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Det skapende universitet

Overtakelse av bygg

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Bygg- og miljøteknikk
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Norges teknisk-naturvitenskapelige universitet
Institutt for bygg, anlegg og transport

NORGES TEKNISK-
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INSTITUTT FOR BYGG, ANLEGG OG TRANSPORT

Oppgavens tittel: Overtakelse av bygg	Dato: 26.5.15 Antall sider (inkl. bilag): 87				
	Masteroppgave	X	Prosjektoppgave		
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Ekstrakt:
Overtakelser av store, komplekse byggeprosjekter er ofte problematiske og konsekvensene kan bli store. Å gjøre prosjektovertakelsen til en mer smidig prosess kan potensielt gi gevinster for alle aktører. Dette er formålet med denne masteroppgaven. Arbeidet består av tre deler; en prosessrapport, tre vitenskapelige artikler og vedlegg. To av artiklene skal presenteres på konferanser og den siste skal sendes til et internasjonalt tidsskrift. Artiklene er skrevet på engelsk, mens prosessrapporten er skrevet på norsk. Hensikten med prosessrapporten er å gi et metaperspektiv på arbeidet med de vitenskapelige artiklene. Det gis en grundigere fremstilling av bakgrunn for oppgaven, en utdyping av forskningsmetode, samt redegjørelse for valg og beslutninger underveis. I tillegg presenteres ubenyttede data og arbeid.

Det ble benyttet en casestudie for å kunne gi et grundig svar på forskningsspørsmålene. Disse tar for seg konsekvenser og årsaker til feil og mangler, samt tiltak for å få bukt med disse utfordringene. Tiltakene ble til slutt sortert på ulike analytiske nivåer. Casen er utvidelsen av et kjøpesenter i Trondheim. Denne casen ble valgt fordi det var et komplekst bygg med flere byggetrinn. Det ble gjennomført intervjuer av nøkkelpersoner, noe som var svært viktig for å fremskaffe informasjon for å svare på forskningsspørsmålene. I tillegg ble det intervjuet personer som ikke var knyttet til casen. Dette ble gjort for å svare på forskningsspørsmålene fra et strategisk perspektiv.

Den første artikkelen tar for seg etiske problemstillinger knyttet til overtakelse. Den neste har fokus på konsekvenser og årsaker til feil og mangler. Den siste har trykket på tiltak og hvilke analytiske nivåer det er hensiktsmessig å implementere disse på. Resultatene tilsier at et stort omfang av feil og mangler er en betydelig utfordring i overtakelsen og at årsakene har sin opprinnelse fra hele byggeprosessen. Dette forstyrrer kvaliteten på både prosessen og produktet. Konsekvensene er både umiddelbare og langsiktige, og innebærer i tillegg noen etiske problemstillinger. Mange tiltak for å bedre overtakelsen eksisterer allerede, men potensialet er trolig ikke fullt unyttet. Konklusjonen tilsier at det er store muligheter for forbedring ved å ivareta kontrollen gjennom hele prosjektet, fra tidligfase til overtakelse. Dette kan bidra positivt i form av økt kvalitet på sluttproduktet og en reduksjon av kostnader for både byggherre, entreprenør og samfunnet.

Stikkord:

1. Handover
2. Delays and defects
3. Causes
4. Countermeasures

Martine Firing

Forord

Denne masteroppgaven er utført våren 2015, ved Institutt for bygg, anlegg og transport ved Norges teknisk-naturvitenskapelige universitet (NTNU). Oppgaven utgjør 30 studiepoeng og er det avsluttende arbeidet på det femårige masterprogrammet i bygg- og miljøteknikk.

Temaet ble valgt som følge av et pågående prosjekt om overtakelse ved instituttet, samt egen erfaring fra overtakelse av byggeprosjekter i forbindelse med sommerjobb. Ambisjonen er å bidra til å skape større suksess i overtakelsen for alle involverte aktører.

Denne oppgaven har en form som er forskjellig fra tradisjonelle masteroppgaver. Den består av (1) en prosessrapport, (2) tre vitenskapelige artikler og (3) vedlegg. Til sammen tilsvarer dette en ordinær masteroppgave. Prosessrapportens formål er å utjevne forskjellen mellom denne formen for masteroppgave og den som tradisjonelt har vært brukt. Rapporten søker å gi et metaperspektiv på arbeidet med de vitenskapelige artiklene. Den første artikkelen er skrevet i anledning konferansen 8th Nordic Conference on Construction Economics and Organization som ble avholdt i Finland i mai 2015, den neste til konferansen IPMA 2015 som avholdes i Panama i september 2015 og den siste er sendt inn til tidsskriftet International Journal of Managing Projects in Business.

Jeg vil benytte anledningen til å takke min veileder, Ola Lædre, og forsker ved instituttet, Jardar Lohne, for godt samarbeid og verdifulle innspill underveis. Spesielt vil jeg takke for hjelpen til arbeidet med artiklene. I tillegg ønsker jeg å gi en stor takk til Veidekkes ansatte på prosjektet City Lade i Trondheim for all inspirasjon og støtte. Uten dere hadde ikke denne oppgaven vært mulig. Alle som har bidratt som informanter fortjener en stor takk. Deres bidrag er en forutsetning for at arbeidet skulle bli til. Mange takknemlige tanker til Amita som har bidratt som korrekturleser. Sist, men ikke minst, tusen takk til familien min og til Steffen, som har gitt meg inspirasjon, motivasjon og støtte underveis.

Never, never, never give up.

Winston Churchill

Trondheim, mai 2015

Martine Firing

Sammendrag

Gevinstene av å gjøre overtakelsene av komplekse byggeprosjekter mer smidige kan være store for alle deltakende aktører i et prosjekt. Det er gjort lite forskning på området og formålet med denne masteroppgaven er å finne ut hvilke problemer som oppstår i overtakelsen, samt årsaker og konsekvenser knyttet til disse. Videre arbeides det med potensielle tiltak som kan implementeres for å gjøre overtakelsen mer vellykket. Tiltakene sorteres på de ulike analytiske nivåene strategisk, taktisk og operasjonelt, etter hvor det er hensiktsmessig å implementere dem.

Utvidelsen av kjøpesenteret City Lade i Trondheim benyttes som casestudie. Dette var et komplekst prosjekt med tre byggetrinn. Det bestod av både nybygg og rehabilitering, i tillegg inkluderte det en sammenkobling av nytt og gammelt bygg. Prosjektet ble utført som en totalentreprise med samhandling.

Det er gjennomført en litteraturstudie for å kartlegge hvilken forskning som er gjort på området til nå og for å identifisere eventuelle kunnskapsgap. Det er gjort søk i ulike databaser for å finne problemer, årsaker, konsekvenser og tiltak. Litteraturstudien inkluderte også relevante standarder og litteratur om ulike analytiske nivåer. Søket etter litteratur viste at det var behov for å benytte seg av flere metoder for å kunne gi tilstrekkelig gode svar på forskningsspørsmålene.

I tillegg til litteraturstudien er det utført en dokumentgjennomgang for å fremskaffe informasjon om casen. Videre er det gjort intervjuer med nøkkelpersoner, både hos entreprenør, byggherre og leietakere, samt med personer som arbeider med utarbeidelse av nye standarder. Dette ble gjort for å kunne gi grundigere svar på forskningsspørsmålene.

Informasjonsgrunnlaget vurderes som godt. Casen var et bygg som hadde mange utfordringer, noe som ga mange funn. Informantene hadde god innsikt i prosjektet og mye å bidra med. Informantene som ikke var case-spesifikke hadde god kjennskap til norsk byggebransje. Intervjuundersøkelsene supplerte litteraturgjennomgangen på en god måte.

Undersøkelsene som er utført viser at et stort omfang av feil og mangler gir utfordringer i overtakelsen. De viktigste årsakene til dette er kort byggetid, uforutsette bygningsmessige utfordringer, lite tilfredsstillende oppfølging av underentreprenører, manglende kvalitetssikring og lite tid til testing, mye endringsarbeid og diffuse kontraktuelle forhold. Samtlige er hendelser som ligger forut for overtakelsen. Konsekvensene av dette er blant annet lavere kvalitet på sluttproduktet, tilleggskostnader for involverte parter, konflikter og mistillit. En rekke tiltak er foreslått for å gi bedre kontroll og dermed en bedre overtakelse. Disse er sortert etter tre analytiske nivåer etter hvor det er hensiktsmessig å implementere dem: Strategisk, taktisk og operasjonelt.

Undersøkelsene som er utført danner grunnlaget for tre vitenskapelige artikler. Én artikkel til konferansen 8th Nordic Conference on Construction Economics and Organization, én til konferansen IPMA2015 og den siste til tidsskriftet International Journal of Managing Projects

in Business. Masteroppgaven består av (1) en prosessrapport som søker å gi et metaperspektiv på arbeidet med artiklene, (2) tre vitenskapelige artikler og (3) vedlegg.

Summary

The rewards of making the handover of complex construction projects more flexible can be considerable for all participating actors in a project. The research on the area seems to be insufficient and the purpose of this thesis is to find the causes of why delays and defects appear in the handover and the subsequent consequences of this. Further, the thesis suggests potential countermeasures that can be implemented to make the handover more successful. The countermeasures are classified according to three analytical levels: Strategic, tactical and operational.

The expansion of the shopping centre City Lade in Trondheim is used as a case study. It was chosen due to the complexity the project represented. The project was divided into three consecutive steps. It consisted of a new construction and rehabilitation of existing buildings, as well as a jointure of new and old building structures. The project was carried out as a design-build contract.

A literature review was conducted to map the established research and find out what the existing literature identifies as most important. The literature review also included relevant standards. The literature search showed that there was a need to use more methods in order to provide sufficient answers to the research questions.

In addition to the literature review, a documentation study was carried out to obtain information about the case study. Thirteen semi-structured interviews were also conducted. Nine of the interviews were case specific, with client, contractor and user representatives respectively. The four others were conducted with policy makers from the industry. The documentation study was used mainly as a preparation for the interviews.

The case study was a building with many challenges, which provided several findings. The informants had adequate insight into the project and much to contribute. The non-case-specific informants had good knowledge about the Norwegian construction industry.

The conducted research has shown that a high extent of delays and defects is a severe problem that appears in the handover. The main causes are short construction period, unexpected structural challenges, unsatisfying supervision of subcontractors, lack of quality assurance and time for testing, a high degree of alteration work and diffuse contractual relationship. In other words, incidents prior to the handover are overrepresented. Lower quality of the final product, a situation where the client feels forced to take over, additional costs for the parties involved, as well as conflicts and distrust constitute the most important consequences. The suggested countermeasures to avoid delays and defects are sorted according to the different analytical levels strategic, tactical and operational.

This master's thesis consists of a process report (part 1), three scientific papers (part 2) and appendixes (part 3). The purpose of the process report is to give a metaperspective on the work with the scientific papers. The research carried out is presented in a scientific paper for the 8th Nordic Conference on Construction Economics and Organization, in a scientific paper

for the conference IPMA2015 and an extended scientific paper for the International Journal of Managing Projects in Business.

Innhold

DEL 1 Prosessrapport

1 Innledning

Dette kapittelet redegjør for bakgrunnen til masteroppgaven og det gis en introduksjon til forskningsspørsmålene.

1.1 Bakgrunn

Alle byggeprosjekter er unike, i form av byggets utforming, prosjektorganisasjonens sammensetning og rammebetingelser satt i kontrakten. Bygging av et moderne kjøpesenter er spesielt utfordrende fordi den tekniske kompleksiteten er høy og mange aktører er involvert. I tillegg er det flere kontraktsparter, byggherren, entreprenør og leietakere som skal flytte inn i bygget. Til sammen bidrar dette til at det er utfordrende og krevende å organisere, planlegge og bygge et slikt prosjekt.

Som en konsekvens av dette er overtakelser av store, komplekse byggeprosjekter ofte problematiske. På initiativ fra Trondheim kommune er det derfor satt i gang et prosjekt om overtakelse ved Institutt for bygg, anlegg og transport ved NTNU. Tre masterstudenter skriver oppgave om temaet våren 2015 og denne oppgaven inngår som et ledd i arbeidet. Undertegnedes arbeid med fordypningsprosjekt høsten 2014 regnes som en pilotstudie for denne masteren. Pilotstudien avdekket at omfanget av feil og mangler på overtakelses-tidspunktet er enormt og at dette kan anses som et hovedproblem i denne fasen. Til tross for at dette oppleves som et stort problem for både prosjekteiere og entreprenører, er det gjort relativt lite forskning på årsaker, konsekvenser og tiltak.

Min bakgrunn for valg av tema for fordypningsprosjektet, er interessen for å bidra til å utvikle en mer smidig overtakelsesprosess for alle involverte aktører. Jeg hadde god kjennskap til casen fra tidligere. Utvidelsen av kjøpesenteret City Lade var et komplekst prosjekt med tre forskjellige byggetrinn og relativt kort byggetid. Prosjektet bestod av både nybygg og rehabilitering, samt en sammenkobling av nytt og gammelt bygg. I tillegg hadde prosjektet et stort antall endringer og tillegg til kontrakten. Overtakelsene knyttet til casen fungerte ikke optimalt og denne erfaringen var en vesentlig faktor til at temaet ble ansett som interessant.

1.2 Ett forskningsarbeid – tre artikler

For å unngå forvirring i videre lesing, er det valgt å nummerere de vitenskapelige artiklene som følger:

- Vitenskapelig artikkel nr. 1: *Ethics in Commissioning*
- Vitenskapelig artikkel nr. 2: *Main Challenges found in the Handover of a Shopping Centre in Norway*
- Vitenskapelig artikkel nr. 3: *Completed Building at Handover*

I utgangspunktet skulle det i arbeidet med masteroppgaven skrives én vitenskapelig artikkel (nr. 2) i tillegg til denne prosessrapporten, men ettersom datagrunnlaget var så godt utviklet dette seg etter hvert til å bli tre.

Den første artikkelen, nr. 1, er en overordnet artikkel om etiske problemstillinger knyttet til overtakelse. Alle de tre masterstudentene som skriver om overtakelse hadde spørsmål om etikk i sine intervjuer. Datagrunnlaget ble ansett som så omfattende og rikt at det var hensiktsmessig å trekke etikk ut av de opprinnelige artiklene og heller skrive en egen med dette som tema. Undertegnede bidro med data, forskningsmetode og casebeskrivelse og er derfor medforfatter til denne artikkelen.

Artikkel nr. 2 omhandler konsekvenser og årsaker knyttet til feil og mangler, samt tiltak for å unngå problemene. Underveis i arbeidet med denne ble det avdekket at årsakene til feil og mangler ligger på ulike nivåer og at potensielle tiltak derfor burde implementeres deretter. Dette var utgangspunktet for artikkel nr. 3, som i stor grad tar for seg tiltak og hvilke analytiske nivåer det er hensiktsmessig å implementere disse på.

1.3 Forskningsspørsmål og formål med arbeidet

Som følge av at omfanget av arbeidet ble utvidet til å omfatte flere artikler, har forskningsspørsmålene utviklet seg underveis og fra artikkel til artikkel.

Artikkel nr. 1, som omhandler etiske problemstillinger knyttet til overtakelse og er et resultat av tre masterarbeider, svarer på følgende forskningsspørsmål:

1. *Hvilke utfordringer av etisk natur oppstår typisk i overtakelsesfasen av byggeprosjekter?*
2. *Hva er de strukturelle/systematiske årsakene til at slike utfordringer oppstår?*
3. *Utnyttes disse utfordringene bevisst av involverte aktører til egen bedrifts vinning, og i hvilken grad utnyttes de?*

Forskningsspørsmålene for vitenskapelig artikkel nr. 2 tar utgangspunkt i forskningsspørsmålene fra pilotstudien. Da var hovedfokus problemer i overtakelsen og konsekvenser som følge av disse. Som nevnt, avdekket dette arbeidet at hovedproblemet i overtakelsen er det store omfanget av feil og mangler. Arbeidet med denne artikkelen tar derfor for seg årsaken til feil og mangler, samt tiltak som kan bedre overtakelsen. Fokus på konsekvenser tas med fra pilotstudien fordi dette er et interessant aspekt å ha med i forskningsartikkelen. Forskningsspørsmålene er utformet med utgangspunkt i bakgrunnen for arbeidet og funn fra pilotstudien:

1. *Hva er konsekvensene av et stort omfang av feil og mangler?*
2. *Hva er årsakene til feil og mangler?*
3. *Hvilke tiltak kan implementeres for å bedre overtakelsen?*

Vitenskapelig artikkel nr. 3 er en videreføring av vitenskapelig artikkel nr. 2, men her løftes forskningen opp på et høyere nivå ved å undersøke hvilke analytiske nivåer, strategisk, taktisk eller operasjonelt, det er hensiktsmessig å implementere tiltak på. Noe av ideen bak denne inndelingen kom etter at undertegnede deltok på et høringsmøte om en ny standard for

prøvedrift. For å få bukt med problemene hjelper det ikke å sette inn tiltak på kun ett nivå. Fordi de case-spesifikke intervjuene kun dekket de taktiske og operasjonelle nivåene, ble det utført nye case-uavhengige intervjuer for å dekke det strategiske nivået. Følgende forskningsspørsmål er utgangspunkt for vitenskapelig artikkel nr. 3:

1. *Hva er konsekvensene av et stort omfang av feil og mangler?*
2. *Hva er årsakene til feil og mangler?*
3. *Hvilke tiltak kan implementeres for å bedre overtakelsen?*
4. *Hvem er ansvarlig for de ulike tiltakene?*

Forskningsspørsmålene besvares i sin helhet i artiklene, mens en utdypet redegjørelse for fremgangsmåte (metode), utdypet resultatdel og forslag til videre arbeid omtales i prosessrapporten. Arbeidsfordelingen mellom forfatterne følger også senere i denne rapporten.

2 Metode

De vitenskapelige artiklene inneholder svært komprimerte delkapitler om forskningsmetode. Dette kapittelet gir derfor en mer utfyllende beskrivelse av hvilke metoder som er benyttet og hvorfor. Hensikten er at dette kapittelet skal være tilsvarende et metodekapittel i en ordinær masteroppgave.

En andel av kapittelet er hentet fra pilotstudien som ble utført høsten 2014. Årsaken er at pilotstudien danner mye av grunnlaget for arbeidet med de vitenskapelige artiklene og det er de samme metodiske tilnærmingene som er brukt i det videre arbeidet.

2.1 Forskningsmetode

«De kvalitative metodene tar sikte på å fange opp mening og opplevelse som ikke lar seg måle» (Dalland, 2012, s. 112). Kvalitative metoder kjennetegnes ved at de går i dybden, får frem spesielle fenomener og søker helhet og sammenheng (Dalland, 2012, Thagaard, 2009). I motsetning til dette er kvantitative metoder tallbaserte og gir få opplysninger om mange undersøkelsesenheter (Samset, 2014). Det legges stor vekt på relevans i en kvalitativ tilnærming og målet er å oppnå en helhetsforståelse.

De vanligste formene for kvalitative metoder er deltakende observasjon og intervju (Thagaard, 2009). Ifølge Moen og Ragnheiður (2011) er disse metodene obligatoriske deler av kvalitativ forskning. Som et supplement, for eksempel som en forberedelse til intervju eller observasjon, benyttes ofte dokumentasjonsstudium (Thagaard, 2009).

