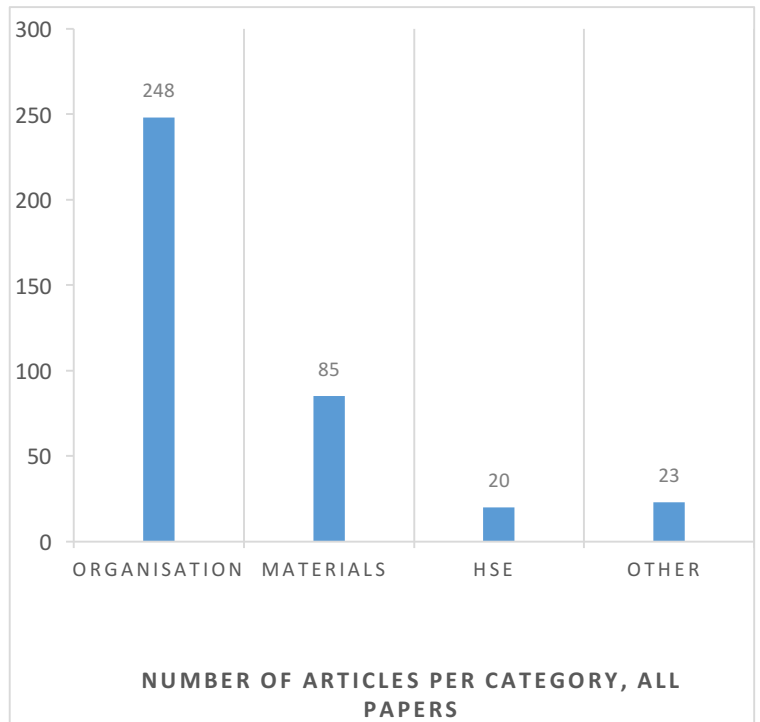


Figure 4 Number of articles per category

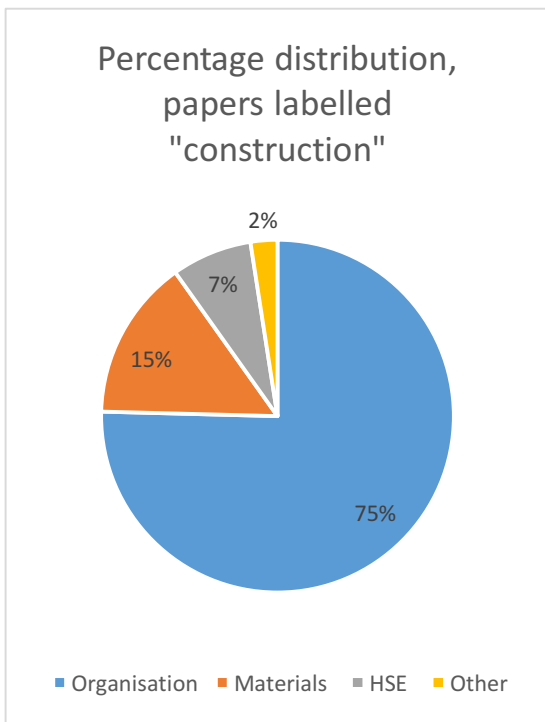


Figure 5 Classification of results, papers labelled "construction"

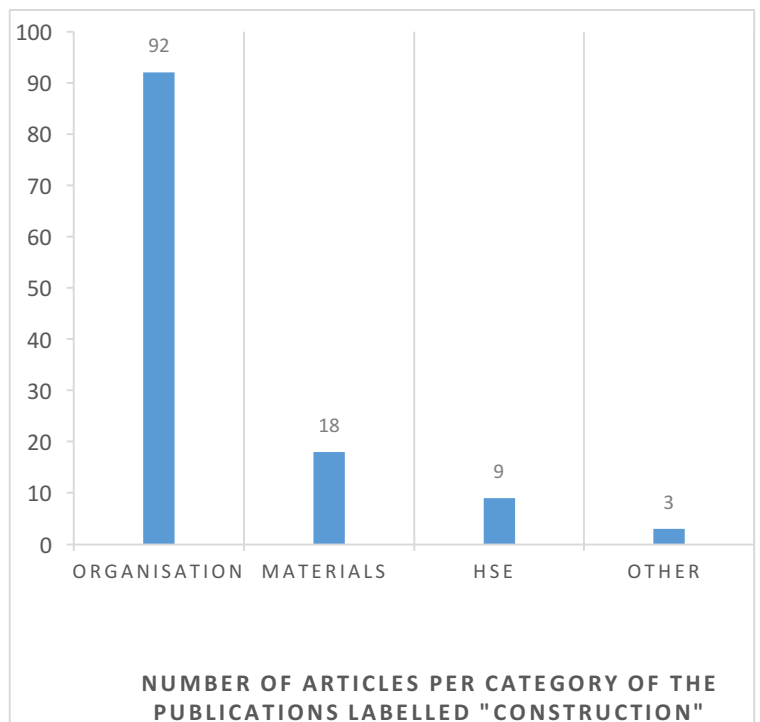


Figure 6 Number of articles per category of publications labelled "construction".

Materials

Within the topic of “Materials” lie all publications on the subject of false/counterfeit materials, be they mainly concerned with construction materials or somehow related to these (e.g. fabrics, electronics or spare parts). Several publications falling outside of the immediate scope of the analysis are thus excluded. Results concerning Intellectual Property (IP) and money-laundering are for example, for the most part, exempt from this analysis. Equally, while using the search word “counterfeit materials”, the majority of results concerned false medicinal drugs and narcotics. The majority of these publications consequently lie outside the scope of this analysis.

In the registered articles, there is consensus that false materials primarily come from Asia, where China in particular is mentioned as a big player (WSA, , 2006)) (Pang, 2008) (Berman and Swani, 2010)

The classic example of false materials is within the fashion industry. This remains to be a major problem for the industry (Hilton et al., 2004). However, false materials have been applicable in several industries. Following is a breakdown of the industries that experience false materials along with some identified key publications:

- **The aerospace industry** (Meshel et al., 2007) (AIA, 2011)
- **The construction industry** (CII, 2014) (CII, 2010)
- **Defence installations** (Talk, 2010) (Stradley and Karraker, 2006)
- **Dental industry** with its use of instruments and materials experience false components. (Santerre et al., 2008) (Christensen, 2010) (Ertas et al., 2014)
- The problem also exists considerable within the **pharmaceutical industry** (Liao et al., 2014)
- Piracy in the **electrical components** are illustrated through several articles. Allen and Curtler (2010) examines how the pirating of electrical components poses a large risk. Lowry (undated) maintain that false products enables customers become less satisfied and that production becomes more expensive for legitimate businesses.
- The Automotive Industry seem as well to be vulnerable to counterfeit parts. Sprovieri (2016) offers a review of different cases of counterfeit car part seizures.

What are the consequences?

This highlights that the problem of false materials has spread to many different industries, and several of these industries perform activities where the presence of false materials could pose a great risk. According to Minchin et al. (2011), there is a general ignorance in the construction industry around this threat. This claim is supported by Engebø et al. (2016).

The motivation for using false products not always cost (Wee et al., 1995) . Swami et al. (2009) refers to a study stating that the younger generation were more willing to buy false products than the older generation.

(Europol, 2011a) shows that false materials do not undergo the same testing procedures as genuine products. Thus, the European safety standards cannot be assumed for such products. The issue of safety was also examined by Cheta (2008). The author concluded that no reliable data on how many injuries you see because of false materials, but it presents examples of actual events.

How can one detect false materials?

Stevenson and Busby (2015), Bryan (2014) and Minchin et al. (2011) all suggest that proper supply-chain management is the key to detect counterfeit materials. Stevenson and Busby states: "*Although Operations management studies refer to the risks of patent and copyright infringements that arise in supply chains, the problem of product counterfeiting has received only limited attention, leaving a clear gap in the understanding.*" (Stevenson and Busby, 2015:110). Caldas et al. (2014) found a distinct increase in formality and systematics in materials management and protection of the right quality and use.

What is being done to combat false materials?

The need to ensure the supply chain is pointed out by Koh (2003). Various identification methods for real products have been proposed in the literature (Countering the counterfeiter , 2007), (Couvret, 2012) (Horn et al., 2013).

Many of the entries under "Materials" deal with how to develop certification solutions for materials. These include chemical markers or watermarks/physical marks that authenticate the product (Yang et al., 2011) (Yoon et al., 2013) (Meylan, 2007).

The construction industry

Some research on use of false materials within the construction industry has been carried out, but the theme is not very well covered. Minchin et al. (2011) point out that the industry is facing a major challenge by showing that counterfeiting of construction goods is a large and dangerous problem. China was found to be the primary source of counterfeit construction goods.

Naderpajouh et al. (2015) establishes that the construction industry's project-oriented nature with many actors make the challenges of false materials bigger. They explore mitigation strategies and propose a framework for governing the risk of false materials. Materials Management Practices in the Construction Industry's study shows "(...) a dramatic increase in the maturity, formality, and systematic approach to materials management (Caldas et al., 2014:1). Minchin et al. (2013) highlight the problem of false materials in terms of manufacturers' lack of understanding of the "close enough" is not good enough.

Despite it being considered that false materials in the industry constitute a major problem, studies show that the problem is not so well known: *"By traveling internationally and interviewing different contractors, government agencies, owners, insurance companies, manufacturers, and suppliers, the research team was able to gain knowledge on the issue. Of*

special interest were situations in which problems with counterfeiting were identified: how they were identified, what products were counterfeit, and whether accompanying documentation such as mill reports and other paperwork or certification stamps were fraudulent. A lack of knowledge about this threat was apparent throughout the industry.”

(Minchin et al., 2011). Furthermore, Minchin et al. (2016) investigated nine hypotheses regarding counterfeiting in the Construction Industry. The main purpose was to highlight how cultural differences may explain contradictions in the perceptions of counterfeiting, as well as investigating potential consequences.

Summary

False materials pose problems in many industries. The trend identified in the literature clear: False materials and products are a worldwide problem that can pose a risk to life and health. Allen and Curtler (2010) identify China as a major player in this area, pointing to estimates that over 95% of counterfeit electronic components originate from China. They also mention that about 15% of world trade is undertaken with false goods, and that the profits of this, in some cases, are being used to finance other criminal activities. Minchin et al. (2011) shows that counterfeit building materials is a big and dangerous problem, and points to China as the country of origin for most such products. Nevertheless, the issues are not particularly well known within the industry.

Organisation

What here is denominated “organisation” is a broad field of analysis, including several work-related challenges of a criminal nature. Typical examples pertinent to the construction industry are illegal immigration, illegal work, non-declared work, corruption-related crime, so-called social dumping, and other general challenges concerning exploitation. As indicated above, this is where the main bulk of the results from the scrutiny of the literature were to be found.

A general overview

The general picture from the literature is that crime-related challenges found within this category must be understood within the general picture of work conditions and their alterations over the last decade.

There exist a variety of theoretical concepts regarding illegal work, as well as a variety of methodologies for assessing the phenomena. Zitkiene et al. (2016) have assessed this methodical problem by providing an in-depth analysis of literature related to illegal work. Loosemore and Lim (2016) provide insight into intra-organisational injustice such as discrimination, poor safety and corruption in the construction industry. Furthermore, the same authors have published a similar paper, focusing on inter-organizational unfairness in the construction industry (Loosemore and Lim, 2015a).

Seierstad (2005) and Stensvik (2007) address the fact that Norway, in common with most European nations, has witnessed a sharp increase in foreign workers due to more liberal migratory flows within the European economic zone. Mendoza (2000) reports that in both Spain and Portugal, native workers have largely left the construction industry, and that migrant workers fill this void. This trend seems to be global in nature. Narayanan and Lai (2005) underline how construction in Malaysia depends almost entirely on immigrant workers, constituting approx. 70% of the workforce in the industry. The sheer number of immigrant workers renders their employment necessary to the extent of replacing native workers. Bernaciak (2016) examines the stances of Polish trade unions on social dumping, EU labour mobility. EU-enlargement and EU service market liberalization. The influx of an immigrant workforce is equally reflected in papers concerned with questions of how migratory flows influence labour markets (Eldring and Friberg, 2013); (Thörnquist, 2013); (Friberg et al., 2014)), institutions (Lundborg, 2006), labour practices (Berntsen, 2016),

temporary staffing agencies (Friberg, 2016) and government reactions to the arising challenges (Wilkinson, 2012).

Work conditions for immigrant workers is underlined as being of particular concern. In the US, immigrant workers are typically exposed to bad treatment and illegal work conditions. Zhang et al. (2014) found that “*30 percent of undocumented migrant labourers were victims of labour trafficking, 55 percent were victims of other labour abuses, and about half of these victimization experiences occurred within the past 12 months*” (2014:65). Immigrant workers seem, in general, to be found in what DeFilippis et al. (2009) denotes “unregulated work” in the US. Under such working conditions, workers are paid less than minimum salary, their working conditions are unsafe, and union bashing is widespread. At the same time, this workforce proves increasingly important, especially in rural areas in the US. The authors maintain that little has been done to understand this mode of work, especially its cross-industry nature. Another interest case regarding immigrant workers is that of the United Arab Emirates, because of their demand for labour. Haider et al. (2016) addressed the issue on whether the governments paid any attention in providing a proper framework to secure the basic rights of migrated force.

Though workforce immigration is general in nature (that is, not sector-specific), the AEC-industry is identified as one of the “hot-spots” for criminal activity arising from this trend. The propensity for foreign workers to meet reduced compensation as compared with domestic workers (Selven, 2007, Rye, 2012) is an indication of inadequate standards for this group, typically with severe juridical implications (Salvesen and Waaktaar, 2008). The positive effects of such low standards, however, are also underlined in construction research, claiming that there would be massively increased project costs if illegal workers were unavailable (Golden and Skibniewski, 2010). Equally, the negative picture is challenged by Williams and Horodnic (2015b). Having analysed the extent to which the general picture of immigrant

workers being the main protagonists of illegal work within the context of the European Union, these researchers maintain the need for a “*more nuanced understanding of the marginalisation thesis as valid for some marginalised populations but not others. Whether similar findings prevail at other spatial scales and in other global regions now needs investigating.*” (Williams and Horodnic,). Other researchers further underline this point. Cremers and Janssen (2008) note that, based on their evidence, they “*cannot detect any causal relationship between migration and the decline in traditional employment relationships, giving rise to various forms of [...] ‘irregular work’.* If a causal relationship is at work, we would rather suggest a reverse one, in that undeclared labour (‘informal work’) provides the preconditions for increased labour migration – including ‘irregular immigration.’”. This point seems to have been taken up in certain contexts. Marie (1994), for instance, reports how French authorities passed from working mainly from a campaign against illegal immigration towards a campaign against illegal work in general (even though the main actors then were found to be French citizens).