I denne oppgaven er relevant, tekstlig informasjon og helhetsforståelse ansett som det viktigste, og det er derfor valgt å benytte kvalitative metoder for å besvare forskningsspørsmålene. En annen årsak er at «kvalitative metoder egner seg godt til studier av temaer som det er lite forskning på fra før, og hvor det derfor stilles særlige store krav til åpenhet og fleksibilitet» (Thagaard, 2009, s. 12). Det er også dette som regnes som styrken ved kvalitativ metode. Som det ble gjort rede for i innledningskapittelet, er overtakelse av bygg et relativt urørt fagfelt på tross av at en forbedring av prosessen potensielt kan gi store gevinster.

Metodetriangulering er benyttet ved først å danne et bilde av etablert kunnskap gjennom en litteraturstudie, for deretter å undersøke virkeligheten direkte gjennom intervju og dokumentgjennomgang. Det benyttes med andre ord flere ulike metoder for å besvare de samme forskningsspørsmålene.

2.2 Litteraturstudie

Begrunnelse for valg av metode

For å kunne skrive en god vitenskapelig artikkel er det viktig å ha god oversikt over den eksisterende forskningen. Teorikapittelet er fundamentet i artiklene og danner grunnlaget for å analysere funnene fra undersøkelsene som skal gjøres. Å undersøke eksisterende litteratur gir også mulighet til å identifisere eventuelle kunnskapsgap. Det ble utført en litteraturstudie i forbindelse med pilotstudien. Denne er supplert i arbeidet med denne oppgaven, men frem-

gangsmåten er den samme. Litteraturstudien er gjennomført i henhold til retningslinjer beskrevet av Blumberg et al. (2014).

Fremgangsmåte

Litteraturstudien ble gjennomført som et systematisk litteratursøk. Utvelgelsen av litteratur foregikk i tre runder. Første runde startet med å identifisere aktuelle søkeord ut fra problemstillingene, for deretter å søke etter litteratur i databasene Bibsys Ask, Engineering Village, Scopus, Web of Science og Google Scholar. Søkeordene som i hovedsak ble benyttet var:

- Commissioning
- Overtakelse/delivery/handover
- Byggefeil/building defects/delays and defects

Som følge av at alle søkeordene gir mange treff, ble det benyttet kombinasjoner av søkeord for å begrense søkene. Et eksempel på dette var «*building* and *commissioning* and *construction*». Enkelte av databasene gir også mulighet til å begrense på fagområde og språk, noe som ble benyttet. Alle aktuelle treff ble systematisk notert i en tabell og lagret i referansehåndteringsverktøyet EndNote.

Runde to gikk ut på å gjennomgå en liste med litteratur som hadde blitt utdelt av veileder. Aktuelle treff fra listen ble registrert i den samme tabellen som i runde én.

Resultatet fra de to første rundene ga 32 kilder som kunne være relevante. Den siste runden bestod derfor i å gå gjennom tabellen fra runde én og to med et kritisk blikk og fargekode kildene etter relevans.

Hver av de relevante kildene fra runde tre ble vurdert etter kriteriene troverdighet, objektivitet, nøyaktighet og egnethet. Alle kildene som ble funnet var vitenskapelige. Blant funnene var tidsskriftartikler, konferanseartikler, rapporter og avhandlinger. Brorparten var i tillegg fagfellevurderte. Utgivelsesår spente fra 1992-2013, men informasjonen var i aller høyeste grad regnet som aktuell. Noen av publikasjonene var rene litteraturstudier, mens andre baserte seg på casestudier eller spørreundersøkelser i tillegg til førstnevnte.

Det har underveis blitt søkt opp relevant litteratur etter hvert som det har blitt avdekket funn ved hjelp av andre metoder, også disse har blitt vurdert etter kriteriene beskrevet ovenfor. Relevante kilder har også blitt funnet ved å se igjennom referanselistene i allerede gode kilder. I tillegg har det blitt utvekslet nyttige artikler med medstudenter som skriver om samme tema. I arbeidet med teorikapittelet til artiklene ble det funnet relevante standarder for å belyse hvordan overtakelsen reguleres i disse. Universitetsbiblioteket NTNU har tilgang til Standard Norges databaser og de aktuelle standardene ble funnet der.

Da det ble bestemt at det skulle skrives en utvidet artikkel (nr. 3), ble det gjort nye litteratursøk som spesielt tok for seg ulike analytiske nivåer. Det ble i tillegg gjort grundige søk etter relevant litteratur i det tidsskriftet det var ønsket at artikkelen skulle bli publisert. Det er en

fordel å ha sitert samme tidsskrift som det man selv ønsker å publisere i for å sette seg inn i en (eventuelt) pågående diskusjon i tidsskriftet omkring samme tema. Det ble gjort gode funn i denne siste runden med litteratursøk og flere artikler fra tidsskriftet er sitert i artikkel nr. 3.

Validitet og reliabilitet

For å vurdere validiteten kan det evalueres om litteraturen er dekkende for å besvare forskningsspørsmålene. Med andre ord om metoden undersøker det den er ment å undersøke (Olsson, 2011). Litteratursøket ble gjort med utgangspunkt i forskningsspørsmålene og kildene som ble funnet dekker deler av temaet denne masteroppgaven omhandler. Siden det til nå ikke er gjort så mye forskning på dette feltet, er utvalget av litteratur noe begrenset. Konklusjonen er derfor at validiteten til litteraturstudien kunne vært bedre, men at deler av årsaken er at temaet for oppgaven er noe urørt.

For å tilstrebe en høy grad av reliabilitet, eller etterprøvbarhet, ble hele søket og alle relevante funn dokumentert nøye gjennom hele litteraturstudien.

Styrker og svakheter

Analysen av problemstillingene var både nyttig og hensiktsmessig, og jeg kom frem til flere aktuelle problemer og dermed søkeord. En svakhet ved denne måten å gå frem på, er at det er nærmest umulig å finne all litteratur som er relevant, og det er heller ingen garanti for å finne de beste kildene. For å bøte på denne svakheten, diskuterte jeg med faglærer og medstudenter for å finne flere gode kilder. Jeg fant også mer relevant litteratur etter hvert som det ble avdekket funn ved hjelp av de andre metodene.

2.3 Innsamling av empiriske data

Litteraturstudien tar for seg det teoretiske grunnlaget for artikkelen, mens den videre metodebeskrivelsen redegjør for hvordan empirisk informasjon er hentet inn. Utgangspunktet for innsamling av empiriske data er en casestudie. Begrunnelsen for å velge case som forskningsmetode er beskrevet under, mens selve casen er nærmere beskrevet i Vedlegg A.

2.3.1 Casestudie

Hvorvidt man skal velge å benytte en casestudie, avhenger av forskningsspørsmålene (Yin, 2014). Dersom disse krever omfattende svar og beskrivelser av fenomener kan det tilsi bruk av case. Har man relativt mye kunnskap om forskningstemaet fra før, slik at man er i stand til å lage gode svaralternativer på for eksempel en spørreundersøkelse, kan man gå for en mer generell undersøkelse med mange respondenter (De nasjonale forskningsetiske komiteene, 2010).

Det at man kan gjøre et dypdykk for å hente ut omfattende informasjon er det som utgjør casestudiens hovedstyrke, spesielt når det forskes på et tema som til en viss grad er lite berørt. Dette var den viktigste begrunnelsen for å benytte en casestudie i dette arbeidet. Det at det er gjort lite forskning på temaet fra før gjør det vanskelig å utføre en generell undersøkelse. Forskningsspørsmålenes utforming og byggeprosjektets kompleksitet tilsa også at det var mer hensiktsmessig å gå i dybden.

Målet ved casestudier er å gi forståelse og innsikt. Denne typen studier kan gi viktige bidrag til, og være et potensielt springbrett for, videre forskning (Olsson, 2011). Svakheten ved en casestudie kan ifølge Olsson (2011, s. 44) være at: «Casestudier skal ikke være representative eller generaliserbare». Resultatene fra en casestudie er alltid tids- og stedavhengige, det vil si at etterprøvbarhet kan være vanskelig. Dette kan tolkes som at resultatene ikke kan overføres til andre situasjoner eller prosjekter. Flyvbjerg (2006) bestrider til en viss grad dette:

> One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas "the force of example" is underestimated.
>
> (s. 228)

Siden dette arbeidet er ment som et utgangspunkt for videre forskning, ble det ikke ansett som noen stor ulempe at resultatene ikke kunne generaliseres i like stor grad som resultatene fremskaffet via andre vitenskapelige metoder.

Casen City Lade ble valg som følge av at undertegnede hadde god kjennskap til prosjektet fra sommer- og deltidsjobb i Veidekke Entreprenør AS, til sammen ca. seks måneder. I tillegg har jeg arbeidet som deltidsansatt på en av butikkene på senteret. Den første delovertakelsen, gjennomført sommeren 2013, var ikke optimal. Åpent kjøpesenter i byggeperioden, ombygging av eksisterende bygg, samt sammenkobling av nytt og gammelt bidro til ytterligere kompleksitet. Bygget ble derfor ansett som et godt eksempel på hvor utfordrende det kan være å overlevere moderne, komplekse bygg.

2.3.2 Dokumentgjennomgang

Begrunnelse for valg av metode

Olsson (2011) anbefaler å bruke dokumentgjennomgang som forberedende aktivitet selv om det i hovedsak samles inn data på andre måter. Dokumentgjennomgang er også en hensiktsmessig metode for å bekrefte data som allerede er samlet inn ved hjelp av andre metoder (Yin, 2014). Med bakgrunn i dette ble kontrakten mellom byggherre og entreprenør gjennomgått. Dette ble gjort for å være best mulig forberedt til intervjuene og forstå hvilke rammer prosjektet ble bygget innenfor. I tillegg ble det utført en gjennomgang av entreprenørens mal for prosjektplan, samt brosjyrer om Veidekkes egen tilnærming til Lean Construction og Last Planner System, kalt involverende planlegging (IP). Disse dokumentene ble gjennomgått for å få en bedre forståelse av entreprenørens interne systemer for planlegging og gjennomføring av prosjekter.

Fremgangsmåte

Både kontrakten, malen for prosjektplan og brosjyrer om IP ble undersøkt. Det ble tatt notater underveis i de tilfellene der det ble funnet noe som var relevant.

Validitet og reliabilitet

Verken kontrakten eller mal for prosjektplan er direkte relevante for å svare på kjernen i forskningsspørsmålene, men problemer med prosjektstyringen kan være noe av årsakene til

feil og mangler som blir oppdaget så sent som i overtakelsen og en gjennomgang ble derfor ansett som viktig. Entreprenørens brosjyrer om IP ble sett på som relevante med tanke på tiltak for å bedre overtakelsen. Validiteten vurderes som ok, men kunne vært bedre ved for eksempel å utforske mer omfattende dokumenter som omhandlet prosjektet og som i større grad svarte på problemstillingen, for eksempel byggeprogrammet.

Gjennomgangen av disse dokumentene var problemfri noe som gir gode forutsetninger for etterprøvbarhet. Datagrunnlaget kunne vært større.

Styrker og svakheter
Styrken ved dokumentgjennomgangen var at den ga nyttig informasjon som kunne brukes både i utarbeidelse av intervjuguiden, i selve intervjusituasjonene og i arbeidet med å finne tiltak. En vesentlig svakhet var at det kun var noen få dokumenter som ble gjennomgått, og at disse kom fra entreprenøren. Det kunne eksempelvis være hensiktsmessig å ta for seg byggeprogrammet og dokumenter fra samhandlingsfasen for å få et enda bredere perspektiv.

2.3.3 Intervju

Begrunnelse for valg av metode
Intervju som forskningsmetode ble valgt for å kunne gjøre en dyp og grundig undersøkelse av problemet. Målet med intervjuene var å hente ut mest mulig informasjon og å se prosjektet fra flere sider. Dette stemmer godt med Yin (2014), som mener at intervju er en svært egnet metode for å skaffe til veie casestudieinformasjon.

Et intervju gir tilgang på mer grundig informasjon enn en kvantitativ undersøkelse med svaralternativer. Kunnskapen er mer nyansert og informantene får mulighet til å utdype sine meninger. I motsetning til en spørreundersøkelse, gir intervju rom for oppfølgingsspørsmål.

Fremgangsmåte
Den samme intervjuguiden ble brukt i alle intervjuene, en noe forkortet versjon i intervjuene som ikke var case-spesifikke. Guiden tok utgangspunkt i forskningsspørsmålene og hensikten var at dette skulle gi en logisk fremstilling av resultatene. Intervjuguiden starter med en presentasjon av forfatteren, prosjektet og temaet. Guiden kan ses i Vedlegg B.

Valg av informanter
For å finne og velge ut informanter ble det brukt en metode som Dalen (2011) kaller «kriterieutvelging». Denne metoden går ut på å lage kriterier for utvelging, for deretter å finne informanter som oppfyller disse.

Kriteriene som ble lagt til grunn ved utvelgelsen av de case-spesifikke informantene var:

- Informanten skal ha fulgt prosjektet fra et tidlig stadium, gjerne fra kontraktsinngåelse.
- Informanten skal ha en nøkkelrolle i forbindelse med planlegging, gjennomføring og oppfølging av prosjektet.

Kriteriene som ble lagt til grunn for utvelgelsen av de ikke case-spesifikke informantene var:

- Informanten skal jobbe med utvikling av standarder og regelverk på et høyt strategisk nivå i norsk byggebransje.

Ifølge Dalen (2011) er det i noen studier viktig å benytte seg av mer enn én gruppe av informanter. For å være i stand til å se prosjektet fra flere sider ble det i denne studien valgt ut intervjuobjekter fra både byggherreombud, prosjekteier, totalentreprenør, leietakere og personer på et strategisk nivå i norsk byggebransje. De ni første som ble intervjuet hadde tilknytning til casen. Informantene representerte entreprenør, byggherre og leietakere, med andre ord de operasjonelle og taktiske nivåene. Disse intervjuene ble utført høsten 2014 og første kvartal 2015 og dekket de to nevnte nivåene på en god måte. I forbindelse med vitenskapelig artikkel nr. 3 ble det gjennomført fire nye intervjuer for å inkludere det strategiske nivået. Det ble avdekket ytterligere konsekvenser av og årsaker til feil og mangler. Tiltakene som kom frem i arbeidet med intervjuene ble bearbeidet og aggregert, samt sortert på rett analytisk nivå. Deretter ble det analysert hvilke årsaker tiltakene kunne bidra til å løse. Noe av informasjonen som kommer frem vil være sammenfallende og noe vil være ulikt for de forskjellige gruppene.

Til sammen ble det rekruttert tretten informanter. Disse fikk selv velge tid og sted for intervjuene innenfor et visst tidsrom. Majoriteten av intervjuene ble utført på de ulike informantenes arbeidsplasser. To av intervjuene ble utført via telefon fordi fysisk møte ikke var mulig som følge av geografisk avstand.

Én uke før det enkelte intervju ble det sendt en e-post for endelig å bekrefte avtalt tidspunkt. Denne e-posten inneholdt også intervjuguiden, se Vedlegg B.

Intervjuet
Intervjuene ble utført som halvstrukturerte. Det vil si at en del spørsmål var klare på forhånd, men at informanten også fikk lufte andre problemstillinger. Ifølge Postholm (2010) gjør dette at intervjuet får en form som minner mer om en jevnbyrdig samtale. En stor fordel med denne formen for intervju, er at den gir mer rom for oppfølgingsspørsmål enn et strukturert intervju.

Det ble gjort lydopptak av majoriteten av intervjuene. Fordelene med lydopptak er at meningsinnholdet bevares og at gjengivelsen av informasjonen blir mest mulig korrekt. Det gjorde også at intervjuene ble mer avslappet fordi fokus kunne være på hva informantene sa, ikke at alt måtte skrives ned så fort og korrekt som mulig. Ulempene med lydopptak kan være at informantene legger bånd på seg og ikke ønsker å besvare alle spørsmålene like detaljert som de ville gjort om intervjuet ikke hadde blitt tatt opp. I tillegg til lydopptak ble det tatt korte notater underveis som sikkerhet ved tekniske problemer. I de to tilfellene hvor informantene ikke var komfortable med at intervjuet ble tatt opp, ble det skrevet et grundige og utfyllende referater som ble sendt dem i ettertid.

For at informantene skulle føle seg komfortable med intervjusituasjonen, ble det innledningsvis pratet litt om «løst og fast». Deretter ble det gitt en liten introduksjon av oppgaven, planen om å skrive vitenskapelige artikler, samt gjort rede for hvordan opp-

lysningene som kom frem ville bli behandlet. Det ble i tillegg gjort en avklaring på om informantene ønsket anonymitet. Enkelte av informantene ønsket ikke at deres navn, firma eller tilknytning til prosjektet skulle gjøres kjent. Under intervjuene ble spørsmålene stilt i samme rekkefølge som i intervjuguiden, men med tilpasninger underveis. Der det falt naturlig, ble det gitt oppfølgingsspørsmål eller ytret et ønske om utdyping.

Aktiv lytting ble brukt ved å nikke bekreftende til informantenes uttalelser og ved å spørre informantene om budskapet ble oppfattet riktig. Intervjuene ble avsluttet ved at det ble spurt om informantene hadde noe mer å legge til og om de var tilgjengelig for spørsmål senere dersom noe skulle komme opp.

Etterarbeid

Fordi det var vanskelig å notere ordrett underveis, og for å beholde mest mulig av meningsinnholdet og unngå misforståelser, ble intervjuene transkribert i etterkant. I intervjuene hvor det ikke ble gjort opptak, ble det skrevet et grundig referat. Transkripsjonene/ referatene ble sendt til informantene for gjennomlesing og skriftlig godkjenning.

Validitet og reliabilitet

Validitet handler om resultatene kan regnes som gyldige. I et forskningsintervju vil det si at det er de rette informantene som blir brukt, og at deres troverdighet vurderes som høy (Kvale et al., 1997). Som nevnt tidligere ble det lagt til grunn visse kriterier da informantene skulle velges. Samtlige informanter tilfredsstilte disse kriteriene og ble derfor ansett som troverdige. Det er i tillegg viktig for validiteten at kvaliteten på intervjuet kan regnes som god nok (Kvale et al., 1997). Dette ble sikret ved at det ble stilt spørsmål som ga mulighet for utfyllende svar. I arbeidet med denne studien ble det tilstrebet å ha relativt åpne, ikke-ledende spørsmål med rom for gode og utfyllende beskrivelser. I tillegg ble intervjuene avsluttet med å spørre om informantene ønsket å legge til noe mer.

Ifølge Kvale et al. (1997) handler validitet i tillegg om at forskeren må være kritisk til seg selv og sine egne tolkninger. Med andre ord å gjøre en validitetsvurdering av forskerrollen og hvordan denne kan ha påvirket tolkningen av resultatene (Dalen, 2011). I denne studien kan dette ha hatt en betydning fordi jeg tidligere har jobbet på prosjektet, som kollega til en av informantgruppene og som «motpart» til de andre. Dette kan utgjøre en fare for hvor objektivt resultatene kan tolkes. Det at jeg kjente informantene og prosjektet fra tidligere kan også være en fordel med tanke på hvor komfortable informantene følte seg under intervjuet. Det ble presisert i hvert intervju at oppgaven er skrevet på vegne av NTNU og at hensikten med oppgaven var å lage en balansert fremstilling som ikke var til fordel eller ulempe for noen av partene. I tillegg til å være kritisk til seg selv er det viktig at forskeren er kritisk til funnene. Hvordan en person oppfatter en situasjon er subjektivt og tanker om spesielt årsaker, men også tiltak, kan være farget av personens rolle i prosjektet. Informantenes svar er derfor tolket med et kritisk blikk. Totalt sett regnes derfor validiteten på resultatene fra intervjuene som høy.