Be the main reason immigration or not, the construction industry is clearly identified as one of the industries where irregular work is found to be the most frequent, causing significant challenges on subjects such as HSE (Kili et al., 2008). The consequences of using irregular work are equally identified as being potentially severe for the organisations in question.

Dinkovski (2005) identify fines and juridical processes as potential implications.

The consequences of irregular work

In Europe, so-called “envelope-wages” – a system whereby some of the salary is open to tax deduction, and the rest is not – is a widespread problem (Williams, 2009a). This is an illustration of a more general point, notably that the borders between regular and irregular employment are not as clear-cut as often assumed (Williams, 2009b). Williams (2009b:147) comments that “*formal labour markets in the European Union are not always quite as pure,*

wholesome and legitimate as might be supposed. Until now, it has been commonly assumed that the formal economy is separate and discrete from the informal economy. To contribute to the emerging literature showing that this is not always the case and that the formal economy can be permeated by informal practices, a so far little discussed employment arrangement is here brought to the fore in which formal employers pay their formal employees two wages, one declared and the other an undeclared ('envelope') wage”.

Williams also sees the practice of "envelope wages" as a relevant problem for the construction industry. *“The finding is that one in 20 employees receive some of their wage from their employer as an undeclared “envelope wage” and on average this amounts to two-fifths of their wage packet. This payment arrangement, however, is more prevalent in some businesses, places and populations than others. Smaller businesses and construction firms are more likely to pay envelope wages.”* (Williams, 2009a) Williams has also examined the prevalence of this kind of practice in Eastern European countries. *“The finding is that 10 per cent of all employees received envelope wages during the last 12 months amounting on average to two-fifths of their gross annual wage.”* (Williams, 2008)

Thus, despite what one might think, undeclared work and formal employment are not so separate in reality. Williams argues that undeclared work can be combined with formal employment. *“Given the prevalence in the EU of this hybrid employment practice which is neither purely formal nor informal [there is a need for] formal and informal employment are sometimes intimately interlocked and entwined rather than separate and discrete spheres.”* (Williams, 2009b)

Bohn and Owens (2012) argue that "informal employment" is associated with immigration on a general basis and that areas with high concentrations of low-skilled immigrants and a more open labour market are typically characterised by a higher level of "informal employment" within the construction industry. Kangasniemi et al. (2012) examine the economic impact of

immigration. Behling and Harvey (2015) investigated the high level of bogus self-employment in the UK construction industry.

Bengtsson (2014) studied conflicts between trade unions and companies concerning pay and working conditions for EU migrant workers in Sweden. Fromentin (2016) propose another angle to the subject of migrant workers and how the phenomena are affected by changes in the economy. The study concluded that migrant workers seemed to be more affected by changes imposed by economic conditions than native workers are. Khan and Sandhu (2016) stated that differences in national cultures of migrant construction workers have economic, social and environmental impact on both migrant sending- and receiving country.

Understanding cultural differences could therefore contribute to decent work practices. While not directly addressing migration workers, Asare et al. (2015) assessed threats encountered by Chinese construction firms in Africa where labour rights was mentioned as key threat.

[What enables the situation?](#)

According to the literature, it seems that characteristics inherent to the construction industry render it particularly susceptible to framework conditions suitable for criminal activities.

Both the widespread use of employment agencies and informal manners of organisation (the extent and impact of these factors vary globally) are pointed out as important drivers in this context (Costa, 2011). Regarding tax evasion, tax policies and changes in tax policy affect motivation for tax evasion (Ceccato and Benson, 2016). The American Society of Civil Engineers claims that corruption accounts for an estimated \$340 billion of worldwide construction costs each year. Corruption (including bribery, embezzlement, kickbacks, and fraud) in construction projects undermines the delivery of infrastructure services. Further, corruption poses significant risks to construction and engineering companies themselves.

What progress has been made, therefore, in reducing the risk of corruption to construction

projects? It is the purpose of this paper to argue that with improved accountability, attention to ethics and cultural considerations, and reduced corruption, it is possible to construct, operate, and maintain adequate quality and quantity of infrastructure on a more sustainable basis and thereby improve construction practice. This paper will demonstrate how accountability initiatives in construction projects in developed and developing countries can be of benefit internationally to the public and private sectors as well as nongovernment organizations and researchers in their efforts to reduce corruption in infrastructure services (Sohail and Cavill, 2008).

Corruption in construction

Both the existence of corruption, as a problem within the construction industry worldwide, and the strategies for fighting the problem, are explored in several papers, e.g. (Hartley, 2009, Lester, 1999, Sohail and Cavill, 2008, Bowen et al., 2012, Kyriacou et al., 2015). Smith (2006) outlines several dimensions concerning the nature of corruption within the construction industry: *“1. incentives are being given to individuals at all levels within a company, from corporate football matches and horse races to weekends being paid for by a particular subcontractor; 2. the company director force to forge and sign day work sheets to bump up and deliberately overprice variations; 3. bribe is offered by the co-client of a project to issue a practical completion certificate early this would have released money from the funding bank; and 4. constant overclaims by contractors make life challenging and difficult, the contractors used are the best locally at what they do and if ditched, quality would suffer.”*

Van Den Heuvel (2006) explores the phenomena in relation to swindling, monopolies etc. within the context of the Dutch construction industry, following Damit (1983), who analysed the structure of cartels within the industry, along with strategies to fight them. Chancellor and Abbott (2015) addressed the shadow economy of the Australian construction industry and its impact on productivity. Another paper addressing the Australian construction industry

explored behavioural factors perceived to influence corrupt action in the Australian construction industry (Brown and Loosemore, 2015). Also the South African construction industry have been examined in order to report experiences and views regarding corruption (Paul et al., 2015). Within the Dutch Construction industry, Kashiwagi et al. (2015) examined the cause of collusion. The study concluded that the problem was non-technical and related to the delivery of services. Within the Nigerian construction industry, KOLAWOLE (2015) outlines the major areas where corruption taking place.

Loosemore and Lim (2015b) examine the value of organizational justice theory as a basis for better understanding the prevalence and form of unfair inter-firm business practices.

Shan et al. (2016) addressed the underlying factors for corruption in the construction industry. Still, the majority of the research on corruptions are aimed at specific practises or phenomena. Signor et al. (2016) examined the issue of overpricing with the aim of providing a method to determine overpricing by describing the methods used by the Brazilian Federal Police.

Cheung (2016) discuss the use of *agreement not to compete* and whether such agreement are a type of bid rigging practice. Reeves-Latour and Morselli (2016) studied relationships between political and business actors in conspiracies organized around public construction bids while Zhang et al. (2017) have studied causes of Business-to-Government corruption in China. Shan et al. (2015b) have developed a fuzzy measurement model for measuring corruption in construction projects. Another study looked at the effectiveness of response strategies in Chinese Public Construction Sector (Shan et al., 2015a). Furthermore, Shan et al. (2017) studied collusive practices during the whole construction period, providing insight into the primary collusive practices in Chinese construction projects.

Based on the above, it does therefore seem to be recognised that corruption and its associated challenges are widespread in the construction industry. The phenomenon does not, however, seem to be fully explored. Outside the field of academia, industry actors seem, in fact, to be

aware of the problem. CIOB (2013) examined the existence of, and perceptions of, crime and corruption within the UK construction industry. Among the results from the study was that it “*indicates that 49% of respondents believe corruption is common within the UK construction industry*”.

All the articles by Williams and his co-authors covered in this paper, and recognising their other contributions to this field, nuance the picture of the challenges involved as described above. A main claim is that the situation calls for action. However, at the same time, the approach of trying to simply eradicate all forms for unwanted behaviour from the industry will induce new challenges, as the practices experienced arise from certain needs of the actors within the industry. Williams and Nadin (2012) underline, according to this line of thought, that though simply letting the situation develop on the subject of the undeclared economy as hitherto is no viable solution (due to its negative impacts on construction businesses, customers and governments), deterring such work is “*neither effective nor necessarily desirable since most governments wish to move such endeavour into the declared economy rather than simply eradicate it.*” (Williams and Nadin, 2012). In other words, just constricting the demand will not necessarily help if the demand remains constant. Williams and Windebank (2005) underline the need for such nuanced approaches to the challenges involved in undeclared work, arguing for “*moving towards a more "joined-up" public policy approach towards tackling undeclared work and developing social capital rather than treating them as separate policy realms.*”

The insight that irregular work is provoked by conditions of demand is equally presented in several other papers (Barth and Ognedal, 2004, Kenig, 2014, Ødegård and Berge, 2010

) The demand-side challenge seems to imply, in fact that the industry as a whole needs to address the challenge.

An aspect of corruption is whistleblowing or other acts of disclosing of alleged wrongdoings. Oladinrin et al. (2017) analysed whistleblowing in the Construction Organizations, finding that employees often kept silent about misconducts. (Yang et al.) examined the use of Structural Health Monitoring technologies in order to mitigate corruption in the construction industry.

Summary

Within the topic of “Organisation”, several sub-categories of criminal activities are found. Papers on corruption, un-reported and underreported work, and other tax-evasion strategies form the main part. As a whole, these themes are more extensively researched than the other categories covered in this paper.

Health, Safety and Environment (HSE)

Hämäläinen (2009) analyses the interrelation of irregular work and underreporting of dangerous work conditions in general and accidents in particular. A particular challenge is found on the subject of unskilled migrant workers, especially working outside the regulated work environment. The accidents happening to these are found not always to be included in official occupational accident records. Millward (2016) discuss the treatment of migrant construction workers in World Cup 2022 infrastructure projects in Qatar. The paper states that a large numbers of the visiting migrant construction workers were recorded as injured or killed through incidents related to their work.

A study from Sweden (Doos et al., 1994) maintained that immigrant workers cannot be found to be more exposed to occupational accidents than Swedish nationals: *“In fact, most of the comparisons showed a higher accident frequency among workers of Swedish nationality, although statistically significant differences between groups were obtained in only a few cases. There was, however, a higher accident frequency for young and less experienced*

foreign citizens than for young Swedish nationals.”. Orrenius and Zavodny (2009) however, arrive at the opposite conclusion: *“The results indicate that immigrants are in fact more likely to work in risky jobs than U.S.-born workers, partly due to differences in average characteristics, such as immigrants’ lower English-language ability and educational attainment.* Díaz Fuentes et al. (2016) found that most employees in the construction industry in New Orleans did not provide safety equipment, health insurance and threatened to dismiss Latino immigrant workers that asked for it. Marin et al. (2015) have studied the safety climate of Hispanic construction workers, finding that this group experienced a poor safety climate. Teran et al. (2015) mainly address the topic of fall prevention measures among Latino workers, but the results shows that economic conditions, coupled with a lack of enforcement and vulnerabilities of the foreign-born workforce, are principal contributors to risk for falls. Another study addressing an issue within the periphery of HSE-related crime is Fardhosseini and Esmaeili (2016) who studied substance abuse on construction worker safety.

The lack of research in the area of HSE is surprising considering that the research by CIOB (2009) indicated that it is one of the most recognised effects of criminal activities in the UK construction industry, behind theft, was health and safety neglect. Ivensky (2015) provides a review of safety-related legal and regulatory framework regarding the statutory duty of safety care to subcontractors. The author states that more clarity on the subject is needed in order to create safer construction sites.

Other

Within the category "Other" are publications that do not fit under the three main topics of "Organization", "Materials" and "HSE". Eleven out of 23 results in "Other" are publications from Europol and deal with crime in general or crime development, as seen in table 1. A summary of the results is shown in Table 1.

Table 1 - Results in the category "Other"

Author	Year	Title
Europol	2015	Major Europe-wide VAT fraud network busted with the support of Europol and Eurojust
Europol	2015	Massive changes in the criminal landscape
Europol	2014	Organised crime networks/networks targeted in huge law enforcement operation in Europe
Zabkar and Malesic (2014)	2014	Non-military threats to the Security of the Mediterranean
Europol (2013a)	2013	EU drug markets report: A strategic analysis
Europol (2013b)	2013	SOCTA 2013 EU Serious And Organised Crime Threat Assessment
Europol (2012)	2012	Camden asset recovery inter-agency network (carin) leaflet
Europol (2011b)	2011	Global Agenda Council on Organized Crime
Europol (2011c)	2011	OCTA 2011: EU organised crime threat assessment
Putniņš and Sauka (2011)	2011	Size and determinants of shadow economies in the Baltic States
Sheehan (2010)	2010	Globalization: Conundrums and Paradoxes for Civil Engineering
Mills et al. (2009)	2009	Defect Costs in Residential Construction
Barth and Cappelen (2008)	2008	Norms and tax evasion
Europol (2008)	2008	OCTA 2008: EU organised crime threat assessment
Hughes (2007)	2007	CME 25 Conference Construction Management and Economics
Europol (2005)	2005	European Union organised crime report 2005
Europol (2004)	2004	European Union organised crime report 2004
Xue (2004)	2004	China-EU trade relations : The period after 1975
Feld and Schneider (2010)	2010	Survey on the shadow economy and undeclared earnings in OECD countries
Calvani et al. (2008)	2008	Illicit traffic: The invisible hand
Kruisbergen et al. (2015)	2015	Profitability, Power, or Proximity? Organized Crime Offenders Investing Their Money in Legal Economy
Williams and Horodnic (2015a)	2015	Are marginalised populations more likely to engage in undeclared work in the nordic countries?
Dobovšek and Slak (2015)	2015	Old horizons of organised-white collar crime: Critical remarks about the current definition,

As shown in table 1, varieties of different topics are represented in the “other” category. The represented papers did not fit well into an individual category and papers equally fitted to all. While several of these publications do not address the construction industry specifically, they provide insight and statistic to the topic of industry-related crime.

Conclusion

The research presented in this paper indicates that research in the area of “crime in the AEC-industry” has recently started gathering ground. The findings suggest, however, that there still is a long way to go in order to thoroughly address the issues related to crime in the AEC-industry. The structure of the AEC industry creates an environment that makes it susceptible to various criminal activities. As such, the construction industry faces many challenges.

The amount of research that has been carried out varies for the different types of crime in the construction industry. Sub-themes such as illegal immigration and undeclared work are well covered from various sides. An important point has been raised about informal and formal work, which has been considered to this date as separate, is actually blended together well. Workers receive both formal and informal wages. Employment crime is, in other words, organised and complex. False materials has researched far less attention, despite that it is obvious that actors at a senior level are aware of the problem. Nevertheless, many people working within the industry on a daily basis do not realize this. What is quite concerning though, is that despite being recognised as one of the ‘hot spots’ of crimes in construction, HSE neglect is the least researched topic identified by this study.

To address the third research question, namely, what are the most important gaps in the research on crime in the AEC-industry, this study has shown that two important gaps exist in the literature related to materials (particular counterfeit materials) and HSE. Illegal and undeclared work threatens serious players, and the industry is not spared from the dangers of counterfeit materials and issues relating to HSE.

A global trend of national borders effectively being dissolved in relation to trade, movement and employment may potentially lead to an increase in the research conducted on or boarding to issues covered in this study. Brante (2011) coined engineering as the 'failed' profession based on its lack of organisation associated with the category of professions, particularly when compared to professions such as physicians. Thus, if engineering is to continue to uphold its status as one of the classic professions, perhaps a stronger focus on its special responsibility to the common good, while also maintaining a high degree of ethics could be an area to concentrate on.

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Artikkel II: Perceived consequences of counterfeit, fraudulent and sub-standard construction materials



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PERCEIVED CONSEQUENCES OF COUNTERFEIT, FRAUDULENT AND SUB-STANDARD CONSTRUCTION MATERIALS

Atle Engebø^{a*}, Nina Kjesbu^a, Ola Lædre^a and Jardar Lohne^a

^aNorwegian University of Science and technology, Department of civil and environmental engineering, Høgskoleringen 7A N-7491 Trondheim, Norway

Abstract

The quality and suitability of construction materials has a significant impact on critical parameters such as time, cost, and quality in a construction project. Counterfeit, fraudulent and sub-standard (hereafter; CFSS) construction materials is a relatively unknown aspect in the literature. CFSS could potentially affect the degree of project success for both the client and the contractor. This research aims to answer the following research questions: What are the consequences of CFSS materials for the industry? What are the consequences of CFSS materials for the construction process? What are the consequences of CFSS materials for the final material? The research methods consist of a literature review and primary data was collected from the use of 13 in-depth interviews with key personnel from the client, contractor and supplier side of the Norwegian AEC-industry. The study is limited to the Norwegian AEC-industry. The research shows that CFSS-materials affects time, cost and quality in both the construction process and the final product. The use of CFSS-materials could provide “positive” consequences as competitive advantages for the contractor, but not without seriously risking negative consequences as loss of reputation, legal sanctions and/or extra costs. Consequences for the client can – if lucky – be none. If unlucky, the consequences can be higher operational costs or – if really “unlucky” – total structural collapse. The AEC-industry should be aware of false materials, and this paper contributes to exploring a relatively unexplored field within supply chain management in construction projects.

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* Atle Engebø. Tel.: +4790571902

E-mail address: atle.engebø@ntnu.no

1. Introduction

This paper presents an analysis of the perceived consequences of counterfeit, fraudulent and substandard (CFSS) materials in the Norwegian Construction Industry. The construction process is complex and includes a large number of different actors. Construction projects are known to have a potential downside that is larger than the upside (i.e. profit margins). Problems may occur when the strive for profit is combined with information asymmetry, giving rise to opportunistic behaviour [1]. In order to ensure profits, the actors may try to reduce costs by using CFSS materials. Therefore, CFSS materials constitute a threat to products, processes and the whole AEC-industry. According to Bloch and Bush [2], the phenomena can be understood in two dimensions, represented by the supply and the demand side. The supply side focuses on anti-counterfeiting activities and measures to mitigate the threat. The demand side focuses on why and how the phenomena is spreading and why consumers buy counterfeited products.

The Organisation for Economic Co-operation and Development (OECD) states that counterfeiting and piracy are economically driven. Demanders are individual consumers as well as firms that use the products as a transitional component in their production process [3]. Similarly to the view of Bloch and Bush [2], they divide the phenomena into demand- and supply drivers. Demand drivers are the features of the product, the consumer and the institutional environment in which demanders navigate. Supply drivers are market characteristics, technological and logistical considerations and the institutional environment [4]. The OECD stated that in 2013 counterfeit and pirated products accounted for as much as \$461 Billion in world trade [3], a large increase since their previous report that estimated \$200 Billion in the 2008 [4]. In 2015, the European Custom authorities made over 81.000 detentions (cases) valued at 640 million Euros [5]. The report also provided data on countries of origin, showing that the main source for false materials was China. In 2016, US Homeland Security reported 31560 cases of intellectual property rights (hereafter; IPR), an increase of 9 percent since 2015. The report estimated seized goods to be worth \$1.4 billion [6].

According to Gou and Liu [7], materials represent a substantial part of the total value in construction projects. An important aspect of construction projects is supply chain management and procurement of materials. The process of procuring is mainly concentrated on two aspects: 1) supplier selection and 2) procurement cost optimization [7]. If not proper materials are delivered, the entire construction chain is unstable, so CFSS materials provide a threat to productivity in construction projects. Koskela [8] describes waste as a non-value adding activity. Non-value adding activities such as inspections and control could be necessary, while activities as corrections, waiting and stop in production are categorized as unnecessary. To sum up; the use of counterfeit, fraudulent and sub-standard materials does exist in the construction industry. It is difficult to measure the extent, and the consequences seem to be somewhat unexplored. What is certain is that the consequences for the AEC-industry, the construction process and the final products are not beneficial. Therefore, this research aims to answer the following research questions: 1) what are the consequences of CFSS materials for the industry? 2) What are the consequences of CFSS materials for the construction process? 3) What are the consequences of CFSS materials for the final product?

The study is limited to an investigation of the perception of potential consequences among key industry actors within the Norwegian AEC-industry. The analysis does not include an investigation of cases of CFSS or an objective assessment of the extent of CFSS materials within the industry. Thus, it does not seek to provide any form of 'complete' list of consequences. The essence is to contribute to the pool of knowledge regarding potential threats to the construction supply chain (CSC) and to increase awareness among industry actors. Further work needs to be done to address the magnitude and possible mitigating strategies.

2. Methodology

The topic of CFSS materials seems not to be thoroughly investigated in the context of the construction industry. Therefore, in accordance to the prescription of Blumberg [9], an exploratory research methodology was chosen. This research on consequences is a follow-up on previous research conducted on the phenomena in Norway. This research started in 2014 with an extensive literature search, followed up with a pilot-survey regarding different aspects of counterfeiting. The survey was modelled after a survey carried out by CII [10]. Further, research on the existence of the phenomena was conducted in the first quarter of 2016. This research materialized as a research paper published in the summer of 2016 [11].

The methodology for the research presented in this paper consisted of two phases: a literature-review and data-collection. The first step was a critical review of existing literature according to the prescription of Blumberg [9]. The review exposed the limited pool of research that existed on CFSS materials within the construction industry. Because of the scarcity of literature, the review included research not directly related to the construction industry. Thus, to identify real consequences from the use of CFSS materials, the review was supplemented with a search on

news articles covering emerged CFSS cases. Furthermore, the scarcity validates the use of an explorative research design. A qualitative research method was implemented to understand the nature of CFSS materials and their possible effect on the industry and its actors. The use of semi-structured in-depth interviews was considered a convenient tool for providing reliable research data. This approach offered some advantages. First, interviews with industry experts provided some valuable data that would otherwise be hard to collect. The pilot-survey highlighted the lack of knowledge regarding the subject and therefore the need for a qualitative methodology mining data from a knowledge- and experience based source-pool. The use of semi-structured interviews was considered applicable with the research subject, which could be difficult to assess with the use of more structured forms of interviews [12].

Between 2016-2017, thirteen interviews were conducted (10 by the main author, 3 by the second author) according to the prescription to Yin [13]. The interviewees consisted of a variety of experts drawn from different actors in the Norwegian AEC-industry. Therefore, the data stems from public clients, contractors, law-enforcers, industry-organisations, certification-organisations and suppliers. The interviewees were chosen on basis of their experience and knowledge about the research subject. A challenge regarding data collected from a relatively small sample of the industry as a total is the difficulty to generalize the findings. Thus, the purpose of the study is not to generalize, but to provide insight into the phenomena and its potential consequences. As a tool for setting a framework for the interviews, an interview-guide based on the research questions was developed. Since the interviews were part of a larger research project, the interview-guide was designed to gather data on a variety of aspects regarding the research subject. All of the interviews were taped, transcribed and a summary was sent to the interviewees for acceptance. The transcripts from the interviews were analysed by first organizing the raw-data into conceptual categories: existence, specific cases, consequences, mitigating strategies etc. For the purpose of this study, all data that referred to consequences was extracted into its own category and from there further analysed.

3. Theoretical framework

Different terminology concerning CFSS materials is used within both academia as well as the industry. McDonald and Roberts [14] proposed an explanation by addressing the difficulty of aligning one unison definition of the concept of product piracy. They state that an investigation of the phenomena would reveal several categories of interrelated phenomena such as piracy, counterfeiting, look-alikes, sound-alikes, knock-off brands among others. In order to address this, Bloch and Bush [2] chose to define product counterfeiting as the unauthorized copying of trademarked or copyrighted goods that harms legitimate producers through lost sales. Grossman and Shapiro [15] divided the market for counterfeit products into two types. In the first, consumers cannot readily observe the quality or distinguish copies from authentic products. This they define as deceptive counterfeiting. In the second, consumers know or suspect that they purchase counterfeit products. This they define as none deceptive counterfeiting. Regarding the reasons for consumers to knowingly buy counterfeits, Grossman and Shapiro [15] explains that such purchases often are a trade-off between price, quality and risk. Nill and Schultz [16] addressed the non-deceptive side of counterfeiting and linked it to ethical decision making. The process of buying counterfeit products might give the buyer some sort of advantage, but be harmful to the legitimate operators in the market. Berman [17] classified counterfeit products into four categories: “knockoff” products, reverse engineered copies of genuine products, products produced by outsourced suppliers without permission from the original manufacturer and products produced by outsourced suppliers that do not meet the needed requirements without noticing the original manufacturer. As for construction materials, all categories could apply, but “knockoffs” might seem less likely (at least for products related to the constructive part of the project).

The literature has identified several consequences stemming from different types of product piracy. The business- and marketing literature has emphasised on the damage of reputation in addition to the more immediate economic consequences. Nill and Schultz [16] addressed the potential long-term negative effects on society because of the negative effect on technology development. Their idea was that a society that tolerates piracy created negative incentives towards innovation and product development. Infringement of IPR equally have economic consequences. Feinberg and Rousslang [18] worked out an estimate of losses for legitimate US companies due to infringement of intellectual property rights. The study concluded that the profit losses were significant compared to total profit and that the losses were larger than the profit gained by the infringers.

The problem of counterfeit materials is not a new one; during the eighties, a variety of American industries experienced cases of CFSS fasteners. This led to the Fastener Quality Act, signed by then-President Bush in 1990. The Act, a public law that demanded industrial fasteners to be stamped and tested by an accredited laboratory, was in fact a direct result of an investigation regarding counterfeited fasteners [19]. The report stated that counterfeit

fasteners had killed people, reduced defence readiness (counterfeit fasteners were found in US aircraft carriers, Nuclear Submarines and M-60 Tanks) and cost both taxpayers and the American industry millions of dollars [19]. As for the construction industry, Raymond and Jiayi [20] found that non-structural items were identified by the industry to be prone to counterfeiting, especially steel products. The reasons seemed to be two-folded; the first reason was perceived to be the low cost of non-constructive materials, and the second was the long incubation period during which no problem are discovered.

In the media, several cases of CFSS materials were identified. Securing Industry, an information service covering issues surrounding supply chain and brand security reported in 2015 of cases of counterfeited 1500-tonne Terex boom crawler cranes that are sold by the counterfeit manufacturers in the second-hand market [21]. Another case considered Chinese-made drywall [22]. The drywall was alleged to have high levels of sulphur, which corrode piping and cause electric failures as well as alleged health problems. Based on shipping records, estimations indicated that the imported drywall could produce at least 50.000 homes. A case from 2015 demonstrates the potential consequences for the construction process when several construction sites in Minneapolis, where tests showed that the wood materials used was not fire compliant [23]. The investigator stated that the stamps displayed (on the material) were either fraudulent or counterfeit. The result from the investigation led the client to fire the responsible contractor although the contractors claimed that the use of the CFSS materials was unintentional [24]. In 2016, an Architectural Firm pleaded guilty and had to pay \$3 million in fines because of improper use of foreign construction materials. The firm allegedly repacked materials and falsified the documentation so the materials came off as “made in America” [25]. The attention to the problem is not restricted to the US, in Dubai a fire safety expert working at a regulatory level claims that in the period 2004-2014 around 12 percent of contractors and subcontractors were involved in the use of CFSS materials [26]. The contractors seem to list approved products, but later substitutes the approved materials with cheaper and inferior materials. Another expert cited claimed that such practice is necessary in order to fix budget constraints and that such practice could save a contractor millions on very large projects. The worst possible consequence for the construction industry is the possibility of structural failure. A recent case highlighted this reality when a multi-storey building in Kanpur collapsed and killed three people [27]. According to the officials, the building collapsed under its own weight and the cause was indicated to be substandard construction materials.

Studies on consequences of counterfeiting poses some challenges. According to Bosworth [28], measurement is at the heart of the problem. In order to obtain understanding of the scale, nature and consequences, different measures have to be done. The problem is that the characteristics of the phenomena makes it hard to measure. This study adopted a broad definition of the phenomena that includes materials that are considered counterfeit, fraudulent or substandard. On basis of the above, this study identify perceived consequences at industry-, process- and product level.