Reliabilitet handler om at forskningen kan gjentas og resultatene reproduseres (Postholm, 2010). Dette kan være utfordrende ved bruk av kvalitative metoder. Siden det ble brukt en intervjuguide under intervjuene, er det mulig å utføre et tilnærmet likt intervju. Interaksjonen

og personkjemien mellom intervjuer og informant er likevel ikke mulig å reprodusere. For å kvalitetssikre resultatene, ble intervjuene tatt opp og transkribert i etterkant eller de ble grundig referert. Informantene fikk lese gjennom transkripsjonene/referatene for å luke ut eventuelle misforståelser. Dette øker reliabiliteten. Navn, kontaktinformasjon og transkripsjoner er lagret slik at størst mulig etterprøvbarhet kan oppnås.

Styrker og svakheter

Styrkene ved bruk av intervju som forskningsmetode er at det gir mulighet for å studere et fenomen i dybden. Informanten kan utdype og forklare sine opplevelser og synspunkter knyttet til et fenomen. Styrken til det halvstrukturerte intervjuet er at det gir mulighet for oppfølgingsspørsmål dersom noe er uklart. Det at jeg kjente til prosjektet og informantene fra tidligere anses som en styrke fordi større innsikt gir bedre forutsetning for gode oppfølgingsspørsmål. Det kan også være enklere å dele informasjon med en person som man kjenner og som vet en del om prosjektet fra tidligere.

Intervjuets svakhet er at måten spørsmålene stilles på kan ha en innvirkning på svarene. Det samme gjelder for spørreskjemaer, men der er dette konsekvent og likt for alle informanter. Dette er ikke tilfellet i intervjuet, der måten spørsmålet stilles på potensielt kan variere fra intervju til intervju. Det kan også være en svakhet at informanten selv velger hvor mye informasjon han/hun ønsker å dele. Målet er å avdekke informantens forståelse og opplevelse av fenomenet og forskeren må derfor forutsette at informanten forteller det han/hun mener er viktig for å belyse problemstillingen. En annen vesentlig svakhet er at intervju er en svært hensiktsmessig metode for å finne ut *hva* som har skjedd, men nærmest uegnet for å undersøke *hvorfor*. Dette er fordi tanker om årsaker gjerne er farget av informantens syn og agenda. Intervju ble allikevel regnet som den eneste aktuelle metoden for å få tilstrekkelige svar på forskningsspørsmålene, men informantenes årsaksforklaringer ble behandlet med et kritisk blikk.

3 Ubenyttede data og arbeid

Siden en vitenskapelig artikkel er en svært komprimert fremstillingsform, er det flere av spørsmålene fra intervjuguiden som ikke har blitt besvart i artiklene. Dette gjelder spesielt funn fra de case-spesifikke intervjuene. En del av disse dataene ble behandlet i pilotstudien og en forkortet versjon er presentert i det følgende kapittelet. I tillegg presenteres data på etiske problemstillinger knyttet til overtakelse som danner noe av grunnlaget for artikkel nr. 1. Kapittelet avsluttes med en arbeidsmatrise benyttet for å få oversikt over intervjuresultatene.

3.1 Gjentakende utfordringer fra byggetrinn til byggetrinn

Flere av informantene sier at de samme problemene hadde en tendens til å gjenta seg fra byggetrinn til byggetrinn. Samtlige informanter nevnte feil og mangler i de tekniske anleggene, spesielt på elektronikksiden, som et gjentagende problem. De samme elementene gikk igjen, men dette gjorde også at hele organisasjonen var bedre rustet til å møte de samme utfordringene i byggetrinn 3

Leietakerprosessen og leietakerhåndteringen ble trukket frem av flere av informantene som utfordrende, både i byggetrinn 1 og 3. Mange av leietakerne, spesielt i byggetrinn 3, ble signert sent. Dette medførte ekstra arbeider i en allerede presset situasjon både for administrasjonen, som skulle håndtere selve prosessen, og for produksjonen. Informantene er dog samstemte i at denne prosessen forbedret seg betraktelig fra byggetrinn 1 til 3, på tross av en del utfordringer i det siste byggetrinnet

3.2 Lærdom fra byggetrinn til byggetrinn

Informantene var enstemmig i at det var stor forbedring, spesielt fra byggetrinn 1 til 3. I etterkant av byggetrinn 1 ble det avholdt et evalueringsmøte der byggherre og entreprenør deltok. I forkant av møtet hadde entreprenør hatt en egen, intern evaluering. Byggherre fortalte at evalueringen opplevdes som ryddig og konstruktiv, men at det allikevel var spenning knyttet til den videre utviklingen.

Entreprenør uttalte at det var større fokus på fremdrift i byggetrinn 3 og at det var viktig å ha en god plan som faktisk ble fulgt. Det ble satt inn en egen ressurs nettopp på dette. Informanten trakk frem at det å ha egne milepæler underveis og kjøre kontroller mot disse fungerte veldig bra. Det ga mer styring. Økt fokus på produksjon og en klar produksjonsstrategi var viktige punkter som bidro til forbedring. Det var en utfordring, både for prosjektering og produksjon, at byggetrinn 3 lå i et eksisterende bygg. En av informantene mente dette var mulig å håndtere med den produksjonsstrategien som var utarbeidet. I tillegg ble det internt i entreprenørorganisasjonen gjort en tydeligere fordeling av oppgaver og ansvarsområder. Både entreprenør og byggherre understreket at dette var et viktig og riktig grep.

En av informantene mente en viktig lærdom fra byggetrinn 1 var å ha omforente kvalitetsnivåer. Altså at entreprenør og byggherre var enig om kvalitetene på arbeidene i forkant av utførelse. Dette ble blant annet definert på betongarbeider. I de tilfellene hvor det ble

oppdaget avvik, ble disse rettet opp allerede i råbyggfasen, før andre fag satte i gang. Dette gjorde at avvikene hadde minimale konsekvenser i forhold til hva de kunne hatt.

Informantene på det strategiske nivået var enige i at potensialet for læring fra prosjekt til prosjekt er stort, men at dette i dag ikke utnyttes i tilstrekkelig grad. Ved hvert nytt byggeprosjekt starter man på nytt, men med blanke ark. Noe av årsaken ligger i lovverket, som til dels hindrer det offentlige i å benytte entreprenører de er fornøyd med på nytt. Private ut-byggere har større mulighet til å drive med forbedringsarbeid og erfaringsoverføring enn offentlige utbyggere.

3.3 Problemenes forutsigbarhet

Det ble arrangert månedlige møter mellom byggherre og entreprenør. Fremdrift var et av de faste punktene på agendaen i disse møtene. Ifølge byggherre var entreprenør i disse møtene klar på at fremdriften var i rute.

Informantene fra både entreprenør og byggherre uttrykte at de i månedene i forkant av overtakelsen av byggetrinn 1 var bekymret for fremdriften. Byggherre sendte et formelt brev til entreprenør seks til åtte uker før overtakelsesdato, der det ble uttrykt bekymring for fremdriften. Entreprenør fulgte opp sine underentreprenører og leverandører aktivt, tilbake-meldingene var positive med hensyn på fremdrift og svarene gikk i at «de skulle få det til». En av informantene erkjente at det burde ha ringt noen varselbjeller og at entreprenør burde vært litt mer kritisk og sørget for at det ble mer realisme i optimismen. I ettertid sitter en av informantene igjen med inntrykk av at enkelte av underentreprenørene ikke var helt ærlige med hensyn til egen fremdrift.

Entreprenør fortalte også at det opplevdes som utfordrende at overleveringen av byggetrinn 1 lå midt i sommerferien. Det gjorde det vanskelig å bemanne opp slik at fremdriften kunne komme i rute. Byggherre på sin side sa at entreprenøren fikk tilbud om utsettelse noen måneder før planlagt ferdigstillelse, men at tilbudet ble avslått. Dette medførte at senteret måtte åpne uansett hvor lav ferdiggraden var.

Mange og uklare kontraktsforhold ble trukket frem av flere av informantene fordi dette ble opplevd som utfordrende. Den største utfordringen sett fra leietakernes side var at leieavtalen med utleier i flere tilfeller ble signert på et veldig tidlig tidspunkt, før totalentreprenøren var kontrahert. Dette medførte at leietakerne ble pliktet til å benytte entreprenører som det ikke var inngått egen avtale med. Dette er noe som gjentar seg i alle kjøpesenterprosjekter og ikke noe som er unikt for dette prosjektet. Totalentreprenøren opplevde kontraktsforholdene som utfordrende fordi det ble inngått avtaler mellom leietakere og byggherre som de ikke var klart over. En av informantene mente dette i alle høyeste grad er forutsigbart og noe som går igjen i alle prosjekter av denne typen.

3.4 Problemenes opprinnelsesfase

De fleste problemene som oppstår kan relateres til flere av fasene i et prosjekt. Enkelte har opprinnelse tidlig i prosjektet. Spesielt ble det påpekt at de kontraktuelle utfordringene stam-

mer fra samhandlingsfasen. En informant påpeker at enkelte ting i kontrakten kan utvikle seg til å bli uklare etter hvert.

Planlegging av fremdrift, produksjonsstrategi og rolleavklaring stammer fra planleggingsfasen av prosjektet. Ofte oppstår det behov etter hvert og de eksisterende rollene klarer ikke å dekke disse. En del arbeider kan havne i grensesnittet mellom flere fag og ansvarsområder. Informantene påpekte i denne sammenheng at en grundig rolleavklaring er sentral for at prosjektet skal fungere.

En god del av problemene stammer fra produksjonen og produksjonsplanleggingen. Eksempler på dette er produktvalg, underentreprenører som ikke har kontroll på egen fremdrift og mangel på tid til kvalitetssikring og -testing.

3.5 Etiske problemstillinger knyttet til overtakelse

Leietakerne opplevde ofte at entreprenør prioriterte fellesarealene til utleier fremfor arealene til leietakerne fordi de økonomiske konsekvensene av å ikke gjøre dette er store for entreprenørene. En av informantene mente at totalentreprenør bør prioritere leietakere i større grad og samtidig kvalitetssikre sine under-entreprenørers tilbud før de videresendes til leietakerne. Informanten opplevde at det muligens spekuleres i å tjene penger på leietakerne, f.eks. ved å gi en høyere påslagsprosent enn den som gis til utleier.

Den største utfordringen sett fra leietakernes side var at leieavtalen med utleier i flere tilfeller ble signert på et veldig tidlig tidspunkt, før totalentreprenøren var kontrahert. Dette medførte at leietakerne ble pliktet til å benytte entreprenører som det ikke var inngått egen avtale med (f.eks. tekniske entreprenører, betingelser for rigg og drift, etc.). Dette medførte en monopolsituasjon der leietakerne var pliktet til å bruke de leverandørene/entreprenørene som utleier hadde avtale med. Konsekvensene av dette var uklarheter og forskjellige oppfattelser om tidsfrister, prioriteringer og kvalitet på arbeider.

Entreprenøren fortalte at flere av leietakerne «prøvde seg» ved flere anledninger, som f.eks. å komme med forsinkelseskostnader i ettertid på forsinkelser de selv hadde skyld i. I tillegg var det flere som utnyttet at det var noen uklarheter i kontrakten, samt det at det var flere ulike kontraktsforhold (tre kontraktsparter).

Informanter fra entreprenøren fortalte at enkelte leietakere utnyttet kaoset i forbindelse med overtakelsen ved å ikke følge opp plikter som de selv hadde signert på at de skulle følge. Eksempler på dette var HMS og avfallshåndtering. Sistnevnte hadde direkte konsekvens for entreprenøren fordi entreprenøren selv måtte sette inn ressurser for å håndtere dette (ikke medregnet i rigg- og driftskostnadene).

En av informantene trakk frem at når det gjaldt HMS var ikke byggherre med i like stor grad som han burde. Byggherre påla entreprenøren å følge reglene, men fulgte ikke selv opp sine egne plikter i henhold til Byggherreforskriften. Informanten fortalte videre at det var mistanker om at den del av entreprenørene som jobbet for leietakerne ikke hadde fulgte arbeidsmiljøloven eller tariffsatsene, men at det var vanskelig å finne konkrete bevis. Totalentreprenører har en påse-plikt, men det var lite de kunne gjøre konkret.

3.6 Resultatmatrise

Tabell 1 presenterer resultatene fra samtlige intervjuer og er utgangspunkt for funnene de tre artiklene omtaler. Som nevnt tidligere, kom det frem av pilotstudien at feil og mangler kan anses som et hovedproblem og inndelingen av matrisen stemmer derfor ikke helt med inndelingen i artiklene. Flere av punktene som omtales som «problemer» i matrisen er egentlig årsaker til at feil og mangler har oppstått. Dette er en oppdagelse som ble gjort underveis og siden matrisen kun er ment som et arbeidsverktøy er ikke denne endret som følge av dette funnet.

Tabell 1 Arbeidsmatrise for innsamling av resultater fra intervjuene.

Problemer	Konsekvenser	Årsaker	Tiltak
For lav ferdiggrad - Feil og mangler (spesielt på tekniske fag) - Gjelder både kontraktsarbeider og leietakerarbeider	- Uenigheter - nekte overtakelse - Kvalitetsavvik (bygger inn feil og mangler) - Økonomisk – overtid, overnatting, etc. - Redusert omdømme - Estetiske avvik - Psykologisk aspekt (tvil på egne evner) - Dårlig sikring av verdier når fasader ikke er på plass. - Byggherre føler seg tvunget til å ta over et produkt som ikke er ferdig. - Lavere kvalitet på sluttproduktet. - Midlertidige tiltak som ofte blir permanente.	- Kort byggetid – stress og kaos. - Uforutsette problemer. - Få med erfaring fra kjøpesenter. - Fremdriftsstyring – akkumulering av forskyvninger. Fører igjen til at det arbeides overalt samtidig. - For dårlig oppfølging av UEer - Uriktig informasjon fra underentreprenører. - UEer viste større forpliktelser overfor VD enn for LT. - Lite detaljerte tegninger fra arkitekt (bytte av arkitekt, uerfarne). - Ikke nok fokus på betongarbeider. - Sene bestillinger fra byggherre. - Ferdigstilling og innflytting går parallelt. Ingen innflyttingsperiode. - Mangel på låste tegninger fra LT.	- Fokus på fremdrift (egne milepæler på utfordrende arbeider, fremdrift må ha fokus på logistikk: publikumsarealer førstepri). Bas og formann tidligere inn for å sette tidsbruk på arbeidsoppgaver. - Involverende planlegging iht. VDs egen modell: kommunikasjon mellom nivåene i modellen. Aktiv bruk av project – sortere ut fremdriftsplaner på fag: Eierskap til plan. - Bytte av problematiske produkter. - Oppbemanning av funksjonærstab. - Leietakere med i fremdriftsplan og ansett som en betydelig del av prosjektet. - Tydelig rolleavklaring. - God dialog med og *kontinuerlig* oppfølging av underentreprenører fra dag 1. - Klar beslutningsstrategi. - Godt samarbeid internt. - Hindringsanalyse – fokus på sunne aktiviteter - Klar produksjons- og leietakerstrategi (mtp. logistikk). - Bruke samme folk på nytt – «eksperter» - Klare krav til arkitekt. - Fokus på hensiktsmessig

			byggetid - Kontinuerlig fokus på KS. - Hensiktsmessig å ferdigstille f.eks. én måned i forkant av overtakelse for å få tid til innflytting/testing/igangkjøring. Kostnadsspørsmål. Hva lønner seg på lang sikt?
Mangelfull kvalitetssikring og testing av tekniske installasjoner	- Lavere kvalitet på sluttproduktet (bygger inn feil og mangler) → Kostnader - Økte drifts- og vedlikeholdskostnader	- Fremdriftsstyring – dårlig tid til befaringer. - Ikke tilstrekkelig fokus på dette. - Uklar ansvarsdeling. - Ferdigstilling og innflytting går parallelt. Ingen innflyttingsperiode.	- Fokus på fremdrift – IP - Bruk av eksternt firma til systemintegrasjon. - Bruk av uavhengige kontroller - Bruk av digitale hjelpemidler som nettbrett med f.eks. PlanGrid - Forberfaringer 3-4 uker før overlevering. Styre etter 0 feil. - Riktige ressurser. En «senior» hos entreprenøren som har erfaring og som har evne til å ha oversikt samtidig som vedkommende ser framover.
Ikke omforent kvalitetsnivå	- Uenigheter - Økonomisk - Mindre fornøyde brukere/eier	- Flere kontraktsforhold.	- Avklaring med både byggherre og leietakere i forkant av igangsettelse. - Befaringer med både byggherre og entreprenør der kvaliteten avklares.
Leietakere - Signert sent - Uteblivende betaling/diskusjoner omkring allerede signert kontrakt.	- Uenigheter - Tidspress - Stort press på allerede presset organisasjon. - Lokaler ikke ferdige til LT flyttet inn. - Risiko for at butikken ikke fikk åpne på den planlagte åpningsdagen	- Markedssituasjon. - Useriøse aktører.	- Plan for leietakere som blir signert sent og håndteringen av disse. - God dialog med byggherre. - Tilstrekkelig ressurser til å håndtere leietakere. - Klarere kontraktsforhold.
Stort endringsomfang (+ 25 %)	- Forsinkelser - Økte kostnader - Uenighet og tvister om ansvar - Ressurser	- Langt tidsspenn fra oppstart av prosjekt til oppstart bygging. Tegninger ikke endret i stor nok grad før byggestart.	- God dialog med byggherre. - Plan for endringshåndtering. - Tidligere involvering av byggherre. - Oppdatering av relevante dokumenter som f.eks.

		- Endret kjøpesentermarked. - Vanskelig å se den akkumulerte effekten av mange endringer.	byggeprogram og tegninger. - Oppbemanning for å håndtere.
Uklare ansvarsforhold mellom byggherre og entreprenør	- Mangelfull oppfølging av leietakere, HMS, etc. i tråd med Byggherreforskriften.	- Mangel på ansvarsavklaring i forkant av oppstart	- Tidlig ansvarsavklaring.
- Flere kontraktsforhold: 1) Mellom byggherre og entreprenør 2) Mellom byggherre (utleier) og leietaker 3) Mellom entreprenør og leietaker	- Entreprenør får monopol på prising av leietakerarbeider. - Misnøye, uenighet, tvister - Bevisst utnytting av uklarheter i kontrakt. - LT forventer mer enn det entreprenør har forpliktet seg overfor BH til å gjøre. - LT forventer en annen finish enn det entreprenør og BH har avtalt	- Ikke overensstemmelse mellom de ulike kontraktene.	- Tydelig avklaring og overensstemmelse mellom ulike kontrakter. - Bedre kommunikasjon mellom byggherre og entreprenør dersom dette ikke er tilfelle.
Mangel på informasjon (kvalitet og videreformidling mellom ulike faser)			- Understreke viktigheten av dokumentasjon og stille krav til at dette er klart før overtakelse (før prøvedrift iht. ny standard)

4 Anbefaling om videre arbeid

Denne studien har primært tatt for seg ett unikt byggeprosjekt og det kan derfor være fornuftig å utvikle studien til å inkludere flere prosjekter, for eksempel ved å samle funnene fra de tre masteroppgavene som handler om overtakelse. Hvert prosjekt er unikt, men allikevel er det sannsynlig at en del av funnene er sammenfallende.