4. Findings and discussion

The interviewees were especially eager to reflect on the variety of threats, opportunities and consequences the phenomena of CFSS materials posed on the industry-, process- and product level. Table 1 shows a selection of representative quotes highlighting a variety of consequences. The research data was rich; thus, a representation of the data is hereby presented as the matrix below. It does not present a full list of consequences, but a representation of what industry-experts within the Norwegian industry perceive to be real- and potential consequences.

Table 1: A selection of representative quotes

Consequences	Representative quote Industry	Actor
Absence of consequences	“Today, with cases of products with lacking documentation, consequences are as good as none.”	Contractor
Absence of consequences	“In some cases, the contractor gets permission to document afterward [materials], which you really are not allowed to, because the consequences are so great. I think that materials that are not properly document is very risky for Norwegian project, especially in terms of construction safety.”	Contractor
Lack of legal enforcement	“The legal framework is good. Enforcement by authorities and governments have been blunt”	Contractor
Lack of legal enforcement	“There is little enforcement from the authorities. This provides incentives to engage in forgery. I have led a 14 billion NOK project and we have purchased products for billions, but I have never seen an inspector.”	Client

Danger to environment and health	“...the pollutants going astray end up in the food chain and thus have an impact on life and health. It is not the case that it will have any major impact if you encounter construction materials containing hazardous substances. However, if these go astray or exposes to exhaust or the like, it could have consequences. These are not consequences that you discover.”	Client
Reputation	“Major actors can handle economic consequences, but cannot tolerate so-called ethical consequences, which could cause an enormous loss in reputation.”	Contractor
Affecting the level of trust	“In general, I think it affects the level of confidence in the market. If you are constantly afraid of getting products that do not meet the requirement, we lose a bit of confidence in the market”	Contractor
Ability to deny access to projects	“The burden of proof needed to deny a contractor or supplier to get into the next project is large. In other words, it requires a lot of work from our side if such cases should have real consequence.”	Client
Confusing framework for documentation	“A problem is that one does not quite know what to ask for [documentation] and whether you actually control the documentation submitted. There is some confusion about what documentation you should ask for and what the documentation actually says.”	Contractor
Unfair advantages	“Another consequence is that the legitimate actors are overthrown by dishonest actors. One becomes uncompetitive on price and lose tenders. It must sting more economically for those involved. When the risk of getting caught is so small, the temptation could be too great for some.”	Contractor
Lacking incentives to follow-up cases	“The best would be if unfair actors were punished, but it takes a lot. It is unlikely that a client will take the fight; it is easier to say no to the specific product. The client does not pursue the manufacturer, contractor or supplier.”	Client
Prosecution	“...prosecution is first relevant if you have a real consequence as the building collapse or the like.”	Client
Economic or legal sanctions	“...if we bump into these cases, we must exert sanctions such as turnover stop, fines or similar.”	Governing body
Process		
Stopped at handover	“For a contractor, the consequences might be to not receive an acceptance at handover, or getting stops in the work until the case is resolved with the necessary documentation.”	Industry-body
Rework	“If fake materials are discovered, they must be replaced. Total costs increased by the need to correct the error and take longer, potential fines or similar.”	Governing body
Resupply	“From project to project, the consequence will be a legal or financial settlement unless customer and supplier agree on certain measures.”	Contractor
Uncertain responsibility	“In the cases, which I know of, it was discovered before products were adopted. The owner gets a problem. You get a case where it is uncertain whether it is the actual material or assembling that was the problem. The manufacturer blames the carpenter and vice versa.”	Industry-body
Asymmetric risk	“For us as a contractor, the guarantees stipulated in the contracts do not cover such losses. Small companies have the opportunity to turn bankrupt and start up the next day under different name.”	Contractor
Product		
Increase in maintenance	“The client will then experience an economic impact because the constructions durability is not as long as planned, and because maintenance increases.”	Contractor
Increase in maintenance	“Basically, the client gets a building that is not in accordance with Norwegian regulations and could therefore experience higher costs of operation and maintenance. Regarding the quality, it can go on past need for improvements, repairs etc.”	Industry-body
Influences trust between actors	“The fact that customers can trust that the contractor delivers a durable product is important. It is not good if the client has to start with repairs and improvements without being able to complaint back to the contractor.”	Contractor
Compensation	“We have examples where we had to pay compensation because the product did not satisfy Norwegian requirements, which in second order affects the projected lifespan of the building.”	Contractor
Insurance problem	“The client may experience cases where the insurance not cover the use of materials not in according with regulations.”	Industry-body
Inadequate warranty	“A paradox is the warranty period is 5 years, if the client has something to complain about after six years, the contractor have no responsibility.”	Industry-body
Unknown properties	“You do not know the properties when the product is not tested or documented. You do not know fire properties, strength, environmental characteristics, whether it is dangerous hazardous substances etc.”	Industry-body

The findings propose some insight into the consequences for the industry. First, the CFSS-phenomena are strictly associated to economic performance. The economic output is the basis for the existence, which means actors experiences benefits. The discussion on economic benefits dominate the literature. The business literature addresses ethical decision-making, but few studies examine ethical decision-making within the construction industry. A recent study of the ethical behaviour in the design-phase examined the fuzzy line between lawful, but unethical behaviour [29]. The process of acquiring and using materials without validating its legitimacy may be categorised as unethical behaviour. The findings highlighted a variety of consequences on industry-, process- and product level. The following section discusses some of the most prominent consequences extracted from the research data.

5.1 *What are the consequences for the industry?*

The most prominent consequences for the industry is, according to the interviewees, the absence of consequences. The lack of specific cases and absence of attention from the media supports the view of the interviewees. The extensive process of moving from identifying CFSS-materials to impose action partly explain this. The discovery of materials that do not comply with quality, contract or jurisdiction are often categorised as honest mistakes. Thus leads to either the client to grant an exception from the contract or a demand resupply. Still, cases with severe consequences, as structural failure have fatal consequences for the responsible actor(s) as well as for the surroundings. Tough competition and relatively small profit margins consolidates the reality of the industry. The competitions for contracts happens in every stage of the supply chain: between manufacturers, suppliers, subcontractors to main contractors. In this context, the lowest-bid criteria often triumph. Regardless of intention, buying, providing or receiving materials to a lower market price than competitors creates opportunities. Thus creating favourable market-conditions for actors willing to compromise the legal- and ethical framework constituting the market. Actors willing to take the risk of procuring or providing CFSS-materials might earn larger profit margins and at the same time outperform legitimate actors.

The phenomena of CFSS-materials may affect the industry in regards of reputation as well as the level of trust between actors, and between law enforcers and the actors. Some interviewees mentioned the importance of clarifying the intentions of the buyer in cases of CFSS-materials. As stated in the literature, purchasing could be either deliberately or not-deliberately. On the supply-side, the presentation of materials is either deceptive or non-deceptive. Emerging cases related to CFSS-materials could force both the government and the different actors to apply different measures in order to mitigate the problem and thus altering the relation of trust within the industry.

One aspect identified was the consequences for the environment. A characteristic of CFSS-materials is the uncertainty of its qualities. The documentation and certification could be falsified which increases the possibility that the material contain inferior or even hazardous substances. This aspect could pose a threat to users and the environment, both during the lifespan of the construction as well as after demolition. Another aspect identified was the lack of incentives to report. The contractor representatives emphasised on the limitations of liability in the contracts between the supplier and the contractor. The supplier is responsible for the specific materials provided, while the contractor is responsible for the construction consisting of a variety of materials. In cases where specific materials do not correspond, the contractor have the right to demand compensation for the specific material, but has to cover the additional costs himself. This creates both ethical and legal challenges for the actors.

5.2 *What are the consequences for the construction process?*

CFSS materials provide an extra strain on the construction supply-chain. Where cases has emerged, the client might have to impose stricter control, which affecting the other actors involved. Increased control are according to LC-literature categorized as wasteful activities that have negative impact on productivity, cost, time and management [8]. Another highlighted aspect was the fact that the client had few incentives to pursue cases discovered during the construction. The interviewee explained that the process of gathering enough evidence to make a legal case was rather time- and resource consuming. Further, she mentioned the negative effect legal actions could pose on the construction process. Consequently, the common practice was to agree on a resupply-settlement or in cases where the materials was proven to be of sufficient quality, just to settle on an exception granting.

According to the interviewees, cases where materials in do not cohere with requirements or expectations are seen as ‘honest’ mistakes. Therefore, the most common consequence seemed to be the potentiality of doing rework. The second-order effect is, as with increased need for inspections, that rework greatly affects time and cost in the project. Whether the materials are assembled or still in their packaging, the contractor may want to demand resupply of new materials from the supplier. The standard contracts used between the supplier and the contractor are, as described by an interviewee, characterized by and asymmetric distribution of responsibilities. Thus, the contractor could find it challenging to make the supplier responsible for the costs of extensive rework. The worst-case scenario perceived is when the supplier turns bankrupt and the contractor does not get neither resupply nor compensation for the rework.

5.3 *What are the consequences for the final product?*

The worst possible consequence for a construction is structural failure. The risk for such an incident happening was perceived to be minimal and to be something that happened in third-world countries. The claim that such incidents happens top As mentioned in chapter 3 structural failure of a multi-storey building in Kanpur, due to substandard construction materials, cost the lives of three [27]. Similar cases from the western hemisphere were not possible to

identify, but the theoretical risk is still present and should therefore be accounted for.

The majority of the interviewees identified the extra need for maintenance and repairs during the constructions lifetime as probable consequences. A key problem with deceptive CFSS-materials is that they are not easily discovered. In order to discover these, you first need routines for control and second, the responsible instance has to know what to look for. This is especially true for cases where the provided materials are of good enough quality i.e. it seems to match both contract and the general requirements in official legislation. However, the occurrence of errors and defaults caused by fraudulent construction materials will often emerge after handover. The characteristic nature of the phenomena, the fact that the real properties of the materials are unknown supports this assertion. Lower quality affects the durability of the building and deviation in durability emerges after time. Trust between actors was also a major concern for the interviewees. The client expects a product with the properties described in the contract. All deviation from either contractual properties or actual performance affect the value of the product. Both client- and contractor representatives emphasises the importance for the contractor to deliver a durable product. However, all cases where the client experiences negative deviation in quality and durability affect the level of trust.

The last identified area was economic consequences for the contractor and supplier if CFSS-materials were to be discovered after handover. In such circumstances, the client could force the responsible actor to pay compensations. In severe cases, the client could file charges and take the case to court. Regardless of the possibility of compensation, the findings suggest that the client often draw the shortest straw. The interviewees that brought up the warranty period exemplified this. The client could have a problem making the contractor accountable after the warranty had expired. Another problem is the burden of proof needed to make the contractor accountable. The process of proving an increase in maintenance due to CFSS materials will typically prove to be tiresome. For instance, the supplier could blame the assembling-process while the contractor blames the specific material used.

5. Conclusion

This paper presents perceived consequences of counterfeit, fraudulent and sub-standard materials at industry, process and product level. Emerging cases involving CFSS-materials pose threats to all actors involved and the impacts goes beyond just the construction supply chain. Table 2 summarises the most prominent consequences identified by industry experts from the Norwegian construction industry.

Table 2: Prominent consequences

Level	Prominent consequences
Industry	Absence of real consequences & low risk, environment & health concerns, reputation & trustworthiness and unfair advantages
Process	Stopped at handover, rework & resupply, compensations and increased need for control and inspections.
Product	Increased need for maintenance & repairs, influences trust between actors, compensation and insurance & warranty problems

The bottom line is that if CFSS-materials exists, and official reports from both the EU, the USA and the OECD indicate that the construction industry should be aware that actors have infiltrated the supply chain with CFSS-materials. However, even though it is widely accepted that CFSS materials exist, it seems like neither the industry and nor the Norwegian government have applied appropriate tools for uncovering and avoiding it. If nothing happens, the consequences of CFSS materials will probably increase.

6.1 What are the consequences for the industry?

Today, it seems that real consequences to some degree are absent. Cases are considered forgivable, and thereafter handled internally between actors trying to avoid negative attention. Still, at some point, the industry could potentially experience changes in the level of trust between the different actors. As cases of CFSS-materials emerge, countermeasures are initiated. Such measures could be increase in control and enforcement, as well as stricter regulations. Further, it may well occur both between governing bodies and the private actors, as well as internally between the actors. As stated by the literature and validated by the interviewees, the providing and use of CFSS-materials give unfair advantages for the involved actors. Thus, it increases the strain on legitimate actors.

6.2 What are the consequences for the construction process?

CFSS-materials pose a direct threat to the construction supply-chain and may potentially have a devastating effect on the classic performance measurements (time-, cost- and quality). For the process productivity, the need for

rework, resupplies, increased need for control-routines and inspections are all wasteful activities.

6.3 What are the consequences for the final product?

The real value of the building relates to its physical properties. Consequences like needs for maintenance and repair beyond normal expectations may emerge over time. Thereafter the owner need to gather proof that the variance is caused by the specific materials. The following process might prove to be challenging. The supplier blames the assembler and vice versa, the insurance does not cover CFSS-materials or the building warranty are expired.

6.4 Further work

The insight into potential consequences for the industry, the construction process and the delivered product may serve as a basis for further research and development of countermeasures. For example, table 1 does not represent an exhaustive list of consequences. However, it implies a need for appropriate tools for uncovering and avoiding CFSS-materials to enter the construction supply chain. The research on counterfeit, fraudulent and sub-standard materials lacks validation from empirical evidence when it comes to the real magnitude of the problem.