Funnene i forrige kapittel viser at det ofte er de samme problemene som gjentar seg fra byggetrinn til byggetrinn, eller fra byggeprosjekt til byggeprosjekt. Dette tilsier at det er et stort potensiale for læring og erfaringsoverføring, både innad i prosjekter og, ikke minst, fra prosjekt til prosjekt. Erfaringene flere av informantene satt igjen med er at det ofte startes med «blanke ark» selv om potensialet for forbedring er stort. I tillegg viser funnene at en del av problemene faktisk er ganske forutsigbare. Et forslag til videre arbeid er derfor å se på hvordan erfaringsoverføring kan sikres fra prosjekt til prosjekt, samt innad i prosjekter, for å unngå at de samme problemene gjentar seg. I den forbindelse kan det være interessant å se på hvordan offentlige byggherrer kan forbedres, utvikle seg og drive erfaringsoverføring. På grunn av lovverket har ikke offentlige byggherrer like muligheter til å utvikle langsiktige samarbeid med entreprenører som private byggherrer har.

Arbeidet har avdekket at det er flere etiske problemstillinger knyttet til byggeprosjekter. I casestudien var det tilfeller hvor aktører utnyttet en kaotisk sluttfase til egen fordel. Dette synes ikke å være forsket mye på og det anbefales derfor å arbeide videre med funnene fra artikkelen om etiske problemstillinger.

Tiltakene som er foreslått i artiklene er ikke testet i virkeligheten og et forslag til videre arbeid er å implementere noen av tiltakene for å se om de har noen innvirkning på omfanget av feil og mangler ved overtakelse. Et alternativ er å undersøke om innføringen av en ny standard om commissioning bidrar til at norske byggherrer i større grad overtar helt ferdige og vel-fungerende bygg.

Under intervjuene kom det frem at det under utvidelsen av Oslo Lufthavn, Gardermoen, satses stort på commissioning. Dette er en enorm utbygging med høy grad av kompleksitet på de tekniske systemene. En anbefaling til videre arbeid er derfor å undersøke i hvilken grad dette fungerer og om denne utbyggingen kan anses som et foregangsprosjekt på commissioning.

5 Arbeidsfordeling mellom forfatterne

5.1 I arbeidet med *Ethics in Commissioning*

Førsteforfatter Jardar Lohne har stått for utarbeidelsen av artikkelen. Masterstudentene Iman Shirkavand, Kim Schneider og undertegnede er medforfattere som følge av at vi har bidratt med datamateriale, forskningsmetode og casebeskrivelser til artikkelen. Ola Lædre er også medforfatter som følge av at han har bistått Lohne i utarbeidelsen av artikkelen. Lædre har i tillegg koordinert datainnsamlingen gjennom å være hovedveileder for de nevnte master-studentene.

5.2 I arbeidet med *Main challenges found in the handover of a shopping centre in Norway* og *Completed Building at Handover*

Fordeling av arbeid med artiklene:

1. Martine Firing
2. Ola Lædre
3. Jardar Lohne

Mine veiledere, Ola Lædre og Jardar Lohne, har hjulpet meg med å utforme forskningsdesign og problemstillinger. Undertegnede har stått for utarbeidelse av hele artikkelen. Jeg har skrevet hele teksten og gjort alle undersøkelsene, som inkluderer litteraturstudium, dokument-gjennomgang og intervjuer. Ola Lædre har i stor grad bidratt med faglige innspill underveis i arbeidet med artiklene. Det vil si forslag til litteratur, artiklenes fokus og faglige oppbygning. Hans forslag har blitt implementert gjennom revisjoner. I tillegg har jeg hatt mange samtaler og diskusjoner med masterstudent, Kim Schneider, som skriver om tilnærmet samme tema, men en annen type bygg. Dette har vært til stor hjelp underveis. Jardar Lohne har, i tillegg til utarbeidelse av forskningsdesign/problemstilling, bistått med akademisk skriving. Han har gjennom hele arbeidet hjulpet til med språklige forbedringer, hensiktsmessig strukturell oppbygning og akademiske formuleringer. Ideen om å skrive en utvidet artikkel ble utviklet i samråd med Lædre og Lohne.

I april 2015 fikk alle masterstudentene som skriver vitenskapelig artikkel tilbud om å få tilbakemelding fra Dr. Glenn Ballard, direktør ved Project Productions Systems Laboratory ved University of California, Berkeley. Utgangspunktet for møtet var vitenskapelig artikkel nr. 2, men tilbakemeldingene har også blitt tatt med i vitenskapelig artikkel nr. 3. Disse gikk blant annet ut på bruk av ord/uttrykk, svakheten ved bruk av intervju som forskningsmetode når det kommer til årsaksforklaringer, balanse mellom teori og funn, etc. En del av tilbakemeldingene ble tatt hensyn til, mens andre er vanskeligere å implementere i ettertid og ses derfor på som lærdom og tips ved eventuelt videre akademisk arbeid.

Den redaksjonelle utformingen er hovedsakelig gjort av undertegnede. Denne er først og fremst utformet med utgangspunkt i tidligere konferanseartikler fra IPMA og retningslinjene fra tidsskriftet for å høyne muligheten for å få artiklene godkjent.

Layout er regulert av konferansen/tidsskriftet og følger på forhånd angitte maler. Disse inkluderer antall ord, type tekst, linjeavstand, referanser, etc.

5.3 I arbeidet med prosessrapporten

Undertegnede har stått for hele utarbeidelsen av prosessrapporten inkludert vedlegg. Hovedveileder, Ola Lædre, har bistått med hjelp til oppbygningen.

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DEL 2 Vitenskapelige artikler

Vitenskapelig artikkel nr. 1

8th Nordic Conference on Construction Economics and Organization

Ethics in Commissioning

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Abstract

The paper reports on a pilot study on commissioning processes in Norwegian construction projects. The study was undertaken in order to address both general questions of ethics in construction project management, and more specific questions pertaining to the commissioning phase of such projects. In addition to a literature review and a documentation study, 13 semi-structured interviews were carried out according to a qualitative approach. Four of these were general in nature (with clients) and nine case-specific (with client, contractor and user representatives). Based on the results, the paper establishes a descriptive picture of ethical challenges in commissioning. The findings indicate that the commissioning process pose significant challenges in light of hidden agendas and power play among the actors. Clients and contractors tend to be systematically suspicious of one another. The major costs in play reinforce this. This research finds signs of actors repetitively utilising the complexity involved in the commissioning phase for own benefit at the expense of other actors, so this paper is relevant for both clients and contractors. Further research is needed both in order to clarify the challenges involved and to develop appropriate measures to address these challenges.

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Keywords: Commissioning, Construction, Contract strategies, Ethics, Hidden agenda

Introduction

This paper outlines an understanding of the ethics of commissioning as part of a more general enquiry within the field of the ethics of the Norwegian construction industry. Later years have witnessed an increasing interest in the field of applied ethics in general and in professional ethics in particular (Christoffersen, 2011). Different professions establish rules and regulations, medical doctors, teachers, social workers etc., and the number of publications is ever increasing. The authors of this paper have so far not seen this trend reflected neither in publications concerning the construction industry in general, nor in actual industry agreements in

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Norway. Notable exceptions from this general statement are the likes of Ray et al. (1999), Hill et al. (2013), Fellows et al. (2004), Corvellec and Macheridis (2010), Collier (2005), Bröchner (2009) and Bowen et al. (2007). The rest – it seems to the authors of this paper – do not appear to have a very widespread, thorough understanding of what an ethic of the construction industry should consist of.

Considering that the construction industry in general and in Norway in particular typically receives attention as an industry of doubtful virtue, 1) where neither the police, the tax authorities nor the professional organisations fully master the challenges posed by professional practice (Andersen et al., 2014), 2), where the inherent complexity in itself opens the opportunity for suspicious dealings (Gunduz and Önder, 2012), 3) where fraudulent business practices undermine the reputation of the industry (Slettebøe et al., 2003) 4) that lacks a clear vision based on a fortified ethical foundation (Constructing Excellence, 2009:18), we find this strange. As Hill et al. (2013) comment, there is probably no simple solution or "quick fix" to the challenges of an ethical nature that the industry faces. Tackling such challenges necessitates both insight and endeavour. This proves especially true when considering the commissioning phase of construction projects. The literature has for instance highlighted the need for further development of commissioning procedures on the subject of renovation (Vainio et al., 2013)

Whilst the analysis is based on Norwegian construction projects, the general nature of the challenges presented ought to render it of interest on a more general level for both clients and contractors.

The problem – challenges and costs

According to Ingvaldsen (2008), 2-6% of net production value is typically used to mend process related damages in construction projects, that is, damages inflicted during the construction process and discovered by the customer or user after the commissioning of the building. Josephson (1994), on the other hand, maintain that such damages can surpass 10% of the total production cost, this number including both damages observed both during and after commissioning.

Norges bygg- og eiendomsforening (2014) concluded that the areas with particular problems were the technical facilities– ventilation, heating/cooling, energy efficiency and moisture related challenges. Others have pointed out fire and fire related questions as of particular importance.

Ulfsnes and Danielsen (2004) studied five projects, and found several discrepancies with respect to fire resilience. One example here is a retreat home lacking documentation concerning fire related questions six months after commissioning. The documentation was still not concluded during the time of the analysis. According to these authors, documentation concerning fire and fire related questions are typically lacking at the time of the commissioning of construction projects. This list most probably can be made much longer.

In the following, we examine why challenges such as these appear repeatedly within the context of the Norwegian construction industry.

The project of this paper – a structural approach to ethical challenges in commissioning
In this paper, we analyse ethical challenges in the commissioning phase for the construction industry from a structural perspective. The underlying idea is that the manner in which the industry is organised and certain inherent characteristics form specific challenges of an ethical nature. Rather than presenting any clear (normative) outline of what is good and bad behaviour, we outline the challenges posed in a descriptive manner.

As the title indicates this paper focuses on ethical challenges involved in the commissioning phase of construction projects. The research questions are:

1) *What challenges of an ethical nature are commonly encountered in the commissioning phase of construction projects?*
2) *What are the structural (systemic) reasons for such challenges appearing?*
3) *Do – and to what extent – actors consciously utilise the challenges in the commissioning process in their business practices?*

The first two of these questions will be addressed in the theoretical framework section of the paper, whilst the third will be addressed in the findings section.

Theoretical framework

In order to understand properly what is involved, a scrutiny of the concepts of ethics and commissioning respectively imposes itself.

What we talk about when we talk about ethics
Some delimitations are – in fact – necessary. Firstly, though often concurrent with, ethics must be separated from the field of the law in order to be fully understood. What is perceived as unethical can – in certain circumstances – be lawful, whilst what is perceived as ethically laudable can be deemed unlawful. In the following we concentrate on ethical judgements of actions, and not on their possible legal implications. According to the literature study carried out in the research process leading up to this paper, neither ethical frameworks nor juridical ordonnances suffice for understanding the challenges the actors of the industry face. By nature, such framework or ordonnances enter the scene post bellum, that is, as measures implemented after conflict has arisen or problems have surfaced, whilst this paper rather situate oneself ante bellum, by illustrating the how's and why's of particular challenges.

Secondly, ethics can be separated into normative and descriptive ethics. The first of these profess judgements concerning the manner of acting in the world. This is ethics as most have encountered it, the lessons promulgated being from different traditions such as deontology (Kant, 2012), consequentialism (Mill, 2002), virtue ethics (typically in the tradition from Aristotle, 2009) or various contemporary approaches (Habermas, 1992; Sartre, 1976; Lévinas, 2014; Foucault, 1976 etc.). Analyses of this sort seem in fact – more or less consciously – to perforate what little seem to be done of ethical analysis within the project management literature. See for instance Helgadóttir (2008) for an example of an Aristotelian analysis.

Descriptive ethics, on the other hand, typically analyses the judgements of behaviour in the world within the vocabulary of ethics. Rather than developing a framework for judging the appropriateness of actions, such analyses typically investigate the reasons underlying such judgements in specific contexts. In this paper, we proceed according to a fully descriptive analysis.

Thirdly, depending on which analytic level the analysis is situated, it is possible to distinguish individually oriented and social ethics (Ray et al., 1999:142). The first of these concerns the individual as moral actor, whilst the other concerns the ethical qualities of social systems. The intention of this paper is not to carry out any sort of blame game on a personal level. What occupies us in this paper concerns judgements of interviewees as representatives of a social group, that is, as professionals within the construction project industry.

In order to address questions as the above posed, with the limitations more or less explicitly outlined here, Taylor (2004) has developed the idea of a so-called social imaginary. The term denotes the common perceptions of what is acceptable behaviour and not within a certain social community. Such perceptions and opinions are often not properly articulated and therefore transmitted from individual to individual as "silent knowledge". The central point of Taylor's argument is that individual actions in the world – that is, why we act as we do – can be made understandable in light of a narrative explaining the function of these individuals within a greater whole. The analysis of such social imaginaries can thus help the analyst to understand why actors act as they do, and why certain actions are judged condemnable whilst others are judged laudable by the actors themselves. Applied on the construction industry, it does, in effect, provide a tool for comprehending the judgements of professionals towards specific practices.

Taylor is not entirely unique in this undertaking, a fact he himself acknowledges. The concept of a social imaginary correspond to some degree to what Wittgenstein calls "background" or what Gadamer calls a "horizon of understanding" – for a discussion of these thinkers, see Dreyfus (1991) and Searle (1995). The appeal of the concept of Taylor – and which distinguishes it at least to some extent from these other conceptions – is the underlining of the social nature of this imaginary. To our purpose it is exactly this social anchorage we are seeking; notably, we want to examine how certain practices occur and are judged within a social relationship such as that of the construction industry.

In sum: in the following pages we carry out a descriptive analysis of a social imaginary as representing the ethical framework understanding of actors within the specific context of the construction industry. This being said, we acknowledge that "language in general always reveal some degree of positioning, [...] an indirect normative choice" (Jankélévitch, 1981:17, our translation). This analysis is entirely based on the Norwegian construction industry, a fact that is reflected in our literature references; the conclusions will hopefully be of pertinence to the industry of other countries.

The formal framework for commissioning in Norway

Even though the challenges involved in the commissioning of construction projects are generic, that is, common to all countries, the legislation and formal frameworks vary largely

from country to country. In the following, we render the major framework governing the Norwegian practice, citing it somewhat in extenso.

The Norwegian commissioning practice is standardised by the Norwegian Standardisation organisation Norsk Standard, and chapter 32 from "NS 8405 Norwegian building and civil engineering contract" summarises the commissioning process as follows:

> *"**32.1 General provisions***
>
> *The contract work shall be taken over by the client in taking over proceedings. The entire contract work shall be taken over unless a partial taking over has already taken place.*
>
> ***32.2 Preparations for the taking over proceedings***
>
> *The contractor shall, in reasonable time before the contract work is completed, give written notice of the taking over proceedings to the client. A period of notice of 14 days, counted from the date when the notice is received, shall normally be regarded as reasonable.*
>
> *The contractor shall give reasonable notice of adjustments, tests or the like that are to be carried out on technical facilities. The notice shall state the prerequisites that must be met in order for the tests to be carried out. Should it be necessary for parallel contractors to carry out specific measures or for parallel contractors to participate in the tests, this shall be stated in the notice.*
>
> ***32.3 Taking over proceedings***
>
> *The parties are obliged to attend taking over proceedings in accordance with clause 32.2. Should one of the parties fail to attend for no valid reason, the other party may carry out the taking over proceedings alone.*
>
> *At the taking over proceedings, the parties shall jointly conduct a careful inspection of the contract work. The client shall also have checked the documents it has been sent by the contractor in connection with functional tests and measurements that, pursuant to the agreement, are to be carried out prior to the taking over. These documents shall have been sent to the client well in advance."*

The further elements of the text outline elements such as the purely procedural components such as the characteristics of the commissioning protocol, (what we perceive to be rare circumstances) the right of the client to refuse taking over the building, the effects of taking over, the effects of taking over only parts of projects, etc. What is essential in this context is that the quoted passages outline the common procedures of commissioning within the Norwegian context. According both to the general experience of the authors and to the interviews carried out, the commissioning process is carried out according to this general understanding in the large majority of Norwegian construction projects.

What does this mean? A central trait to the elements cited above is their relative short-term nature; the outline of a two weeks' notice for takeover constitute a clear example of this, as does the lack of specification to the functional tests. In fact, what this seem to suggest is that the commissioning process in Norway must be considered a relatively punctual affair, where the responsibilities of the project shifts from the contractor to the client in a rather brusque manner.

The formal framework for commissioning in Norway

The punctual nature of the commissioning process, as described in NS 8405, seems to pose certain ethical challenges. Most notably, the punctual nature of the process opens possibilities for actors with less than laudable intentions.

Methodology

The analysis presented in this paper is mainly based on interviews with key actors in all the construction projects examined. In addition, a literature review of general literature on the subject of commissioning and documentation studies of the particular projects have been carried out.

The academic footwork of the research presented here was carried out by three master students of project management, particularly chosen on basis of their understanding of the field and personal initiative. Their interest in the field of commissioning was of a generic nature – a sub-set of questions posed during the interviews addressed the concerned ethical aspects.

A total of 13 semi-structured interviews were carried out, four general (with clients) and nine case-specific (with client, contractor and user representatives). All interviewees have played key roles in the respective projects.

All interviews were semi-structured, based on a qualitative approach. They were open and flexible enough to include the possibility to encompass interesting observations from the respondents. Both the gathering of documentation and the interviews were characterized by willingness to share information. The interviews were all registered on tape (with the consent of the interviewees), and later transcribed.

Findings

In this section, we first present the cases examined, before addressing the challenges observed.

The cases examined

The study included an exam of several construction projects – carried out with both public and private clients, and of varying scope. The following projects have been chosen to include this inherent variety of projects.

1) The expansion of a shopping mall in Trondheim, Norway, was chosen as a case due to the complexity the project represented; three consecutive steps, both new construction and refurbishment, and the jointure of old and new building structures. The project

was equally characterised by a significant amount of changes and additions with respect to the contract.

2) A kindergarten (contract sum approximately NOK 55.5 million) and a nursing home were chosen both on basis of the public sector nature of the projects and on the medium level of complexity they represent. The municipality of Trondheim is both client and operates the buildings. The contract type is design-build.
3) An office building was chosen on basis of it being a so-called simultaneous commissioning project. In such projects, the intended customer of the project participates in the commissioning. This project had, in addition, a special contractual twist, involving a so-called forward-contract with first option. The project is organized as an own legal entity, where the intended customer takes over all the stock by commissioning. Significant defects discovered permit them none the less not to taking over the project. The legal entity is at present owned by a professional property developer, also being the client. This latter is the party that carries out the project up to commissioning. The legal entity has a contract with the design-build-contractor. Continuous meeting activity takes place, and intended customer demands more changes than what is common in functionality based design-build contracts. This is challenging, especially for the design-build-contractor who is responsible for tackling all the changes. Test operations lasting in one month is included in the contract, in order to address challenges concerning fine-tuning and test operations.

Observed ethical challenges

The pilot study did not provide (not surprisingly) enough evidence to provide any evidence of ethically challenging challenges that were valid to the entire industry. Nonetheless, certain highly interesting points came out of the investigations:

1) The option for the client to refuse the commissioning process to proceed appear scary to many clients. Construction project clients vary in nature, but often they hesitate from stopping the process of commissioning. Continuing the commissioning process typically seems less negative than involving a team of lawyers. That the contractors know this seem certain, even though none of the interviewees from the contractors acknowledged this. Certain client representatives maintain that they never obtain all the promised technical solutions established by contract.

2) Contractors not able to meet client demands typically win bids on basis of a price beyond other contractors' prices. Often, such contractors fail to meet the requirements demanded in the commissioning phase. Their technical solutions are often characterised by low-cost standards. The emergence and re-emergence of such non-reliable contractors are typically caused by the bid regime of large public (and private) clients. The lack of proper control systems allow for the reappearance of such actors.

3) There is a clear impression among the clients that contractors understand the need for the project in their operations; particularly in the case of public projects such as schools, the need for the project to be finished at the correct date presses the client to an earlier take-over than otherwise recommendable.

4) A consensus that buildings will typically never function in an optimal manner from the start seems to exist. Such a general understanding seem to imply an increased focus by the contractor on satisfying the immediate concerns of the client, rather than pursuing the long-time interests of the project. In short, public relations seem to mark the relationship between the contractor and the client more than actual faults at commissioning.

5) A general challenge seems to be the concept of commissioning in itself. Contractors seem to envisage such a phase as a phase where not completed work and technical installations can be lifted up to the required standards. Such attitudes do, in effect, undermine the whole idea of an effective commissioning process.

6) Technical installations seem to be characterised by a fuzzy commissioning process. Some of the interviewees report testing and trial several months after the use phase of the project is initiated, and after the contractor reports to be finished.

7) Assuring fire security is crucial during the commissioning process. Interviewees report that this is a field where faults often occur. This is equally documented in the literature (Ulfsnes and Danielsen, 2004), where a lack of identification of such faults are identified as critical for security.

Discussion

As indicated in the above findings section, there are considerable challenges involved in the commissioning process as observed in the Norwegian context. Even if the scope of this pilot study is too limited to in any conclusive manner provide a comprehensive understanding of why such challenges occur, it seems to the authors of this paper that the formal aspects of the commissioning process must bear some responsibility. This is especially true for the abrupt nature of the take-over process; within a couple of weeks (and in practice even shorter time-frames), highly complex projects such as contemporary construction projects often prove to be taken over, and all responsibility moved from the contractor to the client.

It seems important to note that the challenges observed cannot be considered as unlawful as such. Rather, they affront the perceived ethical order, what Taylor called the social imaginary, which constitute the common background of professionals in the field of the construction industry. This has implications for the potential measures to take in order to address these challenges: It seems, in fact, that further legal measures will not suffice/be appropriate to address such challenges. Increasing the consciousness of potential difficulties for professionals in the field appears as a rather more appropriate way to proceed. In light of the fact that the literature study leading up to this study revealed a very limited attention that is given to the field of commissioning in general and ethical challenges in commissioning in particular, in order to achieve such an increased consciousness, more research is in fact inevitable.

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Vitenskapelig artikkel nr. 2

Main Challenges found in the Handover of a Shopping Centre in Norway

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Abstract

There seems to be a common understanding that the Norwegian construction industry faces challenges concerning the presence of delays and defects in the handover process. However, little research has been found regarding countermeasures to avoid these problems. This paper forms a part of a research project on handover processes in Norwegian construction projects, initiated by the municipality of Trondheim. It is supposed to work as a pilot study for further research, and examines: 1) Consequences of delays and defects, 2) the causes of them and 3) potential countermeasures that can be implemented.

The case studied was the expansion of a shopping centre in Norway, a complex project, both structurally and organisationally. In addition to a literature review and a documentation study, nine semi-structured in-depth interviews were conducted. All of the interviews were case-specific, with client, contractor and user representatives respectively.

The consequences of delays and defects were severe and resulted in additional costs, lower quality on the final product and psychological strain for the involved actors. Short construction period, diffuse contractual relationships, lack of quality assurance and a high degree of alteration work are found to constitute the most crucial causes. On the basis of the observed challenges different countermeasures are suggested. Building commissioning, realistic project plans, control on deliveries and independent control are recommended as countermeasures.

The findings indicate a great potential for improvement by keeping the control throughout the whole project. Further experiments are needed to substantiate the recommendations of this paper.

Keywords: Handover process; construction management; commissioning; challenges; countermeasures.

Introduction

The construction of contemporary shopping centre projects is typically characterised by being unique and highly complex. The construction itself is challenging because of scale, technical

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complexity and stringent demands from the authorities. The picture becomes further complicated by there being several parties to the contract: The client, the contractor and tenants. Additionally, a great number of actors are involved in the process, some working for the contractor and others for the tenants. Lastly, the building is highly complex in use and the user group varies from employees to customers and operation and maintenance personnel. Together, this makes it challenging to organise, plan and execute such a project.

This paper reports on experiences from the expansion of a shopping centre in Norway. This case was chosen mainly on the basis of the complexity the project represented. Three consecutive steps constitute the project: 1) A new construction containing shops, 2) a new construction in the shape of a parking structure and 3) a refurbishment of existing construction from a parking structure to a shopping area. The third step equally included a jointure of new and old building structures. The contract type was design-build and the existing part of the shopping centre was open during the construction period. The different tenants (shops) took over their premises from four to six weeks before the grand opening.

The findings of this study indicate that the handover process is a process where several problems appear, especially in the form of delays and defects. Used in this paper, the term handover process includes quality assurance, testing, commissioning, signing and the actual handover of the construction and its documentation.

Even though the consequences of a failed handover process often prove severe, this seems to be a little scrutinised part in contemporary construction project research. The literature study initiating this study revealed in fact that handovers in general, and the handover of shopping centres in particular, seem to be surprisingly little analysed. The authors of this paper find this surprising. Much of the literature support the fact that delays and defects is a problem, but the research on causes and countermeasures seems insufficient.

This paper reports on the handover of one specific case study and analyses the challenges involved in this process. Further, it identifies different countermeasures that can be implemented to improve the handover process.

The analysis is structured according to the following research questions:

1. *What are the consequences of delays and defects?*
2. *What are the causes of delays and defects?*
3. *What countermeasures can be implemented to improve the handover?*

Theoretical Framework

The standard "NS 8407.E:2011 General conditions of contract for design and build contracts" regulates design and build contracts in Norway. NS 8407 governs contractual relations where one of the parties (the design and build contractor) is responsible for all, or substantial parts, of the design and execution of the construction (Standard Norge, 2011). The risk and responsibility for the design and execution of the construction is transferred from the client to the contractor (Lædre, 2009). This includes coordination of subcontractors and progress

planning. An essential document in the context of design and build contracts is the client's project requirements. The client is responsible for preparations of the requirements, while the contractor must deliver the construction in accordance with these requirements and the design-build contract. Typically, the requirement document contains the client's paramount requirements, together with a space- and functional program (Xia et al., 2011, DIFI, 2014). The contractor is free to decide the types of material, handiwork and technical solutions as long as they are in accordance with the contract and the requirements. The client is entitled to carry out inspections to ensure that the work is in compliance with the contract.

Chapter 37 from "NS 8407.E:2011 General conditions of contract for design and build contracts" standardises the practice regarding handovers of design and build contracts. This standard forms the basis of the majority of Norwegian construction projects. According to chapter 37, both the contractor and the client are obliged to attend the handover. As a main rule, the entire contract work must be handed over to the client. As a crucial part of the handover, the standard recommends a careful inspection of the contract works. The further elements of the text contain procedural components such as the characteristics of the handover record, the right of the client to refuse handover and the effects of taking over the construction. The latter imply that the risk of damage is transferred from the contractor to the client and that the client becomes entitled to use the building. When the client takes the construction in use, it is considered taken over (Standard Norge, 2011).

The terms "commissioning" and "building commissioning" are typically used in connection with handover. According to Burnett (2008) the term building commissioning denotes everything from testing and control of technical installations to an overall quality assurance process parallel to the ordinary construction process. The California Commissioning Collaborative (2006), Grondzik (2009) and Ágústsson and Jensen (2012) all define building commissioning as a procedure for systematic quality assurance of construction projects and a way to *prepare* the project for handover in the best possible way. It thus seems that building commissioning is not a phase or an additional quality assurance process, but a procedure running parallel to the existing construction process, from pre-design to handover. An illustration can be seen in Figure 1. In the following, this is the understanding we use.

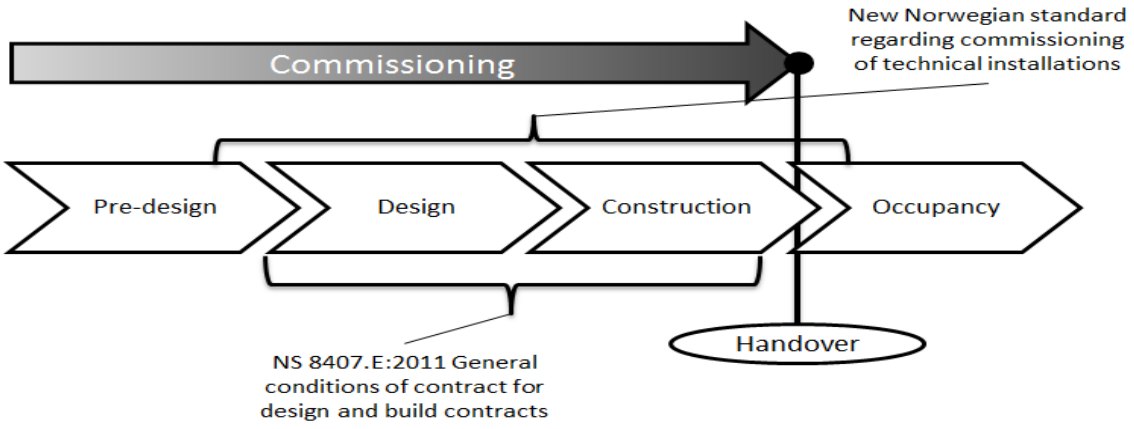

Figure 1 Building commissioning as a preparation for the handover. The importance of commissioning increases as the project approaches the handover.

The existing Norwegian standards do not reflect the perspective on building commissioning as a systematic quality assurance process. The only paragraph concerning commissioning in NS 8407.E:2011 addresses commissioning in a testing and control perspective. However, Standards Norway is presently working on a new standard regarding commissioning on technical installations (Standard Norge, 2015). The suggested new standard defines commissioning as a test and control regime and describes the stages towards a functional building, from pre-design to occupancy; see the illustration in Figure 1. It provides guidelines concerning how and when the commissioning should be carried out, framework conditions, the process itself, and input/output data.

The intention of building commissioning is to systematically prepare the handover of the building and improve its performance by making the technical systems work together. Typically, a commissioning coordinator is hired to lead the process (GSA Public Buildings Service, 2005). The purpose of the procedure is to ensure that the building, included its technical systems, is executed to meet the expectations and requirements of the owner (California Commissioning Collaborative, 2006). To achieve all the advantages offered by using commissioning, it should be a priority already in the pre-design phase, when the client sets the requirements of the project. To attain successful outcomes to commissioning, Burnett (2008) emphasises the importance of the client's commitment. The main responsibility of the client is to clearly communicate the desired outcome of the project.

The cost of commissioning varies from project to project, as every building is unique and the scope of commissioning is of vital importance for the costs. Even though a total building commissioning from pre-design to occupancy is expensive, the potential advantages throughout the lifespan of the building are huge (Burnett, 2008). The following constitute the most significant benefits of commissioning (GSA Public Buildings Service, 2005, California Commissioning Collaborative, 2006): Construction cost savings, improved coordination between design, construction, and occupancy, fewer system deficiencies and improved function of the systems, energy savings, improved indoor environmental quality, improved client and user satisfaction, improved operation and maintenance and increased safety.

The advantages of building commissioning cited above appear not reflected in the current Norwegian standards.

Delays and defects

Increasingly complex buildings increase the possibility of making mistakes. Standard Norge (2006) defines the term quality as the "degree to which a set of inherent characteristics fulfils requirements" (p. 15), where requirements are the "need or expectation that is stated, generally implied or obligatory" (p. 15) and characteristics are the "distinguishing feature" (p. 22). A "defect" implies that the contract works, or parts of the contract work, do not fulfil its requirements (Standard Norge, 2011). This also includes damages arising after the handover, but that are obvious and predictable results of the original defects. A "delay" signifies when a task is not finished within the handover date.

According to Ingvaldsen (2008), 2-6 % of the net production value is typically used to improve process related defects, that is, defects discovered by the client or the users in the

aftermath of the handover of the building. Josephson (1994) claims that such defects can exceed 10 % of the production costs. This includes defects discovered during and after the handover. A survey concerning quality and quality assurance conducted by Norges bygg- og eiendomsforening NBEF [Norwegian Building and Property Association] (2014) concluded that the areas with particular problems were the technical systems (HVAC), energy efficiency and moisture related challenges.

According to Josephson and Hammarlund (1999), most of the defects occurring during production originate from production itself. As much as 50 % of the defect costs can be related to what they term (lack of) human engagement. In this context, human engagement is a collective term for motivation, expectations and commitment, but where few of these defects are intentional (Josephson, 2013). Knowledge, experience and skills are necessary to avoid actions that cause defects and crucial to discover the roots and avoid the problems.

Research methodology

The research was carried out by using one specific case. The case study was conducted according to the principles of Yin (2014). According to Flyvbjerg (2006, p. 228) "one can often generalise on the basis of a single case, and the case study may be central to scientific development via generalisation as supplement or alternative to other methods". The case was chosen due to the complexity the project represented and because the first author had first-hand experience with the project from a summer internship.

The research was conducted according to a qualitative approach, which gives the opportunity to view phenomena holistically (Creswell, 2013). Nine semi-structured interviews with key actors from the selected construction project were conducted. Contractor, client, hired project managers and users were among the informants in order to provide an overall picture. The same structure of questions was used in all the interviews. The interview guide can be found in Firing (2015), however only in Norwegian. A semi-structured approach was chosen to give the informants an opportunity to elaborate their answers and to ask follow-up questions when necessary. Most of the interviews were registered on tape and later transcribed. In the cases were an informant was not comfortable with recording of the interview, written notes were kept. The transcriptions/reports were sent to the informants for approval. The subjective nature of the interview findings has called for a critical view on suggested causes and countermeasures.

As part of the case study, the research was carried out by a literature review and a document study. The literature review was conducted according to the guidelines recommended by Blumberg et al. (2014). The retrieved literature from the review concerns the building process, its different phases and involved actors. In addition, literature on legislation, challenges, consequences, causes and potential countermeasures was investigated. A majority of the literature regarding commissioning had a very technical approach to the topic and was thus not considered as relevant as the literature considering commissioning as an overall quality assurance process running parallel to the ordinary construction process. The documentation studied mainly included the contract of the case and documents regarding the contractor's approach to the Last Planner System®. These documents were chosen due to the need for

understanding the basis of the project and the contractor's routines and systems for progress planning.

Findings and discussion

In this section we address and discuss the challenges observed in the case study and suggest some potential countermeasures. The latter is partly based on the findings from the interviews and partly on the findings from the literature and reflections by the authors. Being a pilot study, the findings presented in this paper are not valid for the entire industry, but they clearly indicate that this is a major point of contagion.

The majority of the informants agreed that the percentage of completion at the date of handover was too low. The most severe delays and defects in the case study concerned the technical systems. This coincides with the findings from the reviewed literature. For instance, on the handover date the fire alarm installations, more specifically the voice alarm, did not work. To handle this problem, the contractor had to use own staff and hire security guards to act as a temporary voice alarm. This lasted for several days and resulted in a huge cost for the temporary solution as well as dispute between the contractor and the client regarding responsibility.

According to several of the informants the construction site was characterised by chaos and people working everywhere the weeks and days prior to the handover. The tenants experienced delays in the delivery of their premises, e.g. cladding glass and rolling grilles were not installed as agreed. The described situation made it easy for dishonest operators to exploit this to their own advantage; in the final phase there were incidents that included both thefts of goods and equipment, as well as threats to the contractor's employees.

Consequences, causes and countermeasures

The majority of the informants answered that the most severe consequence of a high extent of defects and delays was the **unsatisfying quality level.** This has both an economically as well as a functional and esthetical aspect. The building was not functional in an optimal manner from the start and the ideal level is difficult to reach when it is already in use. Lower quality and thus lower value on finished building may be the final consequence of this problem. Findings in the literature suggest that use of commissioning gives advantages in the shape of energy savings and fewer systems deficiencies. On this basis it is reasonable to assume that the client will be the losing part in the long run with increased operation and maintenance costs in the future.

Another severe consequence is that the **client felt forced to take over** a building that, in his opinion, was not finished. Prior to the handover the client was worried concerning the progress and informed the contractor. The response was that everything was under control. Eventually the project passed the "point of no return": There were advertisements about the opening of the shopping centre in the newspaper, on the radio, etc. The client had no choice but opening the centre, even though the quality level was not considered to be satisfactory by the client. According to the standard the client has a right to refuse handover, but the contractor knows very well that when the client starts using the building it is considered taken

over. This is a severe consequence in all construction projects having a final and immovable handover date, e.g. schools, shopping centres and hotels.

According to the informants, more resources were necessary to remedy the lag. The result was **additional costs** for several of the involved actors. The contractor had to hire more workers and use money on necessary overtime. Tenants with contractors from out of town had to buy new traveling tickets and accommodation for their workers. As mentioned above, a probable and severe consequence of delays and defects is higher operations and maintenance costs in the future than would have been the case if the building was complete at the time of handover. Findings in literature indicate that defects discovered in the aftermath of the handover lead to additional costs for the client because they have to be rectified. In addition to increased costs, it is reasonable to assume that more workers may lead to more chaos and thus increased danger for new delays and defects.

The findings imply that unfinished work can result in **discussions and disputes** regarding responsibility. As described above, the client said that the he was in doubt if he wanted to take over the building in the first handover because the result, in his eyes, was unsatisfying. Such a serious conflict in the first part of the project may have resulted in a client more stressed and distrustful than he would have been if the first handover went well. One of the informants explained that with such a challenging process, no matter what the contractor the client will never become fully satisfied with the final product. A possible and severe outcome for the contractor can be a bad reputation in the business and that he may not be considered if client is planning a new construction in the future.

The contractor emphasised the **psychological aspect** as a significant consequence of a challenging handover. As a result of time pressure, unforeseen incidents, alteration work and an unsuccessful first handover, members of the staff were driven to the breaking point. The conclusion of the first construction step was the beginning of the next. Members of the staff needed to have a 100 % overview on two highly critical phases at the same time, this probably made it easy to lose track of the important tasks. Staff that should have had all their attention on the preparations of the handover simultaneously prepared the kick-off of the next construction step. According to the literature, as much as 50 % of the defect costs can be related to lack of human engagement, but not intentioned. In other words the result of high psychological pressure may be even more defects.

When asked about the most crucial contribution to delays and defects, the informants answered **short construction period** and little time available as the main cause. The project was “in a hurry” from day one and several small incidents aggregated to become serious delays. If the carpenter becomes delayed, so does the plumber and electrician. The outcome was chaotic, with many different actors involved, and people working everywhere. When work is carried out everywhere, it is easy to lose progress control.

Unexpected structural problems, as an exceptionally challenging ceiling, damaged walls because of humidity and poorly executed concrete work also affected the progress negatively. As described above, delays in one special field affects the others. Materials behaving unsatisfying can be challenging to foresee and hard to avoid, but there is a great potential for

learning and to use the knowledge in new projects. It goes without saying that it is almost impossible to improve poorly executed concrete when a building is almost finished. Such work needs to be done immediately, and thus the contractor should accomplish a quality assurance straight after execution of the works.

According to the standard, the contractor is responsible for the coordination of the subcontractors. The contractor experienced the **collaboration** with some of them as demanding at some stages in the process, especially in the final phases. The information regarding the subcontractors' progress was experienced as being directly false. Some gave an impression of full control, while the truth was the opposite. This may be a sign of what the literature denotes as lack of motivation and commitment. In a construction project, the contractor is dependent on the various subcontractors feeling commitment and helping to optimise the overall project.