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Artikkel III: Counterfeit, fraudulent and sub-standard materials: The case of steel in Norway

COUNTERFEIT, FRAUDULENT AND SUB-STANDARD MATERIALS: THE CASE OF STEEL IN NORWAY

Nina Eklo Kjesbu¹, Atle Engebø², Ola Lædre³ and Jardar Lohne⁴

Abstract: The international construction industry is subject to several types of crime. Among the least researched is the exposure to counterfeited, fraudulent and sub-standard (CFS) materials. The study presented in this paper examines the presence of these materials in the Norwegian construction industry and the characteristics of the construction industry that render it vulnerable. A survey was sent out to different stakeholders within the industry, collecting experiences and knowledge about these types of materials. More than half of the respondents (9 of 17) stated that they pose a threat to the industry to a high or very high degree. To investigate the presence of these steel products, 3 semi-structured in-depth interviews were conducted with key actors. The data shows the occurrence of these materials in the industry. The interviewees all believed that CFS steel products exist in the Norwegian construction industry, and examples were given of the occurrence of it. The interviewees believed that the industry is vulnerable to this threat because it is easily accessible for temporary and dishonest actors, and it has a high degree of trust combined with a certain lack of controls. Further work can result in recommendations for possible countermeasures.

Keywords: materials, steel, construction industry safety, quality assurance, supply chain management

1 INTRODUCTION

Bertelsen and Koskela (2002) conceptualize production from three views: transformation, flow and value generation (TFV), with the crucial contribution from the theory being "its attention to modelling, designing, controlling and improving production from all these three points of view". Counterfeit, fraudulent or sub-standard (CFS) products threaten the whole production process, undermining all three elements alike. According to Howell (1999), some of the essential features of lean construction are to optimize the delivery process, maximizing performance for the customer at the project level, design of product and process, and the application of production control throughout the life of the product from design to delivery. Engebø et al. (2016) points out that counterfeit materials can threaten lean delivery of projects, and uses assorted steel products as an example. The

¹ MSc Student, Department of Civil and Environmental Engineering, NTNU- Norwegian University of Science and Technology, Trondheim, Norway. nkjesbu@gmail.com +4799582750

² Research Assistant, Department of Civil and Environmental Engineering, NTNU – Norwegian University of Science and Technology, Trondheim, Norway. atle.engebo@ntnu.no

³ Associate Professor, Department of Civil and Environmental Engineering, NTNU – Norwegian University of Science and Technology, Trondheim, Norway. ola.ladre@ntnu.no

⁴ Research Scientist, Department of Civil and Environmental Engineering, NTNU – Norwegian University of Science and Technology/Klima 2050, Trondheim, Norway. jardar.lohne@ntnu.no

essential features of counterfeit, sub-standard or fraudulent (CFS) steel products in Norway are though not fully explored. Equally, in the international research literature, little can be found concerning such products. Simultaneously, there are examples of both unethical and unlawful conduct in the Norwegian construction industry (Lohne et al., 2017). Therefore, this article will examine the presence of CFS steel products in the Norwegian construction industry. The research questions addressed are the following:

- 1) Do CFS steel products exist in the Norwegian construction industry?
- 2) Which key characteristics of the construction industry make it especially vulnerable to these materials?

Because steel products are under an extensive control regime, it is here defined that a breach with the CE marking (compulsory for steel construction products), implies that a product can be CFS. Because of that, the CE regime and the legislations around steel products are investigated in this article. The analysis is limited to load-bearing steel products.

2 METHODOLOGY

In order to investigate the research questions, a literature review related to steel, certificates and laws in the construction industry, a survey on CFS materials, and three semi-structured interviews were carried out. Additionally, a literature review on the characteristics of the construction industry was conducted.

After the literature review on characteristics – limited to research articles on the construction industry – a survey was conducted with different stakeholders in the industry. The survey questions were based on interviews previously done by the Construction Industry Institute (CII) (Minchin et al. 2014). The questions specifically targeted routines for quality control, and experiences with “fake materials”, which in this case was used to describe CFS materials. Although the survey did not specifically target steel, it provided valuable information about the phenomena in general. The survey was done as an online questionnaire, and was sent out to stakeholders in the industry in two rounds. In the first round, 33 possible respondents were contacted. In the second round, it was sent to 44 new possible respondents. In both rounds, the stakeholders who did not respond during the first week received a reminder. In total, 20 respondents answered the survey.

Three semi-structured interviews with senior professionals within the Norwegian industry (producer, purchaser and non-governmental certification parties) were carried out to supplement the findings in the survey. A common interview guide was developed and sent to the interviewees before the interviews. In addition to the questions listed in the interview guide, follow up questions were asked and other subjects were discussed when initiated by the interviewees, just as suggested by Yin (2013). The interviews were conducted at the offices of the interviewees, and the conversations were taped using a voice recorder application. Afterwards, the interviewees were allowed to read through the respective transcripts and comment any misunderstandings. Because of the nature of the topic researched, the interviewees have been anonymised in this article.

3 THEORETICAL FRAMEWORK

3.1 Counterfeit, fraudulent and sub-standard materials (CFS)

The following sub-chapter investigates some laws and regulations relevant to construction materials. It is essential to investigate this because of the definition of CFS

materials previously given. Koskela (1992) investigates the 11 important principles for flow process design and improvement. One of these principles is reducing variability, something that is highly related to material quality.

Actors within the Norwegian construction industry are bound to follow the “Regulation on the documentation of construction products” (In Norwegian: Forskrift om dokumentasjon av byggevarer, hereafter called DOK) (Norwegian Building Authority undated3) DOK includes regulations and rules about the documentation of products for use in the construction industry. DOK states that “CE-marking applies to those construction products where there exists a harmonised standard, or where the producer has chosen to have made a European technical assessment of the product.” (Directorate for Building Quality, undated1). For manufactured steel constructions, the standard NS-EN 1090 is the harmonised standard that applies (Norwegian Steel Association, undated3) NS-EN 1090 consists of three parts, with two of them being relevant for steel products. Part one outlines the requirements for the conformity assessment, and part two provides the technical requirements for steel products.

A declaration of performance is obligatory for products covered by a harmonised standard (Directorate for Building Quality, 2016b). A declaration of performance describes the characteristics and use of the product (Directorate for Building Quality, 2016b). Further, there are ten different requirements that should be stated. Six of them are obligatory: tolerances on dimensions and shape, weldability, fracture toughness, the characteristics of the material when exposed to fire, hazardous elements and durability. In addition, the load bearing capacity, fatigue strength, resistance to fire and deformation should be declared (Directorate for Building Quality, undated2) (Norwegian Steel Association, 2016).

The municipality administration is responsible for issuing a certificate of completion before the building or construction can be used. In “Byggesaksforskriften (SAK10)”, The Directorate for Building Quality states that before the construction or building can be used, a certificate must be given. The municipality must issue the certificate within three weeks (Directorate for Building Quality, 2016a). If a building is proven to be using non CE-marked products, the municipality authorities could refuse to issue the certificate of completion until the material or component has been replaced (Norwegian Steel Association, undated1)

3.2 Characteristics of the construction industry

Ballard and Howell (1998) draw similarities between the construction industry and other manufacturing industries. They especially talk about three characteristics of the construction industry; temporality, uniqueness and on-site production. These characteristics are also investigated by Vrijhoef and Koskela (2005). They look at three fundamental characteristics, which they call site-production, temporary production organisation and one-of-a-kind product. The characteristics in table 1 are a summary of the characteristics found in the literature review. They also include characteristics mentioned by Thomassen (2004) and Dubois and Gadde (2012).

Kjesbu, N.E., Engebø, A., Lædre, O., and Lohne, J. (2017). “Counterfeit, fraudulent and sub-standard materials: The case of steel in Norway” In: *Proc. Lean & Computing in Construction Congress (LC³)*, Vol. 1 (CIB W78), Heraklion, Greece,

Table 1: Characteristics of the construction industry

Source	Characteristics
Dubois and Gadde (2012)	Focus on single project, local adjustment, utilization of standardised parts, competitive tendering, marked-based exchange, multiple roles
Thomassen (2004)	Fragmentation due to many small (and often subcontracting firms), separation of design and coordination from production, highly interdependent activities, poor communication and coordination, sector troubled by low quality, late delivery and overspending
Ballard and Howell (1998)	Temporality, uniqueness, on-site production
Vrijhoef and Koskela	Site-production, temporary production organisation, one-of-a-kind product

Although all of these characteristics seem applicable to the industry, three fundamental characteristics are standing out: temporality, uniqueness and on-site production. These will be emphasised on in this article.

To complement these characteristics, it is also useful to note one peculiarity of the Norwegian society itself. It tends to, in general, have a higher trust than other countries. The World Values Survey (2005-2008) has published data from different countries, including Norway, Germany, Spain and Turkey. Table 2 shows results from the question; “Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?”. (World Values Survey, 2005-2009) As can be observed, Norway stands out as a very high-trusting society.

Table 2: Data from The World Values Survey wave 5: 2005-2009 Question V23

	Norway (N=1,025)	Germany (N=2,064)	Spain (N=1,200)	Turkey (N=1,346)
Most people can be trusted	73.7 %	33.8 %	19.8 %	4.8 %
Need to be very careful	25.7 %	57.9 %	78.9 %	94.6 %

Lichtig (2006) discusses the “five big ideas” of lean project delivery. One of these is to increase relatedness among all project participants, which involves that participants must develop relationship between each other based on trust. The risk of CSF materials must be seen as a threat to a trusting relationship between actors.

4 RESULTS

4.1 Do counterfeit, fraudulent and sub-standard (CFS) steel products exist in the Norwegian construction industry?

Not much research on the occurrence of CFS materials in the Norwegian construction industry has been identified. The 2016 survey did, however, revealed such occurrence or perceived occurrence. As can be seen in figure 1, 53,0 % of the respondents (9 out of the

17 that responded to the question) believed that fake materials are a threat to the construction industry to a high or very high degree.

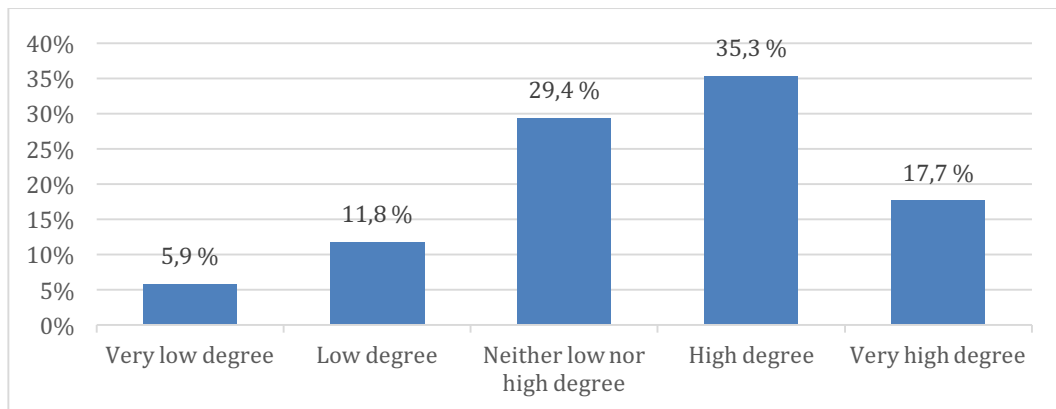


Figure 1 Q4: To what degree do you believe that fake materials are a threat to the construction industry?

Question nine was about the occurrence of such materials in the industry. Out of 17 responding, four people or 23,5 % answered yes to the question, as seen in figure 2.

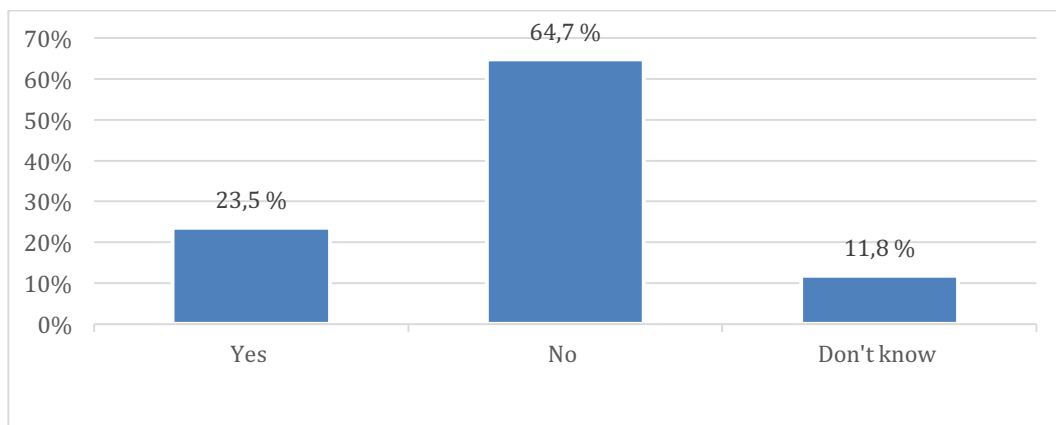


Figure 2 Q9: Have you heard (from what you consider to be credible sources) that someone was exposed to fake materials on a project you did not work on?

To uncover what kind of control functions the respondents of the survey used, they were asked about their quality control of materials. The responds indicated that although some had control procedures at reception, others had “as good as none”. The answers did not state the extensiveness of the control procedures, or whether it included inspections or just document control.

One of the questions addressed whether the respondents perceived that the problem with “fake materials” was increasing or decreasing. Out of the eight, three believed that the problem was increasing, three believed that it was neither increasing nor decreasing and the final two did not know. None of the respondents believed that the problem was decreasing. In the semi-structured interviews, the interviewees were asked about the occurrence of fake materials. One of the respondents had experience with sub-standard steel products delivered to them: *“I have one case where we (...) received a steel product that (...) we later received information (about) from the Directorate for Building Quality that the certificates that were attached to the item most likely were fake or were not correct.”*

A foreign producer had delivered steel to their wholesaler, and it turned out afterwards that the producer delivering the goods was not approved for issuing the certificates. The steel was already in place in a building, and was a part of a load bearing system. The problem got to be known by the producer because they were contacted by authorities. *“We got to localise where (the steel) was, what kind of loads it was exposed to and et cetera, and then nothing more became of the matter after we sent over the documentation and what we had (...)”*

The other interviewees did not suspect any CFS steel products on projects they had worked on. All of the interviewees had, however, heard of other projects with CFS steel materials. While one had heard about a problematic delivery, the two others had heard about specific cases with sub-standard steel. These specific cases involved sub-standard items:

“I know of a project in (name of place in Norway) somewhere where there was delivered steel from a foreign steel supplier (...), one steel quality was described, and it was delivered with a different steel quality.(...) There was described a higher steel quality than what was delivered.”

“I haven’t been in touch with materials where fake steel products were in a project (...), what I have heard from others is that materials that have been imported from China among other things have not had the carbon equivalent that is declared in the material, meaning that it was incorrectly alloyed. (...) And that is very serious.”

All the interviewees believed there was some risk of fake steel products existing in the Norwegian construction industry: *“Yes, I think it does (exist), but I don’t think it is... I think it’s the exception more than the rule (...) So luckily, and we should be happy about, I don’t think it’s a big problem, but (it is true) that it exists and that there are serious consequences if something happens”.*

4.2 Which key characteristics of the construction industry make it especially vulnerable to these materials?

The interviewees were asked directly which characteristics they thought made the industry vulnerable to these materials. One of the issues discussed was the accessibility of the industry:

“(...) very little is required to start a company in the construction industry. You can just buy yourself a pickup truck and a hammer and you’re started, right. So it’s an industry that has been familiar with a lot of “cowboy-business”.

The trust in the industry was also emphasised. One of the respondents pointed at the combination of trust and a certain lack of control:

“Maybe we’re not naïve, but we (...) trust the papers that arrive. And when we never do a third party assessment or a third party control, it is, what can you say, you can’t say a bad characteristic, but an absent requirement in the construction industry. So we could wish that there be more control.”

The certain lack of control was also discussed by another respondent:

“I think the possibility for being caught (by the municipality or the authorities) is disappearingly low. And it is like with everything else: If you’re not controlled, it’s easy to cut a corner or drive too fast. So I think it’s important that the authorities do a lot more controls.”

“If no one asks those questions, we will never uncover anything. Then everyone think that everything is in order. You have the papers. You have the product. It is welded up and assembled. And everyone is happy.”

5 DISCUSSION

The findings provide evidence for the existence of CFS steel materials in Norwegian construction projects. When asked about whether they thought that fake steel products exist in Norwegian construction sites, the respondents answered that they did think so, but they were not sure about how wide-spread it is. Although these responses could imply that the problem is not widespread, the interviewees underlined the graveness of the potential problem, and the importance of it being mitigated. The survey supports the idea that the problem is increasing.

The data presents two main characteristics that allow for the entrance of CFS materials. The first is the industry being easily accessible to temporary and dishonest actors. It is easy to establish a company and join the industry, which is quite unique compared to other industries such as offshore or aviation. This characteristic can be linked to two of the fundamental characteristics of the construction industry; the uniqueness of the product and the temporality of the projects. The temporary and dishonest actors can move between projects, close down business and start up again, and move over large distances and projects.

The second characteristic is the high degree of trust combined with a certain lack of coordinated control measures within the industry. The findings indicate that both the industry and the government have a high degree of trust in the certificates issued. It is not common to do material-testing on deliveries, instead a document control is preferred. The high degree of trust and lack of control can be linked to one of the central characteristics of the construction industry; on-site production.

6 CONCLUSION

From the interviews and the survey, there seems to be evidence for the existence of CFS steel products in the Norwegian construction industry. The survey also revealed that the respondents believe that the problems with “fake materials” are increasing. From the literature, three fundamental characteristics of the industry were mentioned. These were uniqueness, temporality and on-site production. According to the findings, it can be deduced that there are two important characteristics of the industry that render it vulnerable, the industry being accessible to temporary and dishonest actors, and a high degree of trust combined with a certain lack of control. These can in turn be linked to the three fundamental characteristics of the industry. Further work including more interviews with stakeholders in the industry can result in recommendations for countermeasures against the use of these materials. It would also be interesting to see if the same problems exist with other steel products and materials.

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Artikkel IV: Countering counterfeit, fraudulent and sub-standard materials in construction

Countering counterfeit, fraudulent and sub-standard materials in construction

Countermeasures to avoid the use of counterfeit, fraudulent and sub-standard steel materials in the Norwegian construction industry

Nina Eklo Kjesbu*, Atle Engebø, Ola Lædre and Jardar Lohne
Department of Civil and Environmental Engineering
NTNU
Trondheim, Norway
nkjesbu@gmail.com +4799582750

The distribution of counterfeit, fraudulent and sub-standard (CFS) materials is a global phenomenon that also exists in the Norwegian construction industry. CFS materials are materials that are not in accordance with the expected characteristics and performance stated in the CE marking and/or the declaration of performance. Previous research has revealed the presence of CFS steel materials in Norway, but no countermeasures specifically for steel materials have been suggested. This study has examined possible countermeasures against these materials. A survey showed that specific countermeasures against CFS materials are not common, even though the respondents did state that they have routines to ensure material quality. To investigate which countermeasures could be undertaken to avoid CFS steel products, eight semi-structured in-depth interviews were conducted with a total of twelve interviewees. The interviewees believed that more regulations, more on-site inspections from the government and more testing of the materials themselves could be effective countermeasures to mitigate CFS steel materials. However, the findings showed that many of these countermeasures already exist in current rules and regulations, they are just not always taken into use by the industry. The countermeasures provide different degrees of security, occurring in different phases of the projects, and thereby offering the

industry shields of protection against these materials. Thus, this paper recommends that the industry and the government to a larger degree utilize the already existing tools, rather than implementing new regulations.

Keywords: steel materials, counterfeiting, supply chain management, countermeasures, construction

I. INTRODUCTION

The US-based Construction Industry Institute (CII) showed examples of counterfeit materials used in the construction industry in a 2014-report [1]. Engebø et al. (2016) [2] investigated the presence of counterfeit materials in general in the Norwegian construction industry, and found there to be a need for countermeasures stating that “there is equally a need for research regarding anti-counterfeiting strategies. Developing a framework for effective methods and implementation of anti-counterfeiting activities in the supply chain management would be essential to prevent further cases of counterfeited materials within the industry.” Kjesbu et. al. (in press) [3] showed the occurrence of counterfeit, fraudulent and sub-standard (CFS) steel materials in the Norwegian construction industry, and suggested that the industry being available to temporary and dishonest

actors, and the industry being high-trusting were some of the key characteristics to why CFS steel materials could enter the industry.

CFS materials could pose threat to the construction industry, because their performance cannot be fully trusted. It means that the characteristics of the materials, assumed by engineers and planners when designing a structure, do not match the actual characteristics of the product. Cheta (2008) [4] stated that “Counterfeit and rogue industrial parts and materials are a worldwide problem that can put workers and public safety at risk.” [4]

When choosing materials for a structure, engineers calculate the dimensions and properties necessary using data about the characteristics of the materials. If these data are incorrect, it could pose a threat to the lifetime and even the safety of the structure.

Although the research shows the existence of these materials, quantification of the presence is difficult as it would require extensive testing of the materials in question. There seems to be evidence to support the fact that these materials do exist in the industry, and finding countermeasures is then a natural continuation to mitigate the problem.

Therefore, the following research question will be scrutinized in this paper:

Which countermeasures can be undertaken to mitigate CFS steel materials in the Norwegian construction industry?

This paper has been limited to look at load bearing, structural steel products covered by a European harmonized standard. CFS materials are in this article defined as materials that do not satisfy the performance declared in the CE-marking and the associated declaration of performance. It is also important to emphasize that a product being CFS does not necessarily mean that it is not good enough to be used (for example: it will not necessarily lead to collapse) but it creates uncertainty to whether it is good enough or not. In addition, the material will not be in compliance with the current rules and regulations, as well as the assumptions made in the design phase.

II. METHODOLOGY

The research presented in this paper was initiated by a scoping literature study on the research of crime in construction, according to the prescriptions of Arksey and O’Malley (2005) [5]. Major trends in the research literature were analyzed, and weaknesses identified. A closer reading of the literature found most pertinent to the analysis was carried out according to the procedures outlined by Blumberg et al. (2004) [6]. In addition, this paper also utilizes data from a survey conducted, based on a previously conducted survey by the Construction Industry Institute (CII) [1]. The survey followed a relatively broad approach and asked quite general questions around counterfeit materials in the industry. Thus, it provides a general backdrop for the specific research on steel products.

In addition to the initial literature review, additional information relevant to the topic of this paper has been investigated during the process. Two main sources have been utilized to understand industry dynamics and current regulations. These have been the website EN1090.no run by the Norwegian Steel Association [7], and the website of the Directorate of Building Quality [8]. These have not been investigated as a part of a literature review per say, but these online sources have been used to find specific information around the extensive regime that surrounds structural steel products.

The investigation of the issue was further strengthened by conducting 12 semi-structured in-depth interviews with senior professionals within the Norwegian industry. The interviews lasted between 25 minutes and two hours (mostly held in the upper end of the time-scale). The 12 held the following positions: 1) two senior staff members working at a national governmental body, 2) two senior staff members working at a local governmental body, 3) two senior professionals working for two different Norwegian consulting companies, 4) one senior staff member working for a non-governmental certifying party, 5) two senior professionals working for two different steel suppliers, 6) one manager/civil engineer, 7) one purchaser at a Norwegian contracting company, 8) one senior employee working for a steel builder (a producer of steel products, but not a producer of the raw material).

Three of the interviews were held as group sessions. This was not an intentional organization, but contributed to the richness of these interviews. The two persons described in 1) were interviewed together, the same with 2). The third group session included one person from 3), one from 5) plus 6). The rest of the sessions were held individually.

A common interview guide was developed and sent to the respondents before the interviews. This was, however, not done for two of the people in the third group session, as well as one person from 1) and 2). This was also not intended, but happened because they joined the interviews just before they started. They were, however, given the interview guide before the taping and questions started.

In addition to the questions listed in the interview guide, follow-up questions were asked. Furthermore, other subjects were also discussed when initiated by the interviewees as suggested by Yin (2013) [9]. The interviews were conducted at the offices of the respondents, with the exception of the third group session (due to practicalities). Conversations were taped using a voice recorder application. Afterwards, the interviewees were allowed to read through the transcript, and they were allowed to make comments. The interviewees have been anonymized and randomized, due to the steel industry being small and the topic being sensitive. In addition, all references to names of projects, places et cetera have been removed from quotes used in this paper.

III. THEORETICAL FRAMEWORK

CFS materials are in this paper defined as materials that do not meet the characteristics given in the CE-marking or the declaration of performance. This is a very specific definition only applicable to materials covered by a harmonized standard and used in areas covered by the European standards. CFS materials do exist in other industries as well, not covered by these standards. The fashion industry has traditionally been a well-known victim of counterfeiting [10]. Lohne et al. (unpublished) [11] also showed how this problem exists in areas such as the dental industry [12], defense industry [13] and within electrical components [14]. The presence of counterfeit items in the international construction industry was also shown by the Construction Industry Institute [1]. They presented

the following table, table I, with the most frequently counterfeited items according to their findings. As can be noted, counterfeited steel tops the frequency of their findings.

TABLE I. MOST COMMON COUNTERFEITED MATERIALS ACCORDING TO THE CONSTRUCTION INDUSTRY INSTITUTE (MINCHIN ET AL., 2014) [1]

Most commonly counterfeited construction items	
<i>Counterfeited items</i>	<i>Frequency</i>
Steel	17
Fasteners	10
Valves	13
Pipe	12
Circuit Breakers	7
Rotating Equipment Parts	6
Electric Equipment	6
Pipe fittings	6
Pressure Vessel	5
Cement	4
Electrical Conduit Fittings	3
Electrical equipment, flanges, rebar, waterproofing, welding rods	2 each
Capacitors, Cement Kiln, Copper wiring, Door Panic Bars, fan belts, gaskets, glass, ground rods, hand tools, heavy equipment parts, masonry, network routers, O-rings, paint, Safety Equipment, Sprinkler heads, subsea system, tires, titanium bar stock, turbine, blades, weld wire, conduit fittings, switchgear, refractory	1 each

For the case of Norway, Engebø et al. (2016) [2] showed the presence of counterfeit materials in the Norwegian construction industry. Kjesbu et al. (in press) [3] further investigated this, and found examples of CFS steel materials in the Norwegian construction industry. As explained by [3], there is not much research done on this topic. The occurrence of CFS steel materials in the Norwegian construction industry was, however, confirmed by [3].

Steel products are currently under quite an extensive control regime in Norway and the European Union. Prefabricated steel products intended for load-bearing functions in buildings are covered by the European harmonized standard

EN1090 part I and II. Products that are covered by such a harmonized standard are required to have a CE-marking and an associated declaration of performance [15]. The Directorate for Building Quality have issued a guide for the inspection of materials. The guide for “Inspection of product documentation” states that “All construction products should have a sufficient amount of product documentation before they are used in the building.” [16] The product documentation of CE-marked goods include three items, 1) CE-marking, 2) Declaration of performance, 3) instructions for assembly/use. The product documentation of non-CE-marked goods include 1) a marking, 2) product documentation, 3) instructions for assembly/use [16]. In addition, it is common to issue a material certificate.

The Declaration of Performance is a declaration that states the performance of the product. It must include information about tolerances on dimensions and shape, weldability, fracture toughness, the characteristics of the material when exposed to fire, hazardous elements (radioactivity and cadmium), and durability [17].

The municipalities in Norway have the authority to inspect and control materials. The local authorities are responsible for issuing a certificate of completion when a building has been finalized. If non-CE-marked materials have been utilized, the municipality can demand that the irregular products must be replaced. The municipality is also responsible for doing random inspections and controls of constructions and buildings. The municipality, however, must cover all fields of expertise within construction. The Directorate for Building Quality state on their website that “Inspections are a task and a duty for the municipality, and one of the most important instruments for achieving good buildings for a good society. In 2016 and 2017, the municipalities will prioritize inspecting education and training in the companies, and documentation for products that are used in the building.” [18]

The Directorate for Building Quality has made a checklist for the control of prefabricated steel products. [19] The list includes, for level 1, to check whether or not the products are CE-marked, it asks whether the system 2+ (FPC) is used, which technical organ has certified the production control

of the producer, if the producer is certified for the class of the building (development class) and if the assembly instructions can be presented. The list also has a level 2 control, where it is checked that the following characteristics are declared in the declaration of performance: geometric tolerances, weldability, fracture toughness, the effect of fire, release of cadmium, durability and load capacity. For a level 3 control, the list asks if the responsible company can document that the performance declared for the prefabricated steel construction is in compliance with the design foundation.