Together with a short construction time, a high extent of **alteration work** caused additional time pressure. In the end, alteration work surpassed 25 % of the original value of the contract. Despite this fact, the construction period remained the same. The findings indicate that some of the alteration work could be explained by tenants being **signed late** and thus moving into the centre at a late stage. Such complications are mainly due to **market fluctuations**, which may be difficult for the project organisation to influence. Tenants signed late are entitled to the same tenant process as those signed early, and this may "steal" important resources from the project organisation in a challenging phase. The contractor stated the rest probably could be traced back to an unsatisfying process regarding the development of the **client's requirements** as well as late decisions from the client. This emphasises the findings from the literature about the importance of precise and well-formulated client's requirements as a basis for the tender competition. Client engagement and the client's responsibility to clearly communicate the desired outcome can be crucial to project success.

Both the client and contractor respondents agreed that the outcome of the causes above was an **unsatisfying quality assurance process**. On-site inspections with representatives from both the client and the contractor prior to the handover lacked. As a result, delays and defects that could have been discovered earlier were detected during the very last inspections. The experience was the same with testing and control of technical installations. The time allocated to conduct such inspections was insufficient to the need and thus the systems were infested with defects at the time of handover. The fact that installation lasted until the handover date, did not contribute to a satisfying quality assurance process. To be able to carry out a satisfying quality assurance and testing, the installations need to be finished on time, preferably some weeks/months prior to the handover.

Another cause was **diffuse contractual relationships**. There were several contractual relationship and lack of consistency between them. There was one main contract between the contractor and the client, regulated by the previous version of NS 8407.E:2011. At the same time, both the client and the contractor had their own contracts with each and every of the tenants. The problems occurred when there was lack of consistency between the contracts the client had with the tenants and the contracts the contractor had with the tenants. The

contractor experienced higher expectations from the tenants than what was agreed in the contract, and the tenants experienced not to receive the product they were entitled to according to the contract with the client. The result was a lack of agreement upon quality in the handover process. If these contractual relationships were more distinct, this problem could most probably have been avoided.

The described incidents originate from all parts of the construction process and could probably have been avoided with already existing countermeasures and emphasis on handover from day one. Procedures and rules already exist, but are not being followed.

To make sure the products meet the client's expectations, both the findings and the reviewed literature suggest **building commissioning** as a countermeasure. According to the literature, building commissioning is a proper measure to prepare the building for handover, make sure it meets the requirements of the client and increase the quality of the final product. A professional commissioning coordinator can be hired to lead the process, but the use of building commissioning places demands on both the client and contractor throughout the whole project.

In the pre-design phase, the client and the contractor must cooperate to develop **realistic project plans**, including preparation of contracts and client's requirements. As this was a shopping centre, there were several contracting parties. To avoid misunderstandings and conflicts, it is decisive to ensure consistency between the different contracts. The contracts should state responsibility and what the client is entitled to, as well as milestones and what is expected to be delivered at each milestone. A professional preparation of the client's requirements may contribute to decrease the amount of supplementary and alteration work during the execution period. The findings further indicate that the construction period should be considered carefully. In this case, the construction period seems to have been too short and this resulted in a challenging execution phase. Several small delays accumulate fast and the findings from the case study indicate a need for an extended construction period, especially when the extent of alteration work increases.

The majority of the informants accentuate **control on deliveries** as a premise for a successful handover, especially when the construction period is short. Progress planning, quality assurance and client's commitment are countermeasures contributing to better control. It is particularly important that the design build contractor involves the subcontractors in the progress planning to give a sense of obligation and commitment and simultaneously checks up on them frequently. To avoid work everywhere in the building at the same time, the findings also suggest that the progress plan should be seen in connection with a distinct production strategy. What to produce. Who, where and when. With so many actors involved, the findings emphasise the importance of thinking about logistics when making a production strategy, in other words begin the works in one end and work one's way through the construction. The findings further suggest that the contractor should conduct quality assurance inspections continuously to discover and improve defects and delays as early as possible. Control on deliveries also makes demands on the client, who should commit to the decisions and requirements made in the pre-design phase.

Both the literature and the findings suggest the use of independent control as a countermeasure to ensure the product meets the expectations. The inspections should be conducted by a professional third-party and emphasise on the integration of technical systems as this was found to be the most severe problem in the case study. This presupposes a well-functioning project organisation, unless it will only be a contribution to more chaos.

Conclusion

Table 1 presents a summary of identified causes, consequences and potential counter-measures.

Table 1 Challenges in the handover and countermeasures to avoid them. The parenthesises denotes responsibility of the countermeasures.

Delays and defects		
Consequences	**Causes**	**Potential countermeasures**

• Unsatisfying quality level
• The client felt forced to take over
• Additional costs
• Disputes and distrust
• Psychological aspect
	• A short construction period
	• Unexpected structural challenges
	• Challenging collaboration with sub-contractors
	• High extent of alteration work – same construction period
	  ○ Late signing of tenants
	  ○ Market fluctuations
	  ○ Client's requirements
	• Lack of quality assurance and testing
	• Diffuse contractual relationships
		• Use of building commissioning (client and contractor)
		• Realistic project plans (client and contractor)
		  ○ Contracts (client)
		  ○ Client's requirements (client)
		  ○ Construction period (client and contractor)
		• Control on deliveries (client and contractor)
		  ○ Progress planning (contractor)
		  ○ Quality assurance (contractor)
		  ○ Client's commitment (client)
		• Independent control (third-party)

Our main conclusion is that to avoid delays and defects, and further, severe consequences, the project must avert chaos in the last period before the handover. Based on the findings from the case study, there are multiple causes leading to defects and delays, the majority of them occur *prior* to the handover. They can act in chain or in combination with each other. In most cases, the consequences are severe for all involved actors. The findings indicate that counter-measures that can be used in the preparation for the handover already exist, but the potential is not fully exploited. In this paper, building commissioning is suggested as a countermeasure. A commissioning coordinator can lead the process, but the contractual parties are obligated to deliver throughout the whole project. The client and the contractor have a shared responsibility to make realistic plans from the inception of the project. This makes the potential for control throughout the project greater. Furthermore, the contractor is committed to execute and control that the deliveries are in accordance with the agreed time and quality. This includes progress planning and a systematic quality assurance process. Simultaneously,

the client must commit to his own early decisions to avoid supplementary and alteration work. Lastly, the findings suggest independent control as a relevant countermeasure to assure the works are in accordance with the client's requirements.

The findings indicate a great potential for improvement by keeping the control throughout the whole project. The outcome may be increased quality on the final project and money saved for both the client and the contractor.

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Vitenskapelig artikkel nr. 3

Completed Building at Handover

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Abstract

Purpose

A common understanding seems to be that the Norwegian construction industry faces challenges in the handover process, especially regarding delays and defects. However, little research has been found regarding countermeasures to avoid these problems. This paper forms a part of a research project on handover processes in Norwegian construction projects, initiated by the municipality of Trondheim. The paper examines 1) The consequences of delays and defects 2) the causes of delays and defects 3) potential countermeasures to implement and 4) who are responsible for these countermeasures.

Methodology

In addition to a literature review and a documentation study, thirteen semi-structured in-depth interviews were conducted. Nine of the interviews were case-specific, with representatives from the client, contractor and user in an expansion of a shopping centre in Norway. The four others were conducted with policy makers.

Findings

Delays and defects have several causes and the consequences are severe. The problems origin during the whole construction process and potential countermeasures are thus appropriate for different levels of analysis. The findings indicate a great potential for improvement.

Practical implications

The conclusions describe countermeasures on operational, tactical and strategic level that will reduce the challenges in the handover process.

Originality/value

Existing literature do not extensively cover the challenges related to the handover process. The findings indicate a great improvement potential by keeping the control throughout the whole project. Further experiments are needed to substantiate the recommendations of this paper.

Keywords: Handover process; construction management; commissioning; challenges; countermeasures.

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Introduction

The construction of contemporary shopping centre projects is typically characterised by being unique and highly complex. The construction itself is challenging due to scale, technical complexity and stringent demands from the authorities. The picture becomes further complicated by there being several parties to the contract: The client, the contractor and tenants. Additionally, a great number of actors are involved in the process, some working for the contractor and others for the tenants. Lastly, the building is highly complex in use and the user group varies from employees to customers and operation and maintenance personnel. This makes it challenging to organise, plan and execute such a project.

This paper reports on experiences from the expansion of a shopping centre in Norway. The case was chosen mainly on the basis of the complexity the project represented. Three consecutive steps constitute the project, each ending with a handover: 1) A new construction containing shops, 2) a new construction in the form of a parking structure and 3) a refurbishment of existing construction from a parking structure to a shopping area. The third step equally included a jointure of new and old building structures. The contract type was a design-build contract and the existing part of the shopping centre was open during the construction period. The different tenants (shops) took over their premises from four to six weeks prior to the grand opening.

The findings of Firing et al. (2015) indicate that delays and defects are considered as a severe problem in the handover process. This challenge typically occurs prior to the handover. Standard Norge (2006) defines the term quality as the "degree to which a set of inherent characteristics fulfils requirements" (p. 15), where requirements are the "need or expectation that is stated, generally implied or obligatory" (p. 15) and characteristics are the "distinguishing feature" (p. 22). A "defect" implies that the contract works, or parts of the contract work, do not fulfil its requirements (Standard Norge, 2011). This also includes damages arising after the handover, but which are obvious and predictable results of an original defect. A "delay" signifies when a task is not finished within the handover date. The definitions of delays and defects proposed by Standard Norge (2011) are adopted in this paper.

Increasingly complex buildings increase the possibility of making mistakes. According to Ingvaldsen (2008), 2-6 % of the net production value is typically used to improve process related defects. That is, defects discovered by the client or the users in the aftermath of the handover of the building. Josephson (1994) states that the costs of such defects can exceed 10 % of the total production costs. This includes defects discovered during and after the handover. A survey concerning quality and quality assurance conducted by Norges bygg- og eiendomsforening NBEF [Norwegian Building and Property Association] (2014) concluded that the areas with particular problems were the technical systems (HVAC), energy efficiency and moisture related challenges. Forcada et al. (2013) found that the most common defects in residential buildings were missing items or tasks, surfaces/appearances and inappropriate installations.

According to Josephson and Hammarlund (1999), most of the defects occurring during production originate from production itself. As much as 50 % of the defect costs may origin

from what they term (lack of) human engagement. In this context, human engagement is a collective term for motivation, expectations and commitment, but where few of these defects are intentional (Josephson, 2013). Research conducted by Emmitt (2014) shows that 40 % of the defects can be traced back to decisions taken prior to the execution phase. Findings from Schneider et al. (2015) identify several causes in the relationship between client and contractor. Knowledge, experience and skills are necessary to avoid actions that cause defects. This is also crucial to discover the roots. Digby et al. (2014) emphasise the value of solving the problems by the roots rather than treating the symptoms.

Kvalnes (2014) reports on honesty in projects and argues that misreporting from projects can be an ethical challenge. Truthful and available information is a premise for successful planning and execution of a project and may contribute to improve the project outcome. Müller et al. (2013) claim that project managers are reluctance to report on performance issues that may cause cost and schedule overruns:

- in hope of being able to balance costs through reduced functionality of the product;
- in hope of recovering through other means at some time in the future;
- in fear of project termination;
- in fear of admitting planning mistakes;
- in fear of losing bonus or other incentives; and
- because of uncertainty about proper timing for escalation.

(p. 35)

According to the findings of Müller et al. (2013), it is reasonable to assume that delays and defects may be hidden on the basis of some of the reasons listed above.

Lohne et al. (2015) discuss the ethical aspects on handover in Norwegian construction projects and indicate that the formal conditions of this process must bear some of the responsibility for the problems occurring. Instead of new or additional regulations, Lohne et al. (2015) suggest increased attention regarding possible challenges among professionals in the industry to avoid them from occurring. According to Firing et al. (2015), desirable countermeasures already exist, but the potential is not fully exploited. An example is quality assurance inspections. Research conducted by Schneider et al. (2015) indicates that the attention during the quality inspections is on visible/esthetical defects rather than defects in expensive technical systems.

The initial literature study revealed in fact that handover in general, and the handover of shopping centres in particular, seem to be surprisingly scarcely analysed. The authors of this paper find this surprising. The research conducted by Lohne et al. (2015), Schneider et al. (2015) and Firing et al. (2015) shows a need for countermeasures on different levels. This paper is a part of the same collective project and continuance of their work on counter-measures.

The basis of the paper is the handover of one specific case study. In addition, policy makers have been interviewed to investigate whether findings from the case study are representative for the industry. The analysis is structured according to the following research questions:

1. *What are the consequences of delays and defects?*
2. *What are the causes of delays and defects?*
3. *What countermeasures can be implemented to improve the handover?*
4. *Who is responsible for these countermeasures?*

Theoretical Framework

In order to properly understand what is involved in the handover process of the case studied, this section scrutinises the general conditions of design and build contracts in Norway. In addition, the concepts of handover and commissioning of such contracts are examined. Finally the concept of different levels of analysis is accounted for.

Design and build contracts in Norway

The standard "NS 8407.E:2011 General conditions of contract for design and build contracts" regulates design and build contracts in Norway. NS 8407 governs contractual relations where one of the parties (the design and build contractor) is responsible for all, or substantial parts, of the design and execution of the construction (Standard Norge, 2011). The risk and responsibility for the design and execution of the construction is transferred from the client to the contractor (Lædre, 2009), including coordination of subcontractors and progress planning. An essential document in the context of design and build contracts is the client's project requirements. The client is responsible for preparations of the requirements, while the contractor must deliver the construction in accordance with the requirements and the contract. Typically, the requirement document contains the client's paramount requirements, together with a space- and functional program (Xia et al., 2011, DIFI, 2014). The contractor is free to decide the types of material, handiwork and technical solutions as long as they are in accordance with the contract and the requirements. The client is entitled to carry out inspections to ensure that the work is in compliance with the contract.

Handover and building commissioning

Chapter 37 from NS 8407.E:2011 standardises the practice regarding handovers of design and build contracts. This standard forms the basis of the majority of Norwegian construction projects.

According to chapter 37, both the contractor and the client are obliged to attend the handover. As a main rule, the entire contract work must be handed over to the client. As a crucial part of the handover, the standard recommends a careful inspection of the contract works. The handover may take place despite of small and less significant delays and defects, but the client has the opportunity to refuse handover of the entire building if the incidents are severe enough. If this is the case, the contractor must pay day penalties until the building is rectified. The further elements of the text contain procedural components such as the characteristics of the handover record and the effects of taking over the construction. The latter imply that the risk of damage is transferred from the contractor to the client and that the client becomes entitled to use the building. When the client takes the construction in use, it is considered taken over (Standard Norge, 2011). Management, operation and maintenance documentation (MOM-documentation) shall be sent to the client no later than three weeks prior to the handover.

The terms “commissioning” and “building commissioning” are typically used in connection with handover. According to Burnett (2008) the term building commissioning denotes everything from testing and control of technical installations to an overall quality assurance process parallel to the ordinary construction process. The California Commissioning Collaborative (2006), Grondzik (2009) and Ágústsson and Jensen (2012) all define building commissioning as a procedure for systematic quality assurance of construction projects and a way to *prepare* the project for handover in the best possible way. It thus seems that building commissioning is not a phase or an additional quality assurance process, but a procedure running parallel to the existing construction process, from pre-design to handover. An illustration can be seen in Figure 1. In the following, this is the understanding we use.

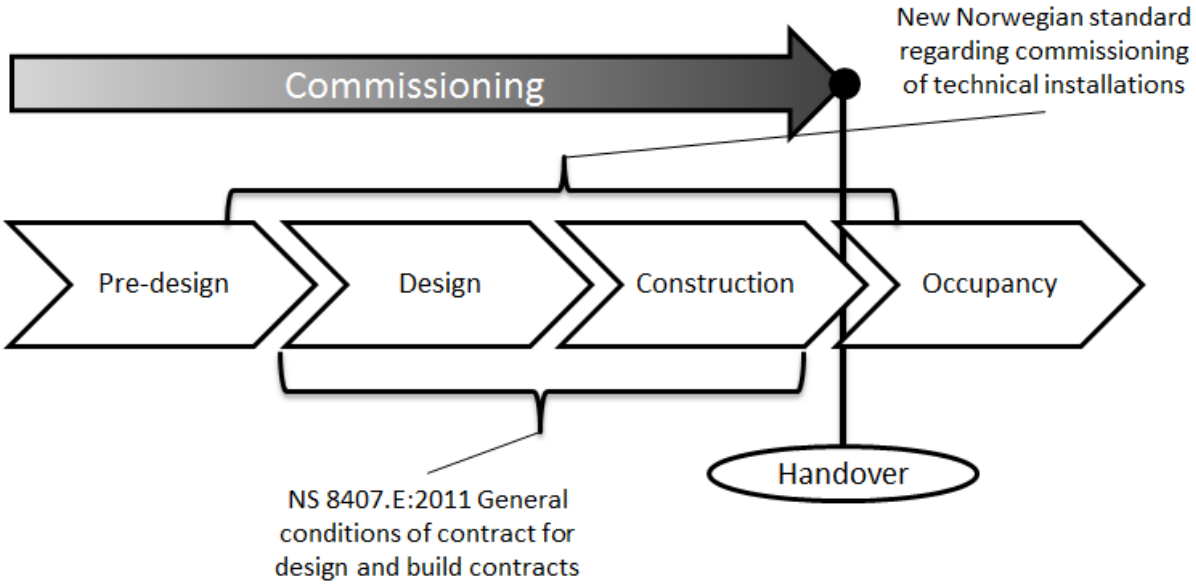

Figure 1 Building commissioning as a preparation for the handover. The importance of commissioning increases as the project approaches the handover.

The existing Norwegian standards do not reflect the perspective on building commissioning as a systematic quality assurance process. The only paragraph concerning commissioning in NS 8407 addresses commissioning in a testing and control perspective. However, Standards Norway is presently working on a new standard regarding commissioning on technical installations (Standard Norge, 2015). This new standard specifies routines and tests that are included as a part of the commissioning process, from pre-design to occupancy. The purpose of the standard is to make sure the building meets the requirements of the client. The client develops the requirements and specifications in the pre-design or design phase (dependent on contract type). In the suggested standard the construction phase is divided into four different phases, see Figure 2. The installation phase includes fabric testing and assembling. An important milestone in this phase is mechanical completion. In the system start-up phase the different systems are tested and balanced. Operation includes training of operating personnel and integrated tests to make sure the technical systems work together. The seasonal testing is conducted with users in the building to make sure the performance of the building meets the requirements independent of use and weather conditions. Figure 2 illustrates that a delay in

the mechanical completion or in the start-up phase causes shorter time to use for operation and seasonal testing.

The development of a new standard seems to be an attempt to introduce commissioning to Norwegian construction industry.

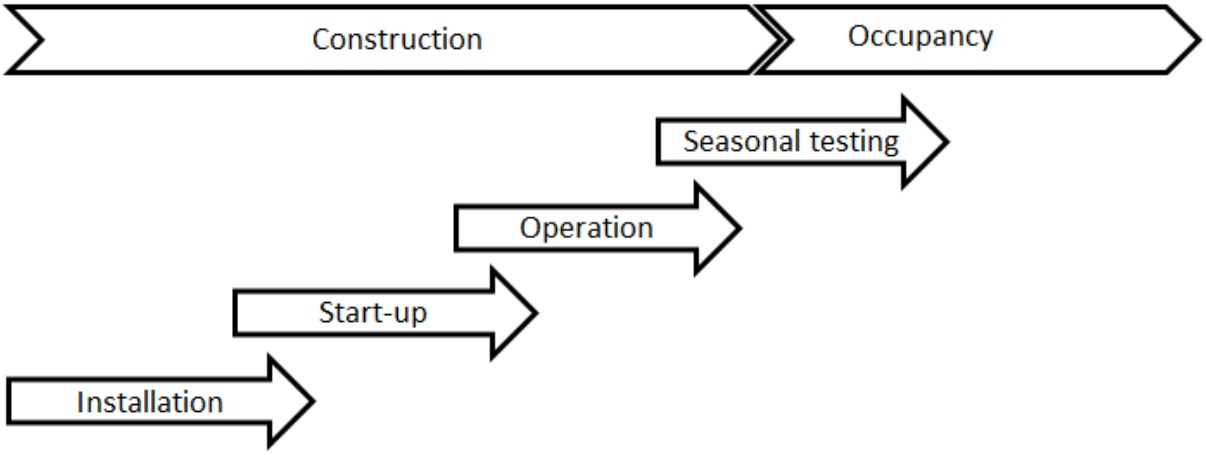

Figure 2 The commissioning process as described in the new Norwegian standard.