Correspondingly, these levels represent different degrees of inspections, where level 1 is the simplest. The Directorate for Building Quality states that “Level 1 describes the simplest form of inspections. The other levels build on each other, and implicate a more extensive inspection. Inspections on level 3 can be extensive, and are more resource demanding, and then it is important to emphasize that many illegalities can be uncovered already at inspections at level 1 and 2.” [20] The system 2+ (FPC) refers to a system 2+ Factory Production Control. According to the Norwegian Steel Association, a control according to the system 2+ involves the following bullet points: “initial type testing (ITT), FPC which includes implementation of procedures, naming a welding coordinator, conducting a quality control system for the welders, regular controls, tests and evaluations according to a control plan” [21]. Additionally, it involves being assessed by a technical control organ which shall conduct “initial inspection of the workshop, initial inspection of FPC, continuous surveillance, assessment and approval of FPC”, the last will typically include a yearly revision [21].

This paper is looking into finding countermeasures against CFS materials, and therefore it was important to look at any countermeasures already suggested. In their 2014-report, the Construction Industry Institute [1] suggested some countermeasures to be undertaken to fight and mitigate the problem of counterfeit materials in general. These included securing supply chain integrity stating that the industry should “[c]onfirm and verify that every link in the supply chain is secure and observed. Responsible manufacturers have designed and implemented

highly-reliable and secure distribution networks that ensure product integrity. The use of brokers, re-sellers, and unauthorized distributors (at any level in the supply chain) are common entry-points for counterfeit products. Your immediate supplier could be trustworthy, but could also be a victim of counterfeit entry points up stream.” [1] They also suggested that other countermeasures than supply chain integrity could be conducted, suggesting “enhanced supplier pre-qualification, more diligent sourcing practices, manufacturing surveillance, resident inspection, third party verification, unscheduled in-process inspections”. [1]

Engebø et al. (2016) [2] did, as mentioned, not suggest any countermeasures, but called for anti-counterfeiting measures implemented in supply chain management. Kjesbu et al. [3] pointed at the industry being easily available for temporary and dishonest actors, and the high trust in Norway combined with a certain lack of control, as reasons for why CFS materials can enter the Norwegian construction industry. [3] also showed this high level of trust in Norway by presenting the following table, here shown as table II, concerning trust in the industry. This table was based on data from the World Values Survey [22].

TABLE II. DATA FROM THE WORLD VALUES SURVEY WAVE 5: 2005-2009 QUESTION V23 [3] [22]

Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?				
	<i>Norway</i> (N=1,025)	<i>Germany</i> (N=2,064)	<i>Spain</i> (N=1,200)	<i>Turkey</i> (N=1,346)
Most people can be trusted	73.7 %	33.8 %	19.8 %	4.8 %
Need to be very careful	25.7 %	57.9 %	78.9 %	94.6 %

IV. RESULTS

In this chapter, the results from both the survey and the interviews will be presented. The survey focused more on the countermeasures already

undertaken by the respondents, while the interviews were also focusing on possible future countermeasures. The survey was also focusing on materials in general, while the interviews were centered around load bearing steel products and materials. Note that the term “fake materials” has been used in some cases, this is the same as CFS materials.

The survey asked the respondents to state which procedures their organization used to avoid fake materials. The answers can be found in table III.

TABLE III. SURVEY-QUESTION 12

Procedures to avoid fake materials Question 12 from survey	
”Pre-qualification of suppliers and framework agreements”	”We only use recognized suppliers, and rely on that they have everything in order.”
”Approval for suppliers, testing of incoming raw materials”	”Difficult to know, the certificates are ok.”
”Requirements for product specification, declaration of performance, environmental specification. Requirement for the producer for ISO9001 or similar.”	”Clarification meetings, IEH (Initiative for ethical trade), start bank”
”Start bank”	”Ask for and check product documentation and CE marking. Use productXchange.”

So, the respondents did say that their organization had procedures to avoid such materials. When asked about if their firm had initiated preventive measures against fake materials, (question 19), 70 % (7) answered no, while 30 % (3) stated that they did not know.

To look at the requirements that the companies already have for their suppliers, they were also asked whether or not they use a list of approved suppliers. In total 10 people answered the question. As can be seen from table IV, 60 % stated, at the time of the survey, that they had a list of approved vendors, while 30 % did not have such a list.

TABLE IV. SURVEY – QUESTION 17

Do you use a list of approved suppliers? Question 17 from survey	
Yes	60 % (6)
No	30 % (3)
Don't know	10 % (1)

This was then followed up by asking which methods they used when qualifying suppliers for such a list. It was possible to give more than one response, and in total, 18 responses were given, which are shown in table V.

TABLE V. SURVEY – QUESTION 18

If yes answered on the previous questions, which method is used to investigate the suppliers? Question 18 from survey	
Physical inspections	83.3 % (5)
References	83.3 % (5)
Questionnaires	33.3 % (2)
Revision visits	83.3 % (5)
Other (please specify)	16.7 % (1)

The one person that answered “Other (please specify) stated that they had their own purchasing department including a competence center with first-hand knowledge about “these things”

Question 24 was about who was responsible for the quality control of materials in the company. 10 people answered the question, and it was possible to give more than one response. In total, 22 responses were given. These responses can be found in table VI, showing that the executing worker has the highest frequency as the responsible for the quality control.

TABLE VI. SURVEY – QUESTION 24

Who is responsible for the quality control of materials? Question 24 from survey	
Executing worker	50 % (5)
Production leader	30 % (3)
Project manager	20 % (2)
Quality leader	60 % (6)
Construction manager/ Site manager	40 % (4)
Other	20 % (2)

The 12 interviewees suggested different countermeasures that could be implemented to mitigate CFS steel materials in the industry. Several of the respondents saw national and international legislation as a measure. When asked which countermeasure he thought would be most effective, one of the respondents stated the following:

“I think it must be national and international, or national and European requirements from the authorities. That is clear, they are the ones that must go in front. [...] it [CE-marking] should perhaps be just one part of many of these kinds of requirements that should come. It is a great cost for many to implement to be CE-approved. But it should generate something too.”

The need for more controls from the government was also emphasized by other interviewees: “What I think is the best countermeasure is if, for example, the ones who are approving a building, meaning the municipality, that there to a larger degree are independent controls of part-products in building. Because today there are very little controls conducted by the authorities, and we that are professional think that that is a shame. Because it gives opportunities for the unreliable to get financial gain”, said one respondent.

This was also supported by a representative for a supplier: “[...] it's often about resources. It's not easy for a small workshop with little resources to have a lot of control measures and audits and systems. They don't really have the competence for it either [...]” This respondent also mentioned problems around contractors purchasing directly from producers abroad, instead of going through suppliers.

One of the interviewees was especially concerned around the definition of CFS material. He called for attention around the fact that CFS materials are not necessarily not good enough. Another of the respondents suggested that there should be more random controls of the materials themselves, and that destructive tests cannot necessarily be replaced by non-destructive tests (NDT): “There are different NDT control methods you can do on site, hardness measurements and chemical content and et cetera. As portable instruments. But, they are good, but I don't know if they can replace a laboratory test where they also

perform a tensile test and fracture toughness values and things like that. You're not able to test that on-site."

Another of the informants said that his company, a steel supplier, had not had any experience with CFS steel products. He believed that much of the reason for that was their policy on purchases: "We have not, as of the date of today, had any such cases. Then much of the reason can be that we are very clear on where we purchase and from whom we buy."

This need for supply chain management was also supported by one of the interviewees working for a governmental body: "[...] if the steel supplier is the fourth link down [in the supply chain], then it is a little harder to check. [...] the number of sub-contractors in a construction project, that is incredibly important."

Another representative for the government also emphasized the need for controls at the time when the order is placed: "[...] Asking about documentation when you order. Check that they have the papers in order according to 1090. [EN1090]. There are a few checklists there that you can use. And then there is specifying right. [...] That you know what you are ordering."

These government officials did not believe there to be bad intentions if CFS steel products are delivered from the suppliers. Rather, they believed that any use of this most likely was due to a lack of knowledge. "[...] it is not intentional fraud from the suppliers. But, really, they don't really have the opportunity to have a complete overview of everything that they are always getting in, because there are so many links."

In addition to suggesting countermeasures, one of the interviewees also warned against making the rules and regulations too complex. "[...] we mustn't make things too complicated, because then it will definitely not be done. But, it has to be simple and straightforward, and then there must be consequences."

Furthermore, one interviewee also warned against trusting certificates blindly: "But, what is important, I think, is that we don't blindly trust certificates and approvals that everyone has. But, in principle, that is what the world is supposed to function after, right. If you have a document that

states that you are approved after this or that standard, then you as a customer should say "All right, that's good". But that is not possible. Really, you must, if it is going to be secure, check a little bit yourself.

In summary, the respondents stated that they believed that it was important not to only trust the certificates, but that further control measures were necessary. These spanned between international and national legislations to doing an actual destructive testing of the materials. It was also emphasized that the countermeasures should not be made too complicated, and that controlling the supply chain is essential. In addition to the questions already mentioned, the respondents were asked about whether they had gotten information from i.e. the government about CFS materials before. Most of them had not gotten any such information.

V. DISCUSSION

The findings show that there are several countermeasures that can be done to mitigate the threat of CFS steel materials. What was interesting was that many of the interviewees suggested countermeasures corresponding to their own field, meaning that they saw their own part of the industry as a part of the solution. For example, one of the interviewees working with certificates and material tests believed that more testing could be an effective countermeasure. This could of course be because they know their own field of expertise best, and therefore it could be easier to see their own field as a solution to the problem. Also, several of the interviewees pointed at the government, wanting more controls and inspections. The government had, at the time of the interviews, been focusing on control of product documentation for 4-5 months. A document control is, however, the same whether it is done by the authorities or the companies themselves. If the certificates are faked, it would not necessarily be detected regardless of the inspecting party, because it would already have slipped through the quality management of the companies in the supply chain.

The countermeasures suggested can be put into two categories; common measures and company-specific measures. This means that the countermeasures are grouped in what should be

common and what should be conducted (and initiated) by each company. These can be found in table VII and VIII. The countermeasure “more information about CFS materials” has also been added to table VII, since most of the respondents reported that they had not gotten any such information.

TABLE VII. COMMON COUNTERMEASURES

Common countermeasures	
<i>Countermeasure</i>	<i>Conducted by</i>
EU legislations	European authorities
National legislations	National authorities
More inspections from the authorities	National, local authorities
More information around CFS steel materials	International authorities, national authorities. Branch organizations.

In the category common countermeasures, we can see several countermeasures that can be implemented for the whole industry. This includes international (EU) legislations, national legislations, more inspections from the authorities and more knowledge around counterfeit steel materials and certificates. These are countermeasures that are difficult for one company to implement, but rather they should be implemented by the authorities or branch organizations.

Table VIII states the company-specific countermeasures that the interviewees suggested. These included using only familiar producers and suppliers, and utilizing non-destructive tests (NDT) or destructive tests (DT).

TABLE VIII. COMPANY SPECIFIC COUNTERMEASURES

Company-specific countermeasures	
<i>Countermeasure</i>	<i>Conducted by</i>
Using only familiar producers	Suppliers, steel builders, contractors
Using only familiar suppliers	Suppliers, steel builders, contractors
Limiting the amount of levels in the supply chain	Suppliers, steel builders, contractors
Knowledge about the materials	Suppliers, steel builders, contractors
Non-destructive tests	Steel builders, contractors
Destructive tests	Steel builders, importers (contractors)

What should be noted is that almost all the suggested countermeasures already exist in the industry to some degree. The only countermeasure that is not already in place is the increased information around CFS steel materials. There already exists EU-regulations, national regulations, the municipality administration should inspect the products that are used in buildings, and a lot of companies already have policies for purchasing. Still, the counterfeit materials slip through the control system.

In figure 1 on the next page, some of the different countermeasures can be seen, presented as shields. In the first line of countermeasures are EU legislations, represented by European standards and regulations regarding steel materials. Materials can also be tested upon arrival at the European Union. Number one is the countermeasure that includes the largest amount of products, and is also the broadest with respect to the amount of companies affected by the countermeasure. A part of these materials also arrive to shield number two, which is Norwegian

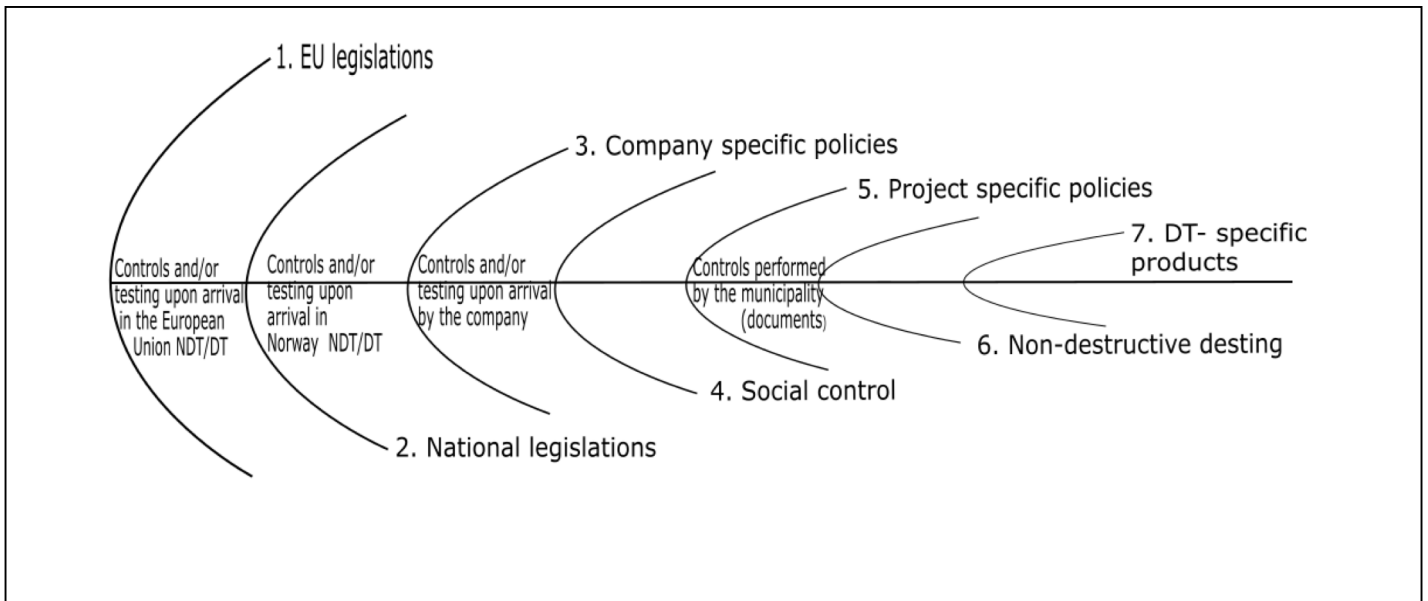


Figure 1: Countermeasures that are conducted at different levels of the supply chain.

national legislations with controls and/or testing when entering Norway.