The intention of building commissioning is to systematically prepare the handover of the building and improve its performance by making the technical systems work together. Often, a commissioning coordinator is hired to lead the process (GSA Public Buildings Service, 2005). The purpose of the procedure is to ensure that the building, including its technical systems, is executed to meet the expectations and requirements of the owner (California Commissioning Collaborative, 2006). By having the client in mind and consider the situation and suggested solutions from the client's perspective, the contractor manages to establish trust and further client satisfaction (Gustafsson et al., 2010). To achieve all the advantages offered by using commissioning, this should be a priority already in the pre-design phase, when the client sets the requirements of the project. To attain successful outcomes of commissioning, Burnett (2008) emphasises the importance of the client's commitment. The main responsibility of the client is to clearly communicate the desired outcome of the project.

The cost of commissioning varies from project to project, as every building is unique and the scope of commissioning is of vital importance for the costs. Even though a total building commissioning, from pre-design to occupancy, is expensive, the potential advantages throughout the lifespan of the building are huge (Burnett, 2008). The following constitute the most significant benefits of commissioning (GSA Public Buildings Service, 2005, California Commissioning Collaborative, 2006): Construction cost savings, improved coordination between design, construction, and occupancy, fewer system deficiencies and improved function of the systems, energy savings, improved indoor environmental quality, improved client and user satisfaction, improved operation and maintenance and increased safety.

Levels of analysis

The rate of success in projects depends on the point of view. According to Hjelmbrekke et al. (2014) it is common to distinguish between three different levels of analysis, strategic, tactical

and operational, when talking about value creation in projects. Haavaldsen et al. (2014) have the same approach, but explain it as different perspectives on deliverables and effects of investment projects. They have in common that each of the levels has its own objectives and corresponding timeframes.

The emphasis on the strategic level is the purpose of the project and the second-order effects of it in a long-term perspective (Samset, 2010). Board of directors in an organisation typically represent the strategic level and the decisions made may be highly complex. The tactical level converts the strategy into relevant output. This is typically done by a project sponsor (Hjelmbrekke et al., 2014). The emphasis on this level is to make decisions that meet the purpose stated in the strategy. On the operational level a supplier is responsible for producing the project output in accordance with the agreed time, budget and quality, in other words a short term perspective.

The understanding of the level slicing varies, but in the context of this paper we define the strategic level as the policy makers and politicians developing new standards and regulations. The sector board for construction and property in Standard Norge consists of members representing the most important stakeholders in the industry. The responsibility of the board includes identifying the need for new standards and discussing the composition of new standardisation committees. The latter typically consists of professionals from the industry working on a voluntary basis. The purpose of developing a new standard in relation to the topic handover may for instance be to improve the quality of new buildings. Subsequent consequences of better buildings may be decreased building costs and decreased impact on the environment, in other words the second-order effects. In this paper we define the tactical level as the client initiating the construction project. This responsibility includes choice of contractors, continuous control of the contractor and monitoring of provisions enshrined in the juridical framework. The client is interested in a building that meets the stated requirements, the first-order effects. The design build contractor represents the operational level. The responsibility of the contractor is to manage and execute the project in accordance with time, budget and requested quality.

The literature review has not resulted in any findings classifying countermeasures on analytical levels. This can indicate a knowledge gap. The authors see the need for classifying as essential to distinguish small problems from big problems and to implement appropriate countermeasures at the right levels of analysis.

Research methodology

A holistic understanding is considered of high importance to answer the research questions properly, so is the opportunity to ask elaborative queries. According to Creswell (2013), qualitative research gives the opportunity to view phenomena holistically. Thus, this research is conducted according to a qualitative approach. The research was carried out by using one specific case. The case study was conducted according to the methodological approach described by Yin (2014). According to Flyvbjerg (2006, p. 228) “one can often generalise on the basis of a single case, and the case study may be central to scientific development via generalisation as supplement or alternative to other methods”. The case was chosen due to the

complexity the project represented and because the first author had first-hand experience with the project from a summer internship.

As part of the case study, the research was carried out by a literature review and a document study. The literature review was conducted according to the guidelines recommended by Blumberg et al. (2014). The retrieved literature from the review concerns the building process, its different phases and involved actors. In addition, literature on legislation, challenges, consequences, causes and potential countermeasures was investigated. A majority of the literature regarding commissioning had a very technical approach to the topic and was thus not considered as relevant as the literature considering commissioning as an overall quality assurance process running parallel to the ordinary construction process. The documentation studied mainly included the contract of the case and documents regarding the contractor's approach to the Last Planner System®. These documents were chosen due to the need for understanding the basis of the project and the contractor's routines and systems for progress planning.

Nine semi-structured interviews with key actors from the case study were conducted. According to Yin (2014) interview is an important source of information in case studies. Contractor, client, hired project managers and users were among the informants in order to provide an overall picture. Four informants represented the operational level and five the tactical level. In addition, four interviews were conducted with policy makers on a strategic level. The same structure of questions was used in all the interviews. The interview guide can be found in Firing (2015), but unfortunately only in Norwegian. A semi-structured approach was chosen to give the informants an opportunity to elaborate their answers and to ask follow-up questions when necessary. Most of the interviews were registered on tape and later transcribed. In the cases were an informant was not comfortable with recording of the interview, written notes were kept. The transcriptions/reports were sent to the informants for approval. The subjective nature of the interview findings has called for a critical view on suggested consequences, causes and countermeasures.

Findings and discussion

In this section we address and discuss the challenges observed in the study and suggest some potential countermeasures to be implemented on strategic, tactical or operational level respectively. The suggested countermeasures are partly based on the findings from the interviews and partly on findings from the literature. The categorisation is done on the basis of reflections by the authors. Being a pilot study, the findings presented in this paper are not valid for the entire industry, but they clearly indicate that this is a major point of contagion.

The majority of the informants agreed that the level of completion at the date of handover was too low. The most severe delays and defects in the case study concerned the technical systems. This is also the impression from a strategic point of view. This coincides with the findings from the reviewed literature. For instance, on the handover date the fire alarm installations, more specifically the voice alarm, did not work. To handle this problem, the contractor had to use own staff and hire security guards to act as temporary voice alarms. This

lasted for several days and resulted in a huge cost for the temporary solution as well as dispute between the contractor and the client regarding responsibility.

According to several of the informants, the weeks and days prior to the handover, was characterised by chaos and people working everywhere. The tenants experienced delays in the delivery of their premises, e.g. cladding glass and rolling grilles were not installed as agreed. The described situation made it easy for dishonest operators to exploit this to their own advantage; in the final phase there were incidents that included both thefts of goods and equipment, as well as threats to the contractor's employees.

Consequences

The majority of the informants answered that the most severe consequence of a high extent of defects and delays was the unsatisfying quality level on the final product. The client experienced this was not as agreed at the time of handover. This has both an economically as well as a functional and esthetical aspect. The building was not functional in an optimal manner from the start and the ideal level is difficult to reach when it is already in use. Lower quality and thus lower value on the finished building may be the final consequence of this problem. Findings in the literature suggest that use of commissioning gives advantages in the shape of energy savings and fewer systems deficiencies. On this basis it is reasonable to assume that the client will be the losing part in the long run with increased operation and maintenance costs in the future.

Another severe consequence is that the client felt forced to take over a building that, in his opinion, was not finished. Prior to the handover the client was worried concerning the progress and informed the contractor. The response was that everything was under control. Eventually the project passed the "point of no return": There were advertisements about the opening of the shopping centre in the newspaper, on the radio, etc. The client had no choice but opening, even though the quality level was not considered to be satisfactory by the client. According to the standard, the client has a right to refuse handover, but the contractor knows very well that when the client starts using the building, it is, according to the standard, considered taken over. A handover date is determined for a reason. This is a severe consequence in all construction projects having a final and immovable handover date, e.g. schools, shopping centres and hotels.

According to the informants, more resources were necessary to remedy the lag. The result was additional costs for several of the involved actors. The contractor had to hire more workers and use money on necessary overtime. Tenants with contractors from out of town had to buy new traveling tickets and accommodation for their workers. As mentioned above, a probable and severe consequence of delays and defects is higher operations and maintenance costs in the future. Findings in literature also indicate that defects discovered in the aftermath of the handover may lead to additional costs for the client because of improvement works. In addition to increased costs, it is reasonable to assume that more workers may lead to more chaos and thus increased danger for new delays and defects.

The findings imply that unfinished work can result in discussions and disputes regarding responsibility. As described above, the client said that the he was in doubt if he wanted to take

over the building in the first handover because the result, in his eyes, was unsatisfying. Such a serious conflict in the first part of the project may have resulted in a client more stressed and distrustful than he would have been if the first handover went well. One of the informants representing the contractor said that with such a challenging process, no matter what the contractor does, the client will never become fully satisfied with the final product. A possible and severe outcome for the contractor can a bad reputation and that he may not be considered as a relevant collaborator in the future.

A chaotic construction period may contribute to the fact that other, severe tasks are given less priority, for instance documentation of concepts, design and execution. Informants from the strategic level talked about as-built and MOM-documentation (management, operation and maintenance). The challenge is twofold; the quality of the delivered documentation is not good enough or the documentation is not delivered in time (or more typically a combination of the two). Lack of proper documentation and information flow is both a challenge in the transition between different phases of the project and in the handover. One small mistake in the execution of for instance a fire concept may lead to disastrous consequences and proper documentation is thus a necessity. Documentation is also essential for testing and control of technical installations. According to the literature, these documents are supposed to be handed to the client prior to the handover, before testing and controlling start. The findings imply that reality is different.

The contractor emphasised the psychological aspect as a significant consequence of a challenging handover. As a result of time pressure, unforeseen incidents, alteration work and an unsuccessful first handover, members of the staff were driven to the breaking point. The conclusion of the first construction step was the beginning of the next. Members of the staff needed to have a 100 % overview on two highly critical phases at the same time, this probably made it easy to lose track of the important tasks. Staff that should have had all their attention on the preparations of the handover simultaneously prepared the kick-off of the next construction step. According to the literature, as much as 50 % of the defect costs can arise from lack of human engagement, but not intentioned. In other words, the result of high psychological pressure may lead to even more defects.

Causes

When asked about the most crucial contribution to a high extent of delays and defects a majority of the informants answered short construction period and little time available as the main cause. The project was “in a hurry” from day one and several small incidents aggregated to become serious delays. If the carpenter becomes delayed, so does the plumber and electrician. The outcome was chaotic, with many different actors involved, and people working almost everywhere the weeks and days prior to the handover. When work is carried out everywhere, it is easy to lose control regarding the progress. Defects are built into the structure and will never be discovered.

Unexpected structural problems, as an exceptionally challenging ceiling, walls damaged by humidity and poorly executed concrete work also affected the progress negatively. As described above, delays in one special field affects the others. Materials behaving unsatisfying

can be challenging to foresee and hard to avoid, but there is a great potential for learning and to use the knowledge in new projects. It goes without saying that it is almost impossible to improve poorly executed concrete when a building is almost finished. Such work needs to be done immediately, and thus the contractor should accomplish quality assurances straight after execution of the work.

According to the standard, the design-build contractor is responsible for the coordination of the subcontractors. The design-build contractor experienced the collaboration with some of them as demanding at some stages in the process, especially in the final phases. The information regarding a few of the subcontractors' progress was experienced as being directly false. Some gave an impression of full control, while the truth was the opposite. This may be a sign of what the literature denotes as lack of motivation and commitment and lack of trust in the project. In a construction project, the contractor is dependent on the various subcontractors feeling commitment and helping to optimise the overall project. Findings from the literature indicate that project managers may be reluctance to report on performance issues that can cause cost and schedule overruns.

Together with a short construction time, a high extent of alteration work caused additional time pressure. In the end, alteration work surpassed 25 % of the original value of the contract. Despite this fact, the construction period remained the same. The findings indicate that some of the alteration work could be explained by tenants being signed late and thus moving into the centre at a late stage. Such complications are mainly due to market fluctuations, which may be difficult for the project organisation to influence. Tenants signed late are entitled to the same tenant process as those signed early, and this may "steal" important resources from the project organisation in a challenging phase. The contractor stated the rest probably could be traced back to an unsatisfying process regarding the development of the client's requirements as well as late decisions from the client. This emphasises the findings from the literature about the importance of precise and well-formulated client's requirements as a basis for the tender competition. Client engagement and the client's responsibility to clearly communicate the preferred outcome can be crucial to project success.

Both the client and contractor respondents agreed that the causes described above further resulted in an unsatisfying quality assurance process because there was no time left. On-site inspections with representatives from both the client and the contractor prior to the handover were insufficient. In the cases inspections were conducted, emphasis was on esthetical delays/ defects rather than expensive technical systems such as ventilation. A wall with some scratches is not a catastrophe compared to an incomplete ventilation system. This confirms the findings from the literature. As a result, delays and defects that could have been discovered earlier were detected during the very last inspections or not at all. This is also the experience of the policy makers; instead of improving delays and defects continuously, this work is deferred. The experience was the same with testing and control of technical installations. The time allocated to conduct such inspections was insufficient to the need and thus the systems were infested with defects, some not working at all, at the time of handover. The fact that mechanical installation lasted until the handover date, did not contribute to a satisfying quality assurance process.

Another probable cause was diffuse contractual relationships. There were several contractual relationships and lack of consistency between them. There was one main contract between the contractor and the client, regulated by the previous version of NS 8407. At the same time, both the client and the contractor had their own contract with each and every of the tenants. The problems occurred when there was lack of consistency between the contracts the client had with the tenants and the contracts the contractor had with the tenants. The contractor experienced higher expectations from the tenants than what was agreed in the contract, and the tenants experienced not to receive the product they were entitled to according to the contract with the client. The result was a lack of agreement upon quality in the handover, which again led to discussions and unnecessary use of time and resources in an already hectic finishing stage.

In summary, the consequences of delays and defects are severe and the causes are several and typically complex. Our analysis is that delays and defects are not about the handover, but about incidents earlier in the construction. This depreciates the quality of both the product and the process. In other words, delays and defects can be considered as symptoms of the real problems. The causes are not just considered as only operational and possible counter-measures should thus be analysed according to different analytical levels.

Countermeasures

Strategic

As defined in the theoretical framework, the strategic level is represented by policy makers from the construction and property industry. Some of the challenges on this level seem to be that work is supposed to be done without imposing resources at its disposal; it is based on voluntary contributions. Members of the sector board and standardisations committees do not have incentives to prioritise this work. To recruit the most qualified people and ensure commitment through the development process, compensation could be a proper measure.

According to the literature the client has a right to refuse handover if delays/defects are severe and affects the use of the building negatively. The client may also refuse to take over the building if the MOM-documentation is not satisfying. The research findings indicate that this is a paragraph that is difficult to enforce. When building for instance a shopping centre, a hotel or a school, the handover date is final. The consequences for the contractor are minimal compared to those for the client and users. The impression of the authors is that the contractors know about this loophole and sometimes take advantage of it. A countermeasure to avoid this problem from occurring can be to strengthen the opportunity to use day penalties. The contractor should be forced to pay day penalties even if only parts of the building are not finished. This could prevent the contractor from slowing the process and the client from feeling forced to take over a building that is not considered finished. The findings indicate that this can increase the quality level at the date of handover. A revision of the standard contract must be done on the strategic, policy maker level, but a proposed amendment may come from the industry.

The current standard forces the client to take over either the entire or substantial parts of the building. The findings indicate that it is almost utopian to expect that the entire building will

be completed by a certain date. This is also the experience of the authors. An alternative is to make the handover more dynamic. This measure gives the opportunity to make quality assurances continuously and thus discover defects at an earlier stage as well as room for improvement. The case study project was executed and handed over in three consecutive, but separate, steps and the experiences were good. The third step was more successful than the two others. The question is whether the client is willing to take over the responsibility for parts of the building while works are still going on. This measure requires a change in the standard to open for smaller handovers during the project.

A change in the juridical framework to protect the rights of the client may also be an opportunity. The findings imply a mandatory third party control as a premise for issuance of certificate of completion. This suggestion involves a change of legislation and is therefore a comprehensive process, but it will ensure that the building, including its technical systems, performs as expected. The quality level of new construction projects will increase and the extent of delays and defects at the time of handover decrease. Simultaneously it will protect the interests of the client so that he will receive the quality he has paid for and prevent him from taking over a product that is not satisfying. An alternative is that the contractors do this voluntary.

Tactical

In the pre-design phase, the client and the contractor must cooperate to develop realistic project plans, including preparation of contracts and client's requirements. The client is considered as responsible for several of these countermeasures and they are thus located on the tactical level.

The challenges previously described imply a need for professionally developed client's requirements and specifications. This must be done prior to the design phase in order for the requirements to be taken into consideration from the very beginning. Late changes typically result in expensive and unnecessary alteration work; the case study is a good example of this. This countermeasure may also contribute to a more satisfying quality level because both the design and construction phases are allowed to focus on doing the work right the first time rather than implementing and planning alteration work. The client is responsible for the development of the requirements and the countermeasure must thus be implemented on a tactical level.

In relation to the contract the findings further imply that the construction period should be thoroughly considered. In this case, the construction period seems to have been too short and this resulted in a challenging execution phase. Several small delays have a tendency to accumulate and the findings from the case study indicate a need for an extended construction period, especially when the degree of alteration work increases.

As this is a shopping centre, there are several contracting parties; client, contractor and tenants, each having its own agenda. To avoid misunderstandings and conflicts, it is crucial to clarify the roles and responsibilities of each actor and to ensure consistency between the different contracts. Conflicts steal time and resources from other important tasks and should be avoided as far as possible. A professional juridical process on development of the contracts

may be appropriate to ensure consistency. By considering this from the very start, the client may contribute to create a better framework for cooperation and prevent potential conflicts and disputes. Contract type and development of the contract is considered as a tactical decision. This is why this countermeasure belongs to this level of analysis.

To handle the challenge regarding an unsatisfying quality level and high extent of delays and defects, the findings indicate a need for making inspections prior to the handover. The inspections can be conducted in cooperation with the contractor and the tenants. The contractor will most likely arrange internal inspections, but that is not considered by the authors as sufficient. By performing inspections together with the other contracting parties, delays and defects can be discovered and repaired in time. By initiating inspections the client shows commitment to the final result and takes responsibility at the same time, thereby lifting the quality assurance up to a tactical level.