In addition to European and national legislation, companies can also choose to adopt their own policies, which is shown as shield number 3. They can for example decide that they only want to work with a certain list of producers, or that they only choose materials produced within a certain quality assurance scheme. Some of the companies choosing to have company specific policies can also choose to undertake a social control, which is shown as shield number four. A typical form of company policies is choosing only to work with familiar suppliers or producers. Choosing only certain producers would be stricter than choosing only specific suppliers. In addition to this, the companies can decide to implement certain rules and policies for specific projects. This can be done because the project is especially risky, or it can be done as a response to client demands regarding the steel production. When all these countermeasures have been undertaken, companies purchasing steel can also decide to perform a non-destructive or a destructive test of the steel materials, shown as shields number 6 and 7. Destructive testing is in the core, being the most extensive and likely the most expensive countermeasure. Destructive testing is also the countermeasure most limited, because you

really only test the product itself, since the sample is destroyed in the process. In addition, there is a risk that the product purchased does not have the same properties as the tested sample.

Number 1-5 are essentially about supply chain management, securing that the different levels of the supply chain are in compliance with the demands of the company and of the government. Additionally, we can also see that there are some control functions where the materials can be controlled and tested upon arrival at the different stages. The two last stages in the figure, destructive and non-destructive testing, are controls of the specific materials themselves and must be seen as an extra level of security when necessary. It can be noted that the countermeasures suggested vary greatly in both cost and where on the time-line of a project they should be conducted. The countermeasures should also be seen in relation with the risk and possible consequences. Accordingly, to figure one, as the possible consequences of using CFS steel materials increase, the countermeasures should get stricter. For example, destructive testing is very expensive and takes time. It is therefore perhaps not so relevant if the possible consequences are not so serious.

One of the challenging areas showed in figure 1 is social control. The problem with recommending using familiar suppliers or producers is that it is a countermeasure that sometimes is not available. Although some companies normally use the same producers or the same suppliers, it is sometimes not possible due to changes in production, a rapid need for products or other circumstances. If a company is to implement only using a certain producer or supplier, it may sometimes be forced to break this policy, and therefore other countermeasures must also be in place for these circumstances.

VI. CONCLUSION

This paper aimed to answer the research question *Which countermeasures can be undertaken to mitigate CFS steel materials in the Norwegian construction industry?*

The initial idea was to find new countermeasures that could be implemented in the industry to mitigate and to fight the threat of CFS steel materials. The literature review, document studies, survey and interviews showed that many countermeasures are already in place to mitigate CFS steel materials. These are mainly centered around supply chain management. Some of the countermeasures suggested by the interviewees were common countermeasures, for example national and European laws and regulations. Additionally, each company purchasing steel products can have their own policies for suppliers. To a large extent, the interviewees thus suggested already existing countermeasures, or countermeasures that the industry is already able to implement today, with a basis of the current regime. The problem is that not all of the existing countermeasures are utilized. The interviewees confirmed the need for more inspections from the government. The government already has this authority, and what the respondents really called for was an increased frequency of these controls.

Therefore, this article recommends that the existing countermeasures are further followed up before introducing new countermeasures to complicate the process further. For finding out which countermeasures would be most important to follow up, a quantification of the problem would be in order. This is because finding out where the

products enter the supply chain would be necessary to know where the loop holes are the biggest.

VII. FURTHER WORK

Engebø et. al (2016) [10] suggested that there should be done some testing of materials to quantify the problem. That is also the recommendation after this paper. Further work could also include looking at other industries for countermeasures relevant for the construction industry. This could for example be the petroleum industry or aviation. Looking at other materials than CFS steel would also be interesting, to get a deeper insight to the problem within other types of materials.

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Del C: Vedlegg

Vedlegg 1: Spørsmål til spørreundersøkelse

Spørreundersøkelse om falske materialer i BAE-næringen

Del 0: Informasjon om den som svarer

1. Stilling:

2. Organisasjon

- Rådgivende firma
- Entreprenør
- Underentreprenør
- Byggherre
- Annet (vennligst spesifiser)

Spørreundersøkelse om falske materialer i BAE-næringen

Del 1: Introduksjonsspørsmål

3. I hvor stor grad mener du at det er en forskjell på falske materialer og på materialer av lav kvalitet?

Svært liten grad Liten grad Verken eller Stor grad Svært stor grad

4. I hvor stor grad mener du at falske materialer er en trussel mot byggebransjen?

Svært liten grad Liten grad Verken eller Stor grad Svært stor grad

5. I hvor stor grad er dine kunder (for eksempel hovedentreprenør, byggherre) klar over problemet med falske materialer?

Svært liten grad Liten grad Verken eller Stor grad Svært stor grad

6. Hvilke produkter bidrar ditt firma med til bransjen?

- Bygning
- VVS
- Elkraft
- Tele/automatisering
- Andre installasjoner
- Utendørs
- Prosjektledelse/prosjektstyring
- Bestiller prosjekter/prosjekteier
- Annet (vennligst spesifiser)

7. I hvor stor grad mener du at fagfeltet fra forrige spørsmål er sårbart for falske materialer?

Svært liten grad Liten grad Verken eller Stor grad Svært stor grad

8. Kjenner du til noen eller mistenker du at noen har vært utsatt for falske materialer i et prosjekt du har jobbet på?

- Ja
- Nei
- Vet ikke

9. Har du hørt (fra det du anser som troverdige kilder) at et prosjekt du ikke har jobbet på har vært utsatt for falske materialer?

- Ja
- Nei
- Vet ikke

10. Fra hvilket land får du i hovedsak materialer?

- Norge
- Andre vesteuropeiske land
- Søreuropeiske land
- Nord-Amerika
- Kina
- Annet (vennligst spesifiser)

11. I hvilken grad har du fått informasjon om falske materialer fra norske myndigheter?

Svært liten grad

Liten grad

Verken eller

Stor grad

Svært stor grad

Spørreundersøkelse om falske materialer i BAE-næringen

Del 2: Spørsmål om firmaets/organisasjonens bevissthet og forhåndsregler

12. Hvilke prosedyrer bruker din organisasjon for å unngå falske materialer?

13. Hvilke prosedyrer har dere for kvalitetskontroll av materialer?

14. Hvor langt ut i verdikjeden har dere kvalitetskontroll på materialer? (Slik som underentreprenører og underleverandører?)

15. I hvor stor grad hadde du vært positiv til en tredjepartskontroll av materialers ekthet?

Svært liten grad

Liten grad

Verken eller

Stor grad

Svært stor grad

16. Hvor store ressurser (% av salg etc) bruker organisasjonen din på å unngå falske materialer?

17. Benytter dere en liste av godkjente leverandører?

Ja

Nei

Vet ikke

18. Hvis ja på forrige spørsmål, hvilken metode brukes for å undersøke leverandørene? (Vennligst kryss av alle metodene dere bruker)

- Fysisk inspeksjon
- Referanser
- Spørreskjema
- Revisjonsbesøk
- Annet (vennligst spesifiser)

19. Har ditt firma igangsatt forebyggende tiltak mot falske materialer?

- Ja
- Nei
- Vet ikke

20. Hvis ja på forrige spørsmål, hvilke av dem har vært effektive og hvilke har vært ineffektive?

21. Har ditt firma en liste av godkjente opprinnelsesland for materialer?

- Ja
- Nei
- Vet ikke

22. Har ditt firma en liste av ikke-godkjente opprinnelsesland for materialer?

- Ja
- Nei
- Vet ikke

23. Har ditt firma forsikring som dekker bruk av falske materialer?

- Ja
- Nei
- Vet ikke

24. Hvem er ansvarlig for kvalitetskontrollen av materialer?

- Utførende håndverker
- Produksjonsleder
- Prosjektleder
- Kvalitetsleder
- Byggeleder/Anleggsleder
- Annet (vennligst spesifiser)

25. Klassifiserer dere leverandører, underentreprenører og underleverandører etter hvor kritiske leveransene deres er?

- Ja
- Nei
- Vet ikke

26. Ved kjøp av store partier, hvordan gjennomfører organisasjonen din stikkprøver av materialene opp mot egenskapene de hevdes å ha?

Spørreundersøkelse om falske materialer i BAE-næringen

Del 3: Spørsmål om avslørte falske materialer og produkter

Dersom du aldri har opplevd hendelser med falske materialer, eller oppdaget falske materialer på et prosjekt, vennligst scroll ned og trykk deg videre til neste side.

27. Beskriv alle falske materialer og produkter som har blitt oppdaget på ett av dine prosjekter

28. Hva ble/kunne ha blitt konsekvensene? (sikkerhet, firmaets rykte, rettslige følger, økonomiske konsekvenser osv)

29. Hvor var kilden til de falske materialene?

30. Hvor skulle de falske materialene?

31. Hvor ble de falske materialene kjøpt?

32. Hvor var innkjøperen lokalisert?

33. Hvor i verdikjeden kom de falske materialene inn? (Som hos underentreprenør, underleverandør etc)

34. Hvordan ble de falske materialene oppdaget?

35. Kom de falske materialene fra en godkjent leverandør?

- Ja
- Nei
- Vet ikke

36. Hvordan reagerte forfalskeren/leverandøren på å bli konfrontert med funnet av falske materialer?

37. Var emballasjen/produktmerket forfalsket?

- Ja
- Nei
- Vet ikke

38. Hvis nei på forrige spørsmål, hva var falskt ved materialet/produktet?

39. Var dokumentasjonen/sertifiseringen av materialet forfalsket?

- Ja
- Nei
- Vet ikke

40. Hadde materialet feilaktig fått stempel?

- Ja
- Nei
- Vet ikke

41. Hvordan reagerte andre på bruk av falske materialer da du fortalte om det?

42. Var hovedbekymringen deres penger? Sikkerhet?

43. Har ditt firma noen gang fått negativ presseomtale på grunn av falske materialer?

- Ja
- Nei
- Vet ikke

44. Har du noen gang måttet gjøre reklamasjonsarbeider eller gjøre arbeid på nytt på grunn av falske materialer?

- Ja
- Nei
- Vet ikke

Spørreundersøkelse om falske materialer i BAE-næringen**Del 4: Avsluttende spørsmål**

45. Har du noen gang fått tips eller indikasjoner på at materialer du har kjøpt eller hadde tenkt å kjøpe har vært falske?

- Ja
 Nei
 Vet ikke

46. Tror du at du med dine nåværende prosedyrer hadde greid å identifisere falske materialer?

- Ja
 Nei
 Vet ikke

47. Har du noen tiltak du mener vil fungere for å hindre bruk av falske materialer?

48. Hvordan mener du at muligheten for inntjening med falske materialer er i forhold til risikoen?

49. Tror du at problemet med falske materialer er økende eller avtakende?

- Økende
 Avtakende
 Verken økende eller avtakende
 Vet ikke

50. Kjenner du til andre vi burde sende denne undersøkelsen til? Organisasjoner, enkeltpersoner eller annet?

Vedlegg 2: Intervjuguide til intervjuer

Intervjuguide

Del 1:

1. Kjenner du til eller mistenker du at noen har vært utsatt for falske stålprodukter i et prosjekt du har vært tilknyttet?
2. Beskriv alle falske stålprodukter som har blitt oppdaget på ett av dine prosjekter. (Type stålprodukt, opprinnelsesland, mulig konsekvens, dokumentasjon)
3. Har du hørt (fra det du anser som troverdige kilder) at et prosjekt du ikke har jobbet på har vært utsatt for falske stålprodukter?
4. Mener du at det finnes falske stålprodukter i omløp ved norske byggeplasser?

Del 2:

5. Er det noen egenskaper ved byggebransjen som gjør den utsatt for falske materialer?
6. Hva hadde konsekvensene kunne blitt dersom dere/noen hadde oppdaget falske stålprodukter på et prosjekt? Forsinkelser, økonomisk tap etc.?

Del 3:

For byggherrer, entreprenører etc:

7. Hvordan kvalifiserer dere leverandører av stålprodukter?
8. Hvilke tiltak har dere for å sikre kvaliteten på stålproduktene dere mottar?
9. Hvilke tiltak har dere for å sikre kvaliteten på dokumentasjonen?
10. Har dere klart å avdekke noe ved hjelp av disse tiltakene?

For alle:

11. Hva mener du kunne vært andre tiltak for å sikre seg mot forfalskede stålprodukter?
12. Hvilke tiltak mener du ville være de mest effektive?
13. Har dere fått informasjon om forfalskede stålprodukter fra andre (f.eks. norske myndigheter, produsenter etc.?)
14. Hvor langt ned i verdikjeden har dere kvalitetskontroll på materialer?

Del 4:

FUU-byggevarer er falske, uredelige eller utilstrekkelige byggevarer.

15. Hvilke juridiske, økonomiske og markedskonsekvenser eksisterer for bruk eller involvering med FUU-byggevarer?
16. Hva er de potensielle konsekvensene av bruk av FUU-produkter når det kommer til byggeprosessen og det endelige byggverket for henholdsvis entreprenøren og byggherren?
17. Hvem er mest sårbar i møte med slike produkter, og hvem sitter med risikoen?

Avslutning:

18. Er det noe jeg har glemt å spørre om?
19. Kan jeg kontakte deg igjen ved eventuelt flere spørsmål?