To make sure the product meet the client's expectations, both the findings and the reviewed literature suggest building commissioning as a possible measure. This includes more time to preform tests and inspections of technical systems, as well as training of operate and maintenance personnel. According to the literature, building commissioning is a proper measure to prepare the building for handover, make sure it meets the requirement of the client and increase the quality of the final product. A professional commissioning coordinator can be hired to lead the process. Coordinator or not, the use of building commissioning places demands on both the client and contractor throughout the whole project. Whether to use commissioning or not is up to the client and thus a tactical decision. Building commissioning can be expensive, but the potential advantages are several. The client can for instance require or encourage the contractor to use the new Norwegian standard as a framework to conduct commissioning in the project. Findings indicate that to become a success, the importance of commissioning must be deeply rooted in the organisations of both the client and the contractor.

Operational

Control on deliveries is a premise for a successful handover, especially when the construction period is short. To avoid work "everywhere" in the building at the same time, the findings suggest that the progress plan should be viewed in connection with a distinct production strategy. What to produce, who, where and when. With so many actors involved, the findings emphasise the importance of thinking about logistics when making a production strategy. In other words, begin the works in one end and work one's way through the construction. This is a way to retain the control and a production strategy may contribute to higher productivity and the avoidance of additional costs as a consequence of the need for extra resources. It is also a measure which facilitates inspections continuously to discover delays and defects prior to handover. The key is to discover delays and defects as early as possible, so that the costs to improve the works can be kept low. To deliver the building in accordance with time, budget and quality is the responsibility of the contractor and the measure thus belong on the operational level.

The findings imply that there is too much emphasis on "end milestones", for instance the final handover of the building from the contractor to the client. The experience of the informants is that all activities at least use the allotted time. If the groundwork delayed by two weeks, it is extremely hard, almost impossible, to remedy the lag as the project moves toward handover. Emphasis on "end milestones" seem thus not to be sufficient. In addition to the already known and approved milestones, the contractor organisation can introduce other important milestones in the progress plans, for instance "start milestones". Activities starting on the planned date are more likely to be completed in time. As found in the literature, a delay in the installation of technical systems will affect and shorten the available time to use for start-up, testing, balancing and seasonal testing. A worst case scenario, as in the case study, is if there is no time available at all. The findings from the interviews argue that milestones should be critical dates that indicate the status of the project from the very start. Such dates can for instance be start-up installation, start-up control and balancing, etc. The use of milestones can be a way to illustrate the consequences of not being finished in time; by retarding the start-up of an activity, you simultaneously delay the completion date.

Sufficient resources are considered as crucial to be able to keep the control throughout the whole project, especially when the construction period is short. Lack of resources, both in the project organisation and among the craftsmen, contributes to uncertainty and chaos. Delays and thus additional costs to remedy the lag may be the consequence. Simultaneously there will be an extra pressure on already overworked people. When the scope of a project increases, for instance when the extent of alteration work exceeds the frame agreed upon, the contractor must increase the project staffing. The findings from the literature indicate that the more people have to do, the higher the chance for mistakes. Further, the findings imply that additional resources are not enough. To make the execution productive, each and every actor in the contractor organisation must know his role and area of responsibility. It is especially important to cover the interfaces between the different areas to make sure nothing falls between two stools. This measure may also contribute to better collaboration with the client, subcontractors and tenants, as the areas of responsibility are stated and communicated to the surroundings.

To increase the productivity a possible countermeasure can be to make people "experts". An example from the case study is the challenging ceiling. By using the same craftsmen to produce the whole ceiling, the contractor in the case study experienced that the productivity on this task increased. However, repetitive work has both advantages and disadvantages. Strain on muscles and joints, and a possible lack of motivation among the craftsmen must be taken into consideration.

To make sure the project reaches its milestones, the findings from the interviews argue that cooperation with the subcontractors is a success criterion. The experience from the case study was an unsatisfying subcontractor progress. This was discovered too late and indicates a need for continuous dialogue and inspection of the subcontractors. It is crucial to ensure commitment among the subcontractors and highlight the importance of optimising the entire project rather than parts of it. By establishing a god project environment and involve them in the progress planning, the contractor gives the subcontractors a sense of obligation and

commitment. The design build contractor may further attain that the sub contractors' project managers are honest about their performance. Simultaneously the design build contractor should have people in the organisation with subcontractors as their area of responsibility. This job includes frequent dialogue, follow-up on progress, inspections and the collection of MOM and as-built documentation. The experience of the informants is that this documentation is either handed in too late or not at all. Simultaneously the quality of the documentation is often proven to be unsatisfying. By making one or several people responsible for the subcontractors, it is more likely that documentation is delivered in time and with the right quality.

Both the literature and the findings suggest the use of independent control as a countermeasure to ensure the product meets the expectations. The inspections should be conducted by a professional third-party representative, emphasise on the functionality of the technical systems and the integration of them. This countermeasure presupposes a well-functioning project organisation, unless the independent control will only become a contribution to more chaos. As discussed earlier, such an arrangement can either be voluntary or mandatory. The authors consider measures based on voluntariness as more preferable than those based on coercion and imposition.

To ensure a thorough and professional quality assurance process, the findings indicate a need for subject-specific pre-inspections conducted prior to the handover. This was done before the handover of the third construction step in the case study and worked out very well. This can both be considered as a way to assign responsibility to the subcontractors and a way to move the attention from visible and cheap delays and defects to expensive system delays and defects. This is a measure to distinguish small problems from big problems. The process becomes better because subject-specific inspections give the opportunity to involve professionals on that specific subject, rather than one project manager inspecting the whole building.

Conclusion

Based on the findings in the previous sections, the conclusion is presented in Table 1. The table classifies countermeasures to prevent delays and defects, and at what level these measures should be implemented. The table can be used to distinguish small problems from big problems. The different countermeasures are categorised according to what is evaluated by the authors as the most appropriate level to implement them. Hereby, Table 1 contributes to fill the knowledge gap identified in the theoretical framework.

Table 1 The matrix shows the consequences and causes of delays and defects together with countermeasures to avoid them from appearing in the handover.

Level of analysis	Consequences of delays and defects	Causes of delays and defects	Countermeasures to prevent delays and defects
Strategic (Policy makers)	Forced handover	Lack of commitment by policy makers	Provide compensation for policy makers
	Unsatisfying quality level on the product	Loophole in the standard contract	Modify standard contract to give the opportunity to use day penalties and more dynamic handovers
		Provision in the standard contract regarding handover of the entire contract work	Third-party control (mandatory)
Tactical (Client)	Additional costs	Alteration work	Requirement specification/client's requirements and make decisions in time
	Discussions and disputes in the process	Diffuse contractual relationships	Preparation of contracts and clarification of roles: Client – contractor – tenants
	Unsatisfying quality level on the product	Short construction period	Building commissioning, e.g. use the new Norwegian standard
		Lack of quality assurance	
Operational (Contractor)	Additional costs	Unsatisfying quality assurance	Production strategy
	Lack of proper documentation	Short construction period	Active use of milestones
	Psychological pressure	Unexpected structural problems	Enough resources
	Discussions and disputes	Collaboration/control of subcontractor	Clarification of roles (internally)
	Unsatisfying quality level on the product	Alteration work	Experts in execution
			Subcontractor responsible
			Third-party control (voluntary)
			Subject-specific pre-inspections

As seen in Table 1, the consequences of delays and defects are severe and the causes are many and highly complex. Delays and defects are just symptoms of routines and incidents going wrong prior to the handover and not just on an operational level. This diminishes the value of both the product and the process. Countermeasures should be implemented on all levels to avoid the problems from occurring. The findings indicate that guidelines and routines already exists but are not being followed. A key is to avoid delays from the very start and to ensure quality in all processes during the project. If delays and defects are discovered early, or preferably, entirely avoided, this will help to improve the quality of the building that is handed over, too.

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DEL 3 Vedlegg

Vedlegg A Casebeskrivelse

Casen som blir benyttet i dette fordypningsprosjektet, er en omfattende utvidelse av kjøpesenteret City Lade i Trondheim. Byggeperioden var fra februar 2012 til oktober 2014, og prosjektet ble utført i tre ulike byggetrinn. Bilder fra før og etter utvidelsen kan ses i Figur A-1 og A-2. Prosjekteier var Trondos SA, Norges nest største samvirkelag. Utvidelsen ble gjennomført som en totalentreprise etter samhandling, med Veidekke Entreprenør AS som totalentreprenør. Optiman AS ledet byggeprosessen på vegne av prosjekteier. Kontraktssummen var opprinnelig satt til 341 millioner og endte til slutt på ca. 465 millioner eks. mva. Dette inkluderer tillegg og endringer som har kommet underveis i prosessen.

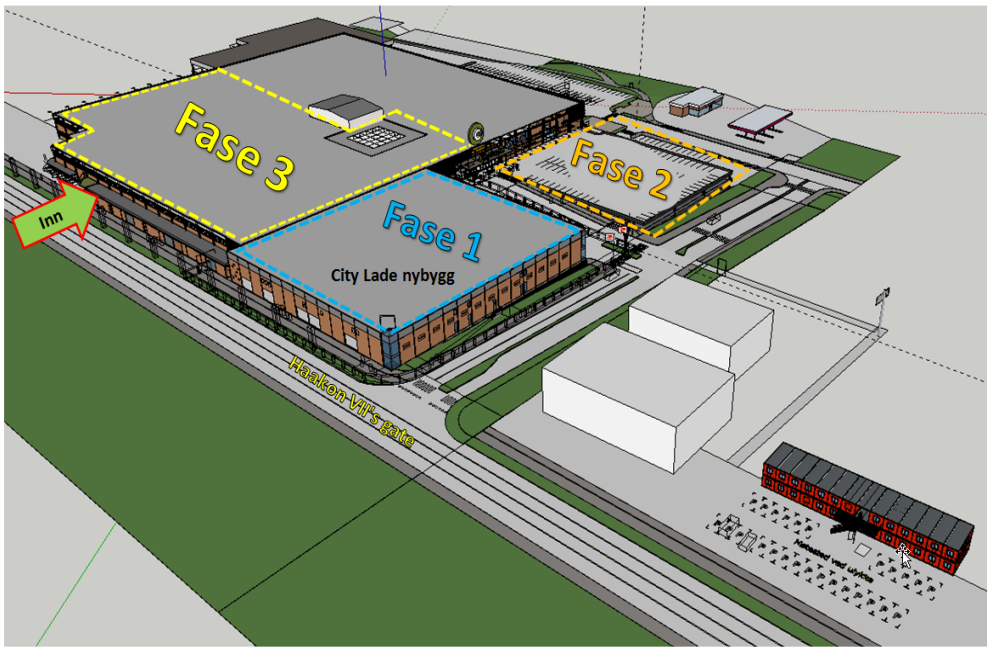
Figur A-1 City Lade før utvidelsen.

Figur A-2 Oversiktsbilde av det planlagte City Lade etter ferdigstilt utbygging (ARC Arkitekter, 2012).

A.1 Prosjektet byggetrinn for byggetrinn

- Byggetrinn 1 (fase 1): Nybygg med rom for i overkant av 20 nye butikklokaler. Foregikk fra februar 2012 til august 2013. Den nye delen skulle kobles til den gamle.
- Byggetrinn 2 (fase 2): Utbygging av parkeringshus. Foregikk fra august 2012 til februar 2013.
- Byggetrinn 3 (fase 3): Ombygging og innredning av eksisterende innvendige arealer. Rom for ca. 40 nye butikklokaler og ombygging av noen gamle. Foregikk fra september 2013 til oktober 2014.

Totalt ble det bygget 18 000 m^2 nytt handelsareal og fellesareal, 6000 m^2 eksisterende areal ble bygget om og renovert, i tillegg ble det bygget 20 000 m^2 nytt parkeringsareal. I Figur A-3 er de tre byggetrinnene markert.



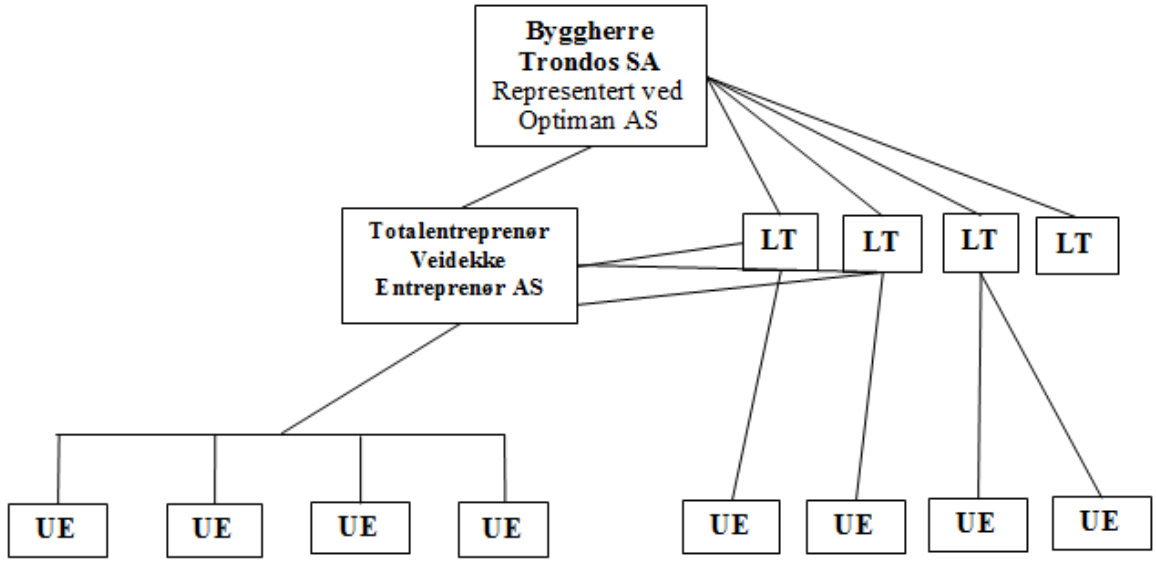
Figur A-3 Oversiktsbilde av prosjektets tre byggetrinn (ARC Arkitekter, 2012).

A.2 Kontraktsmessig organisering

Veidekke og Trondos hadde kontrakt vedrørende utvidelsen av City Lade. Trondos hadde kontrakt med Optiman AS om kjøp av byggherretjenester. Leietakerne som skulle inn i de nye lokalene hadde kontrakter med både prosjekteier Trondos og totalentreprenør Veidekke. Firmaet NCM Development arbeidet for å rekruttere leietakere til senteret på vegne av prosjekteier Trondos. En skisse av prosjektets kontraktsmessige organisering kan ses i Figur A-4.

I praksis var hver leietaker sin egen byggherre. Leietakerne måtte forholde seg til Trondos som prosjekteier og utleier, og Veidekke som totalentreprenør. Kontrakten med Trondos var en standard leiekontrakt, mens kontrakten med Veidekke tok for seg utførelse av obligatoriske arbeider som var forhåndsbestemt for alle lokaler i henhold til et standard vedlegg til kontrakten (skillevegger, glass, rullegitter, tekniske installasjoner). Leietaker stod fritt til å bestille tilleggsarbeider dersom det var behov, forutsatt enighet med Veidekke om pris og grensesnitt. Kontakten med Veidekkes underentreprenører gikk hovedsakelig via Veidekke.

Idet lokalene ble overtatt av sine respektive leietakere, stod de fritt til å bruke egne underentreprenører til de resterende arbeidene.



Figur A-4 Skisse av prosjektets kontraktsmessige organisering. LT = leietaker, UE = underentreprenør.

Vedlegg B Intervjuguide

B.1 Introduksjon

Mitt navn er Martine Firing, jeg er masterstudent ved bygg- og miljøteknikk ved NTNU. Jeg har jobbet på prosjektet City Lade for Veidekke Entreprenør sommeren 2013 og 2014, men skriver denne oppgaven på vegne av Institutt for bygg, anlegg og transport ved NTNU. Oppgaven er case-spesifikt og jeg er interessert i alle tre byggetrinnene av utbyggingen av City Lade.

Gevinstene av å gjøre overtakelsene av store, komplekse byggeprosjekter mer smidige kan være store for alle deltakende aktører i et prosjekt. Det er gjort lite forskning på området og den overordnede problemstillingen for denne masteroppgaven er derfor:

Hvordan oppnå økt suksess i overtakelsen av byggeprosjekter?

Med forskningsspørsmålene:

1. *Hvilke problemer oppstår i overtakelsen?*
2. *Hvilke konsekvenser følger av problemene?*
3. *Hva er årsakene til problemene?*
4. *Hvilke faser av prosjektet stammer problemene fra?*
5. *Hvilke tiltak kan settes inn for å øke suksessen i overtakelsen?*

Målet er å utvikle en liste med tiltak for å unngå problemer i overtakelsen. Problemer og konsekvenser var hovedfokus i prosjektoppgaven, mens årsaker, faser og tiltak er tema for masteroppgaven.

Prosedyre for intervju

- Det gjøres opptak av intervjuet hvis det er i orden for informant.
- Jeg skriver et referat i etterkant, så ordrett som mulig, og sender dette til informant for godkjenning.
- Åpenhet/anonymitet.

Bakgrunnsinformasjon om informant

Navn:

Stilling:

Rolle i prosjekt (hvor lenge har du jobbet med prosjektet?)

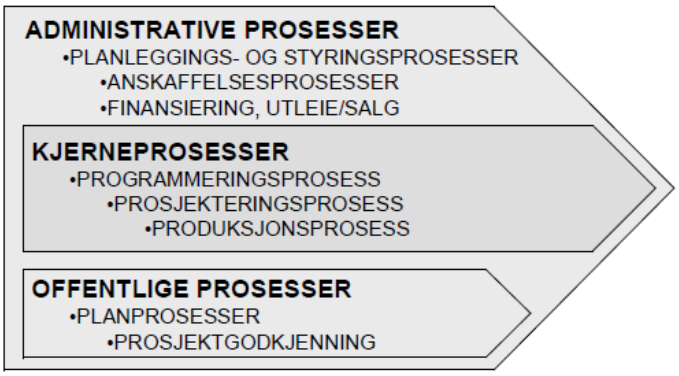
B.2 Spørsmål

1. *Hvilke problemer oppstår i overtakelsen?*
   1.1. Hvilke problemer har oppstått i forbindelse med de tre overtakelsene?
   1.2. Har samme problemer gjentatt seg i flere av overtakelsene?
   1.3. På hvilken måte mener du det har blitt tatt lærdom fra byggetrinn til byggetrinn?
   1.4. Forutså du på noe tidspunkt disse problemene?
   1.5. Hva mener du har vært det mest utfordrende med prosjektet City Lade?
   1.6. Hva mener du fungerte bra? (Problemer du har opplevd på andre prosjekter, men som gikk bra her).

2. *Hvilke konsekvenser følger av problemene? (F.eks. med tanke på økonomi, funksjonalitet, fremdrift).*
   2.1. Kan du for hvert av problemene du nevnte i spørsmål 1.1 utdype konsekvensene som fulgte av problemene?

3. *Hva er årsakene til problemene? (F.eks. brukermedvirkning, endringer, forsinkelser, rammebetingelser, tvister, etc.)*
   3.1. For hvert av problemene i spørsmål 1.1, kan du si noe om årsakene og hva som kunne vært gjort for å forhindre at disse problemene oppstod?
   3.2. Hvilke etiske utfordringer møtte du/dere under overleveringsfasen?
   3.3. Opplevde du/dere at aktører utnyttet aspekter ved overleveringsfasen? (kaos på slutten etc., frist som byggherre må overholde etc.,)

4. *Hvilke faser problemene mener du at problemene fra spørsmål 1.1 stammer fra?*



Figur B-1 Byggeprosessens delprosesser (Eikeland, 1999).

5. *Hvilke tiltak mener du kunne vært satt i gang for å unngå at de nevnte problemene i 1.1 oppstod?*

Er det noe du vil legge til?

Er du tilgjengelig for ev. flere spørsmål senere hvis det er noe mer jeg kommer på